SEMESTER IX

Option-I (Course Work)

To be effective from year-2024

ELECTIVE 1

COURSE TITLE: Large Language Models

Course Code: IMDAMJLL0924						Examination Scheme	T	P
Total number of Lecture Hours: 56 Total number of Practical Hours: -						External	80	-
						Internal	20	-
Lecture(L):	4	Practical (P):	-	Tutorial(T):	-	Total Credits		4

Course Objectives

1. Master advanced techniques in pre-training, fine-tuning, and transfer learning of LLMs.
2. Understand scaling laws and the challenges of training large models.
3. Implement cutting-edge architectures and explore their applications in diverse NLP tasks.
4. Evaluate and optimize LLM performance across tasks using various benchmarks.
5. Address ethical and societal challenges associated with the use of large models.

Course Content	TEACHING HOURS
UNIT 1:	**14 Hrs**
Introduction to LLMs; Popular and domain-specific LLMs; Evolution from traditional models to LLMs (n-grams, RNNs, LSTMs to Transformers; Transformer architecture: Encoder, decoder, self-attention, positional encoding; multi-head attention; Implementing a basic transformer model.	
UNIT 2:	**14Hrs**
Data pre-processing for LLMs: Understanding the effects of data on model performance, Introduction to Masked and Causal Language Models, Exploring BERT, T5 and GPT architectures; Unsupervised learning techniques in LLMs; Fine-tuning a pre-trained model (BERT or GPT) for a downstream task. Prompt engineering; Techniques for zero-shot, few-shot and transfer learning; Pre-training and fine-tuning approaches.	
UNIT 3:	**14Hrs**

Scaling laws and model efficiency: impact of model size, dataset size, and computational resources; Exploring distributed and parallel training techniques including data, model, and pipeline parallelism.	
UNIT 4:	**14Hrs**
Optimizing LLM training: mixed precision, gradient checkpointing, pruning quantization, optimizers for LLMs, evaluating LLMs on various benchmarks. Bias and fairness in LLMs: Identifying sources of bias and exploring mitigation strategies; Societal impacts: Disinformation, content moderation, and Ethical implications.	

Textbooks

1. Jay Alammar, Maarten Grootendrost; Hands-On Large Language Models; O'reilly Media Inc
2. Sinan Ozdemir; Quick Start Guide to Large Language Models, Second Edition; Addison-Wesley

ReferenceBooks

1. Uday Kamath, Kevin Keenan,*et al*; Large Language Models: A Deep Dive; Springer
2. Lewis Tunstall, Leandro von Werra; Natural Language Processing with Transformers; O'reilly Media Inc

COURSEOUTCOMES(CO):

CO1: Demonstrate proficiency in advanced techniques for pre-training, fine-tuning, and transfer learning specific to large language models (LLMs).

CO2: Analyze and articulate the scaling laws of LLMs, including the challenges and implications of training large models effectively.

CO3: Design and implement state-of-the-art LLM architectures, understanding their nuances and applications across a variety of natural language processing (NLP) tasks.

CO4: Employ various benchmarks to systematically evaluate and optimize the performance of LLMs, applying appropriate metrics and methodologies.

CO5: Critically assess the ethical and societal challenges associated with LLM usage, including bias, fairness, and implications for disinformation and content moderation.

COURSE TITLE: AI Assurance

Course Code: IMDAMJAA0924						Examination Scheme	T	P
Total number of Lecture Hours: 56						External	80	-
Total number of Practical Hours: -						Internal	20	-
Lecture(L):	4	Practical (P):	-	Tutorial(T):	-	Total Credits		4

Course Objectives

- Define AI assurance and explain its importance in ensuring fair, accountable, transparent, and ethical AI systems.
- Identify and assess risks and biases in AI systems, and apply tools and best practices to mitigate them while balancing performance metrics.
- Apply techniques for explainability and interpretability to enhance the transparency of AI models and meet legal requirements in regulated industries.
- Implement auditing techniques, ensure compliance with global standards, and establish continuous monitoring strategies for AI systems.

Course Content	TEACHING HOURS
UNIT 1:Introduction to AI Assurance and Governance	**15 Hrs**
Introduction to AI Assurance: Definition, Need, and Scope, The role of AI in decision-making and societal impact, Key principles of AI Assurance: Fairness, Accountability, Transparency, and Ethics (FATE), Case studies: Failures of AI systems and their societal implications.	
UNIT 2: Risk, Bias, and Performance in AI Systems	**14Hrs**
Risk assessment in AI: Identifying vulnerabilities and threats, Understanding bias in AI: Sources, types, and impact, Tools for detecting and mitigating bias in AI models, Performance metrics in AI: Accuracy, Precision, Recall, and F1-score, Trade-offs between fairness and performance, Best practices in AI model validation and testing.	
UNIT 3: Explainability and Interpretability in AI	**14Hrs**

Introduction to Explainability in AI: Importance and Challenges, Explainability techniques: SHAP, LIME, and counterfactual explanations, Interpretable machine learning models: Linear models, decision trees, rule-based models, Black-box models vs. white-box models, Use cases of explainable AI in regulated industries (finance, healthcare, etc.), Legal requirements for AI interpretability.	
UNIT 4: AI Auditing, Compliance, and Continuous Monitoring	**14Hrs**
Auditing AI systems: Purpose, Scope, and Techniques, Creating audit trails for AI decision-making, Compliance requirements for AI (global standards), Continuous monitoring of AI systems: Tools and strategies, AI in production: Lifecycle management and updates, Ethics committees and roles in AI assurance.	

Textbooks

1. Artificial Intelligence: A Guide for Thinking Humans" **by** Melanie Mitchell, 2019, Ist Edition.

Reference Books

1. AI Ethics by Mark Coeckelbergh, 2020, 1st Edition
2. Fairness and Machine Learning: Limitations and Opportunities" by Solon Barocas, Moritz Hardt, and Arvind Narayanan, 2019, 1st Edition
3. Interpretable Machine Learning: A Guide for Making Black Box Models Explainable by Christoph Molnar, 2019, 1st Edition
4. AI and Machine Learning Audits: A Framework for Auditing Algorithms by Noel Corrigan, 2021, 1st Edition

COURSEOUTCOMES(CO):

CO1: Students will be able to articulate the principles and importance of AI assurance and its impact on societal and decision-making processes.

CO2: Students will assess AI risks and biases, and apply appropriate tools and practices to achieve a balance between fairness and performance.

CO3: Students will utilize explainability techniques and interpretable models to enhance the transparency and compliance of AI systems.

CO4: Students will conduct AI system audits, ensure compliance with standards, and implement strategies for ongoing monitoring and lifecycle management.

ELECTIVE 2

To be effective from year-2024

COURSE TITLE: Embedded Systems

Course Code: IMDAMJES0924						Examination Scheme	T	P
Total number of Lecture Hours: 56						External	80	-
Total number of Practical Hours: -						Internal	20	-
Lecture(L):	4	Practical (P):	-	Tutorial(T):	-	Total Credits		4

Course Objectives

- Understand the fundamental concepts and design challenges of Embedded Systems and Cyber-Physical Systems, including their classification and application areas.
- Describe the architecture and memory organization of the 8051 microcontroller, including its special function registers (SFRs) and I/O ports.
- Program the 8051 microcontroller to handle interrupts, including timer interrupts, external hardware interrupts, and serial communication interrupts.
- Develop skills in interfacing the 8051 microcontroller with external devices, such as LCDs, keyboards, DACs, ADCs, and stepper motors.

Course Content	TEACHING HOURS
UNIT 1:Introduction.	**16 Hrs**
Embedded Systems and Cyber-Physical Systems: Definition, Characteristics, Design Challenges, Classification, Application Areas. **Embedded Hardware Architecture:** General Purpose Processor, Microprocessor Design Options, Microcontroller, Digital Signal Processor, ASIC, PLDs, COTS; Embedded Systems Memory; Other Hardware Components: I/O Subsystem, Timers and Counters, Interrupt Subsystem, UART, PWM and Analog-Digital Conversion, Sensors and Actuators. **Embedded Software Architectures:** Round Robin, Round Robin with Interrupts, Function Queue Scheduling, Real-time Operating System (RTOS); Programming Languages and Tools; Embedded IDE; Debugging.	
UNIT 2: The 8051 Microcontroller.	**14Hrs**
Microcontroller: Introduction, Criteria for choosing a microcontroller; Overview of 8051 Microcontroller family: Architecture, Memory Organization of 8051, SFRs, I/O Ports, Addressing modes. **Basic Assembly Language Programming Concepts:** 8051 Instruction set, Assembler Directives, Subroutine, Stack. Timed delay generations and calculations, Programming of 8051 Timers, Counter Programming, Watch Dog Timer, Real Time Clock.	

UNIT 3:8051 Communication and Interrupts.	**14Hrs**
Basics of Communication: Overview of RS-232, I2C Bus, UART, USB; Communication with 8051: Using I/O Ports, 8051 Serial Port, 8051 connections to RS-232. **8051 Interrupts:** Interrupt vectors and interrupt processing, Level triggered and edge triggered, Masking and priorities; Programming of 8051 Timer interrupts, Programming of External hardware interrupts, Programming of the serial communication interrupts.	
UNIT 4: 8051 Interfacing.	**14Hrs**
Basic Concepts of Interfacing: Introduction; 8051 Interfacing to external memory and accessing external data memory and external code memory. **Interfacing to:** LCD/Keyboard, DAC/ADC, Sensors, Stepper Motor, 8255.	

Textbooks

1. Introduction to Embedded Systems by Shibu K.V., Tata McGraw-Hill (TMH), 2010, 1st Edition
2. The 8051 Microcontroller and Embedded Systems by M.A. Mazidi and J.G. Mazidi, Prentice Hall India (PHI), 2006, 2nd Edition

Reference Books

1. **Embedded Systems** by Raj Kamal, Tata McGraw-Hill (TMH), 2011, 2nd Edition.

COURSEOUTCOMES(CO):

CO1: Demonstrate the ability to identify and classify different types of embedded systems and cyber-physical systems, and explain their role in various application areas.
CO2: Apply knowledge of 8051 microcontroller architecture to develop basic assembly language programs, effectively utilizing its instruction set and addressing modes.
CO3: Implement communication protocols like RS-232 and I2C with the 8051 microcontroller, and manage interrupt-driven tasks to optimize system performance.
CO4: Successfully interface the 8051 microcontroller with a variety of external devices, ensuring accurate data exchange and control, thereby enhancing practical hardware integration skills.

To be effective from year-2024

COURSE TITLE: Business Intelligence

Course Code:		**IMDAMJBI0924**				**Examination Scheme**	
Total number of Lecture Hours: 56						**External**	**80**
						Internal	**20**
Lecture(L):	**4**	**Practicals (P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

1. Develop a comprehensive understanding of the fundamental concepts of Business Intelligence.
2. Gain hands-on experience with BI tools for data analysis, visualization, and reporting.
3. Learn about the design and implementation of data warehousing solutions.
4. Utilize BI tools and techniques to support informed business decision-making.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Business Intelligence	**- Hrs**
Business Intelligence. Factors of Business Intelligence System. Information Pyramid – Data, Information, Knowledge & Intelligence. Basis for Operational, Tactical & Strategic Decision Making. Requirements Gathering in BI. Real time Business Intelligence. Business Intelligence Applications.	**14**
UNIT 2: Data Warehousing Basics	**- Hrs**
Data marts and Analytical data, Organization of the data warehouse. Online Analytical Processing - OLAP Techniques - OLAP Applications - Applying OLAP to Data Warehousing Customer Relationship Management. Enterprise and Departmental Business Intelligence.	**14**
UNIT 3: Business Intelligence Tools	**- Hrs**
Overview of popular BI tools: Tableau, Power BI, QlikView. Hands-on with BI tools: interface and basic functionalities. Data connection and integration with BI tools. Advanced features of BI tools: calculated fields, parameters, and filters.	**14**
UNIT 4: Data Visualization Techniques	**- Hrs**
Principles of data visualization. Basic Reporting and Querying- Toolkits, Basic Approaches- Building Ad-Hoc queries, Building on-demand self service reports. Creating BI reports and Dashboards. Future of Business Intelligence. Critical Challenges for Business Intelligence success.	**14**

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Textbooks

1. Turban, Efraim, et al. "*Business Intelligence: A Managerial Approach*". 4th ed., Pearson, 2021.
2. Ranjan, J. "*Business Intelligence: Concepts, Technologies, and Applications*". 1st ed., Springer, 2020.
3. Chen, H., et al. "*Business Intelligence and Analytics: Systems for Decision Support*". 10th ed., Pearson, 2019.

Reference Books

1. Dhamija, P., and T. W. C. J. "*Business Intelligence: A Primer*". 1st ed., Wiley, 2022.
2. Kudyba, S. "*Business Intelligence, Data Mining, and Optimization for Decision Making*". 1st ed., CRC Press, 2020.
3. Schwartz, E. "*The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*". 4th ed., Wiley, 2016.

COURSE OUTCOMES(CO):

CO1: Explain key Business Intelligence concepts and their applications in business contexts.
CO2: Demonstrate proficiency in using BI tools such as Tableau, Power BI, and SQL for data analysis and reporting.
CO3: Design and implement data warehousing solutions to support BI activities.
CO4: Create and present BI reports and dashboards to support decision-making processes.

LEVEL OF CO-PO MAPPING TABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	2	1	1	1	1	2	1	1	1	2
2	2	2	2	1	3	1	1	1	1	2	1	3
3	3	2	2	2	1	1	1	2	1	1	1	1
4	2	2	1	1	3	1	1	2	1	1	2	2

To be effective from year-2024

ELECTIVE 3

COURSE TITLE: Distributed Algorithms

Course Code: IMDAMJDA0924						Examination Scheme	T	P
Total number of Lecture Hours: 56 Total number of Practical Hours: -						External	80	-
						Internal	20	-
Lecture(L):	4	Practical (P):	-	Tutorial(T):	-	Total Credits		4

Course Objectives

- Understand the fundamental concepts and models of distributed systems, including synchronous, asynchronous, and partially synchronous models.
- Explore communication mechanisms and synchronization techniques used in distributed systems.
- Analyze the challenges of achieving consensus in distributed environments and study consensus algorithms like Paxos.
- Understand fault tolerance techniques in distributed systems and their application in distributed databases and storage systems.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Distributed Systems	**17 Hrs**
Overview of distributed systems and algorithms, Models of distributed systems: Synchronous, asynchronous, and partially synchronous models, Basic concepts in distributed algorithms: Processes, communication, failures, and synchrony, Example distributed algorithms: Leader election, message passing.	
UNIT 2: Communication and Synchronization	**14 Hrs**
Communication in distributed systems: Reliable communication, broadcasting, and multicasting, Synchronization primitives: Logical clocks, vector clocks, and Lamport's timestamps, Mutual exclusion algorithms: Centralized, token-based, and quorum-based approaches, Deadlock detection and avoidance in distributed systems.	
UNIT 3:Consensus and Agreement	**14 Hrs**
The consensus problem: Definitions and challenges in distributed environments, Asynchronous consensus: The impossibility of consensus (FLP result), Paxos algorithm and variations for consensus, Agreement in synchronous and partially synchronous systems.	
UNIT 4: Fault Tolerance and Distributed Databases	**14 Hrs**

Fault tolerance in distributed algorithms: Crash failures, Byzantine failures, and recovery. Distributed transaction processing and atomic commitment protocols, Distributed database consistency and replication algorithms, Distributed storage systems and quorum-based protocols.	

Textbooks

1. **"Distributed Algorithms"** by **Nancy Lynch** (First Edition, 1996).

Reference Books

1. Distributed Systems: Principles and Paradigms" by Andrew S. Tanenbaum and Maarten Van Steen, 2002, 1st Edition
2. Introduction to Reliable and Secure Distributed Programming" by Christian Cachin, Rachid Guerraoui, and Luís Rodrigues, 2011, 2nd Edition
3. Elements of Distributed Computing" by Vijay K. Garg, 2002, 1st Edition

COURSEOUTCOMES(CO):

CO1: Students will be able to describe different models of distributed systems and apply leader election algorithms in various contexts.

CO2: Students will demonstrate the ability to implement synchronization mechanisms like logical clocks and vector clocks in distributed systems.

CO3: Students will be able to evaluate and apply consensus algorithms such as Paxos in distributed computing scenarios.

CO4: Students will be able to design fault-tolerant distributed systems, ensuring reliability in the presence of failures.

COURSE TITLE: AI Tools & Applications

Course Code:	**IMDAMJAT0924**					**Examination Scheme**	
Total number of Lecture Hours: 56						**External**	**80**
						Internal	**20**
Lecture(L):	**4**	**Practicals (P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

1. Gain comprehensive knowledge of key AI tools and frameworks used in industry.
2. Learn to implement and apply machine learning algorithms using popular libraries.
3. Design, implement, and evaluate AI solutions for practical problems, including those in NLP and computer vision.
4. Investigate various applications of AI in domains such as healthcare, finance, and robotics.
5. Develop practical skills in using AI tools to address complex problems and improve decision-making.

Course Content	TEACHING HOURS
UNIT 1: Introduction to AI Technologies	**- Hrs**
Overview of AI technologies, including Neural Networks-Deep Learning, Reinforcement Learning, Computer Vision, Intelligent Assistants, Logic and Automated Reasoning Systems, Planning, and Robotics. Search Strategies: Introduction, Brute Force or Blind Search, Breadth-First Search, Depth-First Search, Hill Climbing, Best-First Search.	**14**
UNIT 2: Introduction to AI tools	**- Hrs**
Introduction to AI tools, including Deep Learning capabilities of RapidMiner and TensorFlow. Developing Deep Learning systems using such tools. Overview of Python- Search Strategies in Python. Overview of Prolog- Production System Using Prolog. Writing programs using Python and PROLOG.	**14**
UNIT 3: Overview of AI Infrastructure	**- Hrs**
Overview of the AI infrastructure and of some of the popular AI platforms, such as Google Cloud AI, AWS, Microsoft Azure Learning Studio, and IBM Watson. Implementation of various classification and clustering techniques to solve real world data.	**14**
UNIT 4: Applications of AI	**- Hrs**
Applications of AI in healthcare: diagnostic tools, predictive models. AI applications in financial services: risk assessment, fraud detection. Techniques for evaluating AI model performance. Metrics for classification, regression, and clustering. Model validation, hyper-parameter tuning, and	**14**

troubleshooting	

Textbooks

1. Russell, Stuart J., and Peter Norvig. "*Artificial Intelligence: A Modern Approach*". 4th ed., Pearson, 2020.
2. Goodfellow, Ian, et al. "*Deep Learning*". 1st ed., MIT Press, 2016.
3. Chollet, François. "*Deep Learning with Python*". 2nd ed., Manning Publications, 2021.

Reference Books

1. Alpaydin, Ethem. "*Introduction to Machine Learning*". 4th ed., MIT Press, 2020.
2. Patel, K., et al. "*Artificial Intelligence and Machine Learning for Coders*". 1st ed., O'Reilly Media, 2020.
3. Brownlee, Jason. "*Machine Learning Mastery with Python: Understand Your Data, Create Accurate Models, and Work Projects End-to-End*". 2nd ed., Machine Learning Mastery, 2019.

COURSE OUTCOMES(CO):

CO1: Identify and explain key AI tools and frameworks, their functionalities, and applications.
CO2: Develop and apply machine learning models using tools like TensorFlow.
CO3: Use AI techniques to address real-world problems and assess their effectiveness.
CO4: Critically evaluate the performance of AI solutions using appropriate metrics.
CO5: Demonstrate the ability to use AI tools in practical applications and real-world scenarios.

LEVEL OF CO-PO MAPPING TABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	3	1	3	1	1	1	1	2	1	1
2	3	3	3	1	2	1	1	1	1	2	1	2
3	3	2	3	2	3	1	1	1	1	3	1	2
4	3	3	3	2	3	1	1	1	1	1	1	2
5	2	2	3	1	2	1	1	1	2	1	1	2

ELECTIVE 4

COURSE TITLE: Graph Machine Learning								
Course Code: IMDAMJGM0924						**Examination Scheme**	**T**	**P**
Total number of Lecture Hours: 56 **Total number of Practical Hours: -**						**External**	**80**	**-**
						Internal	**20**	**-**
Lecture(L):	**4**	**Practical(P):**	**-**	**Tutorial(T):**	**0**	**Total Credits**	**4**	

Course Objectives

- Gain insights into the evolution and architecture of Graph Neural Networks (GNNs) and their relationship to traditional neural networks.
- Understand and apply various graph representation learning techniques, including node embeddings and Graph Convolutional Networks (GCNs).
- Investigate advanced GNN architectures, their training challenges, and the effectiveness of different techniques for various tasks.
- Explore real-world applications of GNNs in fields such as social networks, biology, and recommendation systems, and critically assess their performance.
- Discuss the ethical implications of graph machine learning, including issues related to interpretability and bias.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Graphs and Graph Neural Networks	**Hrs.**
Introduction to Graph Theory: Nodes, edges, directed vs. undirected graphs, weighted vs. unweighted graphs. **Graph Representations:** Adjacency matrices, incidence matrices, graph isomorphism. **Overview of Graph Neural Networks:** Evolution of GNNs, comparison with traditional neural networks. **Applications of GNNs:** Use cases in social networks, biology, and recommendation systems.	**14**
UNIT 2: Graph Representation Learning Techniques	**Hrs.**
Node Embeddings: Introduction to embeddings, DeepWalk, Node2Vec. **Comparison of Embedding Techniques:** Traditional methods vs. neural methods, performance metrics. **Graph Convolutional Networks (GCNs):** Architecture, forward pass, and backpropagation. **Implementing GCNs:** Hands-on implementation using PyTorch Geometric.	**14**
UNIT 3: Advanced Architectures and Techniques	**Hrs.**
Advanced GNN Architectures: GraphSAGE, ChebNet, Graph Attention Networks (GATs). **Training Challenges in GNNs :** Overfitting, scalability, and computational efficiency **Transfer and Semi-supervised Learning:** Techniques and applications in graph contexts **Evaluation Metrics for GNNs:** Accuracy, F1 score, AUC; practical evaluation	**14**

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UNIT 4:Applications and Future Directions	Hrs.
Case Studies of GNN Applications: Fraud detection, drug discovery, recommendation systems. **Ethical Considerations and Interpretability:** Challenges in transparency, fairness, and biases. **Emerging Trends in Graph Machine Learning:** Future research directions, unsupervised learning, and generative models **Novel applications of GNNs.**	14

Textbooks:

2. **Graph Representation Learning** by William L. Hamilton, 1st Edition (2020), Morgan& Claypool Publishers.

Reference Books:

4. Deep Learning on Graphs by Yao Ma, Jiliang Tang, 1st Edition (2021), Cambridge University Press
5. Graph Neural Networks: Foundations, Frontiers, and Applications by Lingfei Wu, Peng Cui, Jian Pei, et al.,1st Edition (2022), Springer.
6. Machine Learning with Graphs: Theory and Practice by Carl Yang, Jiawei Han, 1st Edition (2022), Cambridge University Press.
7. A Comprehensive Introduction to Graph Neural Networksby Xiaoxiao Ma, Jiezhong Qiu, Jian Tang, 1st Edition (2021), Springer

COURSEOUTCOMES(CO):

Upon successful completion of the course, students will be able to:

CO1: Implement and train Graph Neural Networks and other graph representation learning methods using Python and relevant libraries.

CO2: Design and propose innovative applications of GNNs for real-world problems, supported by empirical results.

CO3: Analyze and interpret evaluation metrics for GNNs, applying them to assess model performance and outcomes in practical scenarios.

CO4: Conduct independent research on emerging trends in graph machine learning and present findings clearly and effectively.

LEVELOFCO-PO MAPPINGTABLE

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	2	1	3	2	2	1	1	1	1	2	1	1
2	2	2	3	1	1	1	2	2	1	1	1	2
3	3	2	2	1	3	2	1	1	2	1	1	1
4	2	2	2	1	2	2	1	1	1	1	1	1

To be effective from year-2024

COURSE TITLE: Social Network Analysis and Mining							
Course Code:	IMDAMJSN0924					Examination Scheme	
Total number of Lecture Hours: 56						External	80
						Internal	20
Lecture(L):	4	Practicals (P):	-	Tutorial(T):	-	Total Credits	4

Course Objectives

- To introduce the fundamentals of social network analysis and graph theory.
- To analyze centrality measures and their applications in network structures.
- To explore methods for detecting communities and subgroups within networks.
- To understand the dynamics of network growth and evolution through stochastic models.
- To study the influence of information diffusion in networks and its real-world applications.
- To equip students with practical skills in network mining and data representation techniques.

Course Content	TEACHING HOURS
Unit 1: Introduction to Social Network Analysis and Graph Theory	**15 Hrs**
Introduction to social network analysis. Basics of graph theory and terminology. Different types of networks. Data collection and representation in social networks. Descriptive network statistics.	
Unit 2: Centrality and Community Structures in Networks	**14Hrs**
Centrality measures (degree, closeness, betweenness). Interpretation of centrality in real-world applications. Connectivity and reachability in networks. Cliques and subgroups in networks. Community detection algorithms.	
UNIT 3: Network Dynamics and Stochastic Models	**14hrs**
Network evolution and growth. Preferential attachment and small-world networks. Stochastic models for network generation. Erdős–Rényi and Barabási–Albert models. Dynamic network analysis. Temporal network metrics.	
UNIT 4 : Network Influence and Information Diffusion	**14hrs**
Influence propagation models: Independent Cascade Model, Linear Threshold Model. Information diffusion: Viral marketing, memes, rumor spreading. Modeling cascades in networks: Contagion models, threshold-based models. Influence maximization strategies: Greedy algorithms, heuristic-based methods. Evaluation metrics: Spread, reach, influence score, diffusion speed.	

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Textbooks

1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World" (1st Edition, 2010)
2. Mining the Social Web" (3rd Edition, 2018)

Reference Books

1. Social Network Analysis: Methods and Applications" (1st Edition, 1994)
2. Networks: An Introduction" (1st Edition, 2010)

COURSE OUTCOMES(CO):

CO1: Ability to apply graph theory principles to model and analyze social networks.

CO2: Proficiency in calculating and interpreting centrality measures in networks.

CO3: Capability to identify cliques, subgroups, and communities using detection algorithms.

CO4: Understanding of network evolution and modeling using stochastic processes.

CO5: Competence in sim

ulating information diffusion and influence propagation in networks.

CO6: Mastery in using software tools for mining and analyzing real-world social networks.

LEVELOFCO-PO MAPPINGTABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	2	2	3	-	-	-	1	2	1	2
2	3	3	2	2	2	-	-	-	1	1	1	2
3	2	3	3	3	2	-	-	-	2	2	2	2
4	3	3	2	3	3	-	-	-	1	1	2	2
5	3	2	3	2	3	2	2	-	2	2	2	2
6	3	3	3	3	3	-	2	2	3	3	3	3

To be effective from year-2024

ELECTIVE 5

COURSE TITLE: Robotics								
Course Code: IMDAMJRB0924						**Examination Scheme**	**T**	**P**
Total number of Lecture Hours:56 **Total number of Practical Hours: -**						**External**	**80**	**-**
						Internal	**20**	**-**
Lecture(L):	**4**	**Practical(P):**	**-**	**Tutorial(T):**	**0**	**Total Credits**	**4**	

Course Objectives

- Gain a foundational knowledge of robotics and develop skills in spatial descriptions, transformations, and the mathematical representations used in robotics.
- Learn to analyze both forward and inverse kinematics, using Denavit-Hartenberg parameters and Jacobians.
- Understand the principles of dynamics and force analysis, including Lagrangian mechanics and effective moments of inertia.
- Master the concepts and techniques for trajectory planning, including polynomial trajectory planning.
- Explore motion control systems, including PID controllers and frequency-domain analysis.
- Investigate various applications of robotics across different fields, including industry, medicine, and future technologies.

Course Content	**TEACHING HOURS**
UNIT 1: Introduction to Robotics, Spatial Descriptions and Transformation	**Hrs.**
Introduction to Robotics: What is robot?, Classification of Robots, Advantages and Disadvantages of Robots, Robot Components, Degree of Freedom, Joints, Robot Coordinates, Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages. **Spatial descriptions and transformation:** Robot as Mechanisms, Matrix Representation, Description of Position and Orientation, Frames and Displacement mappings, Homogeneous transforms, Transformation of free vectors, examples.	**14**
UNIT 2: Kinematics and Jacobians	**Hrs.**
Manipulator forward kinematics: Link description, link connection, Denavit Hartenberg parameters, examples. **Manipulator inverse kinematics**: Solvability, algebraic and geometric approaches, Degeneracy and Dexterity, Examples. **Jacobians:** velocities, static forces and manipulator dynamics **Analysis:** Velocity analysis, linear and rotational velocity of rigid bodies, velocity propagation, Jacobians, velocity transformation and inverse velocity, force transformation and inverse force, examples.	**14**
UNIT 3: Dynamics and Trajectory Planning	**Hrs.**
Dynamic and Force Analysis: Lagrangian Mechanics: A Short Overview, Effective Moments of Inertia, Dynamic Equations for Multiple-DOF Robots, Static Force Analysis of Robots, Transformation of Forces and Moments between Coordinate Frames **Trajectory Planning:** Introduction, Path vs. Trajectory, Basics of Trajectory Planning, Joint- Space Trajectory Planning Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning	**14**

To be effective from year-2024

UNIT 4:Motion Control Systems and Applications	Hrs.
Motion Control Systems- Introduction, Basic Components, and Terminology, Block Diagrams and System Dynamics, Laplace Transform and Transfer Functions **System Characteristics-**First-Order and Second-Order Transfer Functions, Steady-State Error and Root Locus Method, PID Controllers and Compensators **Frequency-Domain Analysis-** Bode Diagrams, Open-Loop vs. Closed-Loop Systems, Multiple-Input and Multiple-Output Systems **Robot applications:** Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.	14

Textbooks:

1. Siciliano, Bruno, et al. "*Springer Handbook of Robotics*". 2nd ed., Springer, 2016.
2. Craig, John J. "*Introduction to Robotics: Mechanics and Control*". 3rd ed., Pearson, 2018.
3. Murphy, Robin R. "*Introduction to AI Robotics*". 1st ed., MIT Press, 2000.

Reference Books:

1. McKerrow, Peter J. "*Introduction to Robotics*". 1st ed., Prentice Hall, 1997.
2. Borenstein, J., et al. "*The Essentials of Robotics*". 1st ed., IEEE Press, 2021.
3. Alonzo, James A. "*Robotics and Automation Handbook*". 1st ed., CRC Press, 2020.

COURSEOUTCOMES(CO):
By the end of this course, students will be able to:

CO1: Execute forward kinematics calculations using Denavit-Hartenberg parameters and solve inverse kinematics problems employing both algebraic and geometric approaches.
CO2: Analyze the dynamics of robotic systems using Lagrangian mechanics, including the computation of effective moments of inertia and static force analysis.
CO3: Describe the components of motion control systems and apply Laplace transforms to analyze system dynamics and stability.
CO4: Assess first-order and second-order transfer functions and design PID controllers for various robotic applications.

COURSE TITLE: Banking & Finance Service Analytics

Course Code:	**IMDAMJBF0924**				**Examination Scheme**		
Total number of Lecture Hours: 56					**External**	**80**	
					Internal	**20**	
Lecture(L):	**4**	**Practicals(P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

- To provide students with an educational base by developing their understanding of critical concepts, techniques & technologies that is relevant to achieving organizational objectives.
- To make them capable of integrating knowledge and skills, to smoothen the processes across various business functions.
- To develop creative, innovative and entrepreneurial mind-set to take managerial decisions.
- Students will learn to assess & evaluate business issues and practices from a local and Global perspective.

Course Content	TEACHING HOURS
	- Hrs
UNIT 1:	
Structure of commercial banks in India, Types, Role, Functions and Services provided by banks. Cash reserve ratio, statutory liquidity ratio, repo and reverse repo, open market operations, security valuation, capital account convertibility.	14
	- Hrs
UNIT 2:	
Kinds of bank deposits, Nomination, Deposit insurance, Opening of accounts for minors, joint account holders, firms, companies, trusts, Societies, Govt. and public bodies, Closure of deposit accounts. Duties and responsibilities of paying and collecting banker.	14
	- Hrs
UNIT 3:	
Merchant Banking: Meaning, Types, Responsibilities of Merchant Bankers, Regulation of Merchant Banking in India. Money remittance services, banking channels. Financial inclusion & Exclusion, Self- Employment Schemes, Women Entrepreneurs, Small Scale Industries, Agricultural Finance, Export Finance, etc.	14

UNIT 4:	- Hrs
Financial Services: Concept, Nature and Scope of Financial Services. Regulatory Frame Work of Financial Services. Growth of Financial Services in India. Types of Financial Services, Fund Based Financial Services. Fee Based Financial Services. Importance, online trading, dematerialization and re-materialization.	14

Textbooks

1. Raghavan, N. R. S. G. K. "*Banking and Financial Services*". 3rd ed., Oxford University Press, 2021.
2. Agarwal, R. R. S. "*Financial Analytics: How to Build a Complete Financial Analytics System*". 1st ed., Wiley, 2020.
3. Mitra, S. C. K. "*Data Analytics for Banking and Financial Services*". 1st ed., Springer, 2022.

Reference Books

1. Prabhakar, V. V. G. S. "*Analytics in Banking and Finance*". 2nd ed., Sage Publications, 2021.
2. Gupta, A. K. "*Big Data in Banking and Financial Services*". 1st ed., Elsevier, 2020.
3. Gupta, R. D. R. M. "*Financial Services Analytics: Understanding Data Science and Its Applications*". 1st ed., Palgrave Macmillan, 2023.

COURSE OUTCOMES(CO):

CO1: Acquiring of Attitude, Skills, Knowledge and experiential learning in all functional areas(s) of Banking & Financial Services.
CO2: Develop Ability to visualize managerial problems and identify various alternatives to solve them.
CO3: Acquire Ability to apply contemporary tools and techniques in making rational decisions.
CO4: Acquire Ability to apply knowledge & understanding of Banking and a Financial Service to complex issues both systematically and innovatively, to improve Business Leadership & Practice.

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	2	2	3	1	1	1	1	2	1	1	1	2
2	3	3	2	1	1	1	2	1	1	2	1	3
3	3	3	2	2	2	1	1	1	1	1	1	1
4	2	3	1	1	3	2	1	1	1	1	2	2