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 3rd to 4th 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

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3rdSemester	Professional Core Course (PC) Cloud Computing	M23MCS301

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Programming Fundamentals**	• Students should have a solid understanding of programming concepts, particularly in Python, as it is widely used in data science for data manipulation, analysis, and machine learning. • Knowledge of data structures (e.g., lists, dictionaries) and control structures (e.g., loops, conditionals) is essential.
2	**Mathematics**	• Understanding of solving linear and quadratic equations • Proficiency in differential and integral calculus, including applications. • Familiarity with geometric shapes, angles, trigonometric functions, and their properties.
3	**Computer Networks and Security**	• Computer Networks, Network Security • Understanding of network protocols, TCP/IP, DNS, and basic network configurations. • Information Security, Cryptography
4	**Operating Systems**	• Operating Systems, Systems Programming. • Knowledge of process management, memory management, file systems, and system calls.
5	**Fundamentals of Probability**	• Knowledge of probability theory, including conditional probability, Bayes' theorem, and probability distributions, is essential. This will help students understand the statistical underpinnings of many data science algorithms, such as Naive Bayes

2. Competencies

S/L	Competency	KSA Description
1	**Introduction to cloud computing**	**Knowledge:** Understanding the definition, scope, and significance of Cloud computing. Awareness of the Historical Developments, Building Cloud Computing Environments, Amazon Web Services (AWS), Google App Engine. **Skills:** Ability to articulate the role and impact of Cloud in various industries. Skill in identifying the different components of the Cloud workflow.. **Attitudes:** Curiosity about the evolving field of Cloud and its applications. Appreciation for the interdisciplinary nature of Cloud, integrating statistics, mathematics, and domain knowledge.
2	**Cloud computing: Application and Paradigm**	**Knowledge:** Understanding cloud service models (IaaS, PaaS, SaaS). Familiarity with deployment models (public, private, hybrid, multi-cloud). Knowledge of cloud architecture principles and best practices. **Skills:** Proficiency in programming/scripting languages (e.g., Python, JavaScript, Bash). Experience with cloud management and orchestration tools. Understanding of database services in the cloud (SQL, NoSQL). Skills in data analysis and visualization tools. **Attitudes:** Encouraging creative solutions and thinking outside the box when designing cloud applications. Commitment to ongoing learning and professional development in cloud technologies.
3	**Cloud Resource Virtualization**	**Knowledge:** Understanding of virtualization concepts, types (e.g., server, storage, network), and benefits. Knowledge of how virtualization fits into IaaS, PaaS, and SaaS models.

		Understanding of resource allocation, provisioning, scaling, and monitoring in a virtualized environment. **Skills:** Experience with virtualization platforms and tools (e.g., VMware vSphere, Microsoft Hyper-V, OpenStack). Ability to deploy and manage virtual machines and containers. Ability to diagnose and resolve issues related to virtualized environments. **Attitudes:** A proactive approach to identifying and addressing challenges in virtualization. A team-oriented attitude, valuing input and expertise from others in cross-functional teams.
4	**Cloud Resource Management and Scheduling**	**Knowledge:** knowledge skill and attitude on cloud resource virtualization. Familiarity with scheduling algorithms (e.g., FIFO, Round Robin, Priority Scheduling) and their applications in cloud environments. **Skills:** Ability to use cloud management tools for monitoring, allocating, and scaling resources effectively. Skills in automation tools and scripting. Ability to set up monitoring tools (like Cloud Watch, Prometheus) and interpret reports to make informed decisions. **Attitudes:** Taking initiative in optimizing resource usage and anticipating potential issues. Understanding the needs of end-users to ensure that resource management aligns with user experience and service level agreements.
5	**Cloud Security**	**Knowledge:** Understanding of cloud security principles, including shared responsibility models and security frameworks. Awareness of common threats and vulnerabilities in cloud environments, such as DDoS attacks, data breaches, and insider threats. **Skills:** Ability to conduct risk assessments to identify vulnerabilities and implement mitigation strategies. Skills in developing and executing incident response plans, including detection, containment, and recovery. **Attitudes:** Ability to work effectively with cross-functional teams, including developers and operations, to foster a culture of security. Willingness to keep up with the latest trends, tools, and threats in cloud security.

3. Syllabus

Cloud Computing **SEMESTER – III**			
Course Code	M23MCS301	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**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

- Understand the concepts, characteristics, delivery models and benefits of cloud computing.
- Explore the key technical, organisational and compliance challenges of cloud computing.
- Analyze the concepts of virtualization efficiently.
- Explore the security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services.

Module -1

Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing.

Text-1: CH-1.3-1.6, 3.1-3.5,3.7,3.8,3.10,3.11,3.14

Module -2
Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Grep The Web application, Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing **Text-1: CH-4.1,4.3-4.11**
Module -3
Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization **Text-1 CH-5.1-5.12**
Module -4
Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, **Text-1: CH-6.1-6.14**
Module -5
Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java **Text-1 : CH-9.1-9.9,9.11,11.1-11.5**
Text Books: 1. Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 2013. 2. Computing Principles and Paradigms, Rajkumar Buyya , James Broberg, Andrzej Goscinsk,I Willey, 2014 **Reference Books:** 1. Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 2013. 2. Computing Principles and Paradigms, Rajkumar Buyya , James Broberg, Andrzej Goscinsk,I Willey, 2014

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3 **Introduction to cloud computing**	Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing.
2	Week 4-6 **Cloud computing: Application and Paradigm**	Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The GrepTheWeb application, Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.

3	Week 7-9 **Cloud Resource Virtualization**	Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization.
4	Week 10-12 **Cloud Resource Management and Scheduling**	Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling.
5	Week 13-15 **Cloud Security Cloud Application Development**	Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java.

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	Description
1	Introduction to cloud computing	Students will be able to define cloud computing and explain its significance in the context Cloud Computing Environments, network-centric computing and network-centric content.
2	Cloud computing: Application and Paradigm	Students will be able to know cloud application and coordination using Zookeeper and MapReduce programming model
3	Cloud Resource Virtualization	Students will be able know the Characteristics of Virtualized, Environments Taxonomy of Virtualization Techniques, Execution Virtualization, Other Types of Virtualization..
4	Cloud Resource Management and Scheduling	Understand the application of control theory to scheduling, two level resources allocation strategies and coordination of multiple autonomic performance mangers.
5	Cloud Security	Students will be able to understand cloud security risks, privacy and trust along with cloud application developed for the (AWS).

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

Course Outcomes (COs):

COs	Description
M23MCS301.1	Apply various concepts of cloud computing and deployment models, security on computing paradigms.
M23MCS301.2	Analyse different virtualization and resource management techniques used in Cloud platform
M23MCS301.3	Design and develop various methods, algorithm for allocating and managing the resources in cloud.

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS301.1	2	-	-	-	2
M23MCS301.2	2	-	-	-	2
M23MCS301.3	-	2	2	2	2
M23MCS301	2	2	2	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Module 1	**5**	**5**		**10**
Module 2	**5**		**5**	**10**
Module 3	**5**	**2**	**3**	**10**
Module 4		**5**	**5**	**10**
Module 5	**2**	**5**	**3**	**10**
Total	**17**	**17**	**16**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	**Total**
Module 1	**7**	**7**	**6**	**20**
Module 2	**8**	**6**	**6**	**20**
Module 3	**6**	**8**	**6**	**20**
Module 4	**6**	**7**	**7**	**20**
Module 5	**7**	**6**	**7**	**20**
Total	**34**	**34**	**32**	**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. **Server less Architectures**: Simplifying application deployment and scaling by abstracting server management. This includes further advancements in Function as a Service (FaaS) and Backend as a Service (BaaS).
2. **Edge Computing**: Expanding cloud capabilities to the edge of the network to reduce latency and improve performance, particularly for IoT and real-time applications.
3. **Artificial Intelligence and Machine Learning**: Integrating AI and ML with cloud services to enable more intelligent automation, enhanced analytics, and better decision-making capabilities
4. **Security and Privacy**: Advancing encryption, identity management, and threat detection to address growing concerns about data protection and compliance in cloud environments.
5. **Quantum Computing**: Exploring how quantum computing can be integrated into cloud platforms to tackle complex problems beyond the capabilities of classical computers.
6. **Advanced Networking**: Developing new networking technologies and protocols to support the growing demands of cloud computing, including better support for high-speed data transfer and network slicing

3rdSemester	Professional Elective Course (PE) Cloud Security	M23MCS302A

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	**Computer Networks**	**TCP/IP, DNS, and HTTP/HTTPS**: Understanding how data moves over the internet and how web traffic is managed. **Firewalls and VPNs**: Knowledge of protecting network boundaries and secure communication channels. **Subnetting and NAT (Network Address Translation)**: Helps in understanding IP address management in cloud infrastructures.
2.	**Cryptography and Network Security**	**Symmetric and Asymmetric Encryption**: How data is secured in transit and at rest. **SSL/TLS**: Securing web traffic. **Public Key Infrastructure (PKI)**: Certificate management and key exchange methods
3.	**Cloud Computing.**	**Virtual Machines (VMs)** and **Containers** (e.g., Docker): How applications are isolated and deployed in cloud environments. **IaaS, PaaS, SaaS**: Knowledge of different cloud service models and their security implications. **Public vs. Private Cloud**: Understanding cloud architecture and deployment models, along with their security differences. **AWS, Azure, GCP**: Familiarity with at least one major cloud platform's security services like AWS Security Hub, Azure Security Center, etc.

2. Competencies

S/L	Competency	KSA Description
1	Cloud Security Governance and Compliance	**Knowledge:** Familiarity with global regulatory frameworks such as **GDPR**, **HIPAA**, **ISO/IEC 27017**, and **NIST**. Understanding of the **Shared Responsibility Model** in cloud computing. Knowledge of data protection laws and privacy standards. **Skills:** Ability to map regulatory requirements to cloud services. Develop and enforce security policies and procedures in cloud environments. Conduct compliance audits and ensure adherence to security standards. **Attitudes:** Attention to detail in compliance with legal and regulatory requirements .Ethical responsibility in data protection and privacy. Proactive attitude toward staying updated on evolving regulations.
2	Identity and Access Management (IAM)	**Knowledge:** Understanding of **IAM** principles and technologies, including **OAuth**, **SAML**, and **OpenID Connect**. Familiarity with role-based and attribute-based access control models. Knowledge of multi-factor authentication (MFA) and single sign-on (SSO) systems. **Skills:** Configure and manage IAM systems for cloud platforms like AWS, Azure, and Google Cloud. Implement least privilege access and role-based security models. Manage access control policies and integrate MFA and SSO solutions. **Attitudes:** Vigilance in maintaining secure access controls. Respect for user privacy and confidentiality. Commitment to applying least privilege and minimizing unnecessary access.
3	Cloud Data Security	**Knowledge:** Understanding encryption techniques for data at rest, in transit, and in use. Familiarity with key management systems (e.g., AWS KMS, Azure Key Vault).Awareness of data classification models and best practices for securing sensitive data. **Skills:** Implement encryption solutions for cloud data storage and transmission.

		Manage and rotate encryption keys securely using cloud-native tools. Create and enforce data security policies that classify and protect sensitive data. **Attitudes:** Accountability in safeguarding sensitive information. Precision in following data encryption and protection protocols. Proactivity in identifying data security risks and mitigating them.

3. Syllabus

Cloud Security **SEMESTER – III**			
Course Code	**(M23MCS302A)**	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:

- To understand the fundamentals concepts of cloud computing.
- To understand the cloud security and privacy issues.
- To understand the Threat Model and Cloud Attacks
- To understand the Data Security and Storage
- To analyze Security Management in the Cloud.

Module -1

Overview of Cloud Computing: Introduction, Definitions and Characteristics, Cloud Service Models, Cloud Deployment Models, Cloud Service Platforms, Challenges Ahead.
Introduction to Cloud Security: Introduction, Cloud Security Concepts, CSA Cloud Reference Model, NIST Cloud Reference Model, NIST Cloud Reference Model.

Module -2

Cloud Security and Privacy Issues: Introduction, Cloud Security Goals/Concepts, Cloud Security Issues, Security Requirements for Privacy, Privacy Issues in Cloud.
Infrastructure Security: The Network Level, the Host Level, the Application Level, SaaS Application Security, PaaS Application Security, IaaS Application Security.

Module -3

Threat Model and Cloud Attacks: Introduction, Threat Model- Type of attack entities, Attack surfaces with attack scenarios, A Taxonomy of Attacks, Attack Tools-Network-level attack tools, VM- level attack tools, VMM attack tools, Security Tools, VMM security tools.

Module -4

Information Security Basic Concepts: an Example of a Security Attack, Cloud Software Security Requirements, Rising Security Threats.
Data Security and Storage: Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security.

Module -5

Evolution of Security Considerations: Security Concerns of Cloud Operating Models, Identity Authentication, Secure Transmissions, Secure Storage and Computation, Security Using Encryption Keys, Challenges of Using Standard Security Algorithms, Variations and Special Cases for Security Issues with Cloud Computing, Side Channel Security Attacks in the Cloud
Security Management in the Cloud: Security Management Standards, Availability Management, Access Control, Security Vulnerability, Patch, and Configuration Management.

Text Books:

1. Cloud Security Attacks, Techniques, Tools, and Challenges by Preeti Mishra, Emmanuel S Pilli, Jaipur R C Joshi Graphic Era, 1st Edition published 2022 by CRC press.
2. Cloud Computing with Security Concepts and Practices Second Edition by Naresh Kumar Sehgal Pramod Chandra, P. Bhatt John M. Acken, 2nd Edition Springer nature Switzerland AG 2020.

Referebce Books

1. Cloud Security Attacks, Techniques, Tools, and Challenges by Preeti Mishra, Emmanuel S Pilli, Jaipur R C Joshi Graphic Era, 1st Edition published 2022 by CRC press.

2. Cloud Computing with Security Concepts and Practices Second Edition by Naresh Kumar Sehgal Pramod Chandra, P. Bhatt John M. Acken, 2nd Edition Springer nature Switzerland AG 2020.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	**Overview of Cloud Computing:** Introduction, Definitions and Characteristics, Cloud Service Models, Cloud Deployment Models, Cloud Service Platforms, Challenges Ahead. **Introduction to Cloud Security:** Introduction, Cloud Security Concepts, CSA Cloud Reference Model, NIST Cloud Reference Model, NIST Cloud Reference Model.
2	Week 3-4:	**Cloud Security and Privacy Issues:** Introduction, Cloud Security Goals/Concepts, Cloud Security Issues, Security Requirements for Privacy, Privacy Issues in Cloud. **Infrastructure Security:** The Network Level, the Host Level, the Application Level, SaaS Application Security, PaaS Application Security, IaaS Application Security.
3	Week 5-6:	**Threat Model and Cloud Attacks:** Introduction, Threat Model- Type of attack entities, Attack surfaces with attack scenarios, A Taxonomy of Attacks, Attack Tools-Network-level attack tools, VM- level attack tools, VMM attack tools, Security Tools, VMM security tools.
4	Week 7-8:	**Information Security Basic Concepts:** an Example of a Security Attack, Cloud Software Security Requirements, Rising Security Threats. **Data Security and Storage:** Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security.
5	Week 9-10:	**Evolution of Security Considerations:** Security Concerns of Cloud Operating Models, Identity Authentication, Secure Transmissions, Secure Storage and Computation, Security Using Encryption Keys, Challenges of Using Standard Security Algorithms, Variations and Special Cases for Security Issues with Cloud Computing, Side Channel Security Attacks in the Cloud
6	Week 11-12:	**Security Management in the Cloud:** Security Management Standards, Availability Management, Access Control, Security Vulnerability, Patch, and Configuration Management.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Blended Learning Approach	**Online Lectures and Tutorials:** Provide foundational knowledge through online recorded lectures and tutorials, allowing students to learn at their own pace. **In-Person Sessions/Workshops:** Conduct hands-on workshops or lab sessions where students can work on securing cloud environments in real time.
2	Hands-on Labs and Simulations	**Practical Exercises:** Use cloud platforms (AWS, Azure, Google Cloud) to offer hands-on experience in configuring security features such as Identity and Access Management (IAM), encryption, and network security controls. **Security Scenarios:** Simulate attacks like DDoS, data breaches, or malware infections to allow students to respond in a controlled environment, teaching incident response and risk mitigation.
3	Case Studies and Real-World Examples	**Case Studies:** Present real-world examples of cloud security breaches (e.g., Capital One breach) to analyze failures in cloud security configurations and practices. **Best Practices:** Discuss industry best practices, like the Shared Responsibility Model, to show how responsibilities for cloud security are divided between cloud providers and customers.
4	Project-Based Learning	**Group Projects:** Assign projects that require students to design, build, and secure a cloud infrastructure. This could include tasks like implementing secure authentication, setting up monitoring, and securing cloud storage. **Security Assessments:** Have students perform security assessments on cloud environments, identifying vulnerabilities and proposing mitigations.

5	Gamification	**Security Competitions:** Organize Capture the Flag (CTF) or other cybersecurity competitions focused on securing cloud environments. This can help students learn in an interactive and engaging way. **Cloud Security Challenges:** Use platforms like Hack the Box or Cloud Goats for cloud security challenges that cover areas like privilege escalation and misconfiguration attacks.
6	Collaborative Learning	**Discussion Groups:** Encourage peer-to-peer learning through discussion groups where students can share knowledge and experience about cloud security. **Forums:** Create a class forum or utilize platforms like Stack Overflow to discuss cloud security challenges and solutions.
7	Problem-Based Learning (PBL)	**Security Problem Scenarios:** Pose open-ended security problems related to cloud environments and encourage students to research, discuss, and propose solutions collaboratively. **Risk Management Exercises:** Engage students in risk assessment tasks where they evaluate cloud security risks and develop mitigation strategies.
8	Regular Assessments and Feedback	**Quizzes and Exams:** Regular quizzes, MCQs, and exams to assess theoretical knowledge of cloud security concepts such as data encryption, threat models, and compliance frameworks. **Peer and Instructor Feedback:** Provide timely feedback on both theoretical and practical tasks to help students improve their understanding and skills.
9	Industry Certifications	**Certification Pathways:** Encourage students to pursue industry-recognized certifications (e.g., AWS Certified Security – Specialty, Certified Cloud Security Professional (CCSP)) as part of their learning journey.
10	Guest Lectures and Webinars	**Industry Experts:** Invite cloud security experts or professionals from cloud service providers to share real-world experiences, discuss emerging threats, and talk about the latest advancements in cloud security. **Webinars on Cloud Security Trends:** Host or recommend webinars on topics like zero-trust security, regulatory compliance (GDPR, HIPAA), and secure DevOps (DevSecOps).

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	Understanding Cloud Security Fundamentals	Learners will understand the basics of cloud computing, including the various service and deployment models. This knowledge is critical for distinguishing the different types of cloud services and their security implications.
2	Cloud Security Governance and Compliance	Students will learn about global security standards and legal frameworks governing cloud security. They will understand how to comply with these standards in real-world cloud implementations.
3	Identity and Access Management (IAM)	This objective teaches the importance of controlling user access to cloud resources. Students will learn how to apply IAM principles to secure systems, including managing identities, roles, and permissions.
4	Data Security in the Cloud	Learners will explore different encryption techniques and practice encrypting sensitive data in cloud environments to ensure confidentiality and data protection.
5	Cloud Network Security	Learners will understand the components of cloud network security, including virtual private networks (VPNs), security groups, and how to configure cloud firewalls to block unauthorized access.
6	Monitoring and Incident Response	Students will learn how to set up and use cloud monitoring and alert systems (e.g., AWS Cloud Watch, Azure Monitor) to track unusual activity and respond to potential security incidents in real-time.
7	Cloud Security Architecture	Students will explore the design principles behind secure cloud infrastructures, focusing on zero-trust models and network segmentation, which minimize the risk of breaches through isolated cloud environments.
8	Risk Management and Threat Modelling	Students will learn how to perform risk assessments to identify vulnerabilities and potential threats in cloud deployments, helping to prioritize and mitigate risks.
9	DevSecOps and Cloud Automation	Students will understand how to integrate security early in the software development lifecycle (DevSecOps), automating security tasks to streamline the continuous delivery of secure cloud applications.
10	Business Continuity and Disaster Recovery	Students will create and test disaster recovery plans, ensuring that businesses can continue operating after a cloud outage or security breach. This includes setting up backup and recovery procedures.

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

Course Outcomes (COs)

COs	Description
M23MCS302A.1	Ability to acquire the knowledge on fundamentals concepts of cloud computing.
M23MCS302A.2	Able to distinguish the various cloud security and privacy issues.
M23MCS302A.3	Able to analyze the various threats and Attack tools
M23MCS302A.4	Able to understand the Data Security and Storage
M23MCS302A.5	Able to analyze the Security Management in the Cloud.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO-1	PSO-2
M23MCS302A.1	3	-	-	2	2
M23MCS302A.2	3	-	-	2	2
M23MCS302A.3	-	3	-	2	2
M23MCS302A.4	-	3	3	2	2
M23MCS302A.5	3	-	3	2	2
M23MCS302A	3	3	3	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

	CO1	CO2	CO3	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**	**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

- **Zero Trust Architecture:** Zero Trust shifts the security focus from network-based perimeters to protecting individual resources. This approach assumes that threats are both inside and outside the network, so every access request is verified and authenticated. Micro-segmentation, continuous monitoring, and least-privilege access are central components of Zero Trust, and cloud environments will continue to implement this model more widely.
- **Artificial Intelligence (AI) and Machine Learning (ML) in Security:** AI/ML algorithms will play a larger role in automating threat detection and response**.** By analyzing vast amounts of data in real-time, AI systems can detect anomalies and potential threats that might go unnoticed by human teams.AI will also help in predictive security, forecasting potential attacks before they occur by studying past patterns and behavior.
- **Advanced Encryption Techniques:** Homomorphic encryption allows data to be processed in its encrypted form without needing to be decrypted, enhancing privacy and security in the cloud. Quantum-resistant encryption will become important as quantum computing advances, potentially breaking current encryption methods.
- **Secure Access Service Edge (SASE): SASE** is a cloud-based security model that integrates **WAN capabilities** with comprehensive security features, including firewalls, secure web gateways, and Zero Trust network access. This trend will help simplify security management, reduce latency, and improve performance as more businesses shift to cloud and remote work models.
- **Cloud-native Security Solutions:** Cloud security will increasingly rely on cloud-native security tools like server less security, Kubernetes security, and container security solutions. These tools are built to work seamlessly with modern cloud infrastructures, offering more robust and scalable protection. Security as Code (SaC) practices will automate security tasks, embedding security configurations and policies into the DevOps workflow.
- **Cloud Security Posture Management (CSPM): CSPM tools** will evolve to continuously monitor cloud security configurations and identify risks like misconfigurations, compliance violations, and data exposure. These tools will integrate more AI-based automation to remediate issues before they are exploited.
- **Decentralized Cloud Security:** Block chain and other decentralized technologies could introduce a new approach to cloud security, enabling decentralized identity management**,** secure data sharing**, and** auditing in a tamper-resistant manner.

3rdSemester	Professional Elective Course (PE) Cyber Forensics	M23MCS302B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic IT Knowledge	Understanding computer systems, networks, and operating systems is essential. Familiarity with both Windows and Unix/Linux environments is particularly beneficial.
2	Networking Fundamentals	Knowledge of networking concepts, protocols (like TCP/IP), and devices helps in analyzing data traffic and identifying network-related evidence.
3	Security Principles	Understanding cybersecurity principles, including encryption, malware, and intrusion detection, is crucial for identifying vulnerabilities and threats.
4	Legal Knowledge	Familiarity with laws and regulations surrounding digital evidence and data privacy helps ensure compliance during investigations.
5	Analytical Skills**:**	Strong problem-solving and analytical abilities are necessary for interpreting data and uncovering relevant information from various sources.
6	Digital Forensics Tools	Experience with forensic tools (like EnCase, FTK, or open-source alternatives) is important for conducting investigations and analyzing evidence.
7	Programming Skills	Basic programming knowledge (Python, for example) can be helpful for scripting tasks and automating processes.
8	Certifications**:**	onsider pursuing relevant certifications, such as Certified Computer Examiner (CCE), Certified Information Systems Security Professional (CISSP), or other specialized forensics credentials.

2. Competencies

S/L	Competency	KSA Description
1	Introduction to Cyber forensics:	**Knowledge** • **Fundamental Concepts**: Understand key principles of cyber forensics, including definitions and the significance of digital evidence. • **Types of Digital Evidence**: Familiarity with various forms of digital evidence (e.g., files, logs, emails) and how they are collected. • **Legal Framework**: Awareness of laws and regulations governing digital evidence, including chain of custody and privacy issues. • **Forensic Tools**: Knowledge of common forensic tools and software used in investigations (e.g., FTK Imager, EnCase). • **Data Structures**: Understanding of file systems and how data is stored and retrieved on different devices. **Skills** • **Evidence Collection**: Ability to collect and preserve digital evidence systematically and legally. • **Data Analysis**: Proficiency in analyzing digital evidence to identify relevant information and draw conclusions. • **Tool Proficiency**: Hands-on experience with forensic tools for imaging, analyzing, and recovering data. • **Documentation**: Skill in writing clear and concise reports that detail findings, methodologies, and conclusions. • **Problem Solving**: Strong analytical and critical thinking skills to approach forensic challenges methodically.

		Attitudes • **Attention to Detail**: A meticulous approach to evidence handling and analysis, ensuring accuracy and thoroughness. • **Ethical Responsibility**: A commitment to ethical practices in handling sensitive data and respecting privacy rights. • **Curiosity and Continuous Learning**: An eagerness to stay updated with the latest developments in technology and forensic methodologies. • **Team Collaboration**: Willingness to work collaboratively with peers, law enforcement, and other stakeholders in investigations. • **Professionalism**: A professional demeanor, particularly when presenting findings or working in high-stakes situations.
2	Evidence Collection and Data Seizure	**Knowledge** 1. **Legal Framework**: • Understanding of laws and regulations governing digital evidence collection (e.g., Fourth Amendment, Computer Fraud and Abuse Act). • Familiarity with chain of custody principles to ensure the integrity of evidence. 2. **Types of Digital Evidence**: • Knowledge of various forms of digital evidence (e.g., files, logs, metadata). • Awareness of volatile vs. non-volatile data and the implications for evidence collection. 3. **Forensic Tools and Techniques**: • Familiarity with tools and software used for data acquisition (e.g., FTK Imager, EnCase, write blockers). • Understanding of data captures techniques, including imaging and cloning. 4. **Environmental Considerations**: • Knowledge of the physical and technical environment in which evidence is collected, including hardware configurations and network setups. **Skills** 1. **Evidence Collection**: • Ability to systematically and legally collect digital evidence while maintaining the integrity of the data. • Proficiency in using forensic tools to create and verify disk images and backups. 2. **Chain of Custody Documentation**: • Skill in accurately documenting the collection process, including the time, date, location, and individuals involved. • Ability to maintain a clear and organized chain of custody log for all collected evidence. 3. **Incident Response**: • Capability to respond to incidents in a timely and effective manner, preserving evidence while addressing the incident. • Skill in identifying which data to seize based on the investigation's focus. 4. **Data Preservation**: • Ability to implement measures that prevent data alteration or loss during the collection process. • Proficiency in using write blockers and secure storage methods for evidence.

		Attitudes 1. **Attention to Detail**: • A meticulous approach to ensure all evidence is collected accurately and thoroughly. • An awareness of the potential consequences of errors in evidence collection. 2. **Ethical Responsibility**: • Commitment to ethical practices in handling sensitive data and respecting privacy rights. • Integrity in ensuring that the collection process adheres to legal and ethical standards. 3. **Professionalism**: • Maintaining a professional demeanour during evidence collection, especially in sensitive or high-stakes situations. • Respect for individuals involved in the process, including suspects, victims, and witnesses. 4. **Curiosity and Continuous Improvement**: • A willingness to learn about new tools, techniques, and best practices in evidence collection and data seizure. • Openness to feedback and adapting processes based on new knowledge or experiences. 5. **Collaboration**: • A collaborative mindset, recognizing the importance of working with law enforcement, legal teams, and other stakeholders during evidence collection.
3	Virtual Machine Forensics	**Knowledge** 1. **Understanding Virtualization Technology**: • Knowledge of virtualization concepts and architectures (e.g., hypervisors like VMware, Hyper-V, KVM). • Familiarity with how virtual machines (VMs) operate, including differences between physical and virtual environments. 2. **Networking in Virtual Environments**: • Familiarity with virtual network configurations, including virtual switches and network adapters. • Understanding how VMs interact with external networks and other virtual machines. **Skills** 1. **Data Acquisition**: • Ability to create forensic images of virtual disks and snapshots using appropriate tools (e.g., FTK Imager, VMDK2RAW). • Proficiency in extracting and analyzing data from VMs without altering their state. 2. **Analysis of Virtual Artifacts**: • Skill in identifying and interpreting artifacts specific to virtual environments, such as log files, user activity, and system configurations. • Ability to analyze virtual machine metadata to reconstruct user actions and system events. 3. **Use of Forensic Tools**: • Proficiency in using forensic tools designed for virtual environments (e.g., Volatility for memory analysis). • Familiarity with tools that support both physical and virtual forensics. 4. **Incident Response**:

		• Capability to respond to incidents involving VMs, including preserving evidence and documenting the environment. • Skill in identifying the relevant VMs and their relationships in multi-VM setups. **Attitudes** 1. **Attention to Detail**: • A meticulous approach to evidence collection and analysis, recognizing the complexities of virtual environments. • An understanding of the importance of accurate documentation to ensure evidence integrity. 2. **Ethical Responsibility**: • Commitment to ethical practices in handling data and respecting privacy, especially in virtualized environments. • Integrity in ensuring compliance with legal standards during forensic investigations. 3. **Adaptability**: • Openness to new technologies and methodologies in the rapidly evolving field of virtualization and forensics. • Willingness to update skills and knowledge to keep pace with advancements in virtual technologies. 4. **Curiosity and Continuous Learning**: • A proactive attitude toward learning about emerging trends and tools in virtual machine forensics. • Engagement in professional development opportunities to enhance forensic capabilities. 5. **Collaboration**: • Willingness to work with IT teams, incident response teams, and legal authorities when investigating virtual environments. • A collaborative mindset to share insights and best practices within the forensic community.

3. Syllabus

Cyber Forensics SEMESTER-III		
Course Code	M23MCS302B	CIE Marks: 50
Teaching Hours/Week (L:T:P: S)	3:0:0:2	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

Introduction to Cyber forensics: Information Security Investigations, Corporate Cyber Forensics, Scientific method in forensic analysis, investigating large scale Data breach cases. Analyzing malicious software. Types of Computer Forensics Technology, Types of Military Computer Forensic Technology, Types of Law Enforcement: Computer Forensic Technology, Types of Business Computer Forensic Technology, Specialized Forensics Techniques, Hidden Data and How to Find It, Spyware and Adware, Encryption Methods and Vulnerabilities, Protecting Data from Being Compromised Internet Tracing Methods, Security and Wireless Technologies, Avoiding Pitfalls with Firewalls Biometric Security Systems

Module 2

Types of Computer Forensics Systems: Internet Security Systems, Intrusion Detection Systems, Firewall Security Systems, Storage Area Network Security Systems, Network Disaster Recovery Systems, Public Key Infrastructure Systems, Wireless Network Security Systems, Satellite Encryption Security Systems, Instant Messaging (IM) Security Systems, Net Privacy Systems, Identity Management Security Systems, Identity Theft, Biometric Security Systems ,Router Forensics. Cyber forensics tools and case studies. Ethical Hacking: Essential Terminology, Windows Hacking, Malware, Scanning, Cracking.

Module 3

Evidence Collection and Data Seizure: Why Collect Evidence, Collection Options Obstacles, Types of Evidence, The Rules of Evidence, Volatile Evidence, General Procedure, Collection and Archiving, Methods of Collection, Controlling Contamination: The Chain of Custody, Reconstructing the Attack, The digital crime scene, Investigating Cybercrime, Investigating Web attacks, Investigating network Traffic ,Identification of Data: Timekeeping, Forensic Identification and Analysis of Technical Surveillance Devices, Reconstructing Past Events.

Module 4

Virtual Machine Forensics - Types of Hypervisors, Hypervisor Files and Formats, Use and Implementation of Virtual Machines in Forensic Analysis, Use of VMware to establish working version of suspect's machine, Networking and virtual networks within Virtual Machine, Forensic Analysis of a Virtual Machine (Imaging of a VM, Identification and Extraction of supporting VM files in the host system, VM Snapshots, Mounting Image, Searching for evidence)

Module 5

Cloud Storage Forensic -Framework (Evidence Source Identification and preservation, Collection of Evidence, Examination and analysis of collected data) Cloud Storage Forensic Analysis. Dropbox analysis: Data remnants on user machines, Evidence source identification and analysis, Collection of evidence from cloud storage services, Examination and analysis of collected data. Google Drive: Forensic analysis of Cloud storage and data remnants, Evidence source identification and analysis - Collection of evidence from cloud storage services, Examination and analysis of collected data, Issues in cloud forensics. Case Studies.

Suggested Learning Resources:

Text Books:

1. Computer Forensics: Computer Crime Scene Investigation, 2nd Edition, John R. Vacca, Charles River Media, 2005.
2. Cyber Forensics - Concepts and Approaches, Ravi Kumar & B Jain,2006, icfai university press

Reference Books:

1. Sunit Belapure and Nina Godbole. Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives. Wiley India Pvt Ltd. 2013.
2. Understanding Cryptography: A Textbook for Students and Practitioners, ChristofPaar, Jan Pelzl, 2010, Second Edition, Springer's.
3. Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts, Ali Jahangiri,First edition, 2009

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	Introduction to Cyber forensics
2	Week 3-4:	Types of Computer Forensics Systems
3	Week 5-6:	Evidence Collection and Data Seizure
4	Week 7-8:	Virtual Machine Forensics
5	Week 9-10:	Cloud Storage Forensic
6	Week 11-12:	Cloud Storage Forensic

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 cybersecurity 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:

- ✓ **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 Fundamental Concepts	• Define cyber forensics and its importance in investigating cybercrimes. • Explain the key principles of digital evidence, including its types, characteristics, and relevance in legal contexts.
2	Knowledge of Legal and Ethical Standards	• Describe the legal framework surrounding cyber forensics, including laws, regulations, and ethical considerations. • Understand the principles of chain of custody and its significance in preserving the integrity of digital evidence
3	Proficiency in Forensic Tools and Techniques	• Gain hands-on experience with common forensic tools (e.g., FTK Imager, EnCase, Autopsy) for data acquisition and analysis. • Learn to create and analyze forensic images of digital devices while maintaining data integrity.
4	Incident Response and Preservation:	• Understand the incident response process and the role of forensics within it. • Learn how to effectively preserve evidence during an incident and document the process accurately.
5	Awareness of Emerging Trends:	• Stay informed about current trends and challenges in cyber forensics, including cloud forensics, IoT forensics, and mobile forensics. • Understand the implications of emerging technologies (e.g., AI, blockchain) on forensic investigations.
6	Data Recovery and Analysis Skills	Develop skills in recovering deleted files and analyzing digital artifacts to uncover relevant information. • Apply analytical techniques to interpret data and reconstruct user activities during investigations.

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

Course Outcomes (COs)

COs	Description
M23MCS302B.1	Understand and apply cyber forensics needs and types of Computer Forensics Systems.
M23MCS302B.2	Demonstrate the ability to utilize different types of computer forensics systems to investigate and analyse digital evidence effectively
M23MCS302B.3	Analyse the steps involved in collecting digital evidence.
M23MCS302B.4	Analyse Design Cloud Storage Forensic.
M23MCS302B.5	Analyse the collection of evidence from cloud storage services

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS302B.1	**3**			2	2
M23MCS302B.2	**3**			**3**	**3**
M23MCS302B.3				**3**	**3**
M23MCS302B.4		**3**		**3**	**3**
M23MCS302B.5	**3**			**3**	**3**
M23MCS302B	**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

- AI and ML can help automate the analysis of large datasets, making it easier to identify patterns and anomalies.
- These technologies can assist in predicting potential threats and breaches based on historical data.
- As more businesses move to cloud-based solutions, forensic methodologies will need to evolve to address the unique challenges of cloud computing.
- The ability to collect and analyze data from multiple cloud providers will become increasingly important.
- With the proliferation of IoT devices, forensics will need to incorporate the analysis of data from a myriad of connected devices.
- Investigating breaches involving IoT will require specialized techniques and tools to handle diverse data formats and protocols.
- Block chain Forensics: As crypto currencies gain popularity, the need for forensics related to block chain transactions will grow.
- Quantum Computing Implications**:** The rise of quantum computing could impact encryption methods, necessitating new forensic approaches to handle future challenges.

3rdSemester	Professional Elective Course (PE) Soft and Evolutionary computing	M23MCS302C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	**Linear Algebra**: Understanding vectors, matrices, and operations on them. **Calculus**: Basics of derivatives and integrals, especially in the context of optimization. **Probability and Statistics**: Basic concepts of probability distributions, Bayes' theorem, and statistical measures.
2	**Computer Science Fundamentals**:	**Basic Understanding of Algorithms**: Awareness of basic algorithmic concepts such as searching and sorting. **Problem-Solving Skills**: Ability to approach problems methodically and devise algorithmic solutions.
3	**Artificial Intelligence Basics**:	Familiarity with basic AI concepts like search algorithms, knowledge representation, and machine learning. **Knowledge of AI Concepts**: Understanding of fundamental AI principles and techniques, as Soft Computing is often used in AI application
4	**Basic Programming Skills**:	**Proficiency in a Programming Language**: Familiarity with Python is particularly useful, as it has many libraries for AI (e.g., TensorFlow, PyTorch, scikit-learn). **Basic Data Structures and Algorithms**: Understanding lists, dictionaries, trees, and basic algorithmic concepts.
5	**Foundational Knowledge in Soft Computing**:	Understanding of fuzzy logic, neural networks, and genetic algorithms, as these are often integrated into evolutionary computing. **Overview of Key Techniques**: Familiarity with neural networks, fuzzy logic, genetic algorithms, and evolutionary computing. **Applications**: Awareness of how these techniques can be applied to real-world problems.
6	**Algorithms and Complexity**:	**Complexity Analysis**: Understanding Big O notation, time complexity, and space complexity. **Asymptotic Analysis**: Ability to analyze how algorithms perform as input sizes grow.
7	Ethical and Practical Considerations:	**Bias and Fairness:** Understanding how generative models can propagate biases present in training data and the ethical implications of generated content. **Model Evaluation:** Techniques for assessing the quality and realism of generated data.

2. Competencies

S/L	Competency	KSA Description
1	Deep Learning Expertise	**Knowledge:** Understanding of foundational architectures such as feed forward neural networks (FNNs) and their components (layers, activation functions). Proficiency with deep learning frameworks such as TensorFlow, PyTorch, Keras, and their associated libraries for building and training models. **Skills:** Ability to design and implement neural network architectures tailored to specific tasks and data types. Skills in applying training techniques and algorithms effectively, including handling large datasets and managing computational resources. **Attitudes:** Willingness to explore and experiment with new architectures and techniques to solve complex problems.

2	Mathematical and Statistical Knowledge	**Knowledge:** Understanding matrix multiplication, inversion, and decomposition techniques (e.g., Singular Value Decomposition). Understanding of convex functions and optimization problems, though less common in generative models, is useful for certain algorithms. **Skills:** Ability to formulate mathematical models and equations for machine learning and generative algorithms. **Attitudes:** Precision in mathematical computations and statistical analyses to ensure the accuracy and reliability of models.
3	Programming and Technical Skills	**Knowledge:** In-depth knowledge of Python, which is the primary language for AI and machine learning tasks. Understanding Python's syntax, libraries, and tools relevant to AI, such as NumPy, Pandas, and Matplotlib. **Skills:** Ability to write clean, efficient, and maintainable code for developing machine learning models and algorithms. Proficiency in using deep learning frameworks to build, train, and fine-tune models. **Attitudes:** A meticulous approach to coding and technical implementation to avoid errors and ensure accurate results.
4	Data Management and Preprocessing	**Knowledge:** Familiarity with common data formats and structures (e.g., JSON, CSV, images in PNG/JPEG, text files). Knowledge of various data types relevant to generative AI, such as images, text, audio, and structured data. **Skills:** Proficiency in applying data cleaning techniques to ensure data quality and usability. Skills in implementing data augmentation techniques to create diverse and representative datasets. **Attitudes:** A meticulous approach to handling and processing data to ensure high-quality inputs for model training.
5	Ethical Considerations and Evaluation	**Knowledge:** Understanding of foundational ethical principles relevant to AI, such as fairness, accountability, and transparency. Familiarity with relevant regulations, guidelines, and standards such as GDPR, CCPA, and industry-specific ethical guidelines for AI. **Skills:** Ability to use statistical and analytical techniques to identify biases in data and model outputs. **Attitudes:** Attention to detail with the commitment 0f ethical practices and an understanding of the responsibility to consider the societal implications of AI technologies.

3. Syllabus

SOFT AND EVOLUTIONARY COMPUTING SEMESTER – III			
Course Code	M23MCS302C	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:

1. To understand the basic principles and concepts of soft computing and evolutionary algorithms
2. To apply soft computing techniques to solve real-world problems in various fields such as engineering, data science, and artificial intelligence.
3. To evaluate the strengths and weaknesses of different soft computing methods compared to traditional computing approaches.
4. To develop skills in designing, implementing, and analyzing algorithms based on soft computing paradigms.
5. To encourage critical thinking skills through the analysis of case studies and practical applications.

Module -1

Introduction to soft computing: ANN, FS,GA, SI, ES, Comparing among intelligent systems
ANN: introduction, biological inspiration, BNN&ANN, classification, first Generation NN, perceptron, illustrative problems
Text Book 1: Chapter1: 1.1-1.8, Chapter2: 2.1-2.6

Module -2

Adaline, Medaline, ANN: (2nd generation), introduction, BPN, KNN,HNN, BAM, RBF,SVM and illustrative problems
Text Book 1: Chapter2: 3.1,3.2,3.3,3.6,3.7,3.10,3.11

Module -3

Fuzzy logic: introduction, human learning ability, undecidability, probability theory, classical set and fuzzy set, fuzzy set operations, fuzzy relations, fuzzy compositions, natural language and fuzzy interpretations, structure of fuzzy inference system, illustrative problems
Text Book 1: Chapter 5

Module -4

Introduction to GA, GA, procedures, working of GA, GA applications, applicability, evolutionary programming, working of EP, GA based Machine learning classifier system, illustrative problems
Text Book 1: Chapter 7

Module -5

Swarm Intelligent system: Introduction, Background of SI, Ant colony system
Working of ACO, Particle swarm Intelligence (PSO).
Text Book 1: 8.1-8.4, 8.7

TEXTBOOKS:

1. Soft computing : N. P Padhy and S P Simon , Oxford University Press 2015
2. Principles of Soft Computing, Shivanandam, Deepa S. N Wiley India, 2011.

Reference Books:

1. Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms , Sami troy and udit chakraborty, 1st Edition, Kindle Edition 2015.
2. Advances in soft computing applications, Shristi karola, Mangey ram, Sachin K. Mangla, Yigit Kazancoglu River publishers 2024.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to soft computing	ANN, FS,GA, SI, ES, Comparing among intelligent systems ANN: introduction, biological inspiration, BNN&ANN, classification, first Generation NN, perceptron, illustrative problems
2	Week 4-6: Adaline, Medaline, ANN	introduction, BPN, KNN,HNN, BAM, RBF,SVM and illustrative problems
3	Week 8-11: Fuzzy logic	introduction, human learning ability, undecidability, probability theory, classical set and fuzzy set, fuzzy set operations, fuzzy relations, fuzzy compositions, natural language and fuzzy interpretations, structure of fuzzy inference system, illustrative problems

4	Week 7-8: Introduction to GA	GA, procedures, working of GA, GA applications, applicability, evolutionary programming, working of EP, GA based Machine learning classifier system, illustrative problems
5	Week 9-12: Swarm Intelligent system	Introduction, Background of SI, Ant colony system Working of ACO, Particle swarm Intelligence (PSO).

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	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
4	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
5	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

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 Examination:

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. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Deep Learning Expertise	Utilize the concept of foundational architectures such as feedforward neural networks (FNNs) and their components (layers, activation functions). Proficiency with deep learning frameworks such as TensorFlow, PyTorch, Keras, and their associated libraries for building and training models.
2	Mathematical and Statistical Knowledge	Utilize the concept of matrix multiplication, inversion, and decomposition techniques (e.g., Singular Value Decomposition). Understanding of convex functions and optimization problems, though less common in generative models, is useful for certain algorithms.

3	Programming and Technical Skills	In-depth knowledge of Python, which is the primary language for AI and machine learning tasks. Understanding Python's syntax, libraries, and tools relevant to AI, such as NumPy, Pandas, and Matplotlib.
4	Data Management and Pre-processing	Familiarity with common data formats and structures (e.g., JSON, CSV, images in PNG/JPEG, text files). Knowledge of various data types relevant to generative AI, such as images, text, audio, and structured data.
5	Ethical Considerations and Evaluation	Understanding of foundational ethical principles relevant to AI, such as fairness, accountability, and transparency. Familiarity with relevant regulations, guidelines, and standards such as GDPR, CCPA, and industry-specific ethical guidelines for AI.

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

Course Outcomes (COs)

COs	Description
M23MCS302C.1	Ability to apply soft computing principles and techniques to solve complex problems across various domains.
M23MCS302C.2	Enhanced problem-solving skills through the application of soft computing methods to real-world scenarios.
M23MCS302C.3	Developing skills in designing, implementing, and analyzing algorithms based on soft computing paradigms.
M23MCS302C.4	Evaluate the strengths and weaknesses of different soft computing methods compared to traditional computing approaches.
M23MCS302C.5	Encouraging students to explore current research trends and advancements in soft and evolutionary computing.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS302C.1	3	-	-	3	3
M23MCS302C.2	-	3	-	3	3
M23MCS302C.3	-	-	3	3	3
M23MCS302C.4	-	-	-	3	3
M23MCS302C.5	-	-	-	3	3
M23MCS302C	**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:

Creativity and Content Generation

- **Art and Media**: Generative AI will continue to revolutionize art, music, and media by enabling new forms of creativity and automation. Artists and creators can use AI to generate unique content, explore new styles, and collaborate with AI systems to enhance their work.
- **Entertainment**: AI-generated scripts, stories, and interactive experiences will become more prevalent, providing personalized content and immersive experiences.

Personalization

- **Customized Experiences**: AI will enable highly personalized experiences in various fields, including education, marketing, and healthcare. For example, AI-driven educational tools can tailor learning materials to individual students' needs and learning styles.
- **Customer Service**: Enhanced chatbots and virtual assistants will offer more personalized and effective customer support, improving user satisfaction and engagement.

Healthcare

- **Drug Discovery**: Generative AI models will accelerate drug discovery and development by predicting molecular structures and potential interactions, leading to faster and more cost-effective development of new treatments.
- **Medical Imaging**: AI will improve diagnostic accuracy by generating high-quality images and analyzing complex patterns in medical data, aiding in early detection and personalized treatment plans.
- **Scientific Research**: AI will assist in generating hypotheses, analyzing large datasets, and simulating experiments, leading to faster scientific discoveries and innovations.

3rdSemester	Professional Elective Course (PE) Advances in storage area network	M23MCS302D

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	**Understanding of Storage Concepts**:	A foundational knowledge of storage technologies, including block storage, file storage, and object storage, is essential.
2.	**Networking Knowledge**	Familiarity with networking principles, including TCP/IP, VLANs, and Fibre Channel, is crucial, as SANs rely heavily on network infrastructure.
3.	**Infrastructure Assessment**	A thorough evaluation of current IT infrastructure is necessary to identify gaps and areas for improvement that can benefit from SAN technology.
4.	**Capacity Planning**	Understanding data growth trends and storage requirements is vital for selecting the right SAN configuration and scaling options.
5.	**Security Measures**	Familiarity with data security best practices and compliance requirements will help ensure that storage solutions meet organizational and regulatory standards.
6.	**Virtualization Expertise**	As many SANs are used in virtualized environments, knowledge of virtualization technologies (like VMware or Hyper-V) is beneficial.
7.	**Backup and Recovery Strategy**	An established strategy for data backup and disaster recovery will enhance the effectiveness of SAN deployment.
8.	**Budget Considerations**	Awareness of the financial implications, including initial investment, ongoing maintenance, and potential cost savings from efficiency gains.

2. Competencies

S/L	Competency	KSA Description
1.	Technical Expertise	**Knowledge**: • Understand the SANs interconnect storage devices and servers • Block-level data access and its benefits over file-level access. • Storage devices (arrays), switches, host bus adapters (HBAs), and SAN management tools. **Skills** • Design scalable and fault-tolerant SAN architectures (e.g., core-edge, mesh topologies). • Plan multi-site SAN setups for disaster recovery and business continuity. • Create, allocate, and manage Logical Unit Numbers (LUNs) for specific workloads. **Attitude** • Stay updated on emerging SAN technologies, protocols, and best practices. • Actively pursue certifications, training, and new knowledge in the field. • Prioritize securing SAN environments from potential threats, including breaches or unauthorized access
2.	**Networking Skills**	**Knowledge**: • Understanding the **OSI Model** and its relevance to SAN communication (e.g., Fibre Channel at Layer 2, iSCSI over TCP/IP at Layers 3 and 4). • Familiarity with switches, routers, and host adapters (e.g., FC switches, Ethernet switches, HBAs, and CNAs). **Skills** • Mastery of TCP/IP, UDP, and Ethernet for iSCSI and FCoE communication. • Proficiency in Fibre Channel (FC) protocol, including frame structure, addressing, and flow control. **Attitude** • Stay updated on emerging networking protocols (e.g., NVMe-oF, FCoE) and tools. • Show enthusiasm for learning about hybrid and cloud-integrated SAN solutions.
3.	**Performance Optimization**	**Knowledge**: • Understanding the differences between HDDs, SSDs, and NVMe drives in terms of throughput, latency, and durability. • Knowledge of storage tiers and how to optimize storage placement based on performance **Skills:** • Skill in configuring and selecting the right storage devices (HDDs, SSDs, NVMe) based on performance requirements such as throughput, latency, and durability. • Understanding the performance characteristics of different storage media and how to optimize storage placement (hot vs. cold data). **Attitude** • A forward-thinking attitude is critical when optimizing performance. • A commitment to continuous, real-time monitoring and performance assessment is essential.

3. Syllabus

Advances in Storage Area Network SEMESTER – III			
Course Code	**M23MCS302D**	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:

- Grasp the core concepts of SAN technology, including its architecture, components, and the differences between SAN, NAS, and DAS. enabling technologies for wireless networking and mobile computing
- Analyze recent advancements in SAN technologies, such as NVMe over Fabrics, software-defined storage, and cloud integration.
- Gain hands-on experience in deploying and configuring SAN solutions in various environments, including traditional data centers and cloud infrastructures.
- Learn techniques for monitoring and optimizing SAN performance, including troubleshooting methods and best practices for load balancing.
- Understand how to integrate SANs with virtualization technologies and manage storage for virtualized environments effectively.

Module -1

Introduction: Server Centric IT Architecture and its Limitations; Storage – Centric IT Architecture and its advantages. Case study: Replacing a server with Storage Networks The Data Storage and Data Access problem; The Battle for size and access. Intelligent Disk Subsystems: Architecture of Intelligent Disk Subsystems; Hard disks and Internal I/O Channels; JBOD, Storage virtualization using RAID and different RAID levels; Caching: Acceleration of Hard Disk Access; Intelligent disk subsystems, Availability of disk subsystems.

Module -2

I/O Techniques: The Physical I/O path from the CPU to the Storage System; SCSI; Fibre Channel Protocol Stack; Fibre Channel SAN; IP Storage. Network Attached Storage: The NAS Architecture, The NAS hardware Architecture, The NAS Software Architecture, Network connectivity, NAS as a storage system. File System and NAS: Local File Systems; Network file Systems and file servers; Shared Disk file systems; Comparison of fibre Channel and NAS.

Module -3

Storage Virtualization: Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level; Storage virtualization on various levels of the storage Network; Symmetric and Asymmetric storage virtualization in the Network.

Module -4

SAN Architecture and Hardware devices: Overview, Creating a Network for storage; SAN Hardware devices; The fibre channel switch; Host Bus Adaptors; Putting the storage in SAN; Fabric operation from a Hardware perspective. Software Components of SAN: The switch's Operating system; Device Drivers; Supporting the switch's components; Configuration options for SANs.

Module -5

Management of Storage Network: System Management, Requirement of management System, Support by Management System, Management Interface, Standardized Mechanisms, Property Mechanisms, In-band Management, Use of SNMP, CIM and WBEM, Storage Management Initiative Specification (SMI-S), CMIP and DMI, Optional Aspects of the Management of Storage Networks, Summary

Text Books:

- Ulf Troppens, Rainer Erkens and Wolfgang Muller: Storage Networks Explained, Wiley India,2013.
- Marc Farley: Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems, Cisco Press, 2005.

Reference Books:

- Robert Spalding: "Storage Networks The Complete Reference", Tata McGraw-Hill, 2011.
- Marc Farley: Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems, Cisco Press, 2005

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Server Centric IT Architecture	Storage – Centric IT Architecture and its advantages. Case study: Replacing a server with Storage Networks The Data Storage and Data Access problem.
2	Week 3-4: Intelligent Disk Subsystems and I/O Techniques	The Physical I/O path from the CPU to the Storage System; SCSI; Fibre Channel Protocol Stack; Fibre Channel SAN; IP Storage. Network Attached Storage: The NAS Architecture, The NAS hardware Architecture.
3	Week 5-6: Storage Virtualization	Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level; Storage virtualization on various levels of the storage Network.
4	Week 7-8: SAN Architecture and Hardware devices	SAN Hardware devices; The fibre channel switch; Host Bus Adaptors; Putting the storage in SAN; Fabric operation from a Hardware perspective.
5	Week 9-10: Management of Storage Network Applications	• Requirement of management System, Support by Management System, Management Interface, Standardized Mechanisms, Property Mechanisms.
6	Week 11-12: Use of SNMP	Storage Management Initiative Specification (SMI-S), CMIP and DMI, Optional Aspects of the Management of Storage Networks.

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
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.

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

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)					

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	**Describe SAN Architectures**	Identify and explain the components and architecture of Storage Area Networks, including key differences between SAN, NAS, and DAS.
2	**Analyze Emerging Technologies**	Evaluate recent advancements in SAN technology, such as NVMe over Fabrics, software-defined storage, and hybrid cloud solutions.
3	**Deploy SAN Solutions**	Demonstrate the ability to install, configure, and deploy various SAN solutions, including both hardware and software components.
4	**Optimize Performance**	Apply techniques for monitoring and optimizing SAN performance, including analyzing metrics and implementing best practices.
5	**Integrate with Virtual Environments**	Understand the integration of SANs with virtualization platforms and manage storage allocation for virtual machines.
6	**Implement Security Measures**	Develop and implement security strategies for SANs, including data encryption, access control measures, and compliance practices
7	**Design Disaster Recovery Plans**	Create comprehensive backup and disaster recovery plans utilizing SAN capabilities to ensure data redundancy and recovery.
8	**Evaluate and Compare Solutions**	Assess and compare different SAN solutions from various vendors based on criteria such as performance, scalability, and cost-effectiveness

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

Course Outcomes (COs)

COs	Description
M23MCS302D.1	Demonstrate knowledge of SAN components, topologies, and protocols
M23MCS302D.2	Apply techniques for managing storage resources effectively within a SAN environment.
M23MCS302D.3	Evaluate and implement data protection mechanisms such as replication, snapshots, and backups.
M23MCS302D.4	Analyze SAN performance metrics and optimize configurations for improved performance.
M23MCS302D.5	Analyze Storage Management Initiative Specification (SMI-S), CMIP and DMI

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PSO-1	PSO-2
M23MCS302D.1	3	-	-	2	2
M23MCS302D.2	3	-	-	2	2
M23MCS302D.3	-	3	-	2	2
M23MCS302D.4	-	3	3	2	2
M23MCS302D.5	-	3	3	2	2
M23MCS302D	-	3	3	2	2

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**					
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:

- **NVMe over Fabrics**: The adoption of NVMe (Non-Volatile Memory Express) over Fabrics will enhance performance and reduce latency in storage networks.
- **Cloud Integration**: Increasingly, SANs will integrate with cloud storage solutions, allowing for hybrid storage architectures that combine on-premises and cloud resources.
- **Software-Defined Storage (SDS)**: The move towards SDS will provide more flexibility and scalability in managing storage resources through software rather than hardware.
- **Automation and AI**: Incorporating automation and artificial intelligence will streamline storage management, enhance predictive analytics, and improve performance optimization.
- **Increased Use of Flash Storage**: The transition from traditional disk-based storage to flash-based solutions will continue, driven by the need for faster access speeds and better efficiency.
- **Enhanced Security Measures**: As data breaches become more common, SANs will see advanced security features, including encryption and improved access controls.

- **Edge Computing**: With the growth of IoT and edge computing, SANs will evolve to support decentralized data processing and storage needs at the edge.
- **Improved Interoperability**: Future SANs will focus on better interoperability between different storage systems and vendors, enhancing flexibility and reducing vendor lock-in.
- **Data Analytics**: Advanced data analytics capabilities will be integrated into SANs to provide insights for better decision-making and resource management.
- **Energy Efficiency**: As sustainability becomes a priority, SAN technologies will evolve to be more energy-efficient, reducing the carbon footprint of storage solutions.

3rdSemester	Professional Elective Course (PE) Business Intelligence and its applications	M23MCS302E

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Understanding of Data Management**	Familiarity with databases, data warehousing, and data modeling concepts is essential. Knowledge of SQL and data retrieval techniques is also beneficial.
2	**Statistical Knowledge**	A foundational understanding of statistics is crucial for analyzing data trends, performing predictive analytics, and interpreting BI reports.
3	**Analytical Skills**	Strong analytical skills are necessary to assess data critically, identify patterns, and make data-driven decisions.
4	**Familiarity with BI Tools**	Knowledge of popular BI tools (e.g., Tableau, Power BI, Qlik) helps in understanding how to visualize and manipulate data effectively.
5	**Business Acumen**	Understanding the business environment and specific industry metrics is important to apply BI insights meaningfully and align them with organizational goals.

2. Competencies

S/L	Competency	KSA Description
1	**Data Analysis and Interpretation**:	**Knowledge**: Proficiency in tools like Excel, SQL, Python, R, or SAS. Familiarity with data cleaning, processing, and analysis techniques. **Skills:** Explaining complex data insights in a clear and concise manner to non-technical stakeholders. Ability to break down complex problems into smaller components. Identifying patterns, trends, and anomalies in datasets. **Attitude:** Questioning the validity and reliability of data sources and methods. Staying focused on the ultimate goal of using data to inform decisions and improve outcomes.
2	**Data Visualization** :	**Knowledge:** The importance of clarity, simplicity, and storytelling. Knowledge of when to use specific types of visualizations (e.g., bar charts, pie charts, scatter plots). **Skills**: Identifying key insights and avoiding clutter or irrelevant information in visualizations. Creating interactive dashboards that allow users to explore data dynamically. **Attitude**: Designing visualizations with the end-user in mind, focusing on accessibility and clarity. Experimenting with innovative visualization styles to present data in engaging ways.
3	**Database Management**:	**Knowledge:** Knowledge of database types: relational (SQL) and non-relational (NoSQL). Familiarity with concepts like schemas, tables, indexes, primary and foreign keys. Mastery of SQL for data manipulation and querying. Basics of non-relational query languages like MongoDB's query syntax. **Skills:** Writing advanced SQL queries, joins, sub queries, and stored procedures. Using tools and scripts to automate routine database tasks like backups or report generation. **Attitude**: Ensuring accuracy in database operations to avoid errors and data inconsistencies. Handling sensitive data responsibly and adhering to compliance standards.

3. Syllabus

BUSINESS INTELLIGENCE AND ITS APPLICATIONS SEMESTER – III			
Course Code	M23MCS302E	CIE Marks	**40**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0:2)**	SEE Marks	**60**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:
CO1:Explain the complete life cycle of BI/Analytical development
CO2:Illustrate technology and processes associated with Business Intelligence framework
CO3: Demonstrate a business scenario, identify the metrics, indicators and make recommendations to achieve the business goal.

Module -1

Development Steps, BI Definitions, BI Decision Support Initiatives, Development Approaches, Parallel Development Tracks, BI Project Team Structure, Business Justification, Business Divers, Business Analysis Issues, Cost – Benefit Analysis, Risk Assessment, Business Case Assessment Activities, Roles Involved In These Activities, Risks Of Not Performing Step, Hardware, Middleware, DBMS Platform, Non Technical Infrastructure Evaluation

Module -2

Managing The BI Project, Defining And Planning The BI Project, Project Planning Activities, Roles And Risks Involved In These Activities, General Business Requirement, Project Specific Requirements, Interviewing Process

Module -3

Differences in Database Design Philosophies, Logical Database Design, Physical Database Design, Activities, Roles And Risks Involved In These Activities, Incremental Rollout, Security Management, Database Backup And Recovery

Module -4

Growth Management, Application Release Concept, Post Implementation Reviews, Release Evaluation Activities, The Information Asset and Data Valuation, Actionable Knowledge – ROI, BI Applications, The Intelligence Dashboard

Module -5

Business View of Information technology Applications: Business Enterprise excellence, Key purpose of using IT, Type of digital data, basics f enterprise reporting, BI road ahead.

Textbooks:
1. Business Intelligence Roadmap: The Complete Project Lifecycle for Decision Support Applications, Larissa T Moss and ShakuAtre, Addison Wesley Information Technology Series, 2003.
2. Fundamentals of Business Analytics, R N Prasad, Seema Acharya, Wiley India, 2011.

Reference Books:
1 Business Intelligence: The Savvy Manager's Guide David Loshin Morgan Kaufmann
2 Delivering Business Intelligence with Microsoft SQL Server 2005 Brian Larson McGraw Hill 2006
3 Foundations of SQL Server 2008 Business Intelligence Lynn Langit Apress 2011

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	Development Steps, BI Definitions, BI Decision Support Initiatives, Development Approaches, Parallel Development Tracks, BI Project Team Structure, Business Justification, Business Divers, Business Analysis Issues, Cost – Benefit Analysis, Risk Assessment, Business Case Assessment Activities, Roles Involved In These Activities, Risks Of Not Performing Step, Hardware, Middleware, DBMS Platform, Non Technical Infrastructure Evaluation
2	Week 3-4	Managing The BI Project, Defining And Planning The BI Project, Project Planning Activities, Roles And Risks Involved In These Activities, General Business Requirement, Project Specific Requirements, Interviewing Process
3	Week 5-6	Differences in Database Design Philosophies, Logical Database Design, Physical Database Design, Activities, Roles And Risks Involved In These Activities, Incremental Rollout, Security Management, Database Backup And Recovery
4	Week 7-8	Growth Management, Application Release Concept, Post Implementation Reviews, Release Evaluation Activities, The Information Asset and Data Valuation, Actionable Knowledge – ROI, BI Applications, The Intelligence Dashboard
5	Week 9-10	Business View of Information technology Applications: Business Enterprise excellence, Key purpose of using IT, Type of digital data, basics of enterprise reporting, BI road ahead.

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 Business 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

1. Question paper pattern will be ten questions. Each question is set for 20 marks. 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. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Understand BI Concepts**:	Explain the fundamental concepts of business intelligence, including data sources, data warehousing, and the BI lifecycle.
2	**Data Analysis Skills**:	Develop the ability to analyze and interpret large data sets using various statistical methods and analytical tools to derive actionable insights.
3	**Data Visualization Techniques**:	Create effective visualizations using BI tools to communicate insights clearly and concisely to stakeholders.
4	**Database Proficiency**:	Gain proficiency in database management, including SQL querying, data integration, and the ETL process to ensure data quality and accessibility.
5	**BI Tools Familiarity**:	Demonstrate proficiency in popular BI tools (e.g., Tableau, Power BI) for data analysis and visualization.

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

Course Outcomes (COs)

CO's	Description
M23MCS302E.1	Explain the complete life cycle of BI/Analytical development
M23MCS302E.2	Illustrate technology and processes associated with Business Intelligence framework
M23MCS302E.3	Demonstrate a business scenario, identify the metrics, indicators and make recommendations to achieve the business goal.
M23MCS302E.4	Analyze data quality and its accessibility using database management
M23MCS302E.5	Interpret Business Enterprise excellence and its purpose.

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS302E.1	-	-	2	3	2
M23MCS302E.2	-	-	-	2	3
M23MCS302E.3	-	2	2	2	2
M23MCS302E.4	-	2	2	2	2
M23MCS302E.5	-	2	2	2	2
M23MCS302E	-	2	2	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					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

- Increased Automation and AI Integration: BI tools will increasingly leverage artificial intelligence and machine learning to automate data analysis, making insights more accessible and actionable. Predictive analytics will become more common, allowing organizations to anticipate trends and make proactive decisions.
- Real-Time Data Processing: The demand for real-time data analysis will rise, enabling businesses to make quicker, data-driven decisions. This will involve advanced technologies like streaming analytics and IoT data integration.
- Enhanced Data Visualization: As the volume of data grows, innovative visualization techniques will emerge, making it easier for users to interpret complex data sets. Interactive dashboards and augmented reality visualizations may become more prevalent.
- Data Democratization: There will be a shift towards making BI tools accessible to non-technical users, promoting a data-driven culture across organizations. Self-service BI platforms will empower employees at all levels to engage with data.
- Focus on Data Governance and Ethics: With increased reliance on data, organizations will prioritize data governance frameworks to ensure compliance with regulations and ethical standards. Transparency in data usage will become essential.
- Integration with Other Business Functions: BI will increasingly integrate with other areas like marketing, finance, and supply chain management, providing a holistic view of organizational performance and fostering collaboration.
- Cloud-Based BI Solutions: The adoption of cloud-based BI solutions will continue to grow, offering scalability, flexibility, and cost-effectiveness. This trend will facilitate easier collaboration and access to data from anywhere.
- Enhanced Security Measures: As data breaches become more common, organizations will invest in advanced security measures to protect sensitive data within BI systems.

3rdSemester	Open Elective Course (OE) IoT and its applications	M23MCS303A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Networking Concepts**	Knowledge of TCP/IP, addressing, and network protocols (IPv4, IPv6)..
2	**Embedded Systems**	Understanding of hardware, sensors, microcontrollers, and their integration with software.
3	**Wireless Communication**	Familiarity with technologies like Bluetooth, Wi-Fi, Zigbee, and cellular networks (e.g., 5G, LTE).
4	**Cloud Computing**	Basic concepts of cloud storage, computing, and services for IoT data management.
5	**Data Analytics**	Skills in processing, analysing, and interpreting large datasets, often using tools like Hadoop, Spark.
6	**Cybersecurity**	Awareness of IoT security challenges, encryption, and privacy concerns.
7	**Programming Skills)**	Proficiency in programming languages like Python, C/C++, or Java for IoT device management and application development.

2. Competencies

S/L	Competency	KSA Description
1	**IoT Architecture Design**	**Knowledge**: Understanding of IoT system architecture, components, and layered structures. **Skills**: Ability to design and implement scalable IoT solutions. **Attitudes**: Attention to detail and a focus on creating efficient, future-proof systems.
2	**Device Integration**	**Knowledge**: Awareness of various IoT devices, sensors, and protocols. **Skills**: Competence in integrating hardware with software platforms using communication protocols (e.g., MQTT, CoAP). **Attitudes**: Flexibility and creativity in solving integration challenges.
3	**Data Collection & Processing**	**Knowledge**: Understanding of data types, formats, and collection methods from IoT devices. **Skills**: Proficiency in handling and processing large datasets from IoT systems using tools like Hadoop or Spark. **Attitudes**: Analytical mindset and curiosity to derive insights from data.
4	**Network Protocols**	**Knowledge**: Familiarity with networking and IoT communication protocols (e.g., Zigbee, LoRaWAN, Bluetooth). **Skills**: Ability to configure and optimize network protocols for secure, reliable IoT communication. **Attitudes**: Proactive approach to ensuring secure and stable connectivity.
5	**Cloud & Edge Computing**	**Knowledge**: Understanding of cloud services (AWS IoT, Azure IoT) and edge computing principles. **Skills**: Ability to deploy IoT solutions using cloud infrastructure and edge devices. **Attitudes**: Openness to innovation and staying updated on cloud and edge technologies.
6	**Security Implementation**	**Knowledge**: Awareness of IoT security threats, encryption techniques, and authentication protocols. **Skills**: Ability to implement security measures such as encryption, firewalls, and secure boot. **Attitudes**: Vigilance and responsibility in addressing security concerns..

7	**Low-Power Device Optimization**	**Knowledge**: Understanding of low-power wireless technologies (e.g., LPWAN, Zigbee). **Skills**: Ability to optimize IoT devices for power efficiency and extended battery life. **Attitudes**: Focus on sustainability and energy-conscious design
8	**Programming & Scripting**	**Knowledge**: Expertise in programming languages used in IoT (Python, C/C++, Java). **Skills**: Ability to develop IoT applications, device firmware, and scripts for automation. **Attitudes**: A hands-on, solution-oriented approach to coding and problem-solving
9	**Troubleshooting &Debugging**	**Knowledge**: Familiarity with common IoT issues (connectivity, sensor failure, data bottlenecks). **Skills**: Proficiency in using debugging tools and techniques for troubleshooting IoT systems. **Attitudes**: Patience and persistence in diagnosing and fixing issues.
10	**Project Management**	**Knowledge**: Understanding of project management principles and tools (e.g., Agile, Scrum). **Skills**: Ability to plan, execute, and oversee IoT projects while coordinating teams. **Attitudes**: Strong leadership, collaboration, and organizational skills.

3. Syllabus

IoT and its Applications **SEMESTER – III**			
Course Code	**M23MCS303A**	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	**3**	Exam Hours	**03**

Course Learning objectives:

- To understand building blocks of Internet of Things and characteristics
- To analyse the revolution of Internet in Mobile Devices, Cloud& Sensor Networks ·
- To interpret the application areas of IOT

Module -1

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

Module -2

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

Module -3

Layer ½ Connectivity: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 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 HadoopMapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study.
TEXTBOOKS: 1. Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications, Daniel Minoli, Wiley,2013. 2. Internet of Things: A Hands on Approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015 **REFERENCE BOOKS:** 1. The Internet of Things, Michael Miller, Pearson, 2015 First Edition 2. Designing Connected Products, Claire Rowland, Elizabeth Goodman et.al, O'Reilly, First Edition, 2015 **VIDEO LINKS:** • https://www.coursera.org/specializations/internet-of-things • https://www.youtube.com/watch?v=Ic63-yf-zuc&list=PL3uLubnzL2Tm5PAw88N1jR9MLTJpuPEnX

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to Big Data Analytics	Internet of Things, Overview and Motivations, , IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation, frameworks-IoT, Basic Nodal Capabilities, Automation, Smart Cards, Tracking, Ring of Steel, Control Application , Myriad Other Applications.
2	Week 3-5: Hadoop Distributed File System and tools	Exploratory Data Analysis and the Data Science Process, The Data Science Process, Case Study, Three Basic Algorithms.
3	Week 6-8: NoSQL, MongoDB and Cassandra	Layer ½ Connectivity, Layer 3 Connectivity, IPv6 Technologies for the IoT, Address Capabilities,IPv6 Protocol Overview, IPv6 Tunnelling, IPsec in IPv6,Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.
4	Week 9-11: MapReduce, Hive, HiveQL, Pig	Case Studies illustrating IoT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications..
5	Week 12-14: Machine Learning Algorithms	Data Analytics for IoT – Introduction, 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	Lecture Method	Focus on clearly explaining complex concepts through real-world examples, visual aids, and interactive discussions.
2	Video/Animation	Helps visualize abstract concepts, complex data flows, and processing techniques, making the material more accessible and easier to understand.
3	Collaborative Learning	Work together on data projects, share insights, and solve complex problems, fostering deeper understanding and practical skills through peer interaction.
4	Real-World Application	Connect theoretical concepts to practical scenarios, enhancing their ability to apply data analysis techniques to solve industry-specific challenges.

5	Flipped Class Technique	Explore foundational concepts independently before class, enabling more in-depth, hands-on data analysis and problem-solving during in-person sessions.
6	Laboratory Learning	Experience with data tools and technologies, enabling to apply theoretical knowledge to real datasets and develop practical data processing and analysis skills.

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 2 test marks from the 3 tests conducted.

Semester End Examination: PG Programmes

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. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Understand IoT Architecture**	Learn the fundamental structure of IoT systems, including devices, sensors, and communication protocols.
2	**Familiarize with IoT Communication Protocols**	Gain knowledge of IoT-specific protocols such as MQTT, CoAP, and LoRaWAN for device-to-device communication.
3	**Master Data Collection and Analysis**	Develop the ability to collect, store, and analyze data generated by IoT devices using tools like Hadoop and Spark.
4	**Learn IoT Security Principles**	Understand the key security challenges and solutions in IoT, including encryption, authentication, and data protection techniques.
5	**Explore IoT Application Domains**:	Learn about various IoT applications in smart cities, healthcare, agriculture, and home automation.
6	**Understand Cloud and Edge Computing in IoT**	Learn how cloud and edge computing technologies support IoT data processing and storage.
7	**Develop Programming Skills for IoT**	Acquire proficiency in programming languages (e.g., Python, C++) for developing IoT applications and device firmware.

8	**Identify IoT Standards and Protocols**:	Familiarize yourself with evolving IoT standards, such as IPv6, RPL, and WPAN technologies.
9	**Apply IoT in Real-World Case Studies**:	Learn to design and implement IoT solutions through practical case studies in sectors like smart cities, environmental monitoring, and healthcare.

8. Course Outcomes (Course skill set)

COs	Description
M23MCS303A.1	Understand and apply schemes for the applications of IOT in real time scenarios
M23MCS303A.2	Analyse and manage the Internet sources
M23MCS303A.3	Evaluate and model the Internet of things to business
M23MCS303A.4	Design and interpret the datasets received through IoT devices and tools used for analysis.
M23MCS303A.5	Implement the IoT applications for real world

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS303A.1	3	-	-	3	3
M23MCS303A.2	-	3	-	3	3
M23MCS303A.3	-	-	3	3	3
M23MCS303A.4		-	-	3	3
M23MCS303A.5		3	-	3	3
M23MCS303A		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:

- **Widespread Smart City Development**: IoT will drive smart city infrastructure, improving traffic management, public services, and energy efficiency.
- **Advancements in Healthcare**: IoT-enabled devices will revolutionize remote patient monitoring, personalized medicine, and health data management.
- **Industrial IoT (IIoT) and Industry 4.**0: Smart factories, predictive maintenance, and automation will be major trends in manufacturing and supply chain management.

- **Expansion of 5G and Edge Computing**: The rollout of 5G networks will enable faster, more reliable IoT device communication, reducing latency through edge computing.
- **Growth in Smart Agriculture**: Precision farming, irrigation control, and soil monitoring will be driven by IoT solutions, boosting agricultural efficiency.
- **Environmental Monitoring and Sustainability**: IoT will support climate change mitigation by providing data for smart energy systems and environmental conservation.
- **Data-Driven Decision Making**: AI and machine learning will integrate with IoT for advanced data analytics, enabling smarter, real-time decision-making.
- **Enhanced Home Automation**: IoT will continue to evolve smart homes with devices that optimize security, energy use, and personal convenience.
- **IoT Security and Privacy**: As IoT expands, the demand for advanced cybersecurity measures to protect data and devices will become more critical.

3rdSemester	Open Elective Course (OE) Fundamentals of Artificial Intelligence	M23MCS303B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Programming Skills:**	Knowledge of programming languages like Python, which is commonly used in AI and machine learning, to implement algorithms and models.
2	**Mathematics Fundamentals:**	A strong foundation in linear algebra, calculus, probability, and statistics to understand and develop machine learning models and algorithms.
3	**Basic Understanding of Algorithms and Data Structures:**	Familiarity with data structures like trees, graphs, and basic algorithms, as they are often used in AI for tasks like search and problem-solving.
4	**Introduction to Logic and Discrete Mathematics:**	Propositional and predicate logic, set theory, and combinatorics are essential for knowledge representation, reasoning, and understanding AI decision-making processes.
5	**Basic Concepts in Data Science:**	Understanding data preprocessing, data visualization, and exploratory data analysis to prepare data for AI applications.

2. Competencies

S/L	Competency	KSA Description
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:** Skills in diagnosing and fixing issues with model performance, such as vanishing/exploding gradients, slow convergence, or unstable training.

3. Syllabus

Fundamentals of Artificial Intelligence SEMESTER-III			
Course Code	**M23MCS303B**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamental concepts of artificial intelligence and key problem-solving techniques.
- Apply the knowledge representation and reasoning techniques to solve complex problems in AI systems.
- Analyse machine learning algorithms to evaluate their perform real-world applications.
- Build the applications of natural language processing and robotics to enhance human-computer interaction.
- Explore the ethical considerations and societal implications of AI technologies

Module-1

Introduction to Artificial Intelligence and Problem Solving: Definition and scope of AI, History and evolution of AI, Types of AI: Narrow AI vs. General AI, Problem formulation and problem-solving techniques, Search algorithms :Uninformed and informed search strategies, Heuristic search and constraint satisfaction problems.

Module-2

Knowledge Representation and Reasoning: Types of knowledge representation, Proposition AI logic and first-order logic ,Semantic networks and frames, Ontologies and their applications, Deductive and inductive reasoning, Rule-based systems and non-monotonic reasoning, Probabilistic reasoning and Bayesian networks.

Module-3

Machine Learning: Introduction to machine learning, Supervised, unsupervised, and reinforcement learning, Common algorithms: Decision trees, SVM, neural networks Evaluation metrics for machine learning models ,Practical applications of machine learning in AI systems.

Module-4

Natural Language Processing and Robotics: Basics of natural language processing (NLP), Text processing and language models, Sentiment analysis and language generation, Robotics fundamentals and sensor technologies, Robot kinematics, control, and applications of AI in robotics.

Module-5

Ethical and Societal Implications of AI: Ethical considerations in AI development ,AI and job displacement ,Privacy concerns and data security, Bias and fairness in AI algorithms, Accountability and transparency in AI systems, The role of government and regulation in AI, Public perception and trust in AI technologies, Future of AI and its impact on society.

Text Books

1. Artificial Intelligence: A Modern Approach "by Stuart Russell and Peter Norvig, 4thEdition(2021)
2. Deep Learning by an Good fellow, Yoshua Bengio ,and Aaron Courville third Edition.

Reference Books:

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop Edition: fourth Edition (2020) "Artificial Intelligence: Foundations of Computational Agents "by David L. Poole and Alan K. Mack worth Edition: third Edition(2021).

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	Definition and scope of AI, Historyand evolution of AI, Types of AI: Narrow AI vs. General AI, Problem formulation and problem-solving techniques, Search algorithms: Uninformed and in formed search strategies, Heuristic search and constraint satisfaction problems.
2	Week 3-4	Types of knowledge representation, Propositional logic and first-order logic, Semantic networks and frames, Ontologies and their applications, Deductive and inductive reasoning, Rule-based systems and non-monotonic reasoning, Probabilistic reasoning and Bayesian networks.

3	Week 5-6	Introduction to machine learning, Supervised, unsupervised, and reinforcement learning, Common algorithms: Decision trees, SVM, neural networks Evaluation metrics for machine learning models, Practical applications of machine learning in AI systems.
4	Week 7-8	Basics of natural language processing (NLP), Text processing and language models, Sentiment analysis and language generation, Robotics fundamentals and sensor technologies, Robot kinematics, control, and applications of AI in robotics.
5	Week 9-10	Ethical considerations in AI development, AI and job displacement, Privacy concerns and data security, Bias and fairness in AI algorithms, Accountability and Transparency in AI systems ,The role of government and regulation in AI ,Public perception and trust in AI technologies, Future of AI and its impact on society.

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 Business 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)

Components		Number	Weight age	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 2 test marks from the 3 tests conducted.

Semester End Examination: PG Programmes
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. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description

1	**Understand BI Concepts**	Explain the fundamental concepts of business intelligence, including data sources, data warehousing, and the BI lifecycle.
2	**Data Analysis Skills**	Develop the ability to analyze and interpret large data sets using various statistical methods and analytical tools to derive actionable insights.
3	**Data Visualization Techniques**	Create effective visualizations using BI tools to communicate insights clearly and concisely to stakeholders.
4	**Database Proficiency**	Gain proficiency in database management, including SQL querying, data integration, and the ETL process to ensure data quality and accessibility.
5	**BI Tools Familiarity**	Demonstrate proficiency in popular BI tools (e.g., Tableau, Power BI) for data analysis and visualization.

8. Course Outcomes

COs	Description
M23MCS303B.1	Understand and apply schemes for the applications of IOT in real time scenarios
M23MCS303B.2	Analyze and manage the Internet sources
M23MCS303B.3	Evaluate and model the Internet of things to business
M23MCS303B.4	Design and interpret the datasets received through IoT devices and tools used for analysis.
M23MCS303B.5	Implement AI applications for real world.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS303B.1	3	-	-	3	3
M23MCS303B.2	-	3	-	3	3
M23MCS303B.3	-	-	3	3	3
M23MCS303B.4		-	-	3	3
M23MCS303B.5	-	-	3	3	3
M23MCS303B	-	-	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

- **Career Opportunities:** AI is one of the fastest-growing fields, and expertise in AI opens up career paths in data science, robotics, natural language processing, and other emerging tech sectors.
- **Advancements in Automation:** Knowledge in AI equips you to contribute to automating processes in various industries, from healthcare and finance to manufacturing and logistics, enhancing efficiency and reducing manual workloads.
- **Innovation and Problem-Solving:** AI skills enable you to develop innovative solutions to complex real-world problems, such as climate change, personalized medicine, and intelligent urban planning, by leveraging data-driven insights.
- **Societal Impact and Ethical Leadership:** A solid foundation in AI includes understanding its ethical implications, allowing you to lead and advocate for responsible AI development, ensuring technology benefits society as a whole.
- **Research and Development in Emerging Technologies:** This subject prepares you for potential contributions to cutting-edge research, such as quantum computing, neural networks, and cognitive AI, driving the next wave of technological breakthroughs.
- **Global Competitiveness:** Mastery of AI enhances your global competitiveness, as nations and industries increasingly invest in AI to stay at the forefront of technological progress and economic growth.

3rdSemester	Open Elective Course (OE) Big data analytics	M23MCS303C

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 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 – III			
Course Code	M23MCS303C	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P)	**(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:

- Understand the basics and Importance of Big Data
- Analyze the Applications and Advantages of Big Data Analytics
- Know the Hadoop Framework and its Ecosystem
- Develop Skills to use Hadoop MapReduce and YARN
- Utilize Essential Hadoop Tools and NoSQL Data Processing and Management

Module -1

Introduction to Big Data Analytics: Big Data Overview - Data Structures, Analyst Perspective on Data Repositories, State of the Practice in Analytics - B1 Versus Data Science, Analytical Architecture, Drivers of Big Data, Emerging Big Data Ecosystem and a New Approach to Analytics, Key Roles for the New Big Data Ecosystem, Examples of Big Data Analytics.
Text Book 1: Topic – 1.1, 1.2, 1.3, 1.4

Module -2

Data Analytics Lifecycle: Data Analytics Lifecycle Overview - Key Roles for a Successful Analytics Project, Background and Overview of Data Analytics Lifecycle, Phase 1: Discovery – Learning the Business Domain, Resources, Framing the Problem, Identifying Potential Data Sources, Phase 2: Data Preparation - Preparing the Analytic Sandbox, Performing ETLT, Learning About the Data, Data Conditioning, Survey and Visualize, Common Tools for the Data Preparation Phase.
Text Book 1: Topic –2.1, 2.2, 2.3

Module -3

Data Analytics Lifecycle - Continued: Phase 3: Model Planning - Data Exploration and Variable Selection, Model Selection, Common Tools for the Model Planning Phase, Phase 4: Model Building - Common Tools for the Model Building Phase, Phase 5: Communicate Results, Phase 6: Operationalize, Case Study: Global Innovation Network and Analysis (GINA).
Text Book 1: Topic –2.4, 2.5, 2.6, 2.7, 2.8

Module -4

Introduction to Hadoop: Introduction, Hadoop and its Ecosystem, Hadoop Distributed FileSystem, MapReduce Framework and Programming Model, Hadoop Yarn, Hadoop Ecosystem Tools.
Introduction to MapReduce: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution.
Text Book 2: Topic –2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 4.1, 4.2

Module -5
NoSQL Big Data Management: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks. **Text Book 2: Topic –3.1, 3.2, 3.3, 3.4, 3.5**
Text Books: 1. Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, David Dietrich, Barry Hellerand Beibei Yang, EMC Education Services, John Wiley & Sons, Inc. 2. Raj Kamal and Preeti Saxena, "Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning", McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966 **Reference Books:** 1. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1 stEdition, Pearson Education, 2016. ISBN13: 978-9332570351 2. Hadoop Operations**:** Eric Sammer, O'Reilly Media, Inc., 2012 Edition. 3. Tom White, Hadoop: The Definitive Guide, 3rd Edition, O'reilly, 2012.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Module I - Introduction to Big Data Analytics	**Week 1**: Big Data Overview Data Structures Analyst Perspective on Data Repositories State of the Practice in Analytics - B1 Versus Data Science Analytical Architecture **Week 2:** Drivers of Big Data Emerging Big Data Ecosystem and a New Approach to Analytics Key Roles for the New Big Data Ecosystem Examples of Big Data Analytics.
2	Week 3-5: Module II - Data Analytics Lifecycle	**Week 3:** Data Analytics Lifecycle Overview Key Roles for a Successful Analytics Project Background and Overview of Data Analytics Lifecycle **Week 4:**Phase 1: Discovery Learning the Business Domain Resources Framing the Problem Identifying Potential Data Sources, **Week 5:** Phase 2: Data Preparation Preparing the Analytic Sandbox Performing ETLT Learning About the Data Data Conditioning Survey and Visualize Common Tools for the Data Preparation Phase.
3	Week 6-8: Module III - Data Analytics Lifecycle - Continued	**Week 6:** Phase 3: Model Planning Data Exploration and Variable Selection Model Selection Common Tools for the Model Planning Phase **Week 7:** Phase 4: Model Building Common Tools for the Model Building Phase Phase 5: Communicate Results **Week 8:** Phase 6: Operationalize Case Study: Global Innovation Network and Analysis (GINA).
4	Week 9-10: Module IV - Introduction to Hadoop& MapReduce:	**Week 9:** Introduction to Hadoop and its Ecosystem Hadoop Distributed FileSystem MapReduce Framework and Programming Model **Week 10:** Hadoop Yarn

		Hadoop Ecosystem Tools MapReduce Map Tasks Reduce Tasks MapReduce Execution
5	Week 11-12: Module V - NoSQL Big Data Management:	**Week 11**:Introduction to NoSQL NoSQL Data Store NoSQL DataArchitecture Patterns **Week 12:** NoSQL to Manage Big Data Shared-Nothing Architecture for Big Data Tasks.

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	Step-by-Step Tutorials	Provide detailed tutorials on the MapReduce model, including writing, compiling, and running MapReduce programs.
5	Lectures and Diagrams	Use diagrams to explain the YARN architecture and its components.
6	Tool-Specific Lectures:	Provide detailed lectures on using Apache Pig, Hive, Sqoop, Flume, HBase, and Oozie.
7	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: Open Elective (OE)

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 Open Elective (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**

FinalC IE 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 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	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	Know the Usage of 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 Understanding of 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 EssentialTools for Data Processing using NoSQL	Handle un-structured data using NoSQL Databases and its Structure of representation.

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

Course Outcomes (COs)

COs	Description
M23MCS303C.1	Understand and apply the basic Big Data Concepts and its Analysis.
M23MCS303C.2	Apply Hadoop framework and its components, including cloud computing and HDFS to form a Big Data Eco-system.
M23MCS303C.3	Analyze Big Data analytics architecture and mechanisms in handling and processing big Data. Describe the
M23MCS303C.4	Implement appropriate techniques and algorithms to optimizing them for better performance.
M23MCS303C.5	Utilize Essential Hadoop and NoSQL Tools to handled ata and its processing.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS303C.1	**3**			**2**	**2**

M23MCS303C.2	**3**			**2**	**2**
M23MCS303C.3	**3**			**2**	**3**
M23MCS303C.4		**2**		**3**	**3**
M23MCS303C.5		**2**		**3**	**3**
M23MCS303C		**2**		**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 third semester of the M.Tech program provides a comprehensive foundation in Big Data and Hadoop technologies and NoSQL System, 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 modeling for disease outbreaks and personalized medicine. Improves patient outcomes, reduces costs, and enhances the overall efficiency of healthcare systems.

3rdSemester	Open Elective Course (OE) Web Technologies	M23MCS303D

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	**Understanding of the Internet and How the Web Works**	Web Browsers: Basic knowledge of how web browsers (like Chrome, Firefox, and Edge) work and how they render websites. Client-Server Model: Understanding that the web works on client-server architecture, where the browser (client) sends requests to servers, and servers send back responses (e.g., HTML files, JSON data). DNS (Domain Name System): Understand how domain names are translated into IP addresses and how websites are found over the internet.
2.	**HTML (HyperText Markup Language)**	Basic Tags: Knowledge of basic HTML tags. Forms and Inputs: Understand how to create forms using <form>, <input>, <button>, and their attributes for user interaction, Semantics**:** Learn semantic HTML tags like <article>, <section>, <nav>, <header>, and <footer> to structure content meaningfully.
3.	**CSS (Cascading Style Sheets)**	**Basic Syntax and Selectors:** Understand how to apply styles to HTML elements using basic selectors (element, id, class, etc.). **Box Model:** Learn how margins, borders, padding, and content work together to create the layout of elements. **Responsive Design:** Basic knowledge of responsive web design using media queries to create layouts that adapt to different screen sizes. **Flexbox/Grid:** Understanding layout mechanisms like Flexbox and CSS Grid for building modern responsive layouts.
4.	**Basic Programming Logic**	**Algorithms and Data Structures:** You don't need advanced knowledge, but basic programming concepts like arrays, objects, loops, and conditionals are important for both frontend and backend development. **Problem Solving:** Ability to break down problems logically and apply programming techniques to solve them.
5.	**DevOps Basics**	Introduction to deployment concepts (e.g., using cloud platforms like AWS or Heroku).
6.	**Basic Understanding of Frameworks**	Learn about popular frontend frameworks/libraries like React, Angular, or Vue.js and backend frameworks like Express (Node.js), Flask, or Django.

2. Competencies

S/L	Competency	KSA Description
1.	**HTML5 and CSS3 HTML5**	**Knowledge:** HTML5 Semantic Elements: Understand new elements like <header>, <footer>, <article>, <section>, and their role in structuring content. **Skills:** Create Forms: Build user-friendly and accessible forms using HTML5's form features and validation. **Attitude:** Adaptability: Stay updated on the evolving HTML5 and CSS3 standards and best practices.
2.	**JavaScript Client-Side Scripting**	**Knowledge:** Core JavaScript Syntax: Understand variables, functions, loops, and conditionals. **Skills:** Debugging: Efficiently debug and troubleshoot JavaScript code using browser tools (e.g., Chrome DevTools). **Attitude:** Problem-Solving: Be proactive in solving interactive and dynamic challenges on the client side.
3.	**Building Single page applications with AngularJS Single page application**	**Knowledge:** AngularJS Basics: Understand the core concepts of AngularJS, such as modules, controllers, services, and directives.. **Skills:** Use Custom Directives: Create reusable custom directives to enhance the functionality of your HTML. **Attitude:** Modular Thinking: Focus on writing modular, reusable, and maintainable code by breaking down the application into components.
4.	**Server Side Programming Server side scripting**	**Knowledge:** Server-Side Languages: Understand core concepts of languages like Node.js, Python (Flask/Django), PHP, Ruby, or Java. **Skills:** Build Server Applications: Develop robust server-side applications using your chosen programming language and framework. **Attitude:** Problem-Solving Mindset: Approach challenges with a focus on finding effective solutions and optimizing performance.
5.	**Introduction to Xml, usage of XML**	**Knowledge:** XML Basics: Understand the structure and syntax of XML, including elements, attributes, and nesting. **Skills:** Create XML Documents: Write valid XML documents using custom tags, attributes, and proper syntax.. **Attitude: Adaptability**: Be open to using XML in different contexts and with various technologies.

3. Syllabus

Web Technologies SEMESTER – III			
Course Code	**M23MCS303D**	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

CO1: Understand the concept of JAVA SCRIPTS, JSP and Servlet concepts., difference between the HTML PHP and XML documents

CO2: Apply JDBC and ODBC technologies to create database connectivity

CO3: Analyze the difference between PHP and XML.

CO4: Design web pages using PHP

Module -1
HTML5 and CSS3 HTML5- Basic Tags, Tables,Forms.HTML5 Tags, HTML Graphics, HTML media, HTML Graphics, HTML APIs. CSS – Background, Borders, margin, Box model. Styling text, fonts, list, links, tables. CSS overflow, float, inline blocks, pseudo classes, pseudo elements.CSS border images, rounded corners.
Module -2
Java Script Client side scripting using java script, Introduction to java script, internal and external Java script files, variables, control statements, loops, Arrays , string handling , How to write functions in JavaScript, inputting and outputting from form elements to JavaScript. DOM concept, creating html elements using java script. Drawing 2D shapes, handling events. Introduction to AJAX
Module -3
Building Single page applications with Angular JS Single page application – introduction , two way data binding, MVC in angular JS, controllers, getting user inputs , loops , Client side routing – accessing URL data , various ways to provide data in angular JS.
Module -4
Server Side Programming Server side scripting, Difference between client side and server side scripting languages. Introduction to PHP, variables, control statements, loops, Arrays, string handling, PHP forms, Global variables in PHP, Regular expression and pattern matching, Database programming: inputting and outputting data from MySQL using PHP, insertion , deletion and updating data. State management in web applications, cookies, Application and session state.
Module -5
Introduction to Xml, usage of XML, XML tags, elements and attributes, attribute type, XML validation: DTD and XSD, XML DOM Case study:-Application Development using Laravel framework
Textbooks: 1.The Complete Reference, HTML and CSS by Thomas A Powell latest edition 2.XML Bible by Horold, Ellotte Rusty

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	Introduction of Web Technologies, HTML5 and CSS3 HTML5- Basic Tags, Tables,Forms.HTML5 Tags, HTML Graphics, HTML media, HTML Graphics, HTML APIs.
2	Week 3-4	Java Script Client side scripting using java script, Introduction to java script
3	Week 5-6	Building Single page applications with Angular JS Single page application
4	Week 7-8	Server Side Programming Server side scripting
5	Week 9-10	Regular expression and pattern matching, Database programming
6	Week 11-12	Xml, usage of XML Case study:-Application Development using LA ravel framework

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

1. Question paper pattern will be ten questions. Each question is set for 20 marks. 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 a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand Fundamental Concepts	Students are able to define key terms and concepts related to web technologies, including HTML, CSS, JavaScript, and web protocols and should Explain the client-server model and how web applications function within this framework.
2	Develop Proficiency in Frontend Technologies	Students are able to Create well-structured and semantic HTML documents to define web page content and Implement JavaScript for dynamic content, including DOM manipulation, event handling, and basic animations.
3	Explore Backend Development	Students should know the role of server-side programming languages (e.g., Node.js, Python, PHP) in web development.
4	Enhance Skills in Web Development Tools	Students are going to Utilize version control systems (e.g., Git) to manage code changes and collaborate on projects effectively.
5	Foster Problem-Solving and Critical Thinking	Student make use logical reasoning and problem-solving skills to debug and optimize web applications.

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

Course Outcomes (COs)

CO's	Description
M23MCS303D.1	Understand the concept of JAVA SCRIPTS, JSP and Servlet concepts., difference between the HTML PHP and XML documents
M23MCS303D.2	Apply JDBC and ODBC technologies to create database connectivity
M23MCS303D.3	Analyze the difference between and PHP and XML
M23MCS303D.4	Design web pages using PHP

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS303D.1	**2**	**-**	**-**	**-**	**2**
M23MCS303D.2	**2**	**-**	**-**	**-**	**2**
M23MCS303D.3	**-**	**2**	**2**	**2**	**2**
M23MCS303D.4	**-**	**2**	**2**	**-**	**2**
M23MCS303D	**-**	**2**	**2**	**-**	**2**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	3	2	3	2	10
Module 2	2	3	2	3	10
Module 3	3	2	3	2	10
Module 4	2	3	2	3	10
Module 5	3	2	3	2	10
Total	13	12	13	12	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	5	5	5	5	25
Module 2	5	5	5	5	25
Module 3	5	5	5	5	25
Module 4	5	5	5	5	25
Module 5	5	5	5	5	25
Total	25	25	25	25	**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

- ✓ Continued Growth of the Web Development Field
- ✓ Rise of Progressive Web Applications (PWAs)
- ✓ Focus on Responsive and Adaptive Design
- ✓ Integration of Artificial Intelligence and Machine Learning
- ✓ Emphasis on Security and Privacy
- ✓ Cloud Computing and Serverless Architectures
- ✓ Career Opportunities and Specializations
- ✓ Continuous Learning and Adaptatio

3rdSemester	Open Elective Course (OE) Image processing	M23MCS303E

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	**Mathematics**	Understanding matrices and vectors is crucial, as images can be represented as arrays of pixel values. Basic concepts like derivatives can help in understanding filters and transformations. Useful for techniques like histogram analysis and noise reduction.
2.	**Programming Skills**	Proficiency in languages like Python, MATLAB, or C++. Python is particularly popular due to libraries like OpenCV, PIL, and scikit-image. Familiarity with algorithms and data structures will help in optimizing image processing tasks.
3.	**Image Representation**	Understand how images are represented in digital form (e.g., pixels, color models like RGB, grayscale
4.	**Basic Image Processing Concepts**	Familiarity with concepts like filtering, convolution, edge detection, and image transformations (e.g., resizing, rotation).
5.	**Libraries and Tools**	**OpenCV:** A powerful library for real-time computer vision. **PIL/Pillow:** A library for opening, manipulating, and saving many different image file formats. **scikit-image:** A collection of algorithms for image processing in Python.
6.	**Computer Vision Basics**	Knowledge of fundamental computer vision concepts can enhance your understanding of how image processing fits into larger projects.

2. Competencies

S/L	Competency	KSA Description
1.	**Mathematics**	**Knowledge:** • **Matricesand Vectors:** Understand how to manipulate matrices and vectors, including operations like addition, multiplication, and inversion. • **Eigen-values and Eigenvectors:** Familiarity with these concepts can help in image compression and transformations. • **Derivatives:** Understand how to compute and interpret derivatives; this is vital for edge detection techniques. • **Integrals:** Familiarity with integrals can help in understanding cumulative distribution functions and area under curves. • **Partial Derivatives:** Know how to work with functions of multiple variables, especially in optimization problems. **Skills:** • **Problem-Solving:** Ability to apply mathematical concepts to real-world problems, especially in image manipulation and analysis. • **Computational Skills:** Proficiency in using mathematical libraries (e.g., NumPy in Python) for matrix operations and statistical calculations. **Attitudes:** • **Curiosity:** An eagerness to explore and understand how mathematical concepts apply to image processing. • **Perseverance:** A willingness to tackle complex mathematical problems and the patience to work through challenging concepts.

2.	**Programming Skills**	**Knowledge:** • **Programming Languages:** Python: Familiarity with Python is crucial due to its extensive libraries (e.g., OpenCV, scikit-image, PIL). • **MATLAB:** Understanding MATLAB can be beneficial, especially in academic settings where it's commonly used. • **Algorithms:** Understanding sorting, searching, and basic image processing algorithms (e.g., convolution). • **Data Structures:** Familiarity with arrays, lists, and dictionaries to manage and manipulate image data effectively. • **Version Control:** Knowledge of tools like Git for managing code changes and collaborating on projects. • **Code Optimization:** Understanding how to write efficient code to improve performance in image processing tasks. **Skills:** • **Coding Proficiency:** Ability to write clean, efficient, and well-documented code. Familiarity with best practices and coding conventions. • **Debugging and Troubleshooting:** Skills to identify and fix bugs effectively. Proficiency in using debugging tools and techniques. • **Library Utilization:** to leverage existing libraries for image processing tasks, such as Open CV for image manipulation and computer vision. • **Project Management:** Skills to manage and organize coding projects, including setting goals, timelines, and deliverables. • **Testing and Validation:** Knowledge of testing frameworks and practices to ensure code reliability and performance. **Attitudes:** • **Curiosity and Willingness to Learn :**An eagerness to explore new programming languages, tools, and techniques related to image processing. • **Problem-Solving Mindset:** A proactive approach to identifying and solving coding challenges, especially in the context of image processing.
3.	**Image Representation**	**Knowledge:** • **Pixels:** Understand what pixels are, how they form an image, and their role in image representation. • **Color Models:** Familiarity with different color models (e.g., RGB, CMYK, HSV) and how they affect image representation. • **Image formats:** Knowledge of various image file formats (e.g., JPEG, PNG, BMP, TIFF) and their properties, including compression methods and lossless vs. lossy formats. • **Image Resolution and Size:** Understand concepts of resolution, aspect ratio, and how they impact image quality and representation. Gray-Scale and Binary Images • **Gray-Scale and Binary Images:** Knowledge of how images can be represented in gray-scale or binary formats and the implications for processing. **Skills:** • **Image Manipulation:** Ability to manipulate images programmatically (e.g., resizing, cropping, rotating) using programming libraries (e.g., OpenCV, PIL). • **Image Analysis:** To analyze images for features such as edges, textures, and shapes using techniques like edge detection and filtering.

		• **Data Representation:** Proficiency in representing images as arrays/matrices and understanding the implications for performance and memory. • . **Attitudes:** • **Attention to Detail:** A meticulous approach to understanding how small changes in representation can affect image quality and processing outcomes. • **Curiosity:** An eagerness to explore different image formats, representation techniques, and their applications in various fields.
4.	**Basic Image Processing Concepts**	**Knowledge:** • **Image Fundamentals**: Types of images (grayscale, color, binary). Image formats (JPEG, PNG, BMP, etc.). Pixel representation and color models (RGB, CMY, HSV). • **Image Processing Techniques**: Image enhancement (contrast stretching, histogram equalization). Noise reduction (smoothing filters, median filters). Edge detection (Sobel, Canny). Image transformation (scaling, rotation). • **Tools and Software**: Familiarity with image processing software (e.g., OpenCV, MATLAB, Python libraries like PIL or scikit-image). Understanding of graphical user interfaces for image editing (e.g., Photoshop, GIMP). **Skills:** • **Technical Skills**: Ability to write and understand code for image processing (e.g., Python, MATLAB). Proficiency in using image processing libraries and tools. • **Analytical Skills**: Ability to analyze and interpret image data. Problem-solving skills to address specific image processing challenges. • **Creativity**: Developing unique solutions for enhancing and manipulating images. Understanding artistic aspects of image presentation. **Attitudes:** • **Attention to Detail**: Precision in manipulating image data and parameters. Carefulness in assessing the quality of processed images.
5.	**Libraries and Tools**	**Knowledge:** • **Understanding Image Libraries:** Familiarity with popular image processing libraries (e.g., OpenCV, PIL/Pillow, scikit-image, Image Magick).Knowledge of functions and methods available in these libraries for image manipulation and analysis. • **File Formats and I/O:** Understanding different image file formats and their properties. Knowledge of reading and writing images using libraries. • **Basic Image Processing Techniques:** Awareness of techniques for filtering, transformation, enhancement, and analysis (e.g., blurring, sharpening, thresholding). Understanding of how these techniques are implemented in libraries. **Skills:** • **Implementation Skills**: Ability to implement basic image processing algorithms using libraries. Skills in applying filters, transformations, and enhancements to images. • **Debugging and Optimization**: Ability to troubleshoot and debug image processing code. Skills in optimizing image processing tasks for performance and efficiency. • **Visualization Skills**: Skills in visualizing processed images and data (e.g., using Matplotlib in Python). Ability to interpret the results of image processing techniques visually.

		Attitudes: • **Problem-Solving Mindset**: An attitude of perseverance in tackling image processing challenges. Openness to experimenting with different techniques and approaches
6.	**Computer Vision Basics**	**Knowledge:** • **Fundamentals of Image Processing**: Understand concepts like pixel, image formats, filtering, and color spaces. • **Computer Vision Techniques**: Familiarity with techniques like edge detection, feature extraction, segmentation, and optical flow. **Skills:** • **Programming Proficiency**: Skills in languages like Python or C++, and familiarity with libraries such as OpenCV, TensorFlow, or PyTorch. **Attitudes:** • **Curiosity and Open-mindedness**: A willingness to explore new ideas and techniques in the rapidly evolving field of computer vision. • **Problem-solving Mindset**: An approach that focuses on breaking down complex problems into manageable parts.

3. Syllabus

Image Processing **SEMESTER – III**			
Course Code	**M23MCS303E**	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:
- Understand the basic concepts and terminology of image processing, image formats, and color models.
- Learn and apply various image enhancement techniques.
- Understand and implement spatial and frequency domain transformations.
- Learn segmentation techniques to partition an image into meaningful regions using segmentation
- Understand and apply morphological operations to analyze and manipulate the structure of images.

Module -1

Introduction And Digital Image Fundamentals: The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing, Elements of Digital Image Processing Systems, Image Sampling and Quantization, Some basic relationships like Neighbours, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations.

Module -2

Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Image Enhancement in the Frequency Domain: Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering.

Module -3

Image Restoration: A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Pereodic Noise Reduction by Frequency Domain Filtering, Linear Position Invarient Dedradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.

Module -4

Image Compression: Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Elements of Information Theory, Error free comparison, Lossy compression, Image compression standard**s.**

Image Segmentation: Detection of Discontinuities, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation, Motion based segmentation.

Module -5

Representation and Description: Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms. **Object Recoginition**: Patterns and Pattern Classes, Decision-Theoretic Methods, Structural Methods
Text Book: • Digital Image Processing- Rafel C Gonzalez and Richard E. Woods, PHI 3rd Edition 2010. • Fundamentals of Digital Image Processing- A K. Jain, Pearson 2004. **Reference Books:** • Digital Image Processing- S.Jayaraman, S. Esakkirajan, T. Veerakumar, TataMcGrawHill2014. • Fundamentals of Digital Image Processing- A K. Jain, Pearson 2004.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: introduction to image processing	Describes about The origins of Digital Image Processing, Fundamentals Steps in Image Processing,Image Sampling and Quantization, Some basic relationships like Neighbours.
2	Week 1-2: Image Enhancement in the Spatial Domain	Describes about Some basic Gray Level Transformations, Histogram Processing, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters
3	Week 5-6: Image Enhancement in frequency Domain:	**Describes** Fourier Transform and the frequency Domain, Smoothing and Sharpening Describes Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filtering..
4	Week 7-8: Image Restoration	Describes A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Pereodic Noise Reduction by Frequency Domain Filtering.
5	Week 9-10::image compression and segmentation	Describes different Image Compression models, Elements of Information Theory, Error free comparison, Lossy compression, and different segmentation techniques
6	Week 11-12: Representation and Description and Object Recognition:	Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms.

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
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

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. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	**Understanding image processing Fundamentals**	• Understand the basic concepts and terminology of image processing, including pixel representation, image formats, and color models. • Explain the concept of digital images, including pixel representation, image resolution, and common image formats.
2	**Image Enhancement in the Spatial Domain**	• Explain the spatial domain and its significance in image processing, including how images are represented as 2D arrays of pixel values. • Implement various intensity transformation techniques, such as linear and nonlinear transformations, to enhance image contrast. • Perform histogram equalization to improve the overall contrast of images and understand its impact on image distribution.
4	**Image Enhancement in the Frequency Domain:**	• Explain the principles of frequency domain representation of images and the significance of frequency components in image analysis • Apply the Fourier Transform and its inverse to convert images between spatial and frequency domains, and understand the implications of this transformation. • Identify and interpret different frequency components in images, distinguishing between low-frequency and high-frequency information.
5	**Image Restoration**:	• Explain the common causes of image degradation, including noise, blur, and distortions, and their effects on image quality. • Differentiate between various types of noise (e.g., Gaussian, salt-and-pepper, speckle) and understand their characteristics and impact on images. • Implement spatial domain methods for image restoration, including median filtering, Wiener filtering, and adaptive filtering. • Apply frequency domain techniques to restore images, using methods such as inverse filtering and constrained least squares filtering
6	**Image Compression:**	• Explain the importance of image compression, including its role in reducing storage space and improving transmission efficiency. • Distinguish between lossy and lossless compression techniques, understanding the trade-offs in image quality and file size.

		• Identify and explain common image compression algorithms, such as JPEG, PNG, and GIF, and their respective use cases.
7	**Image Segmentation**	• Define image segmentation and explain its importance in image analysis and computer vision applications • Identify and compare various segmentation methods, including thresholding, clustering, and edge-based techniques • Apply global and adaptive thresholding techniques to segment images based on pixel intensity
8	**Representation and Description**:	• Explain the different ways to represent images digitally, including pixel-based and feature-based representations. • Distinguish between image representation (how images are stored and structured) and description (how images are analyzed and interpreted) • Understand and apply both spatial and frequency domain representations, including techniques like the Fourier transform.
9	**Object Recoginition**	• Define object recognition and explain its significance in computer vision and artificial intelligence. • Distinguish between object detection (locating objects in an image) and object recognition (classifying objects into predefined categories). • Identify and apply feature extraction methods, such as SIFT, SURF, and HOG, to represent objects in images.

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

Course Outcomes (COs)

COs	Description
M23MCS303E.1	Understanding and apply of the fundamental concepts image enhancement techniques in Image processing
M23MCS303E.2	Implement restoration techniques to recover images degraded by noise.
M23MCS303E.3	Design and apply image compression algorithms,Perform image segmentation using various techniques.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PSO1	PSO2
M23MCS303E.1	2	-	-	-	2
M23MCS303E.2		2	-	-	2
M23MCS303E.3	-		2	2	2
M23MCS303E	-		2	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Module 1	**5**	**5**		**10**
Module 2	**5**		**5**	**10**
Module 3	**5**	**2**	**3**	**10**
Module 4		**5**	**5**	**10**
Module 5	**2**	**5**	**3**	**10**
Total	**17**	**17**	**16**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	**Total**

Module 1	**7**	**7**	**6**	**20**
Module 2	**8**	**6**	**6**	**20**
Module 3	**6**	**8**	**6**	**20**
Module 4	**6**	**7**	**7**	**20**
Module 5	**7**	**6**	**7**	**20**
Total	**34**	**34**	**32**	**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

- **Image Acquisition**: The process of capturing an image using sensors or cameras, converting it into a digital format for processing.
- **Image Enhancement**: Techniques to improve the visual appearance of an image, such as contrast adjustment, brightness correction, and noise reduction.
- **Image Restoration**: Methods to recover an image that has been degraded by factors like noise or blurring, often using filters and mathematical models.
- **Image Compression**: Techniques to reduce the file size of an image for efficient storage and transmission, including both lossy and lossless compression methods
- **Image Segmentation**: The process of partitioning an image into distinct regions or objects, enabling easier analysis and interpretation.
- **Object Recognition**: The ability to identify and classify objects within an image, often using machine learning and deep learning approaches.
- **Morphological Processing**: Operations that analyze and manipulate the structure of objects within an image, using techniques like dilation, erosion, and opening/closing.