MAHARAJA INSTITUTE OF TECHNOLOGY MYSORE

Autonomous Institution Affiliated to VTU

Competency Based Syllabus (CBS)

for

Computer Science and Engineering (CS&E)

(Under Outcome Based Education (OBE) and

Choice-Based Credit System (CBCS))

Offered from 1st to 2nd Semesters of Study

in

Partial Fulfilment for the Award of Master's Degree in

Computer Science and Engineering (CS&E)

2023 Scheme

Board: CS

Scheme Effective from the academic year 2023-24

1st Semester	Basic Science Course (BS) **Advance Mathematics for Emerging Trends**	M23MCS101

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Vector Spaces	Linear Algebra: Basic understanding of matrices, determinants, and systems of linear equations. Calculus: Knowledge of differentiation and integration to understand vector functions. Mathematical Maturity: Ability to comprehend abstract concepts and proofs.
2	Orthogonality and Least Squares	Linear Algebra: Familiarity with matrix operations, inner products, and orthogonal projections. Statistics: Basic understanding of statistical methods and regression analysis. Programming Skills: Ability to implement least squares algorithms in a programming language like Python or MATLAB.
3	Eigenvalues and Eigenvectors	Linear Algebra: In-depth knowledge of matrix theory, including determinants, trace, and characteristic equations. Differential Equations: Basic understanding of differential equations where eigen values and eigenvectors are applied. Numerical Methods: Basic exposure to numerical techniques for solving Eigen value problems.
4	Sampling Theory	Probability and Statistics: Strong foundation in probability theory, random variables, and distributions. Discrete Mathematics: Understanding of combinatorics and basic set theory. Data Analysis: Familiarity with data collection methods and statistical analysis techniques.
5	Numerical Methods	Calculus: Comprehensive understanding of single and multivariable calculus. Linear Algebra: Proficiency in matrix operations and solving linear systems. Programming Skills: Ability to write code for numerical algorithms in languages like Python, MATLAB, or C++. Algorithm Design and Analysis: Basic understanding of algorithm complexity and efficiency.
6	Previous Coursework	Completion of introductory courses in Mathematics or a related field.

2. Competencies

S/L	Competency	KSA Description
1.	**Vector space**	**Knowledge:** • Understanding the definition and properties of vector spaces. • Familiarity with subspaces, bases, and dimensions. • Grasping the concepts of linear combinations, span, and linear independence. **Skills:** • Ability to perform vector operations and transformations. • Applying vector space concepts to solve problems in computer graphics and machine learning. • Developing algorithms that leverage vector space properties for data representation and manipulation. **Attitude:** • Precision in mathematical reasoning and attention to detail. • Appreciation for the abstraction and elegance of vector spaces. • Openness to exploring advanced topics such as functional

		spaces in quantum computing.
2.	**Orthogonality and Least Squares**	**Knowledge:** • Comprehending orthogonal vectors, orthogonal complements, and orthonormal bases. • Understanding least squares approximation and its applications. • Familiarity with QR decomposition and its role in solving least squares problems. **Skills:** • Implementing orthogonalization techniques like Gram-Schmidt. • Solving least squares problems using numerical methods. • Applying orthogonality principles in signal processing and machine learning (e.g., regression analysis). **Attitude:** • Analytical thinking to dissect complex problems into solvable components. • Persistence in iterative problem-solving approaches. • Collaboration with others to verify and validate solutions.
3.	**Eigen values and Eigen vectors**	**Knowledge:** • Understanding the concepts of Eigen values and eigenvectors. • Grasping the spectral theorem and its implications. • Familiarity with diagonalization and its applications in systems of linear equations. **Skills:** • Computing Eigen values and eigenvectors for various matrices. • Applying Eigen value decomposition in dimensionality reduction techniques like PCA. • Utilizing Eigen values and eigenvectors in stability analysis and differential equations. **Attitude:** • Curiosity about the theoretical foundations of algorithms. • Meticulous approach to deriving and verifying results. • Enthusiasm for learning advanced applications in data science and network analysis.
4.	**Sampling Theory**	**Knowledge:** • Understanding the principles of random sampling and sampling distributions. • Grasping the concept of the Nyquist-Shannon sampling theorem. • Familiarity with various sampling techniques (e.g., stratified, systematic). **Skills:** • Designing and implementing sampling methods for data collection and analysis. • Applying sampling techniques in big data contexts to enhance efficiency. • Utilizing sampling theory in Monte Carlo simulations and signal processing. **Attitude:** • Critical thinking in evaluating sampling methods and their applicability. • Awareness of biases and errors introduced by improper sampling.

		• Proactiveness in staying updated with emerging sampling techniques and technologies.
5.	**Numerical Methods**	**Knowledge:** • Understanding numerical approximation methods for solving mathematical problems. • Familiarity with numerical linear algebra, interpolation, differentiation, and integration. • Knowledge of iterative methods for solving nonlinear equations and systems. **Skills:** • Implementing numerical algorithms for root-finding, optimization, and matrix operations. • Applying numerical methods to simulate real-world phenomena in scientific computing. • Utilizing numerical techniques in solving large-scale computational problems. **Attitude:** • Precision in implementing and testing numerical algorithms. • Resilience in dealing with convergence issues and computational errors. • Commitment to continuous learning and improvement in numerical methodologies.

3. Syllabus

Advance Mathematics for Emerging Trends			
Course Code	**M23MCS101**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course objectives: This course will enable students to: 1. Ability to analyse the solution& examine its stability in operator theory. 2. Ability to optimize & solve real life problems. 3. Ability to solve image processing & signal processing problems 4. Develop the knowledge of Linear Algebra to solve the system of equations.			
Module-1			
Vector Spaces: Vector spaces; subspaces Linearly independent and dependent vectors Basis and dimension; co ordinate vectors-Illustrative examples. **Linear trans formations,** Representation of Transformations by matrices.			
Module -2			
Orthogonality and least squares: Inner product, orthogonal sets, orthogonal projections, orthogonal bases. Gram Schmidt orthogonalization process. QR factorizations of a matrices, least square problems, applications to linear models (least square lines and least square fitting of other curves).			
Module -3			
Eigen values and Eigenvectors, orthogonal diagonalization, Singular value decomposition, applications to image processing and statistics, Principal Component Analysis, Differential Equations.			
Module -4			
Sampling theory: testing of hypothesis by t-test, χ^2 test, F-test., Analysis of Variance (ANOVA): one way classification.			
-Module -5			
Numerical Methods: Eigen values of real symmetric Matrices-Givens method and Householder's method. Roots of polynomial equations-Birge-Vieta method and Bairstow's method			
Suggested Learning Resources: **Text Books**			

1. David C. Lay, Steven R. Layand J. J. McDonald, "Linear Algebra and its Applications", Pearson Education Ltd, 5th Edition 2015.
2. Dr. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 42nd edition, 2012.

References Books

1. Kreyzig, "Advanced Engineering Mathematics".
2. R.E, Walpole, R. H. Myres, S .L. Myres and Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson, 2012.
3. T. Veerarajan, Probability, Statistics and Random Process Tata Mc-Graw Hill Co 3rdEdition 2016
4. M K Jain, R. K. Jain, S. R. K. Iyengar, Numerical methods for scientific and engineering New Age International Publishers, Sixth Edition.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Vector Spaces	Vector Spaces: Introduction, Vector spaces; subspaces, Problems, Linearly independent and dependent vectors Basis and dimension; Co-ordinate vectors-Illustrative examples. Linear transformations, Representation of Transformations by matrices
2	Week 3-4: Orthogonality and leastsquares	Orthogonality and least squares: Introduction, Inner product, orthogonal set, Problems, orthogonal projections, orthogonal bases. Gram Schmid orthogonalization process, QR factorizations of a matrices, Least square problems, applications to linear models
3	Week 5-6: Eigen values and Eigenvectors	Eigen values and Eigenvectors- Problems Orthogonal diagonalization-Problems Singular value decompositionProblems Applications to image processing and statistics Principal Component Analysis, Problems Differential Equations.
4	Week 7-8: Sampling theory	Sampling theory: Introduction, Testing of hypothesis by t-test**,** Problems**,** χ^2 test- Problems**,** F-test- Problems**,** Problems**,** Analysis of Variance (ANOVA): one way classification. Problems
5	Week 9-10: Numerical Methods	Eigen values of real symmetric matrices-Given'smethod, Problem Householder's method., Problems, Roots of polynomial equations-Birge-Vieta method Problems, Bairstow's method, Problems
6	Week 11-12: Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Mathematical concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies

6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Note:

Theory Course with 3 Credits: Basic Science Course(BS)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Basic Science Course(BS)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Vector Spaces, Sampling & Numerical Methods	Students will grasp concepts of linear independence, basis, and dimension to analyze and manipulate data in high-dimensional spaces .Also principles of selecting representative data subsets to infer properties of the entire population. Understanding Numerical Methods requires knowledge of computational techniques to approximate solutions for complex mathematical problems that cannot be solved analytically.
2	Designing Vector Spaces, Sampling & Numerical Methods	Students will able to involves in creating structured, high-dimensional spaces to facilitate efficient data representation and manipulation. Designing Sampling and Numerical Methods entails developing robust statistical and computational algorithms to accurately capture data characteristics and solve mathematical problems effectively.
3	Proficiency in Sampling & Numerical Methods	Students will become proficient in understanding and applying statistical techniques to accurately represent and analyze large datasets and entails developing and implementing algorithms to solve mathematical problems efficiently and accurately using computational techniques.

4	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Course Outcomes (COs)
M23MCS101.1	Demonstrate knowledge and understanding of the underlying concepts of Vector space, Sampling theory
M23MCS101.2	Demonstrate knowledge of the mathematical concepts and computational aspects of linear algebra and Numerical methods
M23MCS101.3	Analyze domain related engineering problems and develop analytical problem solving approach making use of the theoretical concepts

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3
M23MCS101.1			**3**
M23MCS101.2			**3**
M23MCS101.3	**2**		
M23MCS101	**2**	**-**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Module 1	**06**			**06**
Module 2		**06**		**06**
Module 3	**06**		**07**	**13**
Module 4		**06**	**07**	**13**
Module 5	**06**	**06**		**12**
Total	**18**	**18**	**14**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Module 1	**20**			**20**
Module 2		**20**		**20**
Module 3			**20**	**20**
Module 4		**15**		**15**
Module 5	**15**		**10**	**25**
Total	**35**	**35**	**30**	**100**

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The " **Advance Mathematics for Emerging Trends** "course in the first semester of the MTech program has strong foundation for several future courses in the Postgraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of computer science. Here are some notable contributions:

Vector Spaces

Future Prospects and Applications:

1. **Machine Learning and Data Analysis**: Vector spaces are crucial in machine learning, especially in the representation of data. Techniques like word embeddings in natural language processing (NLP) and feature vectors in image processing rely on vector spaces.
2. **Quantum Computing**: Quantum states are represented in vector spaces. As quantum computing advances, understanding vector spaces becomes increasingly important for developing quantum algorithms.
3. **Robotics and Computer Vision**: Vector spaces facilitate the representation of spatial information and transformations, crucial for navigation and object recognition in robotics and computer vision.

Orthogonality and Least Squares

Future Prospects and Applications:

1. **Optimization Algorithms**: Least squares methods are fundamental in optimization problems, which are central to machine learning, operations research, and econometrics.
2. **Signal Processing**: Orthogonality is a key concept in signal processing, particularly in decomposing signals into orthogonal components, which is important for noise reduction and data compression.
3. **Data Fitting and Regression Analysis**: Least squares methods are extensively used in fitting models to data, which is critical in predictive analytics and statistical modeling.

Eigen values and Eigenvectors

Future Prospects and Applications:

1. **Principal Component Analysis (PCA)**: PCA is a dimensionality reduction technique that uses eigenvalues and eigenvectors. It is widely used in data science to reduce the complexity of data while preserving essential features.
2. **Graph Theory and Network Analysis**: Eigenvalues and eigenvectors play a role in analyzing the properties of graphs and networks, which is important in understanding social networks, communication networks, and biological networks.
3. **Stability Analysis**: In control systems and differential equations, eigenvalues are used to analyze the stability of systems, which is critical in engineering and scientific applications.

Sampling Theory

Future Prospects and Applications:

1. **Big Data**: Efficient sampling methods are essential for handling large datasets, allowing for the extraction of meaningful insights without processing all the data.
2. **Monte Carlo Methods**: These methods rely on sampling to solve problems in various fields such as finance, physics, and computational biology.
3. **Signal and Image Processing**: Sampling theory is fundamental in converting continuous signals into discrete ones, which is crucial in digital signal processing and image processing.

Numerical Methods

Future Prospects and Applications:

1. **Scientific Computing**: Numerical methods are the backbone of simulations in physics, chemistry, and engineering, enabling the solution of complex differential equations and optimization problems.
2. **Computer Graphics**: Techniques like numerical integration and solving systems of equations are vital in rendering graphics, simulations, and animations.
3. **Cryptography**: Numerical methods are used in various cryptographic algorithms and for solving problems related to number theory, which is essential for secure communication.

Integrative Applications in Computer Science Engineering:

1. **Artificial Intelligence (AI) and Machine Learning**: The mathematical concepts of vector spaces, least squares, eigen values, and numerical methods are deeply integrated into machine learning algorithms, data pre-processing, and model optimization.

2. **Algorithm Development**: Efficient algorithms often rely on numerical methods for performance optimization, including those used in real-time systems and large-scale computations.
3. **Computational Biology**: Eigen values and numerical methods are used in the analysis of biological data, modelling biological processes, and understanding genetic information.

   Understanding these topics not only provides a strong mathematical foundation but also enhances one's ability to develop and implement sophisticated algorithms and models in computer science engineering. The future of these fields looks promising with continuous advancements and new applications emerging in various interdisciplinary areas.

1stSemester	Professional Core Course (IPC) **Essentials of Data Science**	M23MCS102

1. Prerequisites

Sl NO	Proficiency	Description
1	**Programming Fundamentals**	Familiarity with at least one programming language (preferably Python or R), including concepts such as data structures, control flow, and functions.
2	**Statistics and Probability**	Understanding of basic statistical concepts, including descriptive statistics, probability distributions, hypothesis testing, and inferential statistics.
3	**Linear Algebra**	Knowledge of matrix operations, vectors, and linear transformations, as these concepts are essential for many data science techniques
4	**Calculus**	Familiarity with concepts like derivatives and optimization, which are used in various machine learning algorithms and optimization techniques. To fully benefit from this course, students should have a basic foundation in the following areas
5	**Programming Fundamentals**	Familiarity with at least one programming language (preferably Python or R), including concepts such as data structures, control flow, and functions
6	**Statistics and Probability**	Understanding of basic statistical concepts, including descriptive statistics, probability distributions, hypothesis testing, and inferential statistics.
7	**Linear Algebra**	Knowledge of matrix operations, vectors, and linear transformations, as these concepts are essential for many data science techniques.
8	**Calculus**	Familiarity with concepts like derivatives and optimization, which are used in various machine learning algorithms and optimization techniques.

2. Competencies

Sl NO	Competency	Description
1	**Data Science Fundamentals**	• **Knowledge:** Comprehensive understanding of data science principles, the data science lifecycle, and the role of data science in various domains. • **Skills:** Ability to identify and articulate data science problems, evaluate the suitability of data science solutions, and communicate effectively with stakeholders. • **Attitudes:** Appreciation for the ethical considerations and societal impacts of data science, and a commitment to responsible data practices.
2	**Exploratory Data Analysis (EDA)**	• **Knowledge:** In-depth understanding of EDA techniques, including data visualization, summary statistics, and hypothesis testing. • **Skills:** Proficiency in using statistical programming languages (e.g., R) and data visualization libraries (e.g., ggplot2, matplotlib) to explore and analyze data. • **Attitudes:** Curiosity and willingness to explore data from multiple perspectives, and a critical mindset to identify potential biases or limitations.
3	**Machine Learning Algorithms**	• **Knowledge:** Thorough understanding of supervised and unsupervised machine learning algorithms, their underlying mathematical foundations, and their strengths and limitations. • **Skills:** Ability to implement and evaluate machine learning models using programming languages (e.g., Python, R) and libraries (e.g., scikit-learn, TensorFlow, Keras).

		• **Attitudes:** Openness to experiment with different algorithms and techniques, and a commitment to continuously learning and adapting to new developments in the field.
4	**Feature Engineering and Selection**	• **Knowledge:** Understanding of feature engineering techniques, including feature generation, encoding, scaling, and selection methods. • **Skills:** Ability to apply feature engineering techniques to extract relevant and informative features from raw data, and to select appropriate feature subsets for model training. • **Attitudes:** Creativity and domain expertise to identify and engineer meaningful features, and a data-driven approach to feature selection.
5	**Data Engineering and Visualization**	• **Knowledge:** Understanding of data engineering concepts, such as distributed computing frameworks (e.g., Hadoop, Spark), and data visualization principles and best practices. • **Skills:** Ability to process and analyze large-scale data using distributed computing techniques, and to create effective and informative data visualizations using tools like D3.js, Tableau, or Power BI. • **Attitudes**: Appreciation for the importance of scalable data processing and clear communication of insights through visualizations
6	**Social Network Analysis**	• **Knowledge:** Understanding of social network analysis concepts, including graph theory, centrality measures, community detection algorithms, and network modeling techniques. • **Skills:** Ability to represent and analyze social network data using graph analysis libraries (e.g., NetworkX, igraph) and techniques like node embedding and graph neural networks • **Attitudes:** Curiosity about the underlying patterns and dynamics of social networks, and an appreciation for the ethical considerations in analyzing social data.

3. Syllabus

Essentials of Data Science SEMESTER-I			
Course Code	**M23MCS102**	**CIE Marks**	50
Teaching Hours/Week(L:P:SDA)	3:0:2:0	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	04	**Exam Hours**	03
Course objectives: • Programming data science concepts and Big Data, modelling using R language. • Analyze Basic tools of EDA, Data science process with case studies and Different algorithms. • Optimize & solve real life problems with different spam filter. • Explore Feature Generation and Feature Selection.			
Teaching- Learning Process: Chalk and talk method/Power Point Presentation			
Module-1			
Introduction: What is Data Science? Big Data and Data Science hype – and getting past the hype, Why now? – Datafication, Current landscape of perspectives, A data Science Profile, Skill sets. Statistical Inference, Populations and samples, Big Data, new kinds of data, modelling, statistical modelling probability distributions, fitting a model, -Introduction to R			
Module-2			

Exploratory Data Analysis and the Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The Data Science Process, Case Study: RealDirect (online real estate firm). Algorithms, machine Learning Algorithms, Three Basic Algorithms: Linear Regression, k-Nearest Neighbours (kNN), k-means, R Programs for the algorithms

Module-3

Spam Filter, Linear Regression and Spam Filter, K-NN and spam Filter,, Naïve Bayes Algorithm, Spam Filter using Naïve Bayes, Laplace Smoothing,, Comparing Naïve Bayes to K-NN, Scraping the Web, introduction to Logical Regression and M6D case study.

Module-4

Feature Generation and Feature Selection (Extracting Meaning from Data): Motivating application: user (customer) retention. Feature Generation (brainstorming, role of domain expertise, and place for imagination), Feature Selection algorithms. Filters; Wrappers; Decision Trees; Random Forests. Recommendation Systems: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system.

Module-5

Data Engineering, Map reduce, Word Frequency Problem,, Map Reduce Solution, Other Examples of Map Reduce, Pregel-An Introduction. Data Visualization: Basic principles, ideas and tools for data visualization. Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs.

PRACTICAL COMPONENT OF IPCC

1. Load the Iris dataset as a list of lists (each of the 150 lists should have 5 elements). Compute and print the mean and the standard deviation for each of the 4 measurement columns (i.e. sepal length and width, petal length and width). Compute and print the mean and the standard deviation for each of the 4 measurement columns, separately for each of the three Iris species (Versicolor, Virginica and Setose). Which measurement would you consider "best", if you were to guess the Iris species based only on those four values?
2. Load the MNIST dataset. Create a function that, given a position $1 \leq k \leq 10,000$, prints the kthdigit of the dataset (i.e.the k row of the csv file) as a grid of 28 × 28 characters. More specifically, you should map each range of pixel values to the following characters:
   [0, 64) → " "
   [64, 128) → "."
   [128, 192) → "*"
   [192, 256) → "#"
   Compute the Euclidean distance between each pair of the 784-dimensional vectors of the digits at the following positions: 26th, 30th, 32nd, 35th. Based on the distances computed in the previous step and knowing that the digits listed are 7, 0, 1, 1, can you assign the correct label to each of the digits?
   3. Split the Iris dataset into two the datasets - IrisTest_TrainData.csv, IrisTest_TestData.csv. Read them as two separate data frames named Train_ Data and Test_ Data respectively.
   Answer the following questions:
   • How many missing values are there in Train_Data?
   • What is the proportion of Setosa types in the Test_Data?
   • What is the accuracy score of the K-Nearest Neighbor model (model_1) with 2/3 neighbors using Train Data and Test Data?
   • Identify the list of indices of misclassified samples from the „model_1". Build a logistic regression model (model_2) keeping the modelling steps constant. Find the accuracy of the model_2
4. Demonstrate Decision tree classification model and Evaluate the performance of classifier on Iris dataset.
5. Demonstrate any of the Clustering model and Evaluate the performance on Iris dataset.

Suggested Learning Resources:

Text Books

1. Cathy O Neil, Rachel Schutt, 2014, "Doing Data Science-Straight Talk from the Frontline", Orielly
2. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, 2014 Mining of Massive Data Sets, Cambridge University Press

Reference Books

1. Kevin Murphy, 2013, Machine learning: A Probabilistic Perspective,

2. Peter Bruce, Andre Bruce, Practical Statistics for Data Scientists, Orielly Series

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Weeks 1-3	Module 1 - Introduction to Data Science
2	Weeks 4-6:	Module 2 - Exploratory Data Analysis and Machine Learning Algorithms
3	Weeks 7-8:	Module 3 - Spam Filtering and Web Scraping
4	Weeks 9-11	Module 4 - Feature Engineering and Recommendation Systems
5	Weeks 12-14:	Module 5 - Data Engineering, Visualization, and Social Network Analysis
6	Week 15:	: Final project presentations and course wrap-up.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Interactive Lectures**	Lectures will be designed to be interactive, with frequent opportunities for discussion, questioning, and real-time feedback.
2	**Hands-on Coding Exercises**	Regular coding exercises and assignments will be provided to reinforce practical skills in data science programming languages and libraries.
3	**Case Studies and Real-World Examples**	The course will incorporate real-world case studies and examples from various domains to illustrate the applications of data science concepts and techniques.
4	**Group Projects**	Students will work in teams to complete a comprehensive data science project, allowing them to apply their knowledge and skills to a real-world problem.
5	**Guest Lectures**	**Guest Lectures:** Industry experts and practitioners will be invited to share their experiences and insights, providing students with a practical perspective on data science.
6	**Flipped Classroom**	Selected topics will be introduced through pre-recorded lectures or reading materials, allowing class time to be dedicated to discussions, exercises, and problem-solving activities.
7	**Peer Learning**	Students will be encouraged to collaborate, share knowledge, and provide constructive feedback to their peers through study groups, discussion forums, and code reviews.

6. Assessment Details (both CIE and SEE)

CIE:

Theory Course with 4 credits: Integrated Professional Core Course (IPC)

CIE Split up for Integrated Professional Core Course (IPC)

Components		Number	Weightage	Max. Marks	Min. Marks
Theory (A)	Internal Assessment-Tests (A)	2	**60%**	**15**	**06**
	Assignments/Quiz/Activity (B)	2	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**
Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing	Continuous	**60%**	15	06
	Test at the end of the semester	1	**40%**	10	04
	Total Marks		**100%**	**25**	**10**

Final CIE Marks =(A) + (B)

SEE:

Theory Course with 4, 3 and 2 Credits: Integrated Profession Core Course (IPC)

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- The question paper may include at least one question from the laboratory component.

Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Data science principles	To develop a comprehensive understanding of data science principles, techniques, and applications across various domains.
2	Statistical programming languages	To equip students with practical skills in using statistical programming languages (e.g., Python, R) and data science libraries for data manipulation, analysis, and modelling.
3	Data analysis	To enable students to perform exploratory data analysis, feature engineering, and data visualization to extract insights from data.
4	Machine learning algorithms	To provide students with a solid foundation in machine learning algorithms, including supervised and unsupervised learning techniques, for predictive modelling and pattern recognition tasks.
5	Engineering concepts	To introduce students to data engineering concepts and techniques for processing and analysing large-scale datasets.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes and Mapping with POs/ PSOs

M23MCS102.1	Apply exploratory data analysis techniques, machine learning algorithms, and feature engineering methods to analyse and model datasets effectively, addressing real-world problems and scenarios.
M23MCS102.2	Design and implement data engineering pipelines using distributed computing frameworks to process and analyse large-scale datasets, ensuring scalability and efficient data management.
M23MCS102.3	Evaluate the suitability of data science solutions for specific problems and domains, considering factors such as data quality, computational resources, stakeholder requirements, and ethical implications.
M23MCS102.4	Create effective and informative data visualizations to communicate insights from data to stakeholders, facilitating data-driven decision-making and knowledge dissemination.
M23MCS102.5	To introduce students to data engineering concepts and techniques for processing and analyzing large-scale datasets.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS102.1	**3**		**2**	**3**	**3**
M23MCS102.2	**3**	**3**	**3**	**2**	**3**
M23MCS102.3	**2**	**3**		**3**	**3**
M23MCS102.4	**2**	**2**		**2**	**3**
M23MCS102.5	**3**		**3**	**3**	**3**
M23MCS102	**3**	**3**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

The Essentials of Data Science course provides a solid foundation for students to pursue a variety of future paths within the field of data science and beyond.

1. **Advanced Data Science Studies:** Students can further their education by pursuing graduate programs in data science, machine learning, artificial intelligence, or related fields, enabling them to delve deeper into specialized areas and contribute to cutting-edge research.
2. **Industry Roles:** With the skills acquired in this course, students will be well-prepared for roles such as data scientist, machine learning engineer, data analyst, business intelligence analyst, or data engineer in various industries, including technology, finance, healthcare, marketing, and more.
3. **Research and Development:** Students interested in research can explore opportunities in academic or industrial research labs, where they can contribute to the development of new data science techniques, algorithms, and applications.
4. **Entrepreneurship and Innovation:** The knowledge and skills gained in this course can empower students to pursue entrepreneurial ventures, developing innovative data-driven products, services, or solutions.
5. **Domain-specific Applications:** Data science has applications in numerous domains, such as healthcare, finance, marketing, social sciences, environmental sciences, and more. Students can specialize in a particular domain and apply their data science expertise to solve domain-specific problems.
6. **Interdisciplinary Collaboration:** Data science is inherently interdisciplinary, requiring collaboration with experts from various fields. This course will equip students with the ability to effectively communicate and work with domain experts, stakeholders, and cross-functional teams.
7. **Continuous Learning and Professional Development:** The field of data science is rapidly evolving, with new techniques, tools, and applications emerging regularly. This course will instill a mindset of continuous learning and professional development, enabling students to adapt and stay up-to-date with the latest advancements in the field.

Future with this Subject: Career Opportunities and Job Profiles

The field of data science is rapidly growing, with an increasing demand for skilled professionals across various industries. Upon successful completion of this course, students will be well-prepared for a wide range of job roles and career opportunities, including.

1. **Data Scientist:** As a data scientist, students will be responsible for collecting, processing, and analyzing large datasets to extract insights and inform data-driven decision-making. They will apply statistical and machine learning techniques to solve complex problems and communicate their findings to stakeholders.

2. **Machine Learning Engineer:** Machine learning engineers focus on developing and deploying machine learning models and algorithms to solve real-world problems. They work on tasks such as data pre-processing, model training, optimization, and integration into production systems.
3. **Data Analyst:** Data analysts are responsible for collecting, cleaning, and analyzing data to identify trends, patterns, and insights that can inform business decisions. They use statistical techniques and data visualization tools to communicate their findings effectively.
4. **Business Intelligence Analyst:** Business intelligence analysts leverage data to support strategic decision-making within organizations. They design and implement data warehousing and reporting solutions, providing stakeholders with actionable insights for improved business performance.
5. **Data Engineer:** Data engineers are responsible for building and maintaining the data infrastructure and pipelines that enable efficient data processing and analysis. They work with distributed computing frameworks, databases, and data warehousing solutions.
6. **Quantitative Analyst:** Quantitative analysts apply mathematical and statistical models to analyze financial data and develop trading strategies. They work in the finance and investment sectors, using data science techniques to identify market trends and optimize portfolio performance.
7. **Marketing Analyst:** Marketing analysts leverage data science techniques to analyze customer data, understand consumer behavior, and develop targeted marketing strategies. They use predictive modelling and customer segmentation to optimize marketing campaigns and enhance customer experiences.
8. **Healthcare Data Analyst:** In the healthcare industry, data analysts work with electronic health records, clinical trial data, and other medical data to identify patterns, improve patient outcomes, and support medical research.
9. **Social Media Analyst:** Social media analysts use data science techniques to analyze social media data, understand user behavior, and develop strategies for social media marketing, customer engagement, and brand management.
10. **Consultant and Advisor:** With the increasing demand for data-driven solutions, data science professionals can pursue consulting roles, providing expertise and advisory services to organizations across various industries.

1st Semester	Professional Core Course (PC) Cyber Security and Digital Forensics	M23MCS103

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Networking	Understanding of fundamental networking concepts (IP addressing, protocols).
2	Computer Systems	Familiarity with operating systems and hardware components.
3	Programming Concepts	Basic programming skills (e.g., Python, C++).
4	Cyber Security Basics	Knowledge of basic cyber security principles and terminologies.
5	Legal Knowledge	Awareness of fundamental cyber laws and regulations.
6	Analytical Thinking	Ability to think critically and analytically.
7	Research Methods	Basic knowledge of research methodologies and techniques.
8	Digital Forensics Tools	Familiarity with digital forensics tools (such as FTK Imager, Autopsy).

2. Competencies

S/L	Competency	KSA Description
1	Risk Management	**Knowledge**: Understanding of risk management frameworks and methodologies.
		Skills: Ability to assess and mitigate risks.
		Attitudes: Valuing proactive risk management in cyber security.
2	Incident Response	**Knowledge**: Knowledge of incident response processes and procedures.
		Skills: Ability to respond to and manage security incidents.
		Attitudes: Importance of timely and effective incident response.
3	Encryption and Decryption	**Knowledge**: Understanding encryption algorithms and decryption techniques.
		Skills: Implementing encryption and decryption methods.
		Attitudes: Appreciation for data security and privacy.
4	Cyber Laws and Ethics	**Knowledge**: Understanding of cyber laws and ethical standards.
		Skills: Applying legal knowledge to cyber security issues.
		Attitudes: Commitment to ethical practices in cyber security.
5	Digital Forensics Techniques	**Knowledge**: Understanding of digital forensics methodologies and tools.
		Skills: Conducting digital forensics investigations.
		Attitudes: Valuing accurate and thorough forensic analysis.
6	Network Security	**Knowledge**: Understanding network security principles and technologies.
		Skills: Securing wired and wireless networks.
		Attitudes: Importance of maintaining secure network environments.
7	Legal Frameworks for Cybercrime	**Knowledge**: Knowledge of global and Indian cybercrime laws.
		Skills: Applying legal frameworks to cybercrime cases.
		Attitudes: Awareness of the legal implications of cyber activities.
8	Forensic Reporting	**Knowledge**: Understanding the principles of forensic report writing.
		Skills: Creating clear and concise forensic reports.
		Attitudes: Importance of accurate and professional reporting.

3. Syllabus

Cyber Security and Digital Forensics SEMESTER-I			
Course Code	**M23MCS103**	**CIE Marks**	50

Teaching Hours/Week(L:P:SDA)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	04	**Exam Hours**	03

Course objectives:

- Understand various cyber security issues with respect to operating system, wired and wireless networks.
- Analyze the risks and incidents' response
- Learn the art of encryption and decryption
- Understand the violations in cyber world

Teaching- Learning Process: Chalk and talk method/Power Point Presentation

Module-1

Introduction: Introduction to Information Security, what is Cyber Security? Need forCyber Security, Privacy of data, Risk Management, Digital Forensics - Incident response, Security operations.

Module-2

Firewalls, Intrusion Detection, Intrusion Prevention Systems, Honeypots, DoS and DDOS attack, Wireless Security issues-Android and iOS Security, App Security, Secure Boot, Data Exfiltration, Wireless Protected Access (WPA), IEEE 802.1x, 802.11i/ WPA2, Wireless Network Threats, Cloud and IoT Application Security.

Module-3

The legal perspectives: Cybercrime and legal landscape around the world, Why do we need cyber laws: The Indian context, Indian IT Act, Challenges to Indian Law, Weakness in IT Act, Digital Signatures and Indian IT Act, Amendments to Indian IT Act, Cybercrime and punishment, Policy approaches.

Module-4

Introduction: Understanding the need of Computer Forensics, Definitions
Computer Hardware: Analysis of sources for digital evidence, Digital Media, Hard disk basics, mobile phones
Forensic Tools: Forensic hardware, Hardware write/blockers, Hard drive acquisitions, Processing the scene Files and File Systems: Windows file systems, Forensic file images, metadata, File signatures
Forensic software: Different software packages, Basic search queries, ASCII, UNICODE, Regular expressions, viewing and managing keywords and cases, Encryption, password protection, Password recovery tools.
Physical evidence: fingerprints or other evidence on machines, keyboards

Module-5

Forensic Reports: Proper report writing, Explaining forensics to the uneducated, **Email analysis:** IP tracking, Tracking and analysis of emails, Webmail, POP, IMAP, **File signature analysis:** File signatures, File extensions, Detecting file manipulation, **Hash Analysis**: Hashing files, Hash libraries, **Window Artifacts:** My documents, Recycle bin, Installed programs, Windows 10 vs. Windows 11

Text book:

1. Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, McGraw-Hill Education
2. R. Boddington, Practical Digital Forensics, Packt Publishing

Reference Books:

1. N. Jain, D. Kalbande, Digital Forensic: The Fascinating World of Digital Evidences, Wiley
2. M.J. Britz, Computer Forensics and Cyber Crime: An Introduction, Perason
3. A. J. Marcella, G. Guillossou, Cyber Forensics: from data to digital intelligence, Wiley

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction	Competency: Understanding Cyber Security Fundamentals
		Knowledge: Introduction to Information Security, Need for Cyber Security, Privacy of Data.
		Skills: Identifying various types of cyber threats and understanding basic security principles.
		Attitudes: Valuing the importance of privacy and data protection.

2	Week 3-4: Risk Management and Incident Response	Competency: Mastering Risk Management and Incident Response
		Knowledge: Risk Management frameworks, Incident Response processes.
		Skills: Conducting risk assessments, developing incident response plans.
		Attitudes: Importance of proactive and reactive measures in cyber security.
3	Week 5-6: Network Security	Competency: Securing Networks
		Knowledge: Firewalls, Intrusion Detection and Prevention Systems, Honeypots, DoS and DDoS Attacks, Wireless Security.
		Skills: Implementing network security measures, securing wireless networks.
		Attitudes: Commitment to maintaining secure network environments.
4	Week 7-8: Legal Perspectives	Competency: Understanding Cyber Laws and Ethics
		Knowledge: Cybercrime legal landscape, Indian IT Act, Cybercrime and punishment, Policy approaches.
		Skills: Applying legal knowledge to cyber security cases, understanding digital signatures.
		Attitudes: Commitment to ethical practices in cyber security.
5	Week 9-10: Digital Forensics Techniques	Competency: Conducting Digital Forensics Investigations
		Knowledge: Analysis of digital evidence sources, Forensic tools and software, File systems, Encryption and password recovery tools.
		Skills: Using forensic tools, analyzing digital evidence, handling encryption.
		Attitudes: Valuing accurate and thorough forensic analysis.
6	Week 11-12: Forensic Reporting and Analysis	Competency: Developing Forensic Reports and Conducting Analysis
		Knowledge: Report writing principles, Email analysis, File signature and hash analysis, Windows artifacts.
		Skills: Creating forensic reports, analyzing emails and files, understanding hashing.
		Attitudes: Importance of clear, concise, and accurate reporting.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies.
6	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
7	Flipped Class Technique	Utilize a flipped class approach providing materials before class to facilitate deeper understanding.
8	Practical Assignments	Assign hands-on tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

CIE:

- **Theory Course with 4 Credits: Profession Core Course (PC)**
- This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

SEE:

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Cyber Security Fundamentals	Students will grasp the fundamental concepts of cyber security, including the importance of information security, the need for cyber security, and data privacy principles.
2	Mastering Risk Management and Incident Response	Students will learn to conduct risk assessments, develop incident response plans, and understand the importance of proactive and reactive measures in cyber security.
3	Proficiency in Network Security	Students will become proficient in implementing network security measures, securing wired and wireless networks, and understanding various network security threats.
4	Understanding Cyber Laws and Ethics	Students will gain knowledge of the legal landscape of cybercrime, including the Indian IT Act, and understand the importance of ethical practices in cyber security.
5	Conducting Digital Forensics Investigations	Students will learn to use forensic tools, analyze digital evidence, and handle encryption, gaining skills in conducting thorough and accurate forensic investigations.
6	Developing Forensic Reports and Conducting Analysis	Students will understand the principles of forensic report writing, learn to analyze emails and files, and conduct hash analysis, emphasizing the importance of clear reporting.
7	Applying Cyber Security Tools	Through hands-on practice, students will apply their knowledge of cyber security tools, implement security measures, and conduct practical forensic investigations.
8	Analyzing Cyber Security Case Studies	Students will analyze real-world cyber security and legal case studies to understand the application of concepts in practical scenarios.
9	Enhancing Analytical and Problem-Solving Skills	Students will enhance their analytical and problem-solving skills through practical assignments, projects, and collaborative learning activities.
10	Ethical and Professional Responsibility	Students will understand their ethical and professional responsibilities in the field of cyber security, including data privacy,

		intellectual property rights, and adherence to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (Co's)

COs	Description
M23MCS103.1	Understand the fundamentals of cyber security and forensics.
M23MCS103.2	Apply risk management and incident response strategies.
M23MCS103.3	Analyze and implement encryption and decryption techniques.
M23MCS103.4	Evaluate network security issues and solutions.
M23MCS103.5	Develop comprehensive forensic reports and legal knowledge.

CO-PO-PSO Mapping

CO's	PO1	PO2	PO3	PSO1	PSO2
M23MCS103.1	3		3	3	3
M23MCS103.2	3		3	3	3
M23MCS103.3	3	3	3	3	3
M23MCS103.4	3		3	3	3
M23MCS103.5	3		3	3	3
M23MCS103	3	3	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE):

COs	CO1	CO2	CO3	CO4	CO5	Total
Module 1	10					10
Module 2		10				10
Module 3			10			10
Module 4				10		10
Module 5					10	10
Total	10	10	10	10	10	50

Semester End Examination (SEE):

COs	CO1	CO2	CO3	CO4	CO5	Total
Module 1	20					20
Module 2		20				20
Module 3			20			20
Module 4				20		20
Module 5					20	20
Total	20	20	20	20	20	100

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks.

10. Future with this Subject

This course provides a solid foundation for advanced studies and careers in cyber security and digital forensics. Key areas include:

1. **Advanced Cyber Security Courses:** Further studies in penetration testing, advanced cryptography, and secure software development.
2. **Digital Forensics Specializations:** Specializing in mobile forensics, network forensics, and malware analysis.

3. **Cyber Law and Ethics:** Understanding the legal and ethical dimensions of cyber security practices.
4. **Industry Applications:** Careers in cyber security operations, incident response, and risk management.
5. **Research and Development:** Contributing to innovative solutions and advancements in cyber security and digital forensics.This syllabus aims to equip students with the necessary skills, knowledge, and attitudes to excel in the dynamic and critical fields of cyber security and digital forensics.

1st Semester	Professional Core Course (PC) Advanced Database Management System	M23MCS104

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Database Concepts	Understanding of basic database concepts such as tables, records, fields, and relationships. Familiarity with different types of databases (relational, NoSQL, etc.).
2	SQL Proficiency	Strong knowledge of SQL (Structured Query Language) including queries, joins, sub queries, indexing, and transactions.
3	Data Modelling	Ability to design and understand Entity-Relationship (ER) diagrams. Knowledge of normalization and denormalization techniques.
4	Basic Understanding of Web Technologies	Familiarity with web development basics and how web applications interact with databases
5	Concurrency and Transactions	Knowledge of concurrency control, isolation levels, and transaction management.
6	Fundamentals of Data Structures	Understanding of basic data structures like arrays, linked lists, trees, and hash tables.

2. Competencies

S/L	Competency	KSA Description
1	Advanced SQL Skills	**Knowledge**: Mastery in writing complex SQL queries, including advanced joins, sub queries, and set operations **Skills**: Proficiency in creating and managing stored procedures, functions, and triggers **Attitude:** Ability to optimize query performance and tuning indexes to improve throughput and reduce latency in distributed SQL databases.
2	Database Optimization:	**Knowledge:** Skills in performance tuning and query optimization. **Skills**: Understanding of indexing strategies and execution plans. **Attitude:** Knowledge of backup and disaster recovery strategies in SQL databases to ensure data durability and availability.
3	Database design and modelling:	Expertise in designing scalable and efficient database schemas. Proficiency in normalization, denormalization, and data modelling techniques.
4	Database security	**Knowledge**: Competence in implementing database security measures, including user authentication, authorization, and encryption.. Skills in managing roles and permissions **Skills**: Acquire knowledge of feature engineering techniques to extract relevant information from raw data and improve model performance.
5	Backup and recovery	**Knowledge**: Proficiency in database backup and recovery strategies. **Skills**: Regularly check the integrity of backups. Corruption or incomplete backups can render recovery impossible. **Attitude:** Ability to implement disaster recovery plans and perform point-in-time recovery.
6	NoSQL and NewSQL Databases:	**Knowledge**: Familiarity with NoSQL databases (e.g., MongoDB, Cassandra) and their data models. **Skills**: Experience in setting up, configuring, and maintaining NoSQL databases, including backup strategies, monitoring, and scaling. **Attitude:** Understanding of NewSQL database and their use cases.

3. Syllabus

ADVANCE Database Management System

SEMESTER-I			
Course Code	**M23MCS104**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand the appropriate high-performance database like parallel and distributed database
- To understand the Infer and represent the real-world data using object-oriented database
- To understand the Interpret rule set in the database to implement data warehousing of mining
- To understand the Discover and design database for recent applications database for better interoperability

Teaching- Learning Process: Chalk and talk method/Power Point Presentation.

Module-1

Review of Relational Data Model and Relational Database Constraints: Relational model concepts; Relational model constraints and relational database schemas; Update operations, anomalies. Object and Object-Relational Databases: Overview of OOP; Complex objects; Identity, structure etc. Object model of ODMG, Object definition Language ODL; Object Query Language OQL; Conceptual design of Object database.

Module-2

Disk Storage, Basic File Structures, Hashing, and Modern Storage Architectures: Introduction, Secondary Storage Devices, Buffering of Blocks, Placing File Records on Disk Operations on Files, Files of Unordered Records (Heap Files), Files of Ordered Records (Sorted Files), Hashing Techniques, Other Primary File Organizations, Parallelizing Disk Access Using RAID Technology, Modern Storage Architectures. Distributed Database Concepts: Distributed Database Concepts, Data Fragmentation, Replication, and Allocation

Module-3

NOSQL Databases and Big Data Storage Systems: Introduction to NOSQL Systems, The CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based or Wide Column NOSQL Systems, NOSQL Graph Databases and Neo4j.

Big Data Technologies Based on Map Reduce and Hadoop: What Is Big Data? Introduction to Map Reduce and Hadoop, Hadoop Distributed File System (HDFS).

Module-4

Data Warehousing, Decision Support and Data Mining: Decision-Support Systems, Data Warehousing, Data Mining, Classification, Association Rules, Other Types of Associations, Clustering, Other Forms of Data Mining,

Information Retrieval: Relevance Ranking Using Terms, Relevance Using Hyperlinks, Synonyms, Homonyms, and Ontologies, Indexing of Documents, Measuring Retrieval Effectiveness, Crawling and Indexing the Web.

Module-5

Database Security: Introduction to data base security issues, Discretionary access control based on granting and revoking privileges, Mandatory access control and role based access control for multilevel security, SQL injection, introduction to statistical data base security, introduction to flow control, encryption and public key Infrastructure, privacy issues and preservation, challenges to maintaining database security.

Suggested Learning Resources:

Books

1 Fundamentals of Database Systems Elmasri and Navathe Pearson Education 2013

2 Database Management Systems Raghu Rama Krishnan and Johannes Gehrke McGraw-Hill 3rd Edition

Reference Books

1. Database System Concepts Abraham Silberschatz, Henry F. Korth, S. Sudarshan McGraw Hill 6th Edition, 2010

2 Database Management Systems Raghu Rama Krishnan and Johannes Gehrke McGraw-Hill 3rd Edition

4. Syllabus Timeline

S/L	Syllabus Timeline	Description

1	Week 1-2:Review of Relational Data Model and Relational Database Constraints	Relational model concepts; Relational model constraints and relational database schemas; Update operations, anomalies. Object and Object-Relational Databases: Overview of OOP; Complex objects; Identity, structure etc. Object model of ODMG, Object definition Language ODL; Object Query Language OQL; Conceptual design of Object database
2	Week 3-4: Disk Storage, Basic File Structures, Hashing, and Modern Storage Architectures	Introduction, Secondary Storage Devices, Buffering of Blocks, Placing File Records on Disk Operations on Files, Files of Unordered Records (Heap Files), Files of Ordered Records (Sorted Files), Hashing Techniques, Other Primary File Organizations, Parallelizing Disk Access Using RAID Technology, Modern Storage Architectures. Distributed Database Concepts: Distributed Database Concepts, Data Fragmentation, Replication, and Allocation Techniques.
3	Week 5-6: NOSQL Databases and Big Data Storage Systems	Introduction to NOSQL Systems, The CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based or Wide Column NOSQL Systems, NOSQL Graph Databases and Neo4j. Big Data Technologies Based on Map Reduce and Hadoop: What Is Big Data? Introduction to Map Reduce and Hadoop, Hadoop Distributed File System (HDFS).
4	Week 7-8:Data Warehousing, Decision Support and Data Mining	Decision-Support Systems, Data Warehousing, Data Mining, Classification, Association Rules, Other Types of Associations, Clustering, Other Forms of Data Mining, Relevance Ranking Using Terms, Relevance Using Hyperlinks, Synonyms, Homonyms, and Ontologies, Indexing of Documents, Measuring Retrieval Effectiveness, Crawling and Indexing the Web.
5	Week 9-10: Database Security	Introduction to data base security issues, Discretionary access control based on granting and revoking privileges, Mandatory access control and role based access control for multilevel security, SQL injection, introduction to statistical data base security, introduction to flow control, encryption and public key Infrastructure, privacy issues and preservation, challenges to maintaining database security.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Image/Video/Animation	Incorporate visual aids like image/videos/animations to enhance understanding of programming constructs.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Programming-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
7	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
8	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

CIE:

Theory Course with 3 Credits: Professional Core Course (PC)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	TotalMarks			**50**	**20**

FinalCIEMarks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

SEE:

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding fundamentals of C++ Programming Constructs	Students will grasp the fundamental concepts of C++ Programming, including basic constructs.
2	Executing Simple C++ Programs	Students will learn to design and execute basic and simple C++ programs.
3	Programming-Based Learning	Through program execution-based learning, students will undergo the demonstration of C++ programming constructs working principles.
4	Proficiency in C++ Specific Constructs	Students will become proficient in understanding and applying the C++ specific constructs to improve the efficiency of C++programming logics.
5	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with C++ Programming, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS104.1	Select the appropriate high-performance database like parallel and distributed database.
M23MCS104.2	Infer and represent the real-world data using object-oriented database
M23MCS104.3	Interpret rule set in the database to implement data warehousing of mining
M23MCS104.4	Discover and design database for recent applications database for better interoperability
M23MCS104.5	Apply access control and role based access control for multilevel security

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2

M23MCS104.1	**3**			**3**	**3**
M23MCS104.2	**3**			**3**	**3**
M23MCS104.3		**3**		**3**	**3**
M23MCS104.4			**3**	**3**	**3**
M23MCS104.5	**3**	**3**		**3**	**3**
M23MCS104	**3**	**3**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO4	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

1. **Integration of Artificial Intelligence and Machine Learning**
   - **Predictive Analytics**: DBMS will increasingly integrate AI and ML to provide predictive analytics, helping businesses make data-driven decisions.
   - **Automated Database Management**: AI will enable automated tuning, indexing, and query optimization, reducing the need for manual intervention.
2. **Cloud-Based Databases**
   - **Scalability and Flexibility**: Cloud-based DBMS will continue to grow, offering scalable and flexible solutions that can handle large volumes of data.
   - **Cost Efficiency**: Pay-as-you-go models will make it more cost-efficient for businesses to manage their data infrastructure.
3. **Distributed Databases and Edge Computing**
   - **Distributed Architectures**: There will be a rise in distributed databases that can handle data across multiple locations, improving performance and reliability.
   - **Edge Computing**: Storing and processing data closer to the source (edge devices) will reduce latency and improve real-time data processing capabilities.

1st Semester	Professional Core Course (PC) Artificial Intelligence and Machine Learning	M23MCS105

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	Linear Algebra: Matrices, vectors, eigen values, eigenvectors, etc. Calculus: Differentiation, integration, multivariate calculus. Probability and Statistics: Probability theory, random variables, distributions, statistical inference, etc
2	Programming Skills	Proficiency in at least one programming language such as Python, R, or Julia. Understanding of data structures and algorithms
3	Data Analysis	Familiarity with data manipulation and analysis using libraries like NumPy, Pandas, and Matplotlib in Python. Experience in handling datasets, data Pre-processing, and data visualization.
4	Basic Machine Learning Concepts	Understanding of fundamental ML concepts like supervised learning, unsupervised learning, reinforcement learning, etc. Knowledge of common ML algorithms such as linear regression, logistic regression, decision trees, k-nearest neighbours, support vector machines, etc.
5	Data Science Tools and Libraries	Experience with tools and libraries commonly used in data science and ML such as scikit-learn, TensorFlow, PyTorch, etc. Knowledge of Jupyter Notebooks or similar environments for interactive data analysis and experimentation
6	Computer Science Fundamentals	Basics of computer science including algorithms, data structures, and complexity analysis. Understanding of computer architecture, operating systems, and networking.
7	Probability and Statistics	Solid understanding of probability theory including Bayes' theorem, conditional probability, etc. Familiarity with statistical concepts such as hypothesis testing, confidence intervals, etc.
8	Linear Algebra	Knowledge of linear algebra concepts such as vectors, matrices, matrix operations, eigen values, eigenvectors, etc
9	Critical Thinking and Problem Solving	Ability to think critically, analyse problems, and formulate solutions. Strong problem-solving skills are crucial for understanding and applying ML algorithms effectively
10	Domain Knowledge	Depending on the specific application areas of interest (e.g., healthcare, finance, computer vision), having domain-specific knowledge can be advantageous.

2. Competencies

S/L	Competency	KSA Description
1	Understanding of Core Concepts	**Knowledge:** Gain a deep understanding of fundamental concepts in AI and ML, including supervised learning, unsupervised learning, reinforcement learning, neural networks, deep learning, etc. **Skills:** Skills in hyperparameter optimization techniques like grid search**,** random search, and Bayesian optimization to improve model performance. **Attitude:** Skills in diagnosing and fixing issues with model performance, such as vanishing/exploding gradients, slow convergence, or unstable training.
2	Mathematical Foundations	**Knowledge:** Strengthen your proficiency in mathematics, particularly in linear algebra, calculus, probability theory, and statistics, as these form the mathematical underpinnings of AI and ML algorithms. **Skills:** Ability to identify the best deep learning model and architecture for solving specific real-world problems

		Attitude: Knowledge of transfer learning and fine-tuning, which are essential for leveraging pre-trained models for new tasks with limited data.
3	Programming Skills	**Knowledge:** Develop strong programming skills in languages commonly used in AI and ML, such as Python or R. **Skills:** Learn how to efficiently use libraries and frameworks like TensorFlow, PyTorch, scikit-learn, and Keras for implementing AI and ML models. **Attitude:** Understanding of traditional batch processing, where data is collected, processed, and stored in batches
4	Data Handling and Pre-processing	**Knowledge:** Master techniques for data handling, pre-processing, and cleaning to prepare datasets for training and analysis. **Skills:** Understand how to deal with missing data, outliers, and noise in datasets. **Attitude:** Understanding of traditional batch processing, where data is collected, processed, and stored in batches
5	Model Selection and Evaluation	**Knowledge:** Learn how to select appropriate ML models for different tasks and datasets. **Skills:** Develop skills in evaluating model performance using various metrics and techniques such as cross-validation. **Attitude:** Strong analytical thinking and the ability to troubleshoot and improve models based on the behaviour of the training process
6	Deep Learning	**Knowledge:** Gain expertise in deep learning techniques, architectures, and frameworks for tasks such as image recognition, natural language processing (NLP), and sequential data analysis. **Skills:** Ability to design, implement, and fine-tune deep learning models for specific tasks, from initial architecture design to final model evaluation. **Attitude:** Adaptability to rapidly evolving technologies, such as new neural network architectures

3. Syllabus

Artificial Intelligence and Machine Learning **SEMESTER-I**			
Course Code	M23MCS105	**CIE Marks**	50
Teaching Hours/Week(L:P:SDA)	2:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	03	**Exam Hours**	03
Course objectives: 1. To understand the basics of AI. 2. To work with the problem-solving issues of AI. 3. To study advanced problem solving paradigms and knowledge representation. 4. To interpret neural networks, build neural networks to solve various classification problems.			
Teaching- Learning Process: Chalk and talk method/Power Point Presentation			
Module-1			
Introduction, Problem Solving: State space search, General problem solving, characteristics of problem, Exhaustive searches, Heuristic searches, constraint satisfaction.			
Module-2			
Problem Reduction and Game playing: Introduction, problem reduction, game playing, bounded lock ahead strategy, Alpha Beta pruning, Logic concepts and logic programming: Logical Reasoning, propositional calculus and logic, natural deduction system, semantic tableau system, resolution refutation in propositional logic predicate logic, Logic programming.			
Module-3			

Advanced problem-solving paradigm: planning, Introduction, types of planning systems, block world program, logic-based planning, linear planning using goal stack, Means ends analysis, Non-Linear planning strategies, learning plans, Knowledge representation: Introduction, Approaches to knowledge representation, knowledge representation using semantic networks, extended semantic network for KR, knowledge representation using frames.
Module-4
Uncertainty Measure: Probability Theory, Bayesian Belief Networks, Machine Learning Paradigms: Machine learning system, supervised and unsupervised learning, Inductive, deductive learning, Clustering
Module-5
Support vector Machine, case-based reasoning and learning. ANN: Single Layer, Multilayer. RBF, Design issues in ANN, Recurrent Network

Suggested Learning Resources:

Text Books:

1. Artificial Intelligence: Saroj Kaushik, Cengage Learning, 2014 Edition.
2. Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F Luger, Pearson Addison Wesley, 6th Edition, 2008.

Reference books:

1. Artificial Intelligence, E Rich, K Knight, and S B Nair, Tata Mc-Graw Hill, 3rd Edition, 2009.
2. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Prentice Hall 3 rd Edition, 2009.

Skill Development Activities Suggested

- The students with the help of the course teacher can take up technical –activities which will enhance their skill other students should interact with industry (small, medium and large), understand their problems or for see 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.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Weeks1-3	Module1-Introduction, Problem Solving.
2	Weeks4-6:	Module2- Problem Reduction and Game playing.
3	Weeks7-8	Module3 -Advanced problem-solving paradigm.
4	Weeks9-11:	Module4- Uncertainty Measure.
5	Weeks12-14:.	Module5- Support vector Machine.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Interactive Lectures:**	Lectures will be designed to be interactive, with frequent opportunities for discussion, questioning, and real-time feedback.
2	**Handson Coding Exercises:**	Regular coding exercises and assignments will be provided to reinforce practical skills in data science programming language sand libraries.
3	**Case Studies and Real-World Examples:**	The course will incorporate real-world case studies and examples from various domains to illustrate the applications of data science concepts and techniques.
4	**Group Projects:**	Students will work in teams to complete a comprehensive data-science project, allowing them to apply the knowledge and skills to a real-world problem.
5	**Guest Lectures:**	Industry experts and practitioners will be invited to share their experiences and insights, providing students with a practical perspective on data science.

6	**Flipped Classroom:**	Selected topics will be introduced through pre-recorded lectures or reading materials, allowing class time to be dedicated to discussions, exercises, and problem-solving activities.

6. Assessment Details (both CIE and SEE)

CIE:

Theory Course with 3 Credits: Professional Core Course (PC)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

SEE:

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Principles of Algorithm	Develop a deep and comprehensive understanding of the theoretical foundations, principles, algorithms, and methodologies underlying AI and ML.
2	AI & ML Technique	Gain hands-on experience in implementing AI and ML techniques, algorithms, and models using relevant programming languages, libraries, and frameworks.
3	Deep Learning	Explore advanced topics and cutting-edge research areas in AI and ML, including deep learning, reinforcement learning, generative adversarial networks (GANs), natural language processing (NLP), computer vision, etc.
4	Critical Thinking	Develop strong problem-solving skills and critical thinking abilities to analyze complex AI and ML problems, devise effective solutions, and evaluate their performance.
5	Interdisciplinary perspective	Gain an interdisciplinary perspective by integrating concepts, techniques, and methodologies from fields such as computer science, mathematics, statistics, engineering, cognitive science, and domain-specific areas of application.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

M23MCS105.1	Develop a deep understanding of advanced AI and ML concepts, theories, algorithms,

	and methodologies beyond the undergraduate level. Explore topics such as deep learning, reinforcement learning, probabilistic graphical models, natural language processing, computer vision, etc.
M23MCS105.2	Acquire specialized technical skills in AI and ML, including proficiency in programming languages (e.g., Python, R), libraries, and frameworks (e.g., TensorFlow, PyTorch) commonly used in AI and ML research and applications.
M23MCS105.3	Explore emerging trends, cutting-edge technologies, and novel approaches in AI and ML research and applications. Develop research skills to conduct original research in AI and ML, formulate research questions, design experiments, collect and analyze data, and contribute to the advancement of knowledge in the field.
M23MCS105.4	Work on hands-on projects, case studies, and real-world applications of AI and ML to gain practical experience in applying theoretical knowledge to solve practical problems. Collaborate with industry partners, research labs, or start ups to work on industry-relevant projects and gain insights into AI and ML applications in professional settings.
M23MCS105.5	Develop strong problem-solving skills and critical thinking abilities to analyze complex AI and ML problems, devise effective solutions, and evaluate their performance

CO/PO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS105.1	**3**			**3**	**3**
M23MCS105.2	**2**	**3**		**3**	**3**
M23MCS105.3		**2**	**3**	**3**	**3**
M23MCS105.4		**2**	**3**	**3**	**3**
M23MCS105.5	**3**	**2**	**2**	**3**	**3**
M23MCS105	**3**	**2**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	C04	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO4	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

Learning Artificial Intelligence (AI) and Machine Learning (ML) in an M.Tech program in Computer Science and Engineering opens up a plethora of opportunities in various domains. Here's a glimpse into the future with such a specialization:

1. **Cutting-edge Research:** Pursuing AI and ML in M.Techsets the stage for engaging in cutting-edge research. You could delve into areas like deep learning, reinforcement learning, natural language processing, computer vision, robotics, and more. This research could lead to breakthroughs in AI technology, contributing to advancements in various fields.
2. **Industry Demand**: AI and ML are revolutionizing industries across the globe. With an M.Tech specialization, you'll be in high demand for roles such as machine learning engineer, data scientist, AI researcher, AI consultant, and more. Industries ranging from healthcare and finance to manufacturing and automotive are actively seeking professionals with expertise in AI and ML.
3. **Innovation and Entrepreneurship:** Armed with a solid foundation in AI and ML, you'll have the skills to innovate and create disruptive technologies. Many M.Tech graduates in AI and ML venture into entrepreneurship, founding start ups that leverage AI to address real-world problems or introduce innovative products and services.
4. **Academic Pursuits:** For those inclined towards academia, an M.Tech in AI and ML provides a strong platform for further academic pursuits. You could pursue a Ph.D. and contribute to academic research in AI, becoming a faculty member at a university or research institution.
5. **AI Ethics and Governance:** As AI and ML technologies continue to evolve, there's a growing emphasis on ethical AI development and governance. M.Tech graduates with expertise in AI ethics and governance can play pivotal roles in ensuring that AI technologies are developed and deployed responsibly, addressing concerns related to bias, fairness, transparency, privacy, security, and societal impact.
6. **Global Opportunities:** AI and ML talent is in demand worldwide. Whether you aspire to work in tech hubs like Silicon Valley or pursue opportunities in emerging AI markets, your skills will be valued globally. International organizations, research institutions, and multinational corporations are actively recruiting AI and ML professionals.
7. **Continuous Learning and Adaptation:** The field of AI and ML is dynamic and rapidly evolving. As an M.Tech graduate, you'll need to embrace continuous learning to stay updated with the latest advancements, technologies, and methodologies in AI and ML. This commitment to lifelong learning will ensure your relevance and competitiveness in the job market.

1st Semester	Mandatory Core Course (MC) **Research Methodology and IPR**	M23MCS106

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Research Design and Methodologies	Basic knowledge of scientific research principles and methods, typically gained through introductory research methods courses.
2	Statistical Analysis and Data Interpretation	Understanding of basic probability theory and statistical concepts, usually covered in introductory statistics course
3	Academic Writing and Communication:	Basic Skill in writing clear, well-structured research papers and reports, and effectively communicating research findings.
4	Knowledge of Intellectual Property Rights (IPR):	Knowledge of business law or legal studies, and basic understanding of legal terminology related to intellectual property.
5	Critical Thinking and Problem-Solving:	knowledge in the specific field of study (e.g., engineering, social sciences, life sciences), and experience with critical analysis and problem-solving techniques

2. Competencies

S/L	Competency	KSA Description
1	**Research Design and Methodologies**	**Knowledge:** Understanding various research designs, including experimental, correlational, and descriptive methodologies. **Skills:** Ability to design robust research studies, formulates research questions, and select appropriate methodologies. **Attitudes:** Valuing rigor and integrity in research design and execution
2	**Statistical Analysis and Data Interpretation**	**Knowledge:** Familiarity with statistical concepts such as hypothesis testing, regression analysis, and inferential statistics. **Skills:** Proficiency in using statistical software (e.g., SPSS, R) to analyze and interpret data. **Attitudes:** Appreciating the importance of accuracy and objectivity in data analysis..
3	**Academic Writing and Communication**	**Knowledge:** Understanding the structure and format of academic papers, including proper citation and referencing techniques. **Skills:** Ability to write clear, concise, and well-structured research papers and reports.. **Attitudes:** Valuing clarity, precision, and ethical practices in academic writing.
4	**Knowledge of Intellectual Property Rights (IPR)**	**Knowledge:** Understanding the different types of intellectual property (patents, trademarks, copyrights) and the application processes for each.. **Skills:** Ability to navigate the IP application process, including drafting and filing patents. **Attitudes:** Respecting the legal and ethical considerations in protecting intellectual property.
5	**Ethical Considerations in Research**	**Knowledge:** Understanding ethical guidelines and principles in conducting research, including issues related to consent, confidentiality, and data integrity. **Skills:** Ability to apply ethical principles in research design and execution.. **Attitudes:** Commitment to upholding ethical standards and integrity in all research activities.

3. Syllabus

RESEARCH METHODOLOGY AND IPR SEMESTER-I

Course Code	M23MCS106	CIE Marks	50
Number of Lecture Hours/Week(L: P: SDA)	(3:0:0:0)	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

- Overview of formulating research problem and significance of the literature review.
- Demonstrate the types of research designs with experimentation.
- Importance of thesis writing skills.
- Understand the basic concepts of intellectual property and its impact on society.

Module -1

Introduction to Research Methodology: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Qualities of good research, problems encountered by researchers in India.

Text Book 1: **Ch. 1**

Module -2

Literature Review: Necessity of defining problem, Techniques involved in defining the problem, Selecting the problem, The place of the literature review in research, bringing clarity and focus to your research problem, improving your research methodology, broadening your knowledge base in your research area, enabling you to contextualize your findings, how to review the literature, searching for the existing literature, Reviewing the selected literature, developing a theoretical framework, developing a conceptual framework, writing about the literature reviewed.

Text Book 1: Ch. 2, Text Book 2: Ch. 3

Module -3

Research Design: Meaning of research design, need for research design, features of a good design, Important concepts relating to research design, Different research design, Developing a research plan, basic principles of experimental design, Need for Sampling, Steps in sampling design, different types of sample design. Characteristics of good sample design.

Text Book 1: **Ch. 3, 4**

Module -4

Data Collection and Report writing: Collection of primary data, collection of data through questionnaires, observation method, collection of secondary data, some other methods of data collection, Selection of appropriate method for data collection, significance of report writing, layout of research report, different steps in writing report, precautions for writing research report.

Text Book 1: **Ch. 6, 19**

Module -5

Overview of Intellectual property: Invention and creativity, procedure for grant of patents, types of patents, basic concepts of patents, trademarks and copyrights, protection of IPR, Geographical indications, industrial designs, protection of undisclosed information, condition on patent applicants, Duration of protection, term of protection.

Text Book 3: **Ch. 1**

Text Books:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International 3rd Edition, 2014.
2. Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights-Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

Reference books:

1. B L Wadehra, Law relating to patents, trademarks, copyright designs and geographical Indications, Universal Law Publishing, 2000.
2. Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights-Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

e-Resources: https://www.mooc.org/https://onlinecourses.nptel.ac.in/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Research Methodology	**Competency:** Ability to design and conduct rigorous and ethical research studies **Knowledge:** Understanding the principles and components of various research methodologies, including qualitative, quantitative, and mixed methods. **Skills:** Proficiency in formulating research questions, selecting appropriate research designs, and implementing data collection techniques.
2	Week 3-4: Defining the Research Problem	**Competency:** Ability to clearly define and articulate a research problem. **Knowledge**: Understanding the significance of a well-defined research problem and the criteria for selecting a viable research topic.. **Skills:** Proficiency in identifying research gaps, formulating precise research questions, and developing problem statements.
3	Week 5-6: Reviewing the Literature	**Competency:** Ability to conduct a comprehensive and critical literature review. **Knowledge**: Understanding the purpose, structure, and methods of conducting a literature review, including identifying relevant sources and synthesizing existing research. **Skills:** Proficiency in searching academic databases, evaluating the credibility of sources, and summarizing and critiquing existing research findings.
4	Week 7-8: Research Design and Sample Surveys	**Competency:** Ability to design robust research studies and develop effective sampling strategies. **Knowledge:** Understanding the different types of research designs (e.g., experimental, correlation, descriptive). **Skills:** Proficiency in selecting appropriate research designs, developing sampling plans
5	Week 9-10: Data Collection and Interpretation	**Competency:** Ability to collect, interpret, and analyze data systematically. **Knowledge:** Understanding various data collection methods (e.g., surveys, interviews, observations) and basic data analysis techniques. **Skills:** Proficiency in designing data collection instruments, conducting data collection, and applying appropriate methods to interpret and analyze data.
6	Week 11-12: Intellectual Property	Apply learned concepts and competencies to real-world scenarios. Hands-on practice with programming assignments

5. Teaching learning process strategies

S/L	TLP Strategies	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Collaborative Learning	Encourage collaborative learning for improved competency application.
3	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Multiple Representations	Introduce topics in various representations to reinforce competencies

6	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
7	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
8	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

This section of regulations is applicable to all theory-based courses.
The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	3	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Program

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. Thestudentshavetoanswer5fullquestionsselectingonefullquestionfromeachmodule.
4. Marks scored will be proportionally scaled down to 50marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Formulate Research Questions:	Students should be able to Develop clear and focused research questions based on identified research gaps.
2	Design Research Studies:	Create robust research designs tailored to specific research questions using appropriate methodologies.
3	Conduct Literature Reviews:	Perform comprehensive and critical reviews of existing literature to support research objectives.
4	Apply Statistical Analysis:	Utilize statistical tools and techniques to analyze and interpret research data effectively.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on coding projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively in the context of error control coding.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with error control coding, including ensuring data integrity, maintaining confidentiality, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

CO's	DESCRIPTION OF THE OUTCOMES
M23MCS106.1	Apply research methodologies for formulating research problems

M23MCS106.2	Apply suitable methods for data collection, literature review, and interpretation.
M23MCS106.3	Identify the appropriate research design for a specific problem.
M23MCS106.4	Make use of research layout rules for thesis writing.
M23MCS106.5	Analyze the different case studies on intellectual properties, copyrights and patents.

CO-PO-PSO Mapping

CO's	PO1	PO2	PO3	PSO1	PSO2
M23MCS106.1	3	-		3	3
M23MCS106.2	3	-		3	3
M23MCS106.3	3	-	3	3	3
M23MCS106.4		-	3	3	3
M23MCS106.5		-	3	3	3
M23MCS106	3	-	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks.

10. Future with this Subject

•Advancing Innovation and Commercialization: Future research could focus on enhancing methodologies for identifying patentable inventions and optimizing intellectual property strategies to facilitate innovation and commercialization.

•Ethical and Legal Considerations in Research: There is a growing need for research into ethical frameworks and legal guidelines concerning intellectual property rights, ensuring responsible and fair practices in research and innovation.

•Global Intellectual Property Landscape: Research could explore comparative studies of intellectual property systems across different countries and regions, addressing challenges and opportunities for international collaboration and protection.

•Emerging Technologies and IP Challenges: With rapid advancements in fields like AI, biotechnology, and block chain, future studies could examine how these technologies impact intellectual property laws and practices, requiring innovative approaches to IP management.

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1st Semester	Professional Core Laboratory Course (PCL) Advanced DBMS laboratory	M23MCSL107

1. Prerequisites

Sl No	Proficiency	Description
1	Basic Database Concepts	Understanding of fundamental database concepts, including tables, relations, primary and foreign keys, and normalization
2	SQL Proficiency	Ability to write and execute SQL queries, including SELECT, INSERT, UPDATE, DELETE, and JOIN operations. Knowledge of advanced SQL features like subqueries, indexes, views and triggers
3	Database Design	Skills in designing ER diagrams and converting them into relational schema. Familiarity with normalization and denormalization techniques.
4	Programming skills	Experience with at least one programming language (e.g., Java, Python, C#) that can be used for database connectivity and operations. Understanding of how to use database connectors/APIs (like JDBC for Java, psycopg2 for Python)
5	Transaction Management:	Knowledge of transactions, ACID properties, and isolation levels. Understand the concurrency control and recovery
6	Data Modeling and Analysis	Experience with data modelling tools and techniques. Ability to perform data analysis using SQL and other tools.
7	Database Management Systems	Familiarity with popular DBMS software (e.g., MySQL, PostgreSQL, Oracle, SQL Server).. Understanding of database installation and configuration
8	**Advanced Topics**	Basic understanding of advanced topics like distributed databases, NoSQL databases, and big data technologies
9	Operating Systems and Networking	Basic knowledge of operating systems and networking concepts as they relate to database environments. Familiarity with command-line tools and shell scripting
10	Version Control Systems	Basic understanding of version control systems like Git for managing database-related code and scripts

2. Competencies

Sl No	Competency	Description
1	Advanced SQL Skills	**Knowledge**: Mastery in writing complex SQL queries, including advanced joins, sub queries, and set operations **Skills**: Proficiency in creating and managing stored procedures, functions, and triggers **Attitude:** Ability to optimize query performance and tuning indexes to improve throughput and reduce latency in distributed SQL databases.
2	Database Optimization:	**Knowledge:** Skills in performance tuning and query optimization. **Skills**: Understanding of indexing strategies and execution plans. **Attitude:** Knowledge of backup and disaster recovery strategies in SQL databases to ensure data durability and availability.
3	Database design and modelling:	Expertise in designing scalable and efficient database schemas. Proficiency in normalization, denormalization, and data modelling techniques.
4	Database security	**Knowledge**: Competence in implementing database security measures, including user authentication, authorization, and encryption.. Skills in managing roles and permissions **Skills**: Acquire knowledge of feature engineering techniques to extract relevant information from raw data and improve model performance.
5	Backup and recovery	**Knowledge**: Proficiency in database backup and recovery strategies.

		Skills: Regularly check the integrity of backups. Corruption or incomplete backups can render recovery impossible. **Attitude:** Ability to implement disaster recovery plans and perform point-in-time recovery.
6	NoSQL and NewSQL Databases:	**Knowledge**: Familiarity with NoSQL databases (e.g., MongoDB, Cassandra) and their data models. **Skills**: Experience in setting up, configuring, and maintaining NoSQL databases, including backup strategies, monitoring, and scaling. **Attitude:** Understanding of NewSQL database and their use cases.

3. Syllabus

ADVANCED DBMS LABORATORY SEMESTER-I			
Course Code	**M23MCSL107**	CIE Marks	40
Teaching Hours/Week (L:P: S)	1:0:2:0	SEE Marks	60
Credits	02	Exam Hours	100

Sl. NO	**Experiments** **PART A: The following experiments may be implemented on My SQL /ORACLE or other suitable RDBMS with support for object features**
1	**Develop a database application to demonstrate storing and retrieving of BLOB and CLOB objects.** • Write a binary large object (BLOB) to a database as either binary or character (CLOB) data, depending on the type of the field in your data source. To write a BLOB value to the database, issue the appropriate INSERT or UPDATE statement and pass the BLOB value as an input parameter. If your BLOB is stored as text, such as a SQL Server text field, pass the BLOB as a string parameter. If the BLOB is stored in binary format, such as a SQL Server image field, pass an array of type byte as a binary parameter. • Once storing of BLOB and CLOB objects is done, retrieve them and display the results accordingly.
2	**Develop a database application to demonstrate the representation of multi valued attributes, and the use of nested tables to represent complex objects. Write suitable queries to demonstrate their use.** • Consider Purchase Order Example: This example is based on a typical business activity: managing customer orders. Need to demonstrate how the application might evolve from relational to object-relational, and how you could write it from scratch using a pure object-oriented approach. • a. Show how to implement the schema -- Implementing the Application under the Relational Model -- using only Oracle's built-in data types. Build an object-oriented application on top of this relational schema using object views
3	**Design and develop a suitable Student Database application by considering appropriate attributes. Couple of attributes to be maintained is the Attendance of a student in each subject for which he/she has enrolled and Internal Assessment Using TRIGGERS, write active rules to do the following:** • Whenever the attendance is updated, check if the attendance is less than 85%; if so, notify the Head of the Department concerned. • Whenever, the marks in an Internal Assessment Test are entered, check if the marks are less than 40%; if so, notify the Head of the Department concerned. **Use the following guidelines when designing triggers:** • Use triggers to guarantee that when a specific operation is performed, related actions are performed. • Use database triggers only for centralized, global operations that should be fired for the triggering statement, regardless of which user or database application issues the statement. • Do not define triggers that duplicate the functionality already built into Oracle. For example, do not define triggers to enforce data integrity rules that can be easily enforced using declarative integrity constraints.

	• Limit the size of triggers (60 lines or fewer is a good guideline). If the logic for your trigger requires much more than 60 lines of PL/SQL code, it is better to include most of the code in a stored procedure, and call the procedure from the trigger. • Be careful not to create recursive triggers. For example, creating an AFTER-UPDATE statement trigger on the EMP table that itself issues an UPDATE statement on EMP causes the trigger to fire recursively until it has run out of memory. **Design, develop, and execute a program to implement specific Apriori algorithm for mining association rules. Run the program against any large database available in the public domain and discuss the results.** • Association rules are if/then statements that help uncover relationships between seemingly unrelated data in a relational database or other information repository. An example of an association rule would be "If a customer buys a dozen eggs, he is 80% likely to also purchase milk."
PART B: Develop a mini project	
1	**Conduction of Practical Examination:** All laboratory experiments (nos) are to be included for practical examination. Evaluation: 50% of the marks allotted for lab experiment execution and remaining 50% marks for the project demo. Students are allowed to pick one experiment from list of the experiment Strictly follow the instructions as printed on the cover page of answer script for breakup of marks **Change of experiment is allowed only once and marks allotted to the procedure part to be made zero.**

Assessment Details (both CIE and SEE)

CIE for Practical Courses (Program Based):

Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern is

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

Semester End Evaluation (SEE):

SEE for practical Course (Irrespective of Experiment or program based):

- SEE marks for practical course shall be 50 marks

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

- See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
- Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
- Duration of SEE shall be 3 hours.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Weeks1-2	Introduction, bsaic programs example and execution procedure
2	Weeks2-4:	Program1
3	Weeks4-6	Program2

4	Weeks6-8:	Program3
5	Week8-10.	Mini project.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Hands-on Lab Sessions**	• Focus on practical, hands-on lab sessions where students can apply theoretical concepts to real-world scenarios. • Use a variety of database management systems (e.g., MySQL, PostgreSQL, Oracle) to expose students to different environments. Libraries.
2	**Project-Based Learning**:	• Assign projects that require students to design, implement, and optimize a complete database system. • Encourage collaborative projects to foster teamwork and peer learning.
3	**Case Studies and Real-World Examples**:	• Integrate case studies that showcase real-world applications of advancedDBMS concepts. • Analyse and discuss these case studies in class to provide practical insights.
4	**Interactive Lectures and Demonstrations**	• Use interactive lectures to explain complex topics, supplemented by live demonstrations of database tools and techniques. • Encourage student participation and questions during these sessions.
5	**Problem-Solving Sessions**	• Conduct regular problem-solving sessions where students work on complex queries, optimization tasks, and troubleshooting exercises. • Provide immediate feedback and guidance
6	**Guest Lectures and Industry Experts**:	• Invite industry experts and guest lecturers to share their experiences and insights on advanced DBMS topics. • Organize Q&A sessions with these experts to allow students to gain practical knowledge and career advice.
7	**Research and Innovation**:	• Encourage students to explore current research topics in advanced DBMS and present their findings. • Support innovative ideas and projects that push the boundaries of traditional database management
8	**Assessment through Presentations and Reports**:	• Include assessments that require students to present their projects and findings, reinforcing their communication and presentation skills. • Require detailed project reports that document their design choices, implementation process, and lessons learned.

6. Assessment Details (both CIE and SEE)

Assessment Details (both CIE and SEE)

CIE for Practical Courses (Program Based):

Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern is

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

Semester End Evaluation (SEE):

SEE for practical Course (Irrespective of Experiment or program based):

- SEE marks for practical course shall be 50 marks

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

- See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
- Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
- Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Database management system	To provide a thorough understanding of advanced database management system concepts, including complex queries, optimization techniques, and transaction management.
2	SQL Skills	To develop advanced SQL skills for creating, managing, and optimizing databases using sophisticated queries, stored procedures, triggers, and functions
3	Modelling	To equip students with the ability to design efficient and scalable database schemas through advanced data modelling and normalization techniques.
4	Data Warehousing	To provide knowledge on data warehousing concepts, ETL processes, and the use of business intelligence tools for data analysis and reporting
5	Database Security	To emphasize the importance of database security, teaching students how to implement user authentication, authorization, encryption, and secure database management practices.

8. Course Outcomes and Mapping with POs/ PSOs

Course Outcomes

M23MCSL107.1	Demonstrate a deep understanding of complex database management system with various queries and attributes in practices.
M23MCSL107.2	Apply on advanced SQL queries, including subqueries, joins, stored procedures Blob, Lob and triggers.
M23MCSL107.3	Analyse NoSQL database models and big data technologies in appropriate scenarios

CO-PO-PSO Mapping

COs/Pos	PO1	PO2	PO3	PSO1	PSO2
M23MCSL107.1	**2**	**3**		**3**	**3**
M23MCSL107.2	**3**	**3**		**3**	**3**
M23MCSL107.3		**3**	**3**	**3**	**3**
M23MCSL107	**3**	**3**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**CO3**	**Total**

Program1	**10**				**10**
Program2		**10**			**10**
Program3			**10**		**10**
Mini project				**20**	**20**
Total	**10**	**10**	**10**	**20**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	**CO3**	**Total**
Program1	**20**				**20**
Program2		**20**			**20**
Program3			**20**		**20**
Mini project				**40**	**40**
Total	**20**	**20**	**20**	**40**	**100**

10. Future with this Subject

- **Career Advancement:** Database Administrator: Manage and maintain database systems, ensuring their performance, security, and availability Database Developer: Design and develop database applications, optimizing data storage and retrieval Data Analyst/Scientist: Analyze complex datasets to provide insights and support data-driven decision-making.
- **Expertise in Emerging Technologies:** Gain proficiency in NoSQL databases, big data technologies, and data warehousing solutions, which are increasingly in demand across various industries.
- **Research and Development** Engage in cutting-edge research in database technologies, contributing to advancements in areas like distributed databases, data mining, and machine learning.
- Entrepreneurial Opportunities: Leverage advanced DBMS skills to develop innovative data-driven solutions and start new ventures in the tech industry
- **Enhanced Problem-Solving Skills:** Develop strong analytical and problem-solving skills that are transferable to various domains, including software development, system architecture, and IT consultancy.
- **Improved Public Services:** Contribute to the development of efficient public services by designing robust database systems for government and non-profit organizations.

2nd Semester	Professional Core Course (PC) **Big Data Analytics**	M23MCS201

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Computer Science Knowledge	**Computer Programming:** Proficiency in a programming language such as Java, Python, or Scala. Understanding of object-oriented programming (OOP) principles is particularly beneficial. **Data Structures and Algorithms:** Knowledge of fundamental data structures (arrays, lists, stacks, queues, hash tables, trees, and graphs) and algorithms (sorting, searching, etc.).
2	Database Management Systems (DBMS)	**SQL:** Basic understanding of SQL for querying and managing databases. **Relational Databases:** Familiarity with relational database concepts such as normalization, indexing, transactions, and schema design.
3	Basic Statistics and Mathematics	**Descriptive Statistics:** Mean, median, mode, standard deviation, variance, and data distributions. **Probability:** Basic probability concepts and distributions. **Linear Algebra:** Vectors, matrices, and matrix operations.
4	Basic Understanding of Distributed Systems	**Distributed Computing Principles:** Basic concepts of distributed systems, such as distributed storage and processing.
5	Introduction to Cloud Computing	**Cloud Basics:** Understanding of what cloud computing is, its benefits, and basic cloud service models (IaaS, PaaS, SaaS). **Cloud Providers:** Familiarity with major cloud service providers like AWS, Azure, and Google Cloud.
6	Introduction to Big Data Concepts	**Big Data Fundamentals:** Awareness of what big data is, its significance, and its applications. **Data Formats:** Understanding of different data formats (structured, semi-structured, and unstructured).

2. Competencies

S/L	Competency	KSA Description
1	Getting an Overview of Big Data	**Knowledge:** Understanding of the definition and components of big data (Volume, Velocity, Variety, Veracity). Familiarity with the history and evolution of data management leading to big data. **Skills:** Ability to identify and categorize different types of data. Proficiency in analyzing big data characteristics and their implications. **Attitudes:** Appreciation of the transformative potential of big data in various sectors.
2	Introducing Hadoop Framework	**Knowledge:** Understanding of Hadoop architecture and its ecosystem components. **Skills:** Proficiency in setting up and configuring Hadoop environments. Ability to navigate and use the Hadoop Distributed File System (HDFS). **Attitudes:** Openness to learning and adopting new technologies.
3	Hadoop MapReduce Framework	**Knowledge:** Understanding of the MapReduce model, its parallel data flow, and fault tolerance mechanisms. **Skills:** Ability to write, compile, and execute MapReduce programs. Proficiency in optimizing MapReduce jobs for performance and efficiency.

		Attitudes: Problem-solving mindset to tackle data processing challenges.
4	Hadoop YARN Architecture and Tools to Analyze Data	**Knowledge:** Understanding of YARN architecture, schedulers, and backward compatibility. **Skills:** Ability to configure and manage YARN for resource scheduling and job management. Proficiency in using analytical tools to process and analyze big data. **Attitudes:** Openness to adopting new analytical tools and techniques.
5	Essential Hadoop Tools	**Knowledge:** Understanding of the data models and functionalities of Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie. **Skills:** Proficiency in using Apache Pig for data processing. Ability to use Apache Hive for data warehousing and querying. **Attitudes:** Appreciation of the importance of data processing and management tools in big data workflows.

3. Syllabus

Big Data Analytics SEMESTER – II			
Course Code	M23MCS201	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Understand the Fundamentals and Evolution of Big Data
- Analyze the Applications and Advantages of Big Data Analytics
- Master the Hadoop Framework and Ecosystem
- Develop Skills in Hadoop MapReduce and YARN
- Utilize Essential Hadoop Tools for Data Processing and Management

Module -1

Getting an Overview of Big Data: What is Big Data? History of Data Management – Evolution of Big Data, Structuring Big Data, Types of Data, Elements of Big Data-Volume, Velocity, Variety, Veracity, Big Data Analytics, Advantages of Big Data Analytics.
Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities, Use of Big Data in Detecting Fraudulent Activities in Insurance Sector, Use of Big Data in Retail Industry.
Text Book 1: Ch. 1, 2

Module -2

Introducing Hadoop Framework: Introducing Hadoop, How does Hadoop Function?, Cloud Computing and Big Data, Features of Cloud Computing, Cloud Deployment Models, Cloud Delivery Models, Cloud Services for Big Data, Cloud Providers in Big Data Market, In-Memory Computing Technology for Big Data. Hadoop Ecosystem, Hadoop Distributed File System, HDFS Architecture, Features of HDFS, HDFS Components, HDFS user commands.
Text Book 1: Ch. 3, 4
Text Book 2 : Ch. 3

Module -3

Hadoop MapReduce Frame work : The MapReduce Model, Map Reduce parallel data flow, Fault tolerance and speculative execution, Exploring the Features of Map Reduce, Working of MapReduce, Exploring Map and Reduce Functions, Techniques to Optimize MapReduce Jobs, Uses of Map Reduce Map Reduce Programming, compiling and running the Hadoop, word count example, using the streaming interface, using the pipes interface, commands- listing, killing, job status and Hadoop log management.
Text Book 1: Ch. 5
Text Book 2 : Ch. 5, 6

Module -4
Hadoop YARN Architecture and Tools to Analyze Data: Background of YARN, YARN Architecture, Working of YARN, YARN Schedulers, Backward Compatibility with YARN, YARN Configurations, YARN Commands. Analytical approaches, History of analytical tools, Introducing Popular analytical tools, Comparing various analytical tools.**Text Book 1: Ch. 11, 19**
Module -5
Essential Hadoop Tools : Using Apache Pig, Using Apache Hive, Using Apache sqoop, Apache sqoop import and export methods, apachesqoop version changes, Using Apache Flume, Using Apache Hbase, Using Apache OozieHBase Data Model Overview. **Text Book 2: Ch. 7**
Text Books: 1. Big Data: Black Book, DT Editorial Services, Wiley India Pvt. Ltd., 2018 Edition. 2. Hadoop 2 Quick Start Guide : Douglas Eadline , Pearson Education, 2016 Edition. **Reference Books:** 1. Hadoop Operations**:** Eric Sammer, O'Reilly Media, Inc., 2012 Edition. 2. Tom White, Hadoop: The Definitive Guide, 3rd Edition, O'reilly, 2012. 3. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, 4. IBM Corporation, 2012.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Module I - Getting an Overview of Big Data	**Week 1**:Introduction to Big Data, What is Big Data?History of Data Management – Evolution of Big Data, Structuring Big Data **Week 2:**Elements of Big Data, Volume, Velocity, Variety, Veracity Big Data Analytics, Advantages of Big Data Analytics, Use of Big Data in Various Sectors, Social Networking, Preventing Fraudulent Activities, Detecting Fraudulent Activities in Insurance Sector, Retail Industry
2	Week 3-5: Module II - Introducing Hadoop Framework	**Week 3:**Introduction to Hadoop, Cloud Computing and Big Data **Week 4:**Cloud Deployment Models, Cloud Delivery Models, Cloud Services for Big Data, Cloud Providers in Big Data Market **Week 5:**In-Memory Computing Technology for Big Data, Hadoop Ecosystem Hadoop ,Distributed File System (HDFS)
3	Week 6-8: Module III - Hadoop MapReduce Framework	**Week 6:**The MapReduce Model, MapReduce Parallel Data Flow, Fault Tolerance and Speculative Execution **Week 7:**Exploring the Features of MapReduce, Working of MapReduce Exploring Map and Reduce Functions **Week 8:**Techniques to Optimize MapReduce Jobs, Uses of MapReduce, MapReduce Programming
4	Week 9-10: Module IV - Hadoop YARN Architecture and Tools to Analyze Data	**Week 9:**Background of YARN, YARN Architecture, Working of YARN **Week 10:**YARN Schedulers, Backward Compatibility with YARN, YARN Configuration, YARN Commands
5	Week 11-12: Module V - Essential Hadoop Tools	**Week 11**:Using Apache Pig, Using Apache Hive, Using Apache Sqoop **Week 12**:Using Apache Flume, Using Apache HBase, Using Apache Oozie HBase Data Model Overview

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lectures and Presentations	Use multimedia presentations to explain key concepts like the definition of big data, its characteristics (Volume, Velocity, Variety, Veracity), and its evolution.
2	Class Discussions	Facilitate discussions on the advantages of big data analytics and its impact on different industries.
3	Case Study Analysis	Provide case studies on the use of big data in different industries and have students analyze and discuss them in groups.

4	Quizzes and Assessments:	Conduct quizzes to test students' understanding of the fundamental concepts of big data.
5	Interactive Lectures	Use diagrams and flowcharts to illustrate the Hadoop Distributed File System (HDFS) architecture and its features.
6	Hands-On Labs	Conduct lab sessions where students install and configure Hadoop on virtual machines.
7	Step-by-Step Tutorials	Provide detailed tutorials on the MapReduce model, including writing, compiling, and running MapReduce programs.
8	Lectures and Diagrams	Use diagrams to explain the YARN architecture and its components.
9	Tool-Specific Lectures:	Provide detailed lectures on using Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie.
10	Blended Learning	Combine online resources, video tutorials, and in-class activities to provide a diverse learning experience.

6. Assessment Details (both CIE and SEE)

CIE:

Theory Course with 3 Credits: Professional Core Course (PC)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

SEE:

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the Fundamentals of Big Data	Define what constitutes big data and describe its key characteristics: Volume, Velocity, Variety, and Veracity. Trace the history and evolution of data management, leading to the emergence of big data. Differentiate between structured, semi-structured, and unstructured data.
2	Analyze Big Data Analytics and Its Applications	Explain the core elements of big data analytics and its advantages in various industries. Evaluate the use of big data in social networking to enhance user experience and engagement. Assess the role of big data in preventing and detecting fraudulent activities, particularly in the insurance and retail sectors.
3	Master the Hadoop Framework	Describe the architecture and components of the Hadoop ecosystem, including HDFS and MapReduce. Explain how Hadoop functions, including the role of cloud computing in big data processing. Identify key cloud deployment and delivery models, and explain the features of cloud computing relevant to big data.

4	Develop Proficiency in Hadoop Distributed File System (HDFS)	Understand the HDFS architecture, its features, and components. Use HDFS user commands to manage and manipulate data within the Hadoop ecosystem. Describe the in-memory computing technology for big data and its benefits.
5	Gain Skills in Hadoop MapReduce Framework	Explain the MapReduce model, including its parallel data flow, fault tolerance, and speculative execution. Write, compile, and execute MapReduce programs, and optimize these jobs for better performance. Use the streaming and pipes interfaces for different data processing tasks in MapReduce.
6	Explore Hadoop YARN Architecture and Analytical Tools	Describe the background, architecture, and working of YARN, including its schedulers and configurations. Execute YARN commands and understand its backward compatibility. Compare various popular analytical tools, their history, and their applications in big data analysis.
7	Utilize Essential Hadoop Tools for Data Processing	Use Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie for specific data processing tasks. Perform data import and export operations using Apache Sqoop, and understand its version changes. Implement data models in HBase and manage workflows with Apache Oozie.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS201.1	Understand and apply Big Data Concepts and Analytics
M23MCS201.2	Analyze and apply Big Data analytics in various sectors such as social networking, fraud detection, and retail.
M23MCS201.3	Describe the Hadoop framework and its components, including cloud computing and HDFS.
M23MCS201.4	Develop and execute MapReduce programs, optimizing them for better performance
M23MCS201.5	Utilize essential Hadoop tools like Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie for data processing

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS201.1	**3**		**3**	**2**	**2**
M23MCS201.2	**3**		**3**	**2**	**2**
M23MCS201.3			**3**	**2**	**3**
M23MCS201.4	**3**	**2**	**3**	**3**	**3**
M23MCS201.5	**3**	**2**	**3**	**3**	**3**
M23MCS201	**3**	**2**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The "Big Data Analytics" course in the second semester of the M.Tech program provides a comprehensive foundation in Big Data and Hadoop technologies, opening various career paths and opportunities in multiple industries. With the growing importance of data-driven decision-making, professionals skilled in Big Data analytics and Hadoop are in high demand. The integration of emerging technologies will further expand the scope and impact of Big Data, making it a pivotal field for future innovations.

- **Career Opportunities:** Data scientists and analysts are in high demand as organizations seek to extract meaningful insights from their data. With skills in Big Data and Hadoop technologies, professionals can analyze large datasets, identify trends, and make data-driven decisions to benefit businesses.
- **Research and Development:** Professionals with expertise in Big Data can engage in research to develop advanced analytics techniques. This includes predictive analytics, real-time data processing, and innovative ways to handle unstructured data.
- **Machine Learning and AI Integration:** Big Data plays a crucial role in training machine learning models. Researchers can explore the integration of Big Data with AI to create smarter, more efficient algorithms. Leads to advancements in AI technologies, improving automation, decision-making, and personalized services.
- **Emerging Technologies:**IoT devices generate massive amounts of data. Big Data technologies are essential for collecting, processing, and analyzing this data to derive actionable insights. Facilitates smart cities, industrial automation, and improved resource management.
- **Industry Applications:** Big Data analytics can revolutionize healthcare by providing insights into patient care, treatment outcomes, and operational efficiency. It helps in predictive modelling for disease outbreaks and personalized medicine. Improves patient outcomes, reduces costs, and enhances the overall efficiency of healthcare systems.
- **Social Media and Networking:** Social media platforms use Big Data to analyze user behavior, content trends, and advertising effectiveness. Hadoop's ability to handle vast amounts of unstructured data makes it ideal for this sector. Enhances user engagement, optimizes content delivery, and improves targeted advertising.

2nd Semester	Integrated Professional Core Course (IPC) INTERNET OF THINGS	M23MCS202

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Knowledge of Networking:	Understanding of basic networking concepts, including IP addressing, subnets, and protocols.
2	Fundamentals of Programming:	Proficiency in at least one programming language (e.g., Python, C/C++), with a focus on understanding programming logic and syntax.
3	Introduction to Embedded Systems:	Familiarity with the basics of embedded systems and microcontrollers, including how they function and are programmed.
4	Basic Understanding of Data Structures and Algorithms:	Knowledge of fundamental data structures (arrays, linked lists, stacks, queues) and basic algorithms (sorting, searching).
5	Basic Digital Logic Design:	Understanding of digital logic circuits, including binary arithmetic, logic gates, and basic combinational and sequential circuits.
6	Introductory Course in Computer Networks:	Completion of an introductory course in computer networks to understand network layers, protocols, and basic network configurations.
7	Basic Knowledge of Databases:	Understanding of database concepts and basic SQL for managing and retrieving data.

2. Competencies

S/L	Competency	KSA Description
1	Technical Competencies:	**Knowledge:** Understanding the concept and motivations behind IoT. Familiarity with IPv6 and its role in IoT. **Skills:** Knowledge of various IoT definitions and frameworks. Understanding smart metering, health/body area networks, city automation, automotive applications, home automation, smart cards, tracking, and surveillance. **Attitude:** Comprehension of control application examples and other myriad applications.
2	Analytical Competencies:	**Knowledge:** Evaluating the effectiveness and efficiency of various IoT frame works and technologies. Assessing the role and impact of IPv6 in IoT. **Skills:** Analyzing real-world IoT applications in different domains such as home automation, city automation, health networks, etc. **Attitude:** Evaluating case studies illustrating IoT design and its implementation.
3	Practical Competencies:	**Knowledge:** Designing and implementing IoT frameworks and applications. Applying knowledge of basic nodal capabilities in practical scenarios. **Skills:** Designing and developing systems using binary adders, subtractors, comparators, decoders, encoders, and multiplexers. Utilizing programmable logic devices in IoT solutions. **Attitude:** Implementing IoT connectivity solutions using WPAN and cellular/mobile network technologies. Deploying IPv6 technologies and implementing migration strategies.

3. Syllabus

INTERNET OF THINGS SEMESTER – II			
Course Code	**M23MCS202**	CIE Marks	**50**

Number of Lecture Hours/Week(L: T: P: S)	**(3:0:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course objectives: This course will enable students to:

- To provide students with a comprehensive understanding of the Internet of Things, including its definitions, frameworks, and basic nodal capabilities.
- To explore various real-world applications of IoT in areas such as smart metering, health networks, city automation, automotive systems, home automation, and surveillance.
- To impart knowledge on fundamental IoT mechanisms and key technologies, including object identification, structural aspects, and emerging standards.
- To examine the connectivity technologies used in IoT, focusing on both Layer ½ and Layer 3 connectivity, including WPAN, cellular, and IPv6 technologies.
- To enable students to apply IoT concepts and technologies through case studies and practical examples in home automation, smart cities, environmental monitoring, and agricultural productivity.

Module -1

What is 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.

Module -2

Logic Design with MSI Components and Programmable Logic Devices: Binary Adders and Subtractors, Comparators, Decoders, Encoders, Multiplexers, Programmable Logic Devices (PLDs) (Section 5.1 to 5.7 of Text 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

Module -3

Layer ½Connectivity: 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 Tunnelling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.

Module -4

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

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.

Text Books:

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

Reference Books:

1. The Internet of Things Michael Miller Pearson 2015 First Edition, Designing Connected Products Claire Rowland, Elizabeth Goodman et.al O'Reilly First Edition, 2015
2. Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications by Daniel Minoli, Wiley 2013

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to IoT	• What is The Internet of Things? Overview and Motivations • Examples of Applications • IPv6 Role, Areas of Development, and Standardization • Scope of the Present Investigation
2	Week 3-4: IoT Definitions and Frameworks	• IoT Definitions • IoT Frameworks • Basic Nodal Capabilities
3	Week 5-6: IoT Application Examples	• Overview of IoT Applications • Smart Metering/Advanced Metering Infrastructure • Health/Body Area Networks • City Automation • Automotive Applications
4	Week 7-8: IoT Application Examples (Continued)	• Home Automation • Smart Cards • Tracking • Over-The-Air Passive Surveillance/Ring of Steel • Control Application Examples • Myriad Other Applications
5	Week 9-10: Logic Design with MSI Components and PLDs	• Binary Adders and Subtractors • Comparators • Decoders • Encoders • Multiplexers • Programmable Logic Devices (PLDs)
6	Week 11-12: Fundamental IoT Mechanisms and Key Technologies	• Identification of IoT Objects and Services • Structural Aspects of the IoT • Key IoT Technologies
7	Week 12-13:Evolving IoT Standards	• Overview and Approaches • IETF IPv6 Routing Protocol for RPL Roll • Constrained Application Protocol • Representational State Transfer (REST)
8	Week 13-14:Layer ½ Connectivity	• Wireless Technologies for the IoT • WPAN Technologies for IoT/M2M • Cellular and Mobile Network Technologies for IoT/M2M
9	Week 14-15: 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
10	Week 15: Data Analytics for IoT	• Introduction to Data Analytics for IoT • Apache Hadoop • Using HadoopMapReduce for Batch Data Analysis • Apache Oozie • Apache Spark • Apache Storm • Using Apache Storm for Real-time Data Analysis

		• Structural Health Monitoring Case Study

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Interactive Lectures	Use interactive lectures to introduce new concepts. Incorporate questions and discussions to engage students.
2	Coding Sessions:	To provide practical experience in designing and implementing IoT solutions.
3	Project-Based Learning	Objective: To apply theoretical knowledge to real-world problems and develop practical IoT solutions.
4	Case Studies and Real-World Examples	Objective: To illustrate the application of IoT concepts and technologies in various domains.
5	Flipped Classroom and Blended Learning	Objective: To enhance understanding and retention of IoT concepts through active learning.

6. **Assessment Details (both CIE and SEE)**

CIE:

Theory Course with 4 credits: Integrated Professional Core Course (IPC)

CIE Split up for Integrated Professional Core Course (IPC)

Components		Number	Weightage	Max. Marks	Min. Marks
Theory (A)	Internal Assessment-Tests (A)	2	60%	15	06
	Assignments/Quiz/Activity (B)	2	40%	10	04
	Total Marks		100%	25	10
Components		Number	Weightage	Max. Marks	Min. Marks
Laboratory(B)	Record Writing	Continuous	60%	15	06
	Test at the end of the semester	1	40%	10	04
	Total Marks		100%	25	10

Final CIE Marks =(A) + (B)

SEE:

Theory Course with 4, 3 and 2 Credits: Integrated Profession Core Course (IPC)

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- The question paper may include at least one question from the laboratory component.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Understand the Fundamentals of IoT**	Grasp the basic concepts, definitions, and frameworks of IoT. Learn about the motivations driving the development and adoption of IoT technologies.

2	**Explore IoT Applications:**	Identify and describe various applications of IoT, such as smart metering, health/body area networks, city automation, automotive applications, home automation, smart cards, tracking, over-the-air surveillance, and control applications.
3	**Learn Key IoT Technologies and Mechanisms:**	Understand the fundamental mechanisms of IoT and key technologies such as identification of IoT objects and services, and structural aspects of IoT.
4	**Study IoT Standards and Protocols**:	Gain knowledge of evolving IoT standards and protocols, including IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol (CoAP), Representational State Transfer (REST), ETSI M2M, 3GPP Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, and Zigbee IP (ZIP).
5	**Develop Practical IoT Solutions:**	Design and implement IoT systems using MSI components and programmable logic devices, including binary adders and subtractors, comparators, decoders, encoders, multiplexers, and programmable logic devices (PLDs).
6	**Evaluate IoT Privacy and Security:**	Understand the importance of privacy and security in IoT applications and evaluate different techniques to ensure data protection and privacy preservation in IoT systems.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS202.1	Explain the basic concepts and frameworks of the Internet of Things.
M23MCS202.2	Describe various IoT applications in different fields like healthcare and urban management.
M23MCS202.3	Understand key IoT technologies and standards such as IPv6 and Zigbee.
M23MCS202.4	Evaluate and explain connectivity solutions for IoT, including WPAN and cellular networks.
M23MCS202.5	Design and implement IoT solutions for real-world problems in areas like home automation and smart cities.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS202.1	**3**			**3**	**3**
M23MCS202.2	**3**			**3**	**3**
M23MCS202.3		**3**		**3**	**3**
M23MCS202.4			**3**	**3**	**3**
M23MCS202.5			**3**	**3**	**3**
M23MCS202	**3**	**3**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					
Module 2		**10**				
Module 3			**10**			
Module 4				**10**		
Module 5					**10**	
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					
Module 2		**20**				
Module 3			**20**			
Module 4				**20**		
Module 5					**20**	
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

10. Future with this Subject

The field of the Internet of Things (IoT) is rapidly evolving and presents numerous opportunities for those who gain expertise in this area. Here are some potential future prospects for students who complete this course:

1. Career Opportunities in Diverse Industries

Smart Cities and Urban Planning: Design and implement smart city solutions that enhance urban living through intelligent infrastructure, energy management, and public safety systems.

Healthcare: Develop IoT-enabled health monitoring systems, medical devices, and body area networks that improve patient care and facilitate remote diagnostics.

Automotive Industry: Work on connected vehicle technologies, autonomous driving systems, and vehicular networks that enhance transportation safety and efficiency.

Agriculture: Create smart farming solutions that optimize resource usage, monitor crop health, and improve yield through IoT-based systems.

Home Automation: Develop innovative home automation products and solutions that enhance convenience, security, and energy efficiency.

2. Advanced Research and Development

Innovative IoT Applications: Engage in cutting-edge research to explore new applications of IoT in fields like environmental monitoring, industrial automation, and smart grids.

IoT Security: Focus on developing advanced security protocols and privacy-preserving technologies to protect IoT systems from cyber threats.

Interoperability and Standards: Contribute to the development of global IoT standards and protocols that ensure seamless interoperability between diverse IoT devices and platforms.

3. Entrepreneurial Ventures

IoT Startups: Leverage IoT knowledge to create startups that offer innovative IoT products and services, addressing specific market needs and challenges.

Tech Consulting: Provide consulting services to businesses looking to adopt IoT solutions, helping them integrate IoT technologies into their operations and achieve digital transformation.

4. Continued Education and Specialization

Advanced Degrees: Pursue advanced degrees (Master's, Ph.D.) in related fields such as computer science, electrical engineering, or data science with a focus on IoT.

Specialization: Specialize in niche areas within IoT, such as IoT analytics, edge computing, or IoT hardware design, to become an expert in a specific domain.

5. Impact on Society and Environment

Sustainability Initiatives: Develop IoT solutions that contribute to sustainability by optimizing resource usage, reducing waste, and enhancing energy efficiency.

Public Safety and Disaster Management: Create IoT systems that improve public safety and facilitate efficient disaster management and response through real-time monitoring and alerts.

2nd Semester	Professional Elective Course (PE) **Wireless Network and Mobile Computing**	M23MCS203A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Networking Concepts	Familiarity with concepts such as IP addressing, subnetting, routing, and switching is essential. This forms the basis for understanding how data is transmitted over networks..
2	Telecommunications	Knowledge of how data is transmitted over different mediums (wired and wireless), modulation techniques, signal propagation, and spectrum management..
3	Operating Systems	Understanding of how operating systems manage resources, handle processes, and interact with hardware, especially in the context of mobile operating systems (e.g., Android, iOS).
4	Programming Skills	Basic programming knowledge, especially in languages relevant to mobile application development (e.g., Java, Swift, K), and scripting languages (e.g., Python) for network automation and analysis
5	Wireless Technologies	Familiarity with different wireless technologies such as Wi-Fi (802.11 standards), Bluetooth, cellular networks (3G, 4G, and emerging 5G), and their respective architectures and protocols.
6	Security Fundamentals	Understanding of basic security principles and protocols relevant to wireless networks, including encryption, authentication mechanisms, and secure communication
7	Database Management	Basic knowledge of databases and their role in mobile applications and networked systems
8	Internet of Things (IoT)	Awareness of IoT concepts and how they integrate with wireless networks and mobile computing environments.

2. Competencies

S/L	Competency	KSA Description
1	Basic Networking Concepts	**Knowledge:** • Understanding of the basic components of a network: nodes (devices), links (communication channels), and protocols. • Familiarity with the OSI (Open Systems Interconnection) and TCP/IP (Transmission Control Protocol/Internet Protocol) models. **Skills:** • Ability to configure network devices (routers, switches, access points) based on network requirements. • Proficiency in troubleshooting network connectivity issues using tools like ping, trace route, and network analyzers.. **Attitudes:** • Recognition of the importance of network security and adherence to best practices to mitigate risks. • Willingness to adapt to new networking technologies and methodologies as they emerge.
2	Telecommunications	**Knowledge:** • Understanding of basic telecommunications principles, including signal transmission, modulation techniques, and multiplexing. • Knowledge of transmission media types (e.g., guided – twisted pair, coaxial cable, opticalfibre; unguided – wireless). **Skills:** • Ability to design and implement telecommunication networks based on specific requirements and constraints.

		• Skill in configuring network devices (e.g., routers, switches, access points) to ensure optimal performance and reliability. **Attitudes:** • Recognition of the critical importance of reliability and security in telecommunication networks. • Commitment to implementing best practices to safeguard network integrity and protect against threats.
3	Operating Systems	**Knowledge:** • Understanding of fundamental operating system concepts such as processes, threads, scheduling, synchronization, and deadlock handling.. **Skills:** • Ability to install and configure different operating systems (e.g., Windows, Linux distributions) on various hardware platforms. **Attitudes:** • Recognition of the importance of maintaining system reliability and stability in operating system environments.
4	Programming Skills	**Knowledge:** • Understanding of programming language syntax, semantics, and best practices. • Proficiency in at least one high-level programming language (e.g., Python, Java, C/C++, JavaScript). **Skills:** • Ability to write clean, efficient, and well-documented code in various programming languages. • Proficiency in implementing algorithms and data structures to solve computational problems.. **Attitudes:** • Recognition of the importance of writing clean, maintainable code and adhering to coding standards and best practices
5	Wireless Technologies	**Knowledge:** • Understanding of basic wireless communication principles including modulation techniques (e.g., AM, FM, Phase Shift Keying), signal propagation, and interference. **Skills:** • Ability to design and deploy wireless networks based on organizational requirements and constraints. **Attitudes:** • Recognition of the importance of maintaining reliable wireless network connectivity and optimizing performance. • Commitment to implementing best practices to ensure high availability and quality of service (QoS) in wireless networks.
6	Security Fundamentals	**Knowledge:** • Understanding of fundamental security concepts such as confidentiality, integrity, availability **Skills:** • Ability to conduct security assessments (e.g., vulnerability assessments, penetration testing) to identify and mitigate security risks. **Attitudes:** • Recognition of the critical importance of cyber security and commitment to maintaining a high level of security excellence.
7	Database Management	**Knowledge:**

		• Understanding of fundamental concepts of databases such as data models (relational, hierarchical, network), schemas, and data manipulation languages (e.g., SQL). **Skills:** • Proficiency in database administration tasks such as installation, configuration, backup and recovery, and security management. • Skill in monitoring database performance, optimizing system parameters, and ensuring data integrity and availability.. **Attitudes:** • Recognition of the importance of maintaining data integrity and accuracy in database management practices.
8	Internet of Things (IoT)	**Knowledge:** • Understanding of the basic concepts and principles of IoT, including IoT architecture, components (sensors, actuators, IoT devices), and communication protocols **Skills:** • Ability to develop and prototype IoT devices using embedded systems, sensors, actuators, and microcontrollers. • Skill in programming IoT devices and implementing communication protocols for data transmission.. **Attitudes:** • Openness to exploring innovative IoT solutions and applications to address real-world challenges. • Creativity in designing and implementing novel IoT devices and applications

3. Syllabus

Wireless Network and Mobile Computing SEMESTER – III			
Course Code	**M23MCS203A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory + 8-10 Lab slots**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course objectives: This course will enable students to: • Manage TCP/IP and prepare foundation for future Networks • enabling technologies for wireless networking and mobile computing • wireless networking standards • mobile computing applications			
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, GPRS and Packet Data Network, GPRS Network Architecture, GPRS Network Operations, Data Services in GPRS, Applications for GPRS, Billing and Charging in GPRS			
Module -2			

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, 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.
Textbook: **1.** Mobile Computing, Technology, Applications and Service Creation Ashok Talukder, Roopa Yavagal, Hasan Ahmed Tata McGraw Hill 2nd Edition, 2010. **2.** Mobile and Wireless Design Essentials Martyn Mallik Wiley India 2003 **Reference Books** **1.** Mobile Computing Raj kamal Oxford University press 2007, Wireless Communications and Networks, 3G and Beyond ItiSaha Misra Tata McGraw Hill 2009. 2. Mobile and Wireless Design Essentials Martyn Mallik Wiley India 2003

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Mobile Computing Architecture:	Describes about mobile computing architecture, GSM Architecture, Entities, Call routing in GSM, PLMN Interface, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management,
2	Week 3-4: Wireless Networks : Global Systems for Mobile Communication (GSM):	Describes about wireless technology, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices.
3	Week 5-6: Mobile Client:	**Mobile Client:** Moving beyond desktop, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices.
4	Week 7-8: Mobile Operating Systems:	Describes WinCE, Palm OS, Symbian OS, Linux, Proprietary OS Client Development.
5	Week 9-10: Building Wireless Internet Application**s**	Thin client overview: Architecture, the client, Middleware, messaging Servers.
6	Week 11-12: J2ME	Introduces to, CDC, CLDC, MIDP; Programming for CLDC, MIDlet model, Provisioning, MIDlet life-cycle, Creating new application.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description

1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of network concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies

6. Assessment Details (both CIE and SEE)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

3. Components		Number	Weightage	Max. Marks	Min. Marks
(i)	**Internal Assessment-Tests (A)**	**3**	**50%**	**25**	**10**
(ii)	**Assignments/Quiz/Activity (B)**	**2**	**50%**	**25**	**10**
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Wireless Networking Fundamentals	• Describe the principles of wireless communication. • Explain the differences between various wireless technologies (e.g., Wi-Fi, Bluetooth, cellular networks). • Define key terms such as frequency bands, modulation techniques, and signal propagation
2	Wireless Network Architecture and Protocols	• Identify the components of a wireless network (e.g., access points, routers, clients). • Describe the protocols used in wireless networks (e.g., IEEE 802.11 standards, TCP/IP stack in wireless environments
4	Mobile Computing Devices and Technologies	• Define mobile computing and its evolution. • Identify different types of mobile computing devices (e.g., smart phones, tablets, wearables) and their features.

5	Mobile Operating Systems and Applications	• Compare and contrast mobile operating systems (e.g., Android, iOS). • Discuss the architecture of mobile applications and their development frameworks (e.g., Android Studio, Xcode).
6	Mobile Security and Privacy	• Identify common security threats to mobile devices and networks (e.g., malware, phishing). • Discuss security measures to protect mobile devices (e.g., encryption, secure authentication methods).
7	Location-Based Services and IoT Integration	• Explain the concept of location-based services (LBS) and their applications in mobile computing. • Discuss how mobile computing integrates with Internet of Things (IoT) devices and services.
8	Mobile Application Development and Optimization	• Outline the steps involved in mobile application development (e.g., UI/UX design, coding, testing). • Optimize mobile applications for performance, battery efficiency, and responsiveness.
9	Emerging Trends in Wireless Networking and Mobile Computing	• Explore current trends in wireless networking (e.g., Wi-Fi 6, mesh networks) and mobile computing (e.g., edge computing, augmented reality). • Discuss the impact of emerging technologies (e.g., 5G, AI in mobile) on future wireless and mobile computing scenarios

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS203A.1	Apply state of art techniques in wireless communication
M23MCS203A.2	Analyse the third-generation network and Mobile OS and Computing Environment technologies
M23MCS203A.3	Design programs for CLDC, MIDP let model and security concerns using Wireless Languages: Markup Languages, HDML, WML, HTML, cHTML, XHTML, VoiceXML
M23MCS203A.4	Understand and apply client architecture for wireless communication
M23MCS203A.5	Develop Programming for CLDC, MIDlet model, Provisioning, MIDlet life-cycle, Creating new application

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS203A.1	2	-	-	-	2
M23MCS203A.2		2	-	-	3
M23MCS203A.3	-		2	2	3
M23MCS203A.4	2	3		2	3
M23MCS203A.5	2	2		3	3
M23MCS203A	2	2	2	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO2	CO3	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**

Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO2	CO3	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

5G Evolution and Adoption:

- Continued deployment and optimization of 5G networks worldwide, offering unprecedented speed, reliability, and low latency. This will enable seamless connectivity for high-definition video streaming, real-time gaming, and immersive experiences like AR/VR.
- Expansion of 5G into diverse industries such as healthcare (telemedicine, remote surgery), transportation (autonomous vehicles, smart logistics), and manufacturing (smart factories, industrial IoT).

Internet of Things (IoT) Advancements:

- Rapid growth in the number and diversity of IoT devices, leading to a highly interconnected world where smart devices communicate autonomously for improved efficiency and decision-making
- Integration of edge computing with IoT to process data closer to the source, reducing latency and enhancing real-time analytics capabilities. This will support critical applications in smart cities, environmental monitoring, and personalized healthcare.

Artificial Intelligence (AI) and Machine Learning (ML):

- Integration of AI and ML algorithms into mobile devices and wireless networks to optimize performance, predict user behavior, and automate processes. This includes AI-powered voice assistants, personalized recommendations, and predictive maintenance in IoT deployments.
- AI-enabled network management tools for autonomous network optimization, predictive maintenance, and cybersecurity threat detection to ensure robust and secure wireless connectivity.

Security and Privacy Enhancements:

- Heightened focus on cyber security with the implementation of advanced encryption standards, block chain for secure transactions, and biometric authentication for mobile devices. This will address evolving cyber threats and protect sensitive data across wireless networks and IoT ecosystems.
- Stricter privacy regulations and frameworks governing data collection, storage, and usage to protect user privacy rights and build trust in digital interactions.

Emerging Technologies and Applications:

- Continued advancements in augmented reality (AR), virtual reality (VR), and mixed reality (MR) applications for immersive gaming, virtual tourism, remote collaboration, and training.
- Exploration of block chain technology for decentralized IoT networks, secure peer-to-peer transactions, and

Environmental and Sustainability Initiatives:

- Integration of energy-efficient technologies in wireless networks and mobile devices to reduce carbon footprint and enhance sustainability. This includes energy harvesting techniques, smart grids, and eco-friendly IoT solutions.

Global Connectivity and Digital Inclusion:

- Efforts to bridge the digital divide with initiatives aimed at expanding broadband access in underserved regions through satellite internet, mesh networks, and low-earth orbit (LEO) satellites.

2nd Semester	Professional Elective Course (PE) **Natural Language Processing**	M23MCS203B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Foundational Mathematics and Statistics	**Linear Algebra:** Proficiency in linear algebra, including vectors, matrices, eigen values, and eigen vectors. **Calculus:** Understanding of differential and integral calculus, especially optimization techniques. **Probability and Statistics:** Strong grasp of probability theory, statistical inference, and probabilistic models.
2	Introduction to Machine Learning	**Supervised and Unsupervised Learning:** Solid understanding of machine learning algorithms, including classification, regression, clustering, and evaluation metrics. **Neural Networks:** Familiarity with neural network architectures, training processes, and applications in NLP.
3	Programming Proficiency	**Python Programming:** Advanced proficiency in Python, with experience using NLP libraries such as NLTK, spaCy, and machine learning frameworks like Tensor Flow and PyTorch. **Algorithm and Data Structures:** Strong understanding of fundamental algorithms and data structures, including trees, graphs, and dynamic programming.
4	Linguistics	**Syntax and Semantics:** Basic knowledge of syntactic structures and semantic meaning in natural languages. **Morphology and Phonology:** Understanding of word formation processes and sound structures in languages.
5	Core Computer Science Knowledge	**Data Structures and Algorithms:** Advanced coursework or experience in data structures and algorithms. **Theory of Computation:** Understanding of formal languages, automata theory, and complexity theory.

2. Competencies

S/L	Competency	KSA Description
1	Understanding the Origins and Challenges of NLP	**Knowledge:** Understanding of the fundamental concepts such as syntax, semantics, and pragmatics in the context of NLP. **Skills:** Able to analyze the impact of these challenges on the development and application of NLP technologies. Able to evaluate different NLP models and methods in terms of their efficacy and applicability. **Attitudes:** Curiosity about the development of technology, Persistence in overcoming obstacles and challenges in NLP.
2	Implementing and Applying Part-of-Speech Tagging	**Knowledge:** Basic concepts of part-of-speech (POS) tagging. Common challenges in POS tagging, such as ambiguity and unknown words. Different POS tagging methods and algorithms (e.g., rule-based, statistical, machine learning). **Skills:** Able to apply POS tagging to various corpora effectively.Able to evaluate and improve the accuracy of POS tagging systems. **Attitudes:** Analytical mindset for understanding language structures, Persistence in improving tagging performance.
3	Applying Dependency-Path Kernels for Relation Extraction	**Knowledge:** Understanding how dependency paths represent syntactic and semantic relationships. Common challenges in relation extraction using dependency paths. **Skills:** Implement dependency-path kernel methods for extracting relationships between words in text. Evaluate the effectiveness of dependency-path kernels in various NLP tasks through experimental evaluation. **Attitudes:** Curiosity and willingness to explore advanced NLP techniques. Attention to detail in model implementation and evaluation. Persistence in refining and optimizing NLP models.

4	Utilizing Latent Semantic Analysis (LSA) for Text Cohesion Measurement	**Knowledge:** Understanding the concepts of textual cohesion and its importance in NLP. Techniques for identifying and measuring text cohesion using LSA. **Skills:** Use tools like Coh- Metrix to apply LSA in evaluating text types. Able to evaluate and improve the accuracy of cohesion measurement using LSA. **Attitudes:** Analytical mindset to understand and apply complex models. Commitment to continuous learning and improvement in text analysis techniques.
5	Designing and Evaluating Information Retrieval Systems	**Knowledge:** Understanding of classical, non-classical, and alternative IR models. Key features and functionalities of IR systems. Methods for assessing and comparing IR models. **Skills:** Design and implement effective IR systems based on various models. Evaluate the performance of IR systems using appropriate metrics. Fine-tune IR systems for improved accuracy and relevance. **Attitudes:** Analytical thinking for system design and evaluation. Persistence in improving IR system performance.

3. Syllabus

Natural Language Processing SEMESTER – II			
Course Code	M23MCS203B	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- To develop a Comprehensive Understanding of NLP Foundations.
- To master Word-Level and Syntactic Analysis Techniques.
- To enhance Relation Extraction and Semantic Analysis Capabilities.
- To apply Advanced Information Retrieval and Text Mining Techniques.
- To design and Evaluate Information Retrieval Systems and Utilize Lexical Resources.

Module -1

Overview And Language Modelling: Overview: Origins and challenges of NLP- Language and Grammar- Processing Indian Languages-NLP Applications-Information Retrieval, Language Modelling: Various grammars - based Language Models-Statistical Language Model.

Module -2

WORD LEVEL AND SYNTACTIC ANALYSIS: Word Level Analysis: Regular Expressions- Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency-Parsing-Probabilistic Parsing.

Module -3

Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation. Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations. A Case Study in Natural Language Based Web Search: In Fact System Overview, The Global Security.org Experience.

Module -4

Evaluating Self-Explanations in iSTART: Word Matching, Latent Semantic Analysis, and Topic Models: Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems, Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures: Introduction, Cohesion, Coh- Matrix, Approaches to Analyzing Texts, Latent Semantic Analysis, Predictions, Results of Experiments. Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modelling: Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results. Evolving Explanatory Novel Patterns for Semantically-Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining.

Module -5
INFORMATION RETRIEVAL AND LEXICAL RESOURCES: Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval–valuation Lexical Resources: World Net- Frame Net-Stemmers-POS Tagger- Research Corpora.
Textbooks: 1.Natural Language Processing and Information Retrieval, Tanveer Siddiqui, U.S.Tiwary, Oxford University Press, 2008 2.Natural Language Processing and Text Mining, Anne Kao and Stephen R. Potee, Springer-Verlag London Limited, 2007 **Reference books:** 1.Speech and Language Processing: An introduction to Natural Language Processing ,Computational Linguistics and Speech Recognition ,Daniel Jurafsky and James H Martin, Prentice Hall, 20082ndEdition 2. Natural Language Understanding, James Allen, Benjamin/Cummings publishing company, 2ndedition,1995. 3. Information Storage and Retrieval systems, Gerald J. Kowalski and Mark.T. Maybury, Kluwer academic Publishers, 2000 4. Natural Language Processing with Python, Steven Bird, Ewan Klein, EdwardLoper,O'ReillyMedia,2009

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: OVERVIEW AND LANGUAGEMODELING	**Knowledge:** Understanding the historical evolution of NLP from its inception to the present day. Familiarity with various applications of NLP across different domains. **Skills**: Ability to analyze language structures and grammatical rules relevant to NLP. Proficiency in designing and evaluating information retrieval systems.
2	Week 3-5: LANGUAGE MODELING	**Knowledge:** Understanding of different types of grammar-based language models, such as rule-based systems, transformational grammar, and syntactic parsing models. Familiarity with statistical approaches to language modeling, such as n-gram models, hidden Markov models (HMMs), and neural language models (e.g., LSTM, Transformer). **Skills:** Ability to implement statistical language models and evaluate their performance using large-scale corpora and standard evaluation datasets. Proficiency in interpreting experimental results and drawing meaningful conclusions to advance the state-of-the-art in language modeling research and applications.
3	Week 6-8: WORD LEVEL AND SYNTACTIC ANALYSIS	**Knowledge:**Understanding of regular expressions and their application in text processing and pattern matching. Knowledge of context-free grammars (CFGs) and their role in formal language theory and parsing algorithms. **Skills:** Ability to implement regular expressions and finite-state automata for lexical analysis tasks using programming languages like Python, Java, or Perl. Capability to analyze and interpret syntactic structures of sentences using context-free grammars and syntactic parsing techniques.
4	Week 9-11: EXTRACTING RELATIONS FROM TEXT	**Knowledge:** Understanding of subsequence kernels as a method for relation extraction, which involves identifying and extracting relationships between entities based on subsequences of words or tokens. Understanding of domain-specific knowledge required for annotating and interpreting diagnostic text reports, such as medical or technical domains. **Skills:** Ability to implement and apply subsequence kernels and dependency-path kernels for relation extraction tasks using machine learning and natural language processing techniques. Skill in

		interpreting experimental results and conducting evaluations to measure the effectiveness of relation extraction and semantic role labelling systems in specific domains.
5	Week 11-13: EVALUATING SELF-EXPLANATIONS IN iSTART	**Knowledge:** Understanding cohesion in text structures involves recognizing how linguistic elements like conjunctions, lexical repetition, and grammatical cohesion contribute to coherence and readability. Familiarity with probabilistic classification and finite-state sequence modelling techniques includes understanding and applying probabilistic models for document classification and separation based on content. **Skills:** Ability to analyze texts using tools like Coh-Metrix and latent semantic analysis (LSA) to measure cohesion objectively, applying quantitative measures to assess text coherence. Proficiency in implementing sequence mapping algorithms for automatic document classification, including practical skills in data preparation, feature extraction, and model evaluation for document separation tasks.
6	Week 13-15: INFORMATION RETRIEVAL AND LEXICAL RESOURCES	**Knowledge:** Understanding the design features of information retrieval systems, including classical, non-classical, and alternative models, involves knowledge of Boolean retrieval, vector space models, probabilistic retrieval models, and their respective strengths and weaknesses. Familiarity with prominent lexical resources in natural language processing, such as WordNet, Frame Net, stemmers, part-of-speech taggers, and research corpora, is essential for understanding their structure, coverage, and applications in computational linguistics and text mining. **Skills:** Ability to evaluate information retrieval systems using performance metrics such as precision, recall, and F1 score, along with proficiency in designing retrieval algorithms considering factors like query expansion and relevance feedback. Proficiency in utilizing lexical resources for NLP tasks such as word sense disambiguation, semantic similarity measurement, and information extraction, as well as adapting these resources to specific research or application domains.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Multiple Representations	Introduce topics in various representations to reinforce competencies
6	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies
7	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (SEE)**

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	3	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the foundational principles and challenges of NLP	Gain a comprehensive understanding of the origins, evolution, and key challenges in Natural Language Processing (NLP). Explore how NLP intersects with linguistics and computational sciences, addressing issues like ambiguity, context sensitivity, and linguistic diversity.
2	Analyze language structures and computational processing	Examine the principles of language and grammar in the context of NLP. Investigate techniques for processing Indian languages, including script variations, morphological analysis, and resource limitations. Evaluate the role of linguistic structures in enhancing NLP applications such as machine translation, sentiment analysis, and information retrieval.
3	Explore diverse language modelling techniques	Study a range of grammar-based and statistical language models used in NLP. Compare and contrast their methodologies and applications in tasks such as text generation, speech recognition, and language understanding.
4	Master word-level analysis and syntactic parsing	Develop proficiency in using regular expressions, finite-state automata, and morphological parsing for word-level analysis. Implement techniques for spelling error detection, correction, and categorization of words into classes. Gain insights into part-of-speech tagging and its significance in syntactic and semantic analysis.
5	Learn advanced techniques for extracting relations from text	Explore methods like subsequence kernels and dependency-path kernels for extracting relations from text data. Evaluate these techniques through experimental studies in relation extraction and semantic role labelling tasks. Analyze case studies in mining diagnostic text reports and annotating knowledge roles in specific domains.
6	Evaluate and apply advanced NLP methodologies	Assess methodologies such as word matching, latent semantic analysis (LSA), and topic modelling for evaluating self-explanations and measuring textual cohesion. Explore their application in educational technology and cognitive modelling contexts. Investigate automatic document separation techniques using probabilistic classification and finite-state sequence modelling for efficient data processing and retrieval.

7	Examine design features and evaluation of IR systems and lexical resources	Investigate the design features of classical, non-classical, and alternative models in Information Retrieval (IR). Evaluate their performance metrics such as precision, recall, and relevance ranking. Explore lexical resources such as WordNet, FrameNet, stemmers, POS taggers, and research corpora, and their role in semantic analysis and machine learning applications.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS203B.1	Understand the foundational concepts of NLP and language modelling.
M23MCS203B.2	Apply language analysis and modelling techniques.
M23MCS203B.3	Evaluate advanced text processing methods and relation extraction techniques.
M23MCS203B.4	Analyze and critique NLP methodologies and techniques.
M23MCS203B.5	Create and design solutions using information retrieval systems and lexical resources.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS203B.1	-	-	3	3	3
M23MCS203B.2	3	-	-	3	3
M23MCS203B.3	3	-	-	3	3
M23MCS203B.4	-	3	-	3	3
M23MCS203B.5	-	3	-	3	3
M23MCS203B	3	3	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The "Natural Language Processing" as a professional elective course in the second semester of the M.Tech program lays a strong foundation for several future courses in the postgraduate program. The

contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of natural language processing. Here are some notable contributions:

1. Advancements in Language Understanding

As NLP algorithms become more sophisticated, they will enhance our ability to accurately understand and interpret nuances in human language. From sentiment analysis to context-aware dialogue systems, NLP will facilitate deeper and more meaningful interactions between humans and machines.

2. Personalized Learning and Education

In education, NLP holds promise for personalized learning experiences. Adaptive tutoring systems powered by NLP can cater to individual learning styles and pace, offering real-time feedback and customized educational content.

3. Healthcare and Biomedical Applications

NLP is set to revolutionize healthcare through improved clinical decision support systems. By analyzing vast amounts of medical literature and patient records, NLP can assist in diagnosis, treatment recommendation, and drug discovery.

4. Enhanced Customer Experience and Business Insights

Businesses are increasingly leveraging NLP for customer service automation, sentiment analysis of customer feedback, and market trend prediction. Chatbots and virtual assistants equipped with NLP capabilities are transforming customer interaction models.

5. Ethical Considerations and Bias Mitigation

As NLP technologies proliferate, ethical considerations such as bias in language models and privacy concerns will become critical. Future research will focus on developing fairer and more transparent NLP systems that uphold ethical standards and respect user privacy.

2nd Semester	Professional Elective Course (PE) Cyber Security and Cyber Law	M23MCS203C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Computer Basics**	Understanding how computers work, including hardware components like CPU, memory, storage, and input/output devices
2	**Operating Systems**	Familiarity with popular operating systems like Windows, macOS, and Linux, including basic file management and navigation.
3	**Networking**	Basic concepts of how networks operate, including IP addressing, DNS, routing, and protocols like TCP/IP.
4	**Programming**	Basic knowledge of programming concepts can be helpful, though it's not always a strict requirement. Understanding concepts like variables, loops, conditionals, and functions can aid in understanding certain aspects of cyber security.
5	**Mathematics**	While not always necessary, a basic understanding of mathematics, particularly concepts like binary, hexadecimal, and boolean algebra, can be helpful.

2. Competencies

S/L	Competency	KSA Description
1	Cyber Security: Introduction	**Knowledge:** 1. **Introduction to Cyber Security:** Understanding the principles and goals of cyber security. Awareness of the importance of securing digital assets and information. 2. **Hackers:** Knowledge of different types of hackers (e.g., white hat, black hat, grey hat).Understanding hacker motivations and typical methods used in attacks. 3. **Attackers:** Awareness of various types of cyber attackers (e.g., cyber criminals, state-sponsored attackers, hacktivists). Understanding their objectives, such as financial gain, espionage, or disruption. 4. **Types of Attacks:** Familiarity with common cyber attacks (e.g., phishing, ransomware, DDoS).Knowledge of attack vectors and techniques used to exploit vulnerabilities. 5. **Data Recovery:** Understanding techniques and tools for data recovery after a cyber incident. Knowledge of backup strategies and disaster recovery plans. **Skills:** 1. **Incident Detection and Response:** Ability to detect anomalies and potential security incidents. Skills in incident response, including containment, eradication, and recovery. 2. **Vulnerability Assessment and Penetration Testing (Pen Testing):** Skills in identifying vulnerabilities in systems and networks. Ability to conduct ethical hacking to test defences and improve security posture. 3. **Security Tools and Technologies:** Proficiency in using security tools such as firewalls, IDS/IPS, SIEM, and antivirus software. Skills in configuring and managing security infrastructure. 4. **Forensic Analysis:** Ability to gather and analyze digital evidence for cyber crime investigations. Skills in preserving the integrity of evidence and presenting findings in legal contexts. 5. **Secure Coding Practices:** Ability to write secure code and adhere to coding standards to prevent vulnerabilities. Skills in identifying

		and mitigating common coding flaws (e.g., buffer overflows, SQL injection). **Attitudes:** 1. **Ethical Responsibility:** Commitment to ethical behavior and respect for privacy and confidentiality. Adherence to professional codes of conduct and legal guidelines. 2. **Continuous Learning and Adaptability:** Willingness to stay updated with evolving cyber threats and technologies. Readiness to adapt skills and strategies in response to new challenges. 3. **Teamwork and Collaboration:** Ability to work effectively in cross-functional teams to address security issues. Skills in communicating security concepts to non-technical stakeholders. 4. **Critical Thinking and Problem-Solving:** Capacity to analyze complex security incidents and make informed decisions. Ability to anticipate potential risks and implement proactive security measures. 5. **Resilience and Persistence:** Determination to handle and recover from security incidents effectively. Ability to implement preventive measures and maintain a robust security posture.

3. Syllabus

Cyber Security and Cyber Law SEMESTER II		
Course Code	**M23MCS203C**	CIE Marks : 50
Teaching Hours/Week (L:T:P: S)	**(2:0:0:2)**	SEE Marks: 50
Total Hours of Pedagogy	40	Total Marks: 100
Credits	03	Exam Hours: 3
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. • Chalk and Talk • PPT presentation • Animation based videos • Interactive learning		
Module 1 Cyber Security: Introduction in Cyber Security -Hackers - Attackers -Types of Attackers Examples –Data Recovery. Cyber law: Features of Cyber Law - Significance of Cyber Law - Advantages. Data Security - Meaning - Fundamentals of Data Security - Requirements of Data Security - Precautionary Measures.		
Module 2 Tools and Methods Used in Cyber crime: Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)Cybercrimes and Cyber security: The Legal Perspectives Why do we need Cyber law: The Indian Context, The Indian IT Act, Digital Signature and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment, Cyber law, Technology and Students: Indian Scenario.		
Module 3 Authentication and Firewalls - Authentication & Access Control: Identification - Authentication - Authentication by Passwords - Protecting Passwords - Access Control Structure - Evidences - Law of Evidence on Electronic Records, Hackers & its Types - Cracking - Pornography - Software privacy - Data Recovery - File Modification & File access, Recover Internet Usage Data, Recover Swap Files/Temporary/Cache Files, and Introduction to Encase Forensic		
Module 4 Cyber security: Organizational Implications Cost of Cybercrimes and IPR Issues: Lesson for Organizations, Web Treats for Organizations: The Evils and Perils, Security and Privacy Implications from Cloud Computing, Social Media Marketing: Security Risk and Perils for Organization, Social Computing and the		

Associated Challenges for Organizations, Protecting People's Privacy in the Organization, Organizational Guidelines for Internet Usage, Safe Computing Guidelines and Computer Usage Policy, Incident Handling: An Essential Component, Intellectual Property rights in the Cyber security, Importance of Endpoint Security in Organizations.
Module 5 Concept of Cyber law and Cyber Space: Introduction - Meaning and Features of Cyber law - Significance and Advantages of Cyber Law - Meaning of Cyber Space - Inclusive of Cyber Space - Facilitating Functions of Cyber Space - Major Issues in Cyber Space. Need for an Indian Cyber law: Plans of National Information Technology Policy (NITP) - Need for Protection of data - Transactions in Security - Electronic Banking.
Suggested Learning Resources **Text Books:** 1. Jonathan Rosenoer , Cyber law: The Law of Internet, Springer Verlog, Paperback, 17 September 2011 2. John W Ritting House, William M.Hancock, Cyber Security Operations Handbook, Read Elsevier,2004 **Reference Books:** 1. Sunit Belapure and Nina Godbole. Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives. Wiley India Pvt Ltd. 2013. 2. Surya PrakashTripathi, Ritendra Goyal, Praveen Kumar Shukla. Introduction to information security and cyber laws. Dreamtech Press. 2015. 3. Cybersecurity Essentials 4. Charles J. Brooks, Christopher Grow, Philip A. Craig Jr., Donald Short, ISBN: 978-1-119-36239-5 October 2018.
Web links and Video Lectures (e-Resources): • https://www.udemy.com/course/cybersecurity-law-policy • https://academy.apnic.net/en/course/introduction-to-cybersecurity • https://www.coursera.org/specializations/intro-cyber-security • https://www.coursera.org/learn/cybersecurity-for-everyone • https://www.classcentral.com/tag/cybercrime

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	Cyber Security Introduction
2	Week 3-4:	Tools and Methods Used in Cyber crime
3	Week 5-6:	Authentication and Firewalls
4	Week 7-8:	Cyber security Organizational Implications Cost of Cybercrimes and IPR Issues
5	Week 9-10:	Concept of Cyber law and Cyber Space
6	Week 11-12:	Need for Protection of data - Transactions in Security - Electronic Banking.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of cyber security concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies

7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	**Internal Assessment-Tests (A)**	**3**	**50%**	**25**	**10**
(ii)	**Assignments/Quiz/Activity (B)**	**2**	**50%**	**25**	**10**
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- 2 There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- 3The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Foundational Understanding**	• Define cyber security and its significance in protecting digital assets, data, and systems from cyber threats. • Explain the principles of confidentiality, integrity, and availability (CIA) in the context of cyber security.
2	**Cyber Threat Landscape**	• Identify common types of cyber threats and attack vectors, such as malware, phishing, ransomware, and social engineering. • Understand the impact of cyber threats on individuals, organizations, and society.
3	Security Principles and Concepts	• Describe essential cyber security principles and concepts, including defense-in-depth, least privilege, and resilience. • Explain the importance of risk management and mitigation strategies in cyber security.
4	Cybersecurity Technologies and Tools	• Explore fundamental cyber security technologies and tools used to protect networks, systems, and data. • Discuss the role of firewalls, antivirus software, intrusion detection/prevention systems (IDS/IPS), and encryption in cyber security defence.
5	Legal and Ethical Considerations	• Discuss legal and regulatory requirements related to cyber security, including data protection laws (e.g., GDPR, CCPA). • Understand ethical considerations in cyber security practices, including privacy rights and responsible use of technology.

6	Cyber security Awareness and Education	• Highlight the importance of cyber security awareness among users and stakeholders. • Discuss strategies for promoting a cyber security-aware culture within organizations and communities.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCS203C.1	Define and identify the cyber security needs of an organization.
M23MCS203C.2	Predict and analyze the software vulnerabilities and security solutions to reduce the risk of exploitation.
M23MCS203C.3	Identify the cyber crime and modify security architecture for an organization.
M23MCS203C.4	Survey operational and strategic cyber security strategies and policies
M23MCS203C.5	Analyze the major issues in Cyber space

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS203C.1	**3**		**3**	3	3
M23MCS203C.2	**3**			**3**	**3**
M23MCS203C.3				**3**	**3**
M23MCS203C.4		**3**		**3**	**3**
M23MCS203C.5	**3**		**3**	**3**	**3**
M23MCS203C	**3**	**3**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

1. **Rising Cyber Threats:** As technology advances, so do cyber threats. Future cybersecurity will need to defend against more sophisticated attacks, including AI-driven threats and attacks on interconnected IoT devices.
2. **Increased Regulation:** Governments worldwide are likely to introduce more stringent cyber security regulations and standards to protect citizens' data and critical infrastructure. This will necessitate a stronger focus on compliance and cyber security frameworks.
3. **Cyber security Automation:** With the growing volume of threats, automation through AI and machine learning will become essential for detecting and responding to attacks in real-time.
4. **Privacy Concerns:** As more data is collected and processed, privacy concerns will intensify. Cyber laws will need to adapt to protect individuals' rights while enabling legitimate uses of data for innovation and economic growth
5. **International Cooperation:** Cyber threats are often transnational, requiring international cooperation and agreements on cyber security norms, incident response, and data sharing.
6. **Emerging Technologies:** Technologies like quantum computing and 5G will introduce new security challenges and require innovative cyber security solutions.
7. **Skills Shortage:** There is and will continue to be a shortage of skilled cyber security professionals. Addressing this gap through education and training will be crucial.
8. **Ethical and Legal Implications:** As AI and automation play a bigger role in cyber security, ethical considerations around their use in decision-making and compliance with legal standards will become more prominent.
9. **Business Impacts:** Cyber security incidents can have significant financial and reputational impacts on businesses. Organizations will need to prioritize cyber security as a core part of their operations and risk management.

2nd Semester	Professional Elective Course (PE) DECISION SUPPORT SYSTEM	M23MCS203D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Dynamic	Many technical systems requires anticipation and analysis of how the decision will affect.
2	Social	Communication plays a vital role among the many specialized controllers.
3	Coupled	Many systems result in possible unpredictable interactions and consequences.
4	Heterogeneous	Many contributing perspectives and experience levels.
5	Problem-Solving Skills	Develop your analytical and problem-solving skills, as designing efficiently and effective requires making trade-offs and optimizing for different scenarios.

2. Competencies

S/L	Competency	KSA Description
1	Introduction to decision support systems	**Knowledge:** Uses of Decision support systems **Skills:** Decision Making- Rational Decision, Nature of Managers. **Attitudes:** Appropriate Decision Support, Group Decision Making, Intuition, Qualitative data and Decision Making, Business Intelligence and Decision Making
2	Decisions in the organization	**Knowledge:** Appropriate Decision Support. **Skills:** Qualitative data and Decision Making, **Attitudes:** Business Intelligence and Decision Making
3	Group decision support and groupware technologies	**Knowledge:** Group Decision Making, Intuition. **Skills:** knowhow of technologies. **Attitudes:** Intuition to use technologies.
4	Designing and building decision support systems	**Knowledge:** Programming Reasoning. **Skills:** User Interface: Goal, Mechanisms of User Interfaces, User Interface Components. **Attitudes:** Uncertainty.
5	Creative decision making and problem solving	**Knowledge:** Investigate various models in Decision Support Systems. **Skills:** Analyzing and decision making for creativity. **Attitudes:** creativity for problem solving.

3. Syllabus

DECISION SUPPORT SYSTEM (M23MCS203D) SEMESTER – II			
Course Code	M23MCS203D	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

1. Explains the concept of Decision Support Systems
2. Exhibit the decision making techniques
3. Investigate various models in Decision Support Systems
4. Apply Design and development techniques in DSS
5. Design an expert system by applying various Knowledge Acquisition techniques

Module -1

Introduction to decision support systems: DSS Defined, History of decision support systems, Ingredients of a DSS, Data and model management, DSS Knowledge base, User interfaces, User interfaces, The DSS user, Categories and classes of DSSs, Chapter Summary. Decisions and decision makers Decision makers: who are they, Decision styles, Decision effectiveness, How can a DSS help?, A Typology of decisions, Decision theory and Simon's model of problem solving, Bounded decision making, The process of choice, Cognitive processes, Biases and heuristics in decision making.

Module -2

Decisions in the organization: Understanding the organization, Organizational culture. Modeling decision processes: Defining the problem and its structures, Decision models, Types of probability, Techniques for forecasting probabilities, Calibration and sensitivity.

Module -3

Group decision support and groupware technologies: Group Decision making, the problem with groups, MDM support technologies, Managing MDM activities, the virtual workspace, chapter summary. Executive information systems: What exactly is an EIS, Some EIS history, Why area top executives so different?, EIS components, Making the EIS work, The future of executive decision making and the EIS.

Module -4

Designing and building decision support systems: Strategies for DSS analysis and design, The DSS developer, DSS user interface issues, chapter summary. Implementing and integrating decision support systems: DSS implementation, System evaluation, The importance of integration.

Module -5

Creative decision making and problem solving What is creativity?, Creativity defined, The occurrence of creativity, Creative problem solving techniques, Creativity and the role of technology.

Text Books:

1. Decision support system George M. Marakas PHI 2011.
2. "Decision Support and Business Intelligence Systems"Authors: Efraim Turban, Ramesh Sharda, and Dursun Delen Publisher: Pearson

Reference Books

1. "Decision Support Systems and Intelligent Systems"Authors: Efraim Turban and Jay E. Aronson Publisher: Pearson..
2. "Decision Support Systems: Concepts and Resources for Managers"Authors: Daniel J. Power Publisher: Quorum Books

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3	Introduction to decision support systems: Data and model management, DSS Knowledge base, User interfaces, User interfaces, The DSS user, Categories and classes of DSSs, Decisions and decision makers Decision makers: Decision styles, Decision effectiveness. A Typology of decisions, Decision theory and Simon's model of problem solving, Bounded decision making, The process of choice, Cognitive processes, Biases and heuristics in decision making.
2	Week 4-6	Decisions in the organization: Understanding the organization and culture. Modelling decision processes: Defining the problem and its structures. Decision models, Types of probability, Techniques for forecasting probabilities, Calibration and sensitivity.
3	Week 7-9	Group decision support and groupware technologies: Group Decision making, the problem with groups, MDM support technologies, Managing MDM activities, the virtual workspace. Executive information systems: What exactly is an EIS, Some EIS history, EIS components, Making the EIS work, The future of executive decision making and the EIS.
4	Week 10-12	Designing and building decision support systems: Strategies for DSS analysis and design. The DSS developer, DSS user interface issues, chapter summary. Implementing and integrating decision support systems. DSS implementation, System evaluation, The importance of integration.
5	Week 13-15	Creative decision making and problem solving. Creativity defined, The occurrence of creativity, Creative problem solving techniques, Creativity and the role of technology.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Using traditional lecture methods and ICT as and when needed.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance learning.
3	Collaborative Learning	Encourage collaborative learning approaches for peer learning.
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application.
5	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
6	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	**Internal Assessment-Tests (A)**	**3**	**50%**	**25**	**10**
(ii)	**Assignments/Quiz/Activity (B)**	**2**	**50%**	**25**	**10**
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.

- 2 There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- 3The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives
1	Explains the concept of Decision Support Systems
2	Exhibit the decision-making techniques
3	Investigate various models in Decision Support Systems
4	Apply Design and development techniques in DSS
5	Design an expert system by applying various Knowledge Acquisition techniques

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs):

COs	Description
M23MCS203D.1	Recognize the relationship between business information needs and decision making
M23MCS203D.2	Appraise the general nature and range of decision support systems
M23MCS203D.3	Appraise issues related to the development of DSS
M23MCS203D.4	Select appropriate modelling techniques
M23MCS203D.5	Analyze, design and implement a DSS

CO-PO-PSO Mapping:

COs/POs	PO 1	PO 2	PO 3	PSO-1	PSO-2
M23MCS203D.1	3	-	-	2	2
M23MCS203D.2	3	-	-	2	2
M23MCS203D.3	-	3	-	2	2
M23MCS203D.4	-	3	3	2	2
M23MCS203D.5	-	-	3	2	2
M23MCS203D.	3	3	3	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					
Module 2		**20**				
Module 3			**20**			
Module 4				**20**		
Module 5					**20**	
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject:

1. Industries, including technology, finance, healthcare, marketing, and more.
2. Research and Development**:** Students interested in research can explore opportunities in academic or industrial research labs, where they can contribute to the development.
3. Domain-specific Applications: Students can specialize in a particular domain and apply their expertise to solve domain-specific problems.
4. Interdisciplinary Collaboration: This course will equip students with the ability to effectively communicate and work with domain experts, stakeholders, and cross-functional teams.

2nd Semester	Professional Elective Course (PE) Digital Image Processing	M23MCS204A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	**Linear Algebra**: Understanding matrices and vectors is crucial as many image processing techniques involve operations on matrices. **Calculus**: Especially differentiation and integration, which are used in understanding gradients, optimization, and transformations.
2	Signal Processing	Basic knowledge of signal processing concepts is beneficial as many image processing techniques are based on similar principles.
3	Probability and Statistics	Knowledge of probability theory and statistics is useful for understanding noise models, image enhancement techniques, and statistical analysis in image processing
4	Algorithm Design and Analysis	Ability to design and analyse algorithms, including complexity analysis, is important for implementing efficient image processing techniques

2. Competencies

S/L	Competency	KSA Description
1	Understanding of Image Processing Concepts	**Knowledge:** Knowledge of fundamental concepts such as pixels, color models, spatial and frequency domains, image enhancement, restoration, and segmentation. **Skills:** Ability to design, implement, and optimize image processing algorithms to achieve specific objectives (e.g., enhancement, segmentation). **Attitudes:** Eagerness to explore new techniques, algorithms, and advancements in the field of image processing.
2	Mathematical Foundation	**Knowledge:** Proficiency in mathematical concepts like linear algebra (matrices, vectors), calculus (differentiation, integration), probability theory, and statistics as they apply to image processing algorithms. **Skill:** Software Proficiency Skill in using software tools and libraries effectively to manipulate and analyze digital images. **Attitudes:** Attention to Detail Careful consideration of the nuances and details involved in image analysis and manipulation.
3	Signal and Information Processing	**Knowledge:** Understanding of digital signal processing principles relevant to images, including sampling, filtering, Fourier analysis, and wavelet transforms. **Skills: Problem-Solving Capability** to analyze image processing problems, formulate solutions, and troubleshoot issues that arise during implementation **Attitudes: Ethical Awareness** Sensitivity to ethical issues related to image processing, such as privacy concerns, bias in algorithms, and proper use of digital manipulation techniques.
4	Software and Tools	**Knowledge:** Familiarity with programming languages (e.g., Python, MATLAB, C/C++) and libraries (e.g., OpenCV, scikit-image) used for implementing image processing algorithms. **Skills:** Experimental Design and Analysis Skill in designing experiments to evaluate the performance of image processing algorithms and interpreting results statistically. **Attitudes:** Adaptability and Flexibility Willingness to adapt to new tools, techniques, and methodologies as technologies and requirements evolve.
5	Application Domains	**Knowledge:** Knowledge of specific domains where image processing is applied, such as medical imaging, satellite imagery, multimedia, and surveillance. **Skills: Communication**: Ability to communicate technical concepts and findings effectively, both orally and in writing, to diverse audiences. **Attitudes**: **Collaboration**: Ability to work effectively in multidisciplinary teams, leveraging diverse perspectives and skills to solve complex problems in image processing applications.

3. Syllabus

Digital Image Processing			
Course Code	**M23MCS204A**	**CIE Marks**	50
Teaching Hours/Week(L:P:SDA)	**(2:0:0:2)**	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course objectives:

- To define image sampling, quantization, pixels relationship, features, descriptors and classification
- To explain various intensity transformations, image segmentation, various feature extraction approaches, and different classifiers.
- To apply various basic preprocessing (noise reduction, enhancement etc.) and advanced (segmentation, restoration and classification etc.) image processing algorithms.

Teaching- Learning Process : Chalk and talk method/Power Point Presentation

Module-1

Digital Image Fundamentals: Introduction to Digital Image Processing and its components, Image Sensing and Acquisition, Sampling and Quantization, Relationships between pixels, Two-dimensional mathematical preliminaries, Image transforms – DFT, DCT.

Module-2

Image Enhancement: Spatial Domain transforms: gray level transformations, Histogram processing, Frequency Domain transforms: Fourier Transform, Smoothening and Sharpening, Spatial Filtering, Frequency Domain Filters – Gaussian Low pass and High pass Filters, Ideal, Butterworth, and Homomorphic Filtering.

Module-3

Image Restoration: Image Restoration – degradation model, Properties, Noise models, Mean Filters, Order Statistics Adaptive filters, Band reject Filters, Band-pass Filters, Inverse Filtering, Wiener filtering.

Module-4

Image Segmentation: Point detection, Edge detection, Edge linking, and boundary detection, Hough Transform, Similarity-based segmentation – Thresholding, Region growing, Region splitting and merging, Morphological processing- Erosion and Dilation, Opening, Closing, Boundary Extraction, Convex Hull, Thinning, Thickening.

Module-5

Image Representation and Description: Image Understanding techniques- Boundary-based, Region-based, Topological Attributes, Geometric Attributes Description Boundary-based Description, Region-based Description. Image processing research-based case study.

Suggested Learning Resources:

Text Books

- Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing Pearson, Third Edition, 2010
- Digital Image Processing and Computer Vision, R.J. Schalkoff Published by: John Wiley and Sons, NY, 1989.

Reference Books

- Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
- Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
- D E. Dudgeon, and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
- William K. Pratt, Digital Image Processing John Wiley, New York, 2002.

Online Resource

1. https://in.coursera.org/specializations/image-processing
2. https://www.udemy.com/topic/image-processing/
3. https://onlinecourses.nptel.ac.in/noc19_ee55/preview
   https://www.mygreatlearning.com/academy/learn-for-free/courses/digital-imageprocessing

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Weeks 1-3:	Module 1 Digital Image Fundamentals
2	Weeks 4-6:	Module 2 - Image Enhancement
3	Weeks 7-8:	Module 3 - Image Restoration
4	Weeks 9-11:	Module 4 - Image Segmentation
5	Weeks 12-14:	Module 5 - Image Representation and Description
6	Week 15:	Final project presentations and course wrap-up.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Interactive Lectures:**	Lectures will be designed to be interactive, with frequent opportunities for discussion, questioning, and real-time feedback.
2	**Hands-on Coding Exercises:**	Regular coding exercises and assignments will be provided to reinforce practical skills in data science programming languages and libraries.
3	**Case Studies and Real-World Examples**	The course will incorporate real-world case studies and examples from various domains to illustrate the applications of data science concepts and techniques.
4	**Group Projects:**	Students will work in teams to complete a comprehensive data science project, allowing them to apply their knowledge and skills to a real-world problem.
5	**Guest Lectures:**	Industry experts and practitioners will be invited to share their experiences and insights, providing students with a practical perspective on data science.
6	**Flipped Classroom**	Selected topics will be introduced through pre-recorded lectures or reading materials, allowing class time to be dedicated to discussions, exercises, and problem-solving activities.
7	**Peer Learning:**	Students will be encouraged to collaborate, share knowledge, and provide constructive feedback to their peers through study groups, discussion forums, and code reviews.

6. Assessment Details (both CIE and SEE)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	**33. Internal Assessment-Tests (A)**	**3**	**50%**	**25**	**10**
(ii)	**35. Assignments/Quiz/Activity (B)**	**2**	**50%**	**25**	**10**
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- 2 There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- 3The students have to answer 5 full questions selecting one full question from each module.

- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Fundamental Concepts:	Master basic principles such as pixels, color models, spatial and frequency domains, and image representation to establish a solid foundation for further exploration and application of image processing techniques.
2	Mastering Image Enhancement Techniques	Mastering Image Enhancement Techniques: Learn methods such as noise reduction, contrast enhancement, sharpening, and color correction to enhance images for improved visual quality or subsequent analysis.
3	Exploring Image Restoration Methods:	Understand techniques for recovering degraded images (noise, blurring, artifacts) to improve image fidelity in medical imaging, forensics, and other applications.
4	Gaining Proficiency in Image Compression:	Study algorithms for reducing storage/transmission size while preserving image quality to efficiently manage images in multimedia, internet, and storage applications.
5	Image Transformation	Understanding Image Transformation and Geometric Operations

8.Course Outcomes and Mapping with POs/ PSOs

M23MCS204A.1	Understand fundamental concepts in digital image processing such as pixels, color models, and spatial domains.
M23MCS204A.2	Apply the principles behind various image enhancement techniques, including noise reduction and contrast enhancement.
M23MCS204A.3	Analyze image restoration techniques to restore degraded images affected by noise, blurring, or compression artifacts.
M23MCS204A.4	Evaluate the performance of different image segmentation algorithms and their effectiveness in partitioning images into meaningful regions.
M23MCS204A.5	Design and implement a comprehensive image processing solution to address a specific real-world problem or application domain.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PS02
M23MCS204A.1	**3**		**3**	**3**	**3**
M23MCS204A.2				**3**	**3**
M23MCS204A.3	**3**			**3**	**3**
M23MCS204A.4			**3**	**3**	**3**
M23MCS204A.5			**3**	**3**	**3**
M23MCS204A	**3**		**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

The Essentials of Data Science course provides a solid foundation for students to pursue a variety of future paths within the field of data science and beyond.

1. Artificial Intelligence and Machine Learning: Integration of AI and ML techniques will revolutionize DIP, enabling more sophisticated image analysis, pattern recognition, and automated decision-making. This includes applications in autonomous vehicles, medical diagnostics, and surveillance systems.

2. Enhanced Imaging Technologies: Advancements in imaging sensors, such as hyperspectral and multispectral imaging, will provide richer data for analysis, leading to improved accuracy in fields like remote sensing, environmental monitoring, and agriculture.

3. Computational Photography: Techniques like computational imaging and light field photography will redefine how images are captured and processed, enabling new capabilities in photography, augmented reality, and virtual reality.

4. 3D Imaging and Reconstruction: Development of robust algorithms for 3D image reconstruction from multiple viewpoints will enhance applications in medical imaging (e.g., 3D MRI), virtual reality, and archaeological documentation.

5. Real-time and Embedded Systems: DIP algorithms optimized for real-time processing and deployment on embedded systems (e.g., IoT devices, drones) will enable applications in real-time surveillance, smart city infrastructure, and wearable technology.

6. Ethical Considerations and Regulation: Growing awareness of ethical issues (e.g., privacy, bias) in DIP will drive the development of responsible practices and regulatory frameworks to ensure fair and ethical use of image processing technologies.

7. Interdisciplinary Collaborations: Collaboration across disciplines such as computer vision, robotics, neuroscience, and biology will lead to innovative solutions and applications in areas like brain imaging, prosthetics, and human-computer interaction.

2ndSemester	Professional Elective Course (PE) Object Oriented Design	M23MCS204B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Programming Skills	Before delving into OOD, you should have a solid understanding of programming fundamentals. This includes knowledge of variables, control structures (like loops and conditionals), data types, functions/methods, and basic algorithms.
2	Understanding of Object-Oriented Programming	OOD builds upon OOP principles. Therefore, familiarity with concepts such as classes, objects, inheritance, polymorphism, encapsulation, and abstraction is essential. These concepts form the foundation upon which OOD principles are applied.
3	Data Structures	Knowing common data structures (like arrays, linked lists, stacks, queues, trees, graphs) and their basic operations is crucial. OOD often involves selecting appropriate data structures to represent real-world entities and relationships.
4	Algorithms	While not as deep as advanced algorithmic complexity, understanding basic algorithms and their efficiency (Big O notation) helps in designing efficient object-oriented solutions.
5	Design Patterns	Familiarity with design patterns (such as Singleton, Factory, Observer, etc.) is beneficial. These patterns provide proven solutions to common design problems and are widely used in OOD.
6	UML (Unified Modeling Language)	Being able to read and create UML diagrams (class diagrams, sequence diagrams, etc.) is important for visualizing and communicating your designs.
7	Software Development Lifecycle	Understanding the software development process, including requirements gathering, analysis, design, implementation, testing, deployment, and maintenance, gives context to OOD. It helps in applying design principles effectively throughout the lifecycle.
8	Problem-Solving Skills	OOD involves analyzing problems, identifying objects, defining relationships, and designing solutions. Strong problem-solving skills are fundamental to effective OOD.
9	Experience with a Programming Language	While not strictly required, practical experience in applying OOP concepts using a programming language (such as Java, C++, Python) helps reinforce understanding and application of OOD principles.
10	Practice and Experience	Like any skill, proficiency in OOD comes with practice and hands-on experience. Working on projects that involve designing and implementing object-oriented solutions is invaluable

2. Competencies

S/L	Competency	KSA Description
1	**Understanding of OOP Principles**	**Knowledge:** Competence in OOD starts with a solid grasp of Object-Oriented Programming (OOP) principles such as encapsulation, inheritance, polymorphism, and abstraction. This knowledge forms the theoretical foundation upon which OOD is built. **Skills:** Proficiency in applying OOD principles to design software solutions that are modular, maintainable, and scalable. **Attitudes:** Approach problems with a critical mindset, evaluating different design options and selecting the most suitable based on trade-offs.
2	**Design Patterns**	**Knowledge:** Knowledge of common design patterns (Singleton, Factory, Observer, etc.) and their appropriate use in different scenarios demonstrates deeper understanding of OOD concepts. **Skill:** Ability to design complex systems by identifying objects, defining their relationships, and organizing them into coherent class hierarchies. **Attitudes:** Paying attention to details in design, ensuring consistency, clarity, and adherence to best practices.
3	**UML Proficiency**	**Knowledge:** Understanding and ability to use UML diagrams (class diagrams, sequence diagrams, etc.) effectively to visualize and communicate OOD designs. **Skills:** Skill in refactoring existing code to improve its structure, applying principles like SOLID (Single Responsibility, Open/Closed, Liskov Substitution, Interface Segregation, Dependency Inversion). **Attitudes:** Being open to learning new design patterns, methodologies, and technologies to improve OOD skills continuously.
4	**Data Structures and Algorithms**	**Knowledge:** Knowledge of data structures and algorithms relevant to OOD, including their efficiency and suitability for different design scenarios. **Skills:** Ability to translate OOD designs into working code using a programming language, ensuring adherence to design principles and patterns. **Attitudes:** Positive attitude towards solving complex design problems creatively and systematically.

3. Syllabus

Object Oriented Design SEMESTER-II			
Course Code	**M23MCS204B**	**CIE Marks**	50
Teaching Hours/Week(L:P:SDA)	**(2:0:0:2)**	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course objectives:

- To Introduce various designing techniques and methods for object oriented.
- Performance analysis with real time system.
- Demonstrate a familiarity with object oriented data and system.
- To give clear idea on implementing design with UML diagram like state diagram , activity diagram , use case diagram etc.

Teaching- Learning Process : Chalk and talk/PPT/case study/web content

Module-1

The Motivation for Object-Oriented Programming, Classes and Objects: The Building Blocks of the Object-Oriented Paradigm Topologies of Action-Oriented Versus Object-Oriented Applications: Accidental versus Essential Complexity, Waterfall Model, Iterative Model, Different language Prototyping, Software Reusability. Introduction to Classes and Objects, Messages and Methods, Class Coupling and cohesion, Dynamic Semantics, Abstract Classes Differences in Application Topologies, God Class Problem, Role of Agent Classes.

Module-2

The Relationships Between Classes and Objects The Inheritance Relationship: Introduction to Class and Objects Relationships, User Relationships, Six Different ways to implement User Relationships, Heuristics for User Relationships, Containment Relationships, Attributes versus Contained Classes. Introduction to the Inheritance Relationship, Overriding Base Class Methods in Derived Classes, The Use of the Protected Section of a Base Class, The Width and Depth of Inheritance Hierarchies, A Real-World Example of Specialization.
Module-3
Multiple Inheritance, TheAssociationRelationship: Introduction to Multiple Inheritance, The Common Misuse of Multiple Inheritance, A Valid Use of Multiple Inheritance, Accidental Complexity In Languages That Do Not Support Multiple Inheritance, Frameworks That Incorporate Multiple Inheritance, The Use of Multiple Inheritance in the Design of Mixins, DAG Multiple Inheritance, Introduction to Association Associations Implemented Through a Referential Attribute Association Implemented Through a Third-Party Class v
Module-4
Class-Specific Data and Behavior, Physical Object-Oriented Design: Introduction to Class-Specific Versus Object-Specific Data and Behavior Using Meta classes to Capture Class-Specific Data and Behavior, Using Language-Level Keywords to Implement ClassVersus Object-Specific Data and Behavior, Meta classes à la C++, A Useful Abstract Class That Is Not a Base Class?, The Role of Logical and Physical Object-Oriented Design, The Construction of OO Wrappers, Persistence in an OO System, Memory Management Issues, Minimal Public Interfaces for Reusable Components, Implementing Safe Shallow Copies, Concurrent OO Programming, Implementing OO Designs in Non-OO Languages.
Module-5
TheRelationshipBetweenHeuristicsandPatterns,TheUseofHeuristicsin Object-Oriented Design: Heuristics Versus Patterns, Transitivity Among Design Transformation Patterns, The Reflexive Property of Design Transformation Patterns, Other Design Transformation Patterns, The ATM Problem, Choosing a Methodology, A First Attempt at Producing an Object Model for the ATM, Adding Behavior Object Model, Explicit Case Analysis Due to Accidental Complexity, Messaging Objects, The Processing of the Transaction, Returning to the Domain of the ATM, Other Miscellaneous Issues.
Suggested Learning Resources: **Text Books** • Object Oriented Design Heuristic. Arthur J Riel. Addison-Wesley. 1996. • Object - Oriented Modelling and Design With UM. Paperback, Michael R. Blaha. Pearson. 2007 **Reference Books** • Elements of Reusable Object Oriented Software. Ralph Johnson, Erich Gamma, Richard Helm, John Vlissides. Pearson. • Object - Oriented Modelling and Design With UM. Paperback, Michael R. Blaha. Pearson. 2007 **Online Resource** • https://www.youtube.com/watch?v=WpJ_yiwbGyk&list=PLJ5C_6qdAvBHslIkD7JB7kBdgv1SeXy3P • https://www.geeksforgeeks.org/oops-object-oriented-design/

4. Syllabus Timeline

The course will be delivered over a 15-week semester, with the following tentative schedule:

S/L	Syllabus Timeline	Description
1	Weeks 1-3:	Module 1 The Motivation for Object-Oriented Programming, Classes and Objects: The Building Blocks of the Object-Oriented Paradigm Topologies of Action-Oriented Versus Object-Oriented Applications
2	Weeks 4-6:	Module 2 The Relationships Between Classes and Objects The Inheritance Relationship
3	Weeks 7-8:	Module 3 Multiple Inheritance, The Association Relationship
4	Weeks 9-11	Module 4 Class-Specific Data and Behavior, Physical Object-Oriented Design
5	Weeks 12-14:	Module 5 The Relationship Between Heuristics and Patterns, The Use of Heuristics in Object-Oriented Design
6	Week 15:	Case Study presentations and course wrap-up.

5. Teaching-Learning Process Strategies

To facilitate an engaging and effective learning experience, the following strategies will be employed.

S/L	TLP Strategies:	Description
1	**Interactive Lectures:**	Lectures will be designed to be interactive, with frequent opportunities for discussion, questioning, and real-time feedback.
2	**Hands-on Coding Exercises:**	Regular coding exercises and assignments will be provided to reinforce practical skills in data science programming languages and libraries.
3	**Case Studies and Real-World Examples**	The course will incorporate real-world case studies and examples from various domains to illustrate the applications of data science concepts and techniques.
4	**Group Projects:**	Students will work in teams to complete a comprehensive data science project, allowing them to apply their knowledge and skills to a real-world problem.
5	**Guest Lectures:**	Industry experts and practitioners will be invited to share their experiences and insights, providing students with a practical perspective on data science.
6	**Flipped Classroom**	Selected topics will be introduced through pre-recorded lectures or reading materials, allowing class time to be dedicated to discussions, exercises, and problem-solving activities.
7	**Peer Learning:**	Students will be encouraged to collaborate, share knowledge, and provide constructive feedback to their peers through study groups, discussion forums, and code reviews.

6. Assessment Details (both CIE and SEE)

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	43. Internal Assessment-Tests (A)	3	50%	25	10
(ii)	45. Assignments/Quiz/Activity (B)	2	50%	25	10
	TotalMarks			50	20

FinalCIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- 2 There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- 3The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Design techniques	To Introduce various designing techniques and methods for object oriented.
2	Analysis	Performance analysis with real time system.

3	Object Oriented data	Demonstrate a familiarity with object oriented data and system.
4	UML Diagram	To give clear idea on implementing design with UML diagram like state diagram , activity diagram , use case diagram etc.

8. Course Outcomes and Mapping with POs/ PSOs

Upon successful completion of this course, students should be able to

M23MCS204B.1	Apply principles and guidelines derived from experience to effectively design and implement Object-Oriented solutions.
M23MCS204B.2	Analyze how OOP principles such as encapsulation, inheritance, and polymorphism contribute to software design.
M23MCS204B.3	Analyze intricate relationships between objects, such as associations, aggregations, and compositions
M23MCS204B.4	Analyze how Physical Object-Oriented Design bridges software architecture with implementation details.
M23MCS204B.5	Analyze the impact of heuristic choices on software quality, maintainability, and extensibility.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PS01	PSO2
M23MCS204B.1	3			3	3
M23MCS204B.2	3			3	3
M23MCS204B.3		3		3	3
M23MCS204B.4		3		3	3
M23MCS204B.5			3	3	3
M23MCS204B	3	3	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

The Essentials of Object Oriented Design course provides a solid foundation for students to pursue a variety of future paths and beyond.

1. **Foundation for Advanced Concepts:** Object-Oriented Design serves as a foundation for learning more advanced concepts and technologies in software development. It prepares you for exploring topics like design patterns, architectural patterns, enterprise application development, and more sophisticated programming languages.
2. **Adaptability and Reusability:** OOD promotes code reusability and modularity, which are crucial for developing large-scale applications and systems. Understanding OOD enables you to adapt to different programming languages and frameworks more easily because OOP concepts are widely applicable across various technologies.
3. **Collaborative Development:** Knowing OOD facilitates effective collaboration with other developers. It provides a common vocabulary and set of practices that streamline communication and teamwork. Teams that follow OOD principles tend to produce cleaner codebases that are easier to understand, maintain, and extend over time.
4. **Continuous Learning and Improvement:** Object-Oriented Design encourages a mindset of continuous learning and improvement. As you gain experience, you can refine your design skills and stay updated with evolving best practices. It fosters a proactive approach to software development, where you constantly seek better ways to design and implement solutions.
5. **Contribution to Open Source and Community Projects:** Proficiency in OOD allows you to contribute effectively to open-source projects and community initiatives. You can design reusable components or refactor existing codebases to improve functionality and maintainability.

2nd Semester	Professional Elective Course (PE) Multimedia Communication	M23MCS204C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Computer Literacy	A solid understanding of how computers work, file management, and using software applications is essential.
2	Communication Skills	Strong written and verbal communication skills are often required, as multimedia communication involves conveying messages through various media forms.
3	Understanding of Multimedia Concepts	Familiarity with basic multimedia concepts such as digital media formats (image, audio, video), compression techniques, and multimedia design principles.
4	Audio and Video Basics	Understanding of fundamental concepts related to audio and video production, editing, and formats.
5	Web Technologies	Basic knowledge of web technologies such as HTML, CSS, and possibly scripting languages like JavaScript, as multimedia often intersects with web design and development.
6.	Critical Thinking and Creativity	Courses often require students to think critically about multimedia messages and to creatively apply multimedia techniques to solve communication challenges.

2. Competencies

S/L	Competency	KSA Description
1	**Multimedia**	**Knowledge:** Insight into how multimedia is used to communicate messages effectively across various digital platforms. **Skills:** Proficiency in using multimedia tools. **Attitudes:** Ability to critically evaluate multimedia content for its effectiveness and impact.
2	**Text and image compression**	**Knowledge:** Understanding the trade-offs between file size reduction and fidelity of the compressed content. **Skills:** Competence in managing compressed data efficiently for storage, transmission, and retrieval purposes. **Attitudes:** Exploration of new compression techniques and advancements in the field.
3	**Audio compression**	**Knowledge:** Understanding of various audio compression methods. **Skills:** Applying audio compression algorithms and managing compressed audio files for storage, transmission, and playback. **Attitudes:** Selecting appropriate compression settings to balance file size reduction and audio quality.
4	**Video compression**	**Knowledge:** Understanding of various audio compression methods. **Skills:** Applying audio compression algorithms and managing compressed audio files for storage, transmission, and playback. **Attitudes:** selecting optimal compression settings to balance file size reduction and video quality.
5	**Synchronization**	**Knowledge:** Knowledge of techniques for synchronizing media. **Skills:** Synchronizing various media elements using software tools and techniques. **Attitudes:** Designing and delivering engaging multimedia content.

3. Syllabus

Multimedia Communication SEMESTER – II

Course Code	M23MCS204C	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

- Understand the basic need of multimedia and components of multimedia
- Understand the various multimedia standards
- Understand the compression techniques, transform for compression and analyze various compression standards for Text, Image and Video analyze.
- Demonstrate learner autonomy by maximizing use of learning resources and producing quality work.

Module -1

Multimedia Communication **8 hour**

Introduction, multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology, network QoS and application QoS, Digitization principles, Text, images, audio and video.

Text-1: CH-1.1-1.5, 2.1-2.6

Module -2

Text and Image compression **8hour**

Text and image compression, compression principles, text compression- Run length, Huffman, LZW, Document Image compression using T2 and T3 coding, image compression- GIF, TIFF and JPEG

Text-1: CH-3.1-3.5

Module -3

Audio and video compression **8 hour**

Audio and video compression, audio compression – principles, DPCM, ADPCM, Adaptive and Linear predictive coding, Code-Excited LPC, Perceptual coding, MPEG and Dolby coders video compression, video compression principles..

Text-1 CH-4.1-4.3.1

Module -4

Video compression: **8 hour**

Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework.

Text-1: CH-4.3.2-4.3.7

Module -5

Synchronization: **8 hour**

Notion of synchronization, presentation requirements, reference model for synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, and process management techniques.

Text-2 : CH-9-10

Text Books:

- Multimedia Communications. Fred Halsall. Pearson education. 2001.
- Multimedia: Computing, Communications and Applications. Raif Steinmetz, KlaraNahrstedt. Pearson education.2002.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3 **Multimedia Communication**	Describes different media types and network that are used to provide multimedia communication services. Selection of the application that these network support and range of terms that are associated with multimedia communication.
2	Week 4-6 **Text and Image compression**	Describes a selection of the compression algorithms that are used for the compression of text and images.

3	Week 7-9 **Audio and video compression**	Describes a selection of algorithms related to audio and video**.**
4	Week 10-12 **Video compression**	Define the standards that are used for compression of the different media types
5	Week 13-15 **Synchronization**	Describes design, develop, and manage multimedia systems effectively, ensuring seamless synchronization, efficient resource utilization, and optimal performance in multimedia applications.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Using traditional lecture methods and ICT as and when needed.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance learning.
3	Collaborative Learning	Encourage collaborative learning approaches for peer learning.
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application.
5	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
6	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	3	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives
1	Learn the fundamental of Multimedia systems and types of media system
2	Learn and analyze compression techniques
3	Understand and evaluate different protocols of multimedia communication
4	Understand Multimedia Content Management and Retrieval techniques
5	Adapt to Emerging Technologies and Trends in Multimedia

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs):

COs	Description
M23MCS204C.1	Apply QoS to multimedia network applications with efficient routing techniques.
M23MCS204C.2	Analyze the security threats in the multimedia networks.
M23MCS204C.3	Design and develop multimedia communication models and real-time multimedia network applications.
M23MCS204C.4	Understand Multimedia Content Management and Retrieval techniques
M23MCS204C.5	Adapt to Emerging Technologies and Trends in Multimedia

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS204C.1	3	-	-	3	3
M23MCS204C.2	3	-	3	3	3
M23MCS204C.3	-	3	3	3	3
M23MCS204C.4	3	3		3	3
M23MCS204C.5	3			3	3
M23MCS204C	3	3	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO2	CO3	CO3	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO2	CO3	CO3	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject:

- Digital **Marketing and Advertising**: Multimedia communication skills are highly valued in digital marketing and advertising agencies. Professionals in this field create engaging multimedia content for social media campaigns, online advertisements, and interactive marketing strategies.
- Content **Creation and Production**: There is a growing demand for multimedia content creators across platforms such as YouTube, TikTok, and other social media channels. Careers in content creation involve producing engaging videos, graphics, and interactive content that resonate with audiences.

- **User Experience (UX) Design**: Multimedia communication skills are essential in UX design, where professionals create intuitive and visually appealing interfaces for websites, apps, and interactive media platforms. UX designers use multimedia to enhance user interaction and engagement.

Virtual Reality (VR) and Augmented Reality (AR): As VR and AR technologies continue to evolve, there is an increasing demand for multimedia specialists who can create immersive and interactive experiences.

2nd Semester	Professional Elective Course (PE) NoSQL Database	M23MCS204D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Computer Science Knowledge**	Understanding of data structures (arrays, lists, dictionaries, trees, graphs). Basic algorithm concepts (searching, sorting).
2	**Database Fundamentals**	Knowledge of traditional relational databases (SQL, tables, schemas).Understanding of database operations (CRUD operations: Create, Read, Update, Delete)
3	**Programming Skills**	Proficiency in at least one programming language (e.g., Python, JavaScript, Java).Familiarity with database interaction using a programming language (e.g., using SQL libraries or ORMs).
4	**Understanding of Data Models**	Concept of structured vs. unstructured data. Knowledge of different data models (document, key-value, column-family, graph).
5	**Networking and Distributed Systems**	Basic understanding of networking concepts. Familiarity with distributed systems principles (consistency, availability, partition tolerance).
6	**Web Development Basics**	Understanding of web technologies (HTTP, REST APIs). Experience with front-end and back-end development.
7	**Operating Systems and Shell Scripting**	Basic knowledge of operating systems (especially Unix/Linux). Proficiency in shell scripting for automating tasks.
8	**JSON and XML**	Understanding of data interchange formats like JSON and XML, which are commonly used in NoSQL databases.
9	**NoSQL Database Concepts**	Familiarity with the CAP theorem. Understanding the types of NoSQL databases (document-oriented, key-value stores, column-family stores, graph databases).
10	**Practical Experience**	Hands-on experience with at least one NoSQL database (e.g., MongoDB, Cassandra, Redis, Neo4j).

2. Competencies

S/L	Competency	KSA Description
1	**Foundational Knowledge**	**Knowledge:** Understanding the different types of NoSQL databases (document-based, key-value, column-family, graph) and their respective strengths and weaknesses. **Skills:** Ability to design efficient schemas and data models tailored for NoSQL databases. **Attitude:** Willingness to experiment with different NoSQL solutions to find the best fit for specific use cases.
2	**Technical Skills**	**Knowledge:** Knowledge of various types of NoSQL databases (document-based, key-value, column-family, graph) and their differences in data storage and retrieval. **Skills:** Capability to design effective data models that optimize data retrieval and storage efficiency in NoSQL databases. **Attitude:** Proactive approach to identifying and solving complex data management and performance challenges in NoSQL databases.
3	**Programming Skills**	**Knowledge:** Understanding how to optimize data models for query performance and scalability. **Skills:** Ability to perform data aggregations and transformations using NoSQL query languages or APIs. **Attitude:** Eagerness to stay updated with advancements in NoSQL technologies, best practices, and industry trends.

4	**Performance Tuning**	**Knowledge:** Knowledge of the query execution process within the NoSQL database, including how indexes are utilized, data retrieval strategies, and query planning. **Skills:** Ability to interpret performance metrics, identify performance issues, and take corrective actions proactively. **Attitude:** Commitment to implementing thorough performance tuning practices, ensuring that optimizations are carefully tested and validated.
5	**Data Management**	**Knowledge:** Familiarity with query languages (e.g., MongoDB Query Language, Cassandra Query Language) and APIs used for data retrieval, manipulation, and aggregation in NoSQL databases. **Skills:** Skills in writing efficient queries to ensure optimal performance. **Attitude:** Careful consideration of data modelling and schema design to ensure optimal performance and scalability.

3. Syllabus

NoSQL DATABASE			
Course Code	**M23MCS204D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

CO1: Define, compare and use the four types of NoSQL Databases (Document-oriented, KeyValue Pairs, Column-oriented and Graph).
CO2: Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.
CO3: Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.

Module -1

Why NoSQL: Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases. More Details on Data Models; Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modeling for Data Access.

Module -2

Distribution Models: Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums. Version Stamps, Business and System Transactions, Version Stamps on Multiple Nodes.

Module -3

Map-Reduce: Map-Reduce, Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce Key-Value Databases, What Is a Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multioperation Transactions, Query by Data, Operations by Sets.

Module -4

Document Databases: Document Databases, What Is a Document Database, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, ECommerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure

Module -5

Graph Databases: Graph Databases, What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

Textbooks:

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley, 2012
2. Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", 2nd Edition, O'Reilly Publications, 2013. (ISBN-13: 978-9351102694)

Reference Books:

1. Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN13: 978-9332557338)
2. Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022)

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	Introduction and Principles of Combinational NoSQL
2	Week 3-4	Map-Reduce concept introduction to SQL
3	Week 5-6	Distribution Models introduction and application
4	Week 7-8	Document Databases ,features, use cases
5	Week 9-10	Graph Databases concept explanation
6	Week 11-12	Graph Databases concept explanation

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of NoSQL concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.

6. **Assessment Details (both CIE and SEE)**

This section of regulations is applicable to all theory-based courses. The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Elective Course (PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	**Internal Assessment-Tests (A)**	**3**	**50%**	**25**	**10**
(ii)	**Assignments/Quiz/Activity (B)**	**2**	**50%**	**25**	**10**
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations: PG Programmes

Theory Course with 4, 3 and 2 Credits: Professional Core Course (PC)/Professional Elective/Open Elective

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- 2 There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- 3The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the Evolution and Need for NoSQL	Student knows the limitations of traditional relational databases. And analyses given any scenarios and use cases where NoSQL databases are more appropriate.
2	Differentiate Between Types of NoSQL Databases	Student is able to Identify and explain the different types of NoSQL databases: document-oriented, key-value stores, column-family stores, and graph databases. And the strengths and weaknesses of each type.
3	Data Modelling	Student is going to Develop data models appropriate for different types of NoSQL databases. Implement schemas in document-oriented databases (e.g., MongoDB).Understand and apply denormalization and embedding techniques. Design efficient data structures to optimize performance.
4	Technical Skills	Students are going to Execute Create, Read, Update, and Delete operations using NoSQL query languages and Eviscerate and manage indexes to improve query performance.Apply techniques for optimizing queries in NoSQL databases.
5	Performance and Scalability	Student make use of tools and techniques to monitor database performance. Identify performance bottlenecks and apply tuning strategies.
6	Continuous Learning	Student should Stay Updated with NoSQL Trends: Follow the latest developments and best practices in NoSQL technologies with new NoSQL databases and features.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

CO's	Description
M23MCS204D.1	Define, compare and use the four types of NoSQL Databases (Document-oriented, Key Value Pairs, Column-oriented and Graph).
M23MCS204D.2	Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.
M23MCS204D.3	Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.
M23MCS204D.4	Apply techniques for optimizing queries in NoSQL databases
M23MCS204D.5	Apply the latest developments and best practices in NoSQL technologies with new NoSQL

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS204D.1	3	-	-	3	3
M23MCS204D.2	3	-	-	3	3
M23MCS204D.3	-	3	3	3	3
M23MCS204D.4	3			3	3
M23MCS204D.5		3		3	3
M23MCS204D	3	3	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO2	CO3	CO3	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO2	CO3	CO3	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The future of NoSQL databases is bright, with continuous advancements in technology and increasing adoption across various industries. By staying abreast of these trends and developments, professionals and organizations can leverage the full potential of NoSQL databases to meet their evolving data management needs.

1. Big Data and Real-Time Analytics

Scalability and Performance: NoSQL databases are designed to handle large volumes of unstructured and semi-structured data, making them ideal for big data applications.

Real-Time Processing: As real-time data processing and analytics become more crucial for businesses, NoSQL databases will continue to be essential for applications that require low-latency data access.

2. Cloud Computing and Serverless Architectures

Cloud Integration: NoSQL databases are well-suited for cloud environments due to their ability to scale horizontally and handle distributed data across multiple nodes.

Serverless Databases: The adoption of serverless computing models will drive the demand for NoSQL databases that can efficiently manage data without the need for traditional server infrastructure.

3. Micro services Architecture

Decentralized Data Management: Micro services architecture promotes the use of decentralized data stores, and NoSQL databases fit well into this model by providing flexibility and scalability.

Polyglot Persistence: As applications adopt polyglot persistence (using different data storage technologies for different needs), NoSQL databases will be a key component in the data architecture.

4. Data Privacy and Security

Enhanced Security Features: NoSQL databases will continue to evolve to provide enhanced security features, including encryption, fine-grained access controls, and compliance with data protection regulations.

Privacy by Design: Future NoSQL databases will increasingly incorporate privacy by design principles to protect user data and ensure compliance with global privacy laws.

5. Cross-Platform and Multi-Model Databases

Hybrid Databases: The lines between NoSQL and SQL databases are blurring, with many databases now offering hybrid capabilities to support both relational and non-relational data models.

Multi-Model Databases: NoSQL databases will continue to evolve to support multiple data models (document, graph, key-value, column-family) within a single database engine, providing greater flexibility for developers.

6. Adoption in Enterprises

Mainstream Acceptance: NoSQL databases are increasingly being adopted by large enterprises for mission-critical applications, indicating growing trust and maturity in the technology.

Legacy Modernization: Many organizations are using NoSQL databases to modernize legacy systems, enabling more agile and scalable data management solutions.

7. AI-Powered Database Management

Automation and Self-Tuning: AI and machine learning will be used to automate database management tasks such as indexing, query optimization, and resource allocation, making NoSQL databases more efficient and easier to manage.

Predictive Analytics: AI-powered predictive analytics will enhance the ability of NoSQL databases to anticipate and respond to performance issues and changing workloads.

2nd Semester	Professional Core Laboratory Course (PCL) Big-Data Analytics Laboratory	M23MCSL206

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Computer Science Knowledge	**Computer Programming:** Proficiency in a programming language such as Java, Python, or Scala. Understanding of object-oriented programming (OOP) principles is particularly beneficial. **Data Structures and Algorithms:** Knowledge of fundamental data structures (arrays, lists, stacks, queues, hash tables, trees, and graphs) and algorithms (sorting, searching, etc.).
2	Database Management Systems (DBMS)	**SQL:** Basic understanding of SQL for querying and managing databases. **Relational Databases:** Familiarity with relational database concepts such as normalization, indexing, transactions, and schema design.
3	Basic Statistics and Mathematics	**Descriptive Statistics:** Mean, median, mode, standard deviation, variance, and data distributions. **Probability:** Basic probability concepts and distributions. **Linear Algebra:** Vectors, matrices, and matrix operations.
4	Basic Understanding of Distributed Systems	**Distributed Computing Principles:** Basic concepts of distributed systems, such as distributed storage and processing.
5	Introduction to Cloud Computing	**Cloud Basics:** Understanding of what cloud computing is, its benefits, and basic cloud service models (IaaS, PaaS, SaaS). **Cloud Providers:** Familiarity with major cloud service providers like AWS, Azure, and Google Cloud.
6	Introduction to Big Data Concepts	**Big Data Fundamentals:** Awareness of what big data is, its significance, and its applications. **Data Formats:** Understanding of different data formats (structured, semi-structured, unstructured).

2. Competencies

S/L	Competency	KSA Description
1	Getting an Overview of Big Data	**Knowledge:** Understanding of the definition and components of big data (Volume, Velocity, Variety, Veracity). Familiarity with the history and evolution of data management leading to big data. **Skills:** Ability to identify and categorize different types of data. Proficiency in analysing big data characteristics and their implications. **Attitudes:** Appreciation of the transformative potential of big data in various sectors.
2	Introducing Hadoop Framework	**Knowledge:** Understanding of Hadoop architecture and its ecosystem components. **Skills:** Proficiency in setting up and configuring Hadoop environments. Ability to navigate and use the Hadoop Distributed File System (HDFS). **Attitudes:** Openness to learning and adopting new technologies.
3	Hadoop MapReduce Framework	**Knowledge:** Understanding of the MapReduce model, its parallel data flow, and fault tolerance mechanisms. **Skills:**

		Ability to write, compile, and execute MapReduce programs. Proficiency in optimizing MapReduce jobs for performance and efficiency. **Attitudes:** Problem-solving mindset to tackle data processing challenges.
4	Hadoop YARN Architecture and Tools to Analyze Data	**Knowledge:** Understanding of YARN architecture, schedulers, and backward compatibility. **Skills:** Ability to configure and manage YARN for resource scheduling and job management. Proficiency in using analytical tools to process and analyze big data. **Attitudes:** Openness to adopting new analytical tools and techniques.
5	Essential Hadoop Tools	**Knowledge:** Understanding of the data models and functionalities of Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie. **Skills:** Proficiency in using Apache Pig for data processing. Ability to use Apache Hive for data warehousing and querying. **Attitudes:** Appreciation of the importance of data processing and management tools in big data workflows.

3. Syllabus

Big Data Analytics Laboratory **SEMESTER – II**			
Course Code	**M23MCSL206**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(1:0:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**3hrs/week**	Total Marks	**100**
Credits	**02**	Exam Hours	**03**
Course objectives: This course will enable students to: Understand the Fundamentals and Evolution of Big Data Analyze the Applications and Advantages of Big Data Analytics Master the Hadoop Framework and Ecosystem Develop Skills in Hadoop MapReduce and YARN Utilize Essential Hadoop Tools for Data Processing and Management			
PROGRAM-1 Basic Linux Commands. Understanding how to connect to remote Linux server using putty kind of tool. Install Apache Hadoop			
PROGRAM-2 Develop a MapReduce program to calculate the frequency of a given word in a given file.			
PROGRAM-3 Develop a MapReduce program to find the maximum temperature in each year.			
PROGRAM-4 Develop a MapReduce program to find the grades of student's.			
PROGRAM-5 Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.			
PROGRAM-6 Develop a MapReduce program to implement Matrix Multiplication.			
PROGRAM-7 Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day.			
PROGRAM-8 Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data.			

PROGRAM-9

Develop a program to calculate the maximum recorded temperature by yearwise for the weather dataset in Pig Latin

PROGRAM-10

Develop a MapReduce program to analyze Uber data set to find the days on which each basement has more trips using the following dataset.

The Uber dataset consists of four columns they are

Dispatchingbasenumber	date	Activevehicles	trips

PROGRAM-11

Develop a MapReduce program to analyze Titanic ship data and to find the average age of the people (both male and female) who died in the tragedy. How many persons are survived in each class.

The titanic data will be..

Column 1 :Passenger Column 2 : Survived (survived=0 &died=1)

Column 3 :Plasmoquin 4 : Name

Column 5 : Sex Column 6 : Age

Column 7 :SibSp Column 8 :Parch

Column 9 : Ticket Column 10 : Fare

Column 11 :Cabin Column 12 : Embarked

PROGRAM-12

Develop a MapReduce program to find the number of products sold in each country by considering sales data containing fields like

Tranction _ Date	Product	Price	Payment _Type	Name	City	State	Country	Account_ Created	Last Login	Latitude	Longitude

Text Books:

1. Tom White, “Hadoop: The Definitive Guide” Fourth Edition, O’reilly Media, 2015.

Reference Books:

- Glenn J. Myatt, Making Sense of Data , John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O’Reilly, 2011.
- Michael Berthold, David J.Hand, Intelligent Data Analysis, Spingers, 2007.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1	Basic Linux Commands. Understanding how to connect to remote Linux server using putty kind of tool. Install Apache HadoopBig Data Analytics
2	Week 2	Develop a MapReduce program to calculate the frequency of a given word in agiven file.
3	Week 3	Develop a MapReduce program to find the maximum temperature in each year.
4	Week 4	Develop a MapReduce program to find the grades of student’s.
5	Week 5	Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.
6	Week 6	Develop a MapReduce program to implement Matrix Multiplication.
7	Week 7	Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day.
8	Week 8	Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data.
9	Week 9	Develop a program to calculate the maximum recorded temperature by yearwise for the weather dataset in Pig Latin
10	Week 10	Develop a MapReduce program to analyze Uber data set to find the days on which each basement has more trips using the following dataset.

<table>
<tr><td></td><td></td><td>The Uber dataset consists of four columns they are
<table><tr><td>Dispatchingbase_number</td><td>date</td><td>active vehicles</td><td>trips</td></tr></table></td></tr>
<tr><td>11</td><td>Week 11</td><td>Develop a MapReduce program to analyze Titanic ship data and to find the average age of the people (both male and female) who died in the tragedy. How many persons are survived in each class.
The titanic data will be..
Column 1 :Passenger Id Column 2 : Survived (survived=0 &died=1)
Column 3 :Pclass Column 4 : Name
Column 5 : Sex Column 6 : Age
Column 7 :SibSp Column 8 :Parch
Column 9 : Ticket Column 10 : Fare
Column 11 :Cabin Column 12 : Embarked</td></tr>
<tr><td>12</td><td>Week 12</td><td>Develop a MapReduce program to find the number of products sold in each country by considering sales data containing fields like
<table><tr><td>Tranction _Date</td><td>Product</td><td>Price</td><td>Payment _Type</td><td>Name</td><td>City</td><td>State</td><td>Country</td><td>Account _Created</td><td>La Lo</td></tr></table></td></tr>
</table>

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lectures and Presentations	Use multimedia presentations to explain key concepts like the definition of big data, its characteristics (Volume, Velocity, Variety, Veracity), and its evolution.
2	Class Discussions	Facilitate discussions on the advantages of big data analytics and its impact on different industries.
3	Case Study Analysis	Provide case studies on the use of big data in different industries and have students analyze and discuss them in groups.
4	Quizzes and Assessments:	Conduct quizzes to test students' understanding of the fundamental concepts of big data.
5	Interactive Lectures	Use diagrams and flowcharts to illustrate the Hadoop Distributed File System (HDFS) architecture and its features.
6	Hands-On Labs	Conduct lab sessions where students install and configure Hadoop on virtual machines.
7	Step-by-Step Tutorials	Provide detailed tutorials on the MapReduce model, including writing, compiling, and running MapReduce programs.
8	Lectures and Diagrams	Use diagrams to explain the YARN architecture and its components.
9	Tool-Specific Lectures:	Provide detailed lectures on using Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie.
10	Blended Learning	Combine online resources, video tutorials, and in-class activities to provide a diverse learning experience.

6. Assessment Details (both CIE and SEE)

Note:

- ✓ **Different types of courses will different assessment patterns, for which the applicable rules and regulations may be referred.**
- ✓ **An illustration for one of the course is given below.**

- ✓ Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern is

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

SEE for practical Course (Irrespective of Experiment or program based):

- SEE marks for practical course shall be 50 marks

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

- See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
- Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
- Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the Fundamentals of Big Data	Define what constitutes big data and describe its key characteristics: Volume, Velocity, Variety, and Veracity. Trace the history and evolution of data management, leading to the emergence of big data. Differentiate between structured, semi-structured, and unstructured data.
2	Analyze Big Data Analytics and Its Applications	Explain the core elements of big data analytics and its advantages in various industries. Evaluate the use of big data in social networking to enhance user experience and engagement. Assess the role of big data in preventing and detecting fraudulent activities, particularly in the insurance and retail sectors.
3	Master the Hadoop Framework	Describe the architecture and components of the Hadoop ecosystem, including HDFS and MapReduce. Explain how Hadoop functions, including the role of cloud computing in big data processing. Identify key cloud deployment and delivery models, and explain the features of cloud computing relevant to big data.
4	Develop Proficiency in Hadoop Distributed File System (HDFS)	Understand the HDFS architecture, its features, and components. Use HDFS user commands to manage and manipulate data within the Hadoop ecosystem. Describe the in-memory computing technology for big data and its benefits.
5	Gain Skills in Hadoop MapReduce Framework	Explain the MapReduce model, including its parallel data flow, fault tolerance, and speculative execution. Write, compile, and execute MapReduce programs, and optimize these jobs for better performance. Use the streaming and pipes interfaces for different data processing tasks in MapReduce.

6	Explore Hadoop YARN Architecture and Analytical Tools	Describe the background, architecture, and working of YARN, including its schedulers and configurations. Execute YARN commands and understand its backward compatibility. Compare various popular analytical tools, their history, and their applications in big data analysis.
7	Utilize Essential Hadoop Tools for Data Processing	Use Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie for specific data processing tasks. Perform data import and export operations using Apache Sqoop, and understand its version changes. Implement data models in HBase and manage workflows with Apache Oozie.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23MCSL206.1	Understand and apply Big Data Concepts and Analytics
M23MCSL206.2	Analyse and apply Big Data analytics in various sectors such as social networking, fraud detection, and retail.
M23MCSL206.3	Describe the Hadoop framework and its components, including cloud computing and HDFS.
M23MCSL206.4	Develop and execute MapReduce programs, optimizing them for better performance
M23MCSL206.5	Utilize essential Hadoop tools like Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie for data processing

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCSL206.1	**3**	**2**	**3**	**2**	**2**
M23MCSL206.2	**3**		**3**	**2**	**2**
M23MCSL206.3		**2**	**3**	**2**	**3**
M23MCSL206.4	**3**		**3**	**3**	**3**
M23MCSL206.5	**3**		**3**	**3**	**3**
M23MCSL206	**3**	**2**	**3**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The "Big Data Analytics" course in the second semester of the M.Tech program provides a comprehensive foundation in Big Data and Hadoop technologies, opening various career paths and opportunities in multiple industries. With the growing importance of data-driven decision-making, professionals skilled in Big Data analytics and Hadoop are in high demand. The integration of emerging technologies will further expand the scope and impact of Big Data, making it a pivotal field for future innovations.

1. **Career Opportunities:** Data scientists and analysts are in high demand as organizations seek to extract meaningful insights from their data. With skills in Big Data and Hadoop technologies, professionals can analyze large datasets, identify trends, and make data-driven decisions to benefit businesses.
2. **Research and Development:** Professionals with expertise in Big Data can engage in research to develop advanced analytics techniques. This includes predictive analytics, real-time data processing, and innovative ways to handle unstructured data.
3. **Machine Learning and AI Integration:** Big Data plays a crucial role in training machine learning models. Researchers can explore the integration of Big Data with AI to create smarter, more efficient algorithms. Leads to advancements in AI technologies, improving automation, decision-making, and personalized services.
4. **Emerging Technologies:** IoT devices generate massive amounts of data. Big Data technologies are essential for collecting, processing, and analyzing this data to derive actionable insights. Facilitates smart cities, industrial automation, and improved resource management.
5. **Industry Applications:** Big Data analytics can revolutionize healthcare by providing insights into patient care, treatment outcomes, and operational efficiency. It helps in predictive modeling for disease outbreaks and personalized medicine. Improves patient outcomes, reduces costs, and enhances the overall efficiency of healthcare systems.
6. **Social Media and Networking:** Social media platforms use Big Data to analyze user behavior, content trends, and advertising effectiveness. Hadoop's ability to handle vast amounts of unstructured data makes it ideal for this sector. Enhances user engagement, optimizes content delivery, and improves targeted advertising.