Institute of Engineering & Technology

Sitapur Road, Lucknow

Evaluation Scheme & Syllabus

for

M. Tech.

(ARTIFICIAL INTELLIGENCE & DATA SCIENCE)

Syllabus-2nd Year

(Effective from the Session: 2024-25 onwards)

M. Tech. (Artificial Intelligence and Data Science)

Objectives

M. Tech in Artificial Intelligence and Data Science program provides students with a state-of-the-art educational experience to become outstanding, socially responsible engineers of AI systems. Students will learn the theoretical foundations and gain practical skills to manage and engineer various data forms, to make predictive analyses, to derive actionable insights, and develop intelligent hardware and software systems and related cutting-edge AI technologies. This program also provides students with foundational knowledge, experience, and skills that are crucial for a data science career. It features a multidisciplinary curriculum in various application domain of data science such as data Science in health care, social networks, public policy and finance through applied math, statistics and machine learning. Its rigorous, balanced coursework provides students with strong mathematical, computing, and data skills, as well as project experience.

Graduates of this program will have the necessary theoretical knowledge, practical data analysis and coding skills for solving complex real-world problems based on massive amounts of data and also meet the qualifications for various data scientist positions in industry and government. They will graduate with necessary training in applied research in the area.

Program Learning Outcomes

1. Identify and apply fundamental concepts, algorithms, and methodologies to formulate, analyze, design, and evaluate artificial intelligence and machine learning systems.
2. Apply computer science knowledge and tools to assist in performing data science tasks. Summarize and evaluate statistical and machine learning concepts, models, and techniques.
3. Tackle complex machine learning and artificial intelligence problems using contemporary principles, algorithms, technologies, methodologies, and tools.
4. Participate in a team to develop AI and machine learning applications; while recognizing the ethical, economic and environmental implications of their work.
5. Sustain a process of life-long learning in engineering or other professional areas; and Identify ways in which data scientists can contribute to the cultural and economic well-being of diverse societies in local, national, and global scopes.

Program Outcomes (POs) and Program Specific Outcomes (PSO)

Program Outcomes (POs)

PO1: Independently carry out research /investigation and development work to solve practical problems related to Artificial intelligence and Data science.

PO2: Write and present a substantial technical report/document in the area of Artificial intelligence and Data science.

PO3: Demonstrate a degree of mastery over the area related to Artificial intelligence, Machine learning and Data Science.

Program Specific Outcomes (PSO)

PSO1: Analyze and solve the real world problems by applying the knowledge of artificial intelligence, machine learning and data Science.

Credit Summary for M.Tech. (AI & DS) Curriculum

Semester	Subjects	Credits	Marks
I	Core Subjects-02 (4 credit each) Research Methodology (4 credit) Elective Subject-01 (4 credits) Labs-02 (2 credit each)	20	600
II	Core Subjects-02 (4 credit each) Elective Subject-02 (4 credit each) Lab/Mini Project-01 (2 credit) Seminar-01 (2 credits)	20	600
III	Elective Subject-01 (4 credit) Seminar-01 (2 credit) Dissertation-I (10 credit)	16	500
IV	Dissertation-II (16 credit)	16	500
Total		**72**	**2200**

Semester– III

S.No.	Subjects Code	Subject	Period			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MADS(041-045)*	Departmental Elective -IV	4	0	0	4	20	10	70			100
2	MADS-351	Dissertation-I	0	0	20	10	0	0	0	100	200	300
3	MADS-352	Seminar-II	0	0	3	2	0	0	0	100	-	100
	TOTAL					16						500

Semester– IV

S.No.	Subjects Code	Subject	Period			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
2	MADS-451	Dissertation-II	0	0	32	16	0	0	0	150	350	500
	TOTAL					16						500

Departmental Elective -IV*

Subject Code	Subject Name
MADS-041	Data Analytics for Social Media
MADS-042	Advanced Biomedical Imaging
MADS-043	Financial Analytics
MADS-044	Advanced Image Analytics
MADS-045 (added)	Blockchain Architecture
MADS-04X*	----

(*) The list of above Departmental Elective courses is open to include other relevant courses as per the expertise available at the commencement of the semester.

MADS-041 Data Analytics for Social Media		
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course Student will be able to understand to		
CO1	Describe the different types of data commonly found on social platforms and operating on social data.	K1, K2, K3
CO2	Use a social platform API to obtain data and understand the structure of those social data.	K2, K3
CO3	Describe how and why different networks exist within the same data.	K1, K2, K3
CO4	Construct different varieties of networks from a social dataset	K3, K4, K5
CO5	Compute a variety of networks measures from a social media dataset	K2, K3, K4

DETAILEDSYLLABUS		
Unit	**Topic**	**Proposed Lecture**
I	Introduction to Social Networks and Social Media, Social Network Analysis, Key concepts and measures in network analysis –The global structure of networks – The macro-structure of social networks –Personal networks.	**08**
II	Electronic sources for network analysis – Electronic discussion networks – Blogs and online communities – Web-based networks – Knowledge Representation on the Semantic Web –Ontologies and their role in the Semantic Web Ontology languages for the Semantic Web – The Resource Description Framework (RDF)and RDF Schema – The Web Ontology Language (OWL) – Comparison to the Unified Modelling Language (UML) – Comparison to the Entity/Relationship (E/R) model and the relational model.	**08**
III	State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Representing identity – On the notion of equality – Determining equality – Reasoning with instance equality – Evaluating smushing.	**08**
IV	Social network features –Processing and Visualizing Data, Influence Maximization, Link Prediction, Collective Classification. Applications in Advertising and Game Analytics (Use of tools like Unity30 / PyCharm).	**08**
V	Social Media Data Analysis- Characteristics of social media data, Multiodal nature of social media data, data collection methods- API, Scraping and Crawling, data preprocessing, Social media text analysis methods, Analysis of memes and GIFs, Deep Learning methods for social media data analysis.	**08**

Textbooks & References:

1. Peter Mika , Social Networks and the Semantics Web",Springer, 2007
2. BorkoFurht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer,2010.
3. Mathew Ganis, Avinash Koihrkar Social Media Analytics IBM Press 2015.

MADS-042
ADVANCED BIOMEDICAL IMAGING

	Course Outcome (CO)	Bloom's Knowledge Level (KL)
At the end of course, the student will be able to understand		
CO1	To define the principles of image sampling, quantization, enhancement and filtering techniques.	K1, K2
CO2	To discover the different image compression methods and morphological based processes and machine learning techniques for image segmentation.	K1, K2, K3
CO3	To develop the methods of image registration and visualization for medical applications	K3, K4
CO4	To acquire the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis	K1, K2, K3
CO5	To develop algorithms to process and visualize images from different modalities for diagnostic application	K3, K5, K6

DETAILED SYLLABUS

Unit	Topic	Proposed Lecture
I	Image perception- Image model- Image sampling and quantization - 2D DFT and DCT. Image enhancement- Histogram modelling, Spatial operations - Image restoration, Noise models, Image degradation model, Wiener filtering, Maximum entropy restoration.	08
II	Image compression - Lossy and lossless Compression, Predictive techniques - Dilation, Erosion, Open, Close, Skeleton operations, Top-hat algorithm - Morphology based segmentation	08
III	Machine Learning based segmentation algorithms - Singular Value Decomposition (SVD) - Principal Component Analysis and its applications - Support Vector Machine and its applications - Independent Component Analysis and its application	08
IV	Image Registration - Medical image Fusion, SPECT/CT, MR/CT, PET/CT - Image visualization - Volume Rendering, Surface rendering and Maximum Intensity Projection	08
V	Topological attributes - Shape orientation descriptors, Fourier descriptors, - K means clustering, machine learning, Neural Network approaches- Statistical Parametric Mapping in Imaging. Applications of Computer Aided Design (CAD) - General Linear Model (GLM) and its application in functional brain mapping - Group analysis using t-test - Computer Aided Manufacturing (CAM) in Medical Imaging applications, Patient specific modelling - Brain Computer Interface (BCI) and its applications in Neuroscience.	08

Textbooks & References:

1. Reiner Salzer, "Biomedical Imaging: Principles and Applications", 2012, 1st Edition, Wiley, New Jersey.

2. Pears, Nick, Liu, Yonghuai, Bunting, Peter (Eds.) "3D Imaging, Analysis and Applications", 2012, 2nd Edition, Springer, Berlin.

3. Jonathan Wolpaw, Elizabeth Winter, (Eds.) "Brain-Computer Interfaces: Principles and Practice", 2012, 1st Edition, Oxford University Press, Oxford.

MADS-043
FINANCIAL ANALYTICS

	Course Outcome (CO)	Bloom's Knowledge Level (KL)
	At the end of course, the student will be able to	
CO1	Understand foundation in financial analytics for complex financial data.	
CO2	Analyze and model financial data.	
CO3	Evaluate and model Risk on various financial assets.	
CO4	Construct and optimize asset portfolios.	
CO5	Use the most powerful and sophisticated routines in R for analytical finance.	

DETAILED SYLLABUS

Unit	Topic	Proposed Lecture
I	Introduction to financial analytics, business forecasting, and time-series data.	08
II	Basic forecasting models, moving averages, exponential smoothing, and Holt-Winter's forecasting model.	08
III	How to identify if a time series is stationary or not and know how to make non-stationary data become stationary, introduction to ARIMA and its implementation.	08
IV	Modern portfolio theory and advanced topics on algorithmic trading.	08
V	Financial Risk Measurements -Measurement of Risk – credit risk measurement, market risk measurement, interest rate risk measurement, Asset liability management, measurement of operational risk.	08

Textbooks & References:

1. Analysis of Financial Time Series (Wiley Series in Probability and Statistics) Ruey Tsay
2. Time series analysis and its applications. Shumway and Stoffer.
3. Advances in financial machine learning. Marcos Lopez de Prado.

MADS-044
Advanced Image Analytics

	Course Outcome (CO)	Bloom's Knowledge Level (KL)
At the end of course, the student will be able to understand		
CO1	Apply the various techniques for intensity transformations functions. Implement Color image Smoothing and Sharpening.	K1, K2
CO2	Illustrate Morphological operation and Apply Some Basic Morphological Algorithms.	K1, K3, K5
CO3	Apply image segmentation techniques such as Optimum Global Thresholding using Otsu's Methods.	K1, K2, K3
CO4	Analysis various Feature Extraction methods and implement for various real-time Applications.	K1, K2, K3
CO5	Apply and Analysis various Image Pattern Classification methods such as Minimum-Distance Classification, Optimum (Bayes) Statistical Classification, and Deep Convolutional Neural Network.	K2, K3, K5

DETAILED SYLLABUS

Unit	Topic	Proposed Lecture
I	Introduction – Fundamental steps in Image Processing Systems – Image Acquisition – Sampling and Quantization – Pixel Relationships – Mathematical Tools Used in Digital Image Processing.	**08**
II	Morphological Image Processing: Fundamentals - Erosion and Dilation - Opening and Closing– Hit or Miss Transform - Some Basic Morphological Algorithms – Morphological Reconstruction – Grayscale Morphology	**08**
III	Introduction - Point, Line, and Edge Detection – Thresholding: Foundation, Basic Global thresholding, Optimum Global Thresholding using Otsu's Method Multiple Thresholds, Variable Thresholding –Segmentation by Region Growing and by Region Splitting and Merging – Image Segmentation:	**08**
IV	Background - Representation – Boundary Preprocessing – Boundary Feature Descriptors: Some Basic Boundary Descriptors, Shape Numbers, Fourier Descriptors, Statistical Moments - Regional Feature Descriptors: Some Basic Descriptors, Topological and Texture Descriptors, Moment Invariants – Principal Components as Feature Descriptors – Whole-image Features Object – Scale-Invariant Feature Transform (SIFT).	**08**
V	Background -Patterns and Pattern Classes – Pattern Classification by Prototype Matching: Minimum-Distance Classifier, Using Correlation for 2-D prototype matching, Matching SIFT, Features, Matching Structural Prototypes - Optimum (Bayes) Statistical Classifiers – Neural Networks and Deep Learning: Background - The Perceptron - Multilayer Feed forward Neural Networks - Deep Convolution Neural Networks	**08**

Textbooks & References:

1. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing", 4th Edition, Pearson, 2018.

2. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.

3. Anil K. Jain, "Fundamentals of Digital Image Processing", Person Education, 2003.

Block chain Architecture (MADS-045)		
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course, the student will be able to understand		
CO1	Study and understand basic concepts of block chain architecture.	K_1, K_2
CO2	Analyze various requirements for consensus protocols.	K_4
CO3	Apply and evaluate the consensus process.	K_3, K_5
CO4	Understand the concepts of Hyper ledger fabric.	K_1
CO5	Analyze and evaluate various use cases in financial software and supply chain.	K_4, K_5
	DETAILED SYLLABUS	**4-0-0**
Unit	**Topic**	**Proposed Lecture**
I	Digital Money to Distributed Ledgers, DesignPrimitives: Protocols, Security, Consensus, Permissions, Privacy. Basic crypto primitives: Hash, Signature,Hash chain to Block chain, Bitcoin Basic, Basic consensus mechanisms.	**08**
II	Requirements for the consensus protocols, Proof of Work (PoW), Scalability aspects of Block chain consensus protocols, distributed consensus,consensus in Bitcoin. Design goals, Consensus protocols for Permissioned Blockchains	**08**
III	Decomposing the consensus process, Hyper ledger fabriccomponents. BeyondChain code: fabric SDK and Front End, Hyper ledger composer tool.	**08**
IV	Block chain in Financial Software and Systems (FSS): (i)Settlements, (ii) KYC, (iii) Capital markets, (iv) Insurance. Block chain in trade/supply chain: (i) Provenance of goods, visibility,trade/supply chain finance, invoice management discounting, etc.	**08**
V	Blockchain for Government: (i) Digital identity, land records andother kinds of record keeping between government entities, (ii) public distribution system social welfare systems, Blockchain Cryptography, Privacyand Security on Blockchain	**08**

Suggested Readings:

1. Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly
2. Melanie Swa, "Blockchain", O'Reilly
3. "Hyperledger Fabric", https://www.hyperledger.org/projects/fabric
4. Bob Dill, David Smits, "Zero to Blockchain - An IBM Redbooks course", https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html