FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

M.TECH (Computer Science & Engineering-Artificial Intelligence & Machine Learning)

SYLLABUS

FIRST AND SECOND YEAR
(I, II, III & IV Semester)

[Effective from Session 2021-22]

MAM-101:MATHEMATICS FOR AI & MACHINE LEARNING

UNIT	CONTENTS
Unit – I	Linear Algebra Systems of Linear Equations, Matrices, Vectoe Spaces, Linear Independance, Basis and Rank, Linear Mappings, Affine Spaces
Unit – II	Analytic Geometry Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthogonal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations
Unit – III	Matrix Decompositions Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigendecomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny Vector Calculus Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher Order Derivatives, Linearization and Multivariate Taylor Series
Unit – IV	Probability and Distributions Construction of a Probability space, Discrete and Continuous Probabilities, Sum Rule, Product Rule and Bayes' Theorem, Summary Statistics and Independence, Gaussian Distribution, Conjugacy and Exponential Family, Change of Variables/Inverse Transform
Unit – V	Continuous Optimization Optimization Using Gradient Descent, Constrained Optimization, Convex Optimizations Models and Data Data, Models and Learning, Empirical Risk Minimization, Parameter Estimation, Probabilistic Modeling and Inference, Directed Graphical Models

Text Books:

- M.P. Deisenroth, A. Faisal, C Ong, Mathematics for Machine Learning, Cambridge University Press, 2020
- **The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition b**y Trevor Hastie, Robert Tibshirani, Jerome Friedman
- **Mathematics for Machine Learning**by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong
- **Mathematics for Machine Learning — Linear Algebra**by Dr. Sam Cooper &Dr. David Dye
- **Probability Theory: The Logic of Science**by E. T. JaynesSource: https://bayes.wustl.edu/etj/prob/book.pdf

MAM-102:INTRODUCTION TO AI & NEURAL NETWORKS

UNIT	CONTENTS
Unit – I	Introduction : AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation. Searching : Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.
Unit – II	Knowledge Representation & Reasons logical Agents, Knowledge – Based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in propositional logic, Resolution, Forward & Backward. Chaining First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution.
Unit – III	Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.
Unit – IV	Feedforward Neural Networks: Introduction, Analysis of pattern Association Networks, Analysis of Pattern Classification Networks, Analysis of pattern storage Networks. Analysis of Pattern Mapping Networks. Feedback Neural Networks Introduction, Analysis of Linear Auto associative FF Networks, Analysis of Pattern Storage Networks.
Unit – V	Competitive Learning Neural Networks & Complex pattern Recognition, Analysis of Pattern Clustering Networks, Analysis of Feature, Mapping Networks, Associative Memory.

Text Books:

Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.

MAM-103: APPLIED MACHINE LEARNING USING PYTHON

UNIT	CONTENTS
Unit – I	**Machine Learning vs Statistical Modeling & Supervised vs Unsupervised Learning** • Machine Learning Languages, Types, and Examples • Machine Learning vs Statistical Modelling • Supervised vs Unsupervised Learning • Supervised Learning Classification t • Unsupervised Learning • Implementation using Python
Unit – II	**Supervised Learning I** • K-Nearest Neighbors • Decision Trees • Random Forests • Reliability of Random Forests • Advantages & Disadvantages of Decision Trees • Implementation using Python **Supervised Learning II** • Regression Algorithms • Model Evaluation • Model Evaluation: Overfitting & Underfitting • Understanding Different Evaluation Models • Implementation using Python
Unit – III	**Unsupervised Learning** • K-Means Clustering plus Advantages & Disadvantages • Hierarchical Clustering plus Advantages & Disadvantages • Measuring the Distances Between Clusters - Single Linkage Clustering • Measuring the Distances Between Clusters - Algorithms for Hierarchy Clustering • Density-Based Clustering • Implementation using Python **Dimensionality Reduction & Collaborative Filtering** • Dimensionality Reduction: Feature Extraction & Selection • Collaborative Filtering & Its Challenges
Unit – IV	**BUILD MODELS** • Building Logistic regression Model • Building a Naïve Bayes Model • Building a continuous learning Model • Scoring a Predictive Model • Building Deep Learning Architecture • Implementation using Python

Unit – V	• **Data Series** Introduction to Dimension Reduction Dimension Reduction Goals • **Data Refinement** Principal Component Analysis • **Exploring Data** Exploratory Analysis

Text Books:

1: Christopher Bishop. Pattern Recognition and Machine Learning. 2e.
2: Machine Learning , Peter Flach, Cambridge University Press

MAM-201: DEEP LEARNING WITH KERAS AND TENSORFLOW

UNIT	CONTENTS
Unit – I	Introduction to Deep Learning: What is Deep Learning, Curse of Dimensionality, Machine Learning vs. Deep Learning, Use cases of Deep Learning, Human Brain vs. Neural Network, What is Perceptron, Learning Rate, Epoch, Batch Size, Activation Function, Single Layer Perceptron Keras and Deep Learning Libraries: Quick recap of Neural networks, What is Keras, Describing keras, Deep Learning libraries, Regression Models with Keras, Classification Models with Kerascounting parameters, specifying a model, Training, Predicting, Improving Model performance, Activation functions, Batch size and batch normalization, Changing batch sizes, batch normalization effects, hyperparameter tuning, preparing a model for tuning, tuning the model parameters, training with cross-validation
Unit – II	Overview of Tensorflow, Why Tensorflow, Installing TensorFlow, Defining Sequence model layers, Activation Function, Layer Types, Model Compilation, Model Optimizer, Model Loss Function, Model Training, Digit Classification using Simple Neural Network, Improving the model, Adding Hidden Layer, Adding Dropout, Using Adam Optimizer
Unit – III	Convolution Neural Network: Image Classification Example. What is Convolution, Convolutional Layer Network, Convolutional Layer Filtering, ReLU Layer, Pooling, Data Flattening, Fully Connected Layer, Predicting an image, Saving and Loading a Model, Face Detection using OpenCV
Unit – IV	Regional CNN: Regional-CNN, Selective Search Algorithm, Bounding Box Regression, SVM in RCNN, Pre-trained Model, Model Accuracy, Model Inference Time, Model Size Comparison, Transfer Learning, Object Detection – Evaluation,mAP, IoU, RCNN – Speed Bottleneck, Fast R-CNN, RoI Pooling, Fast R-CNN – Speed Bottleneck, Faster R-CNN, Feature Pyramid Network (FPN), Regional Proposal Network (RPN), Mask R-CNN
Unit – V	Boltzmann Machine & Autoencoder What is Boltzmann Machine (BM)?, Identify the issues with BM, Why did RBM come into picture?, Step by step implementation of RBM, Distribution of Boltzmann Machine, Understanding Autoencoders, Architecture of Autoencoders, Brief on types of Autoencoders, Applications of Autoencoders

Text Books:

Deep Learning with TensorFlow 2 and Keras: Regression, ConvNets, GANs, RNNs, NLP, and more with TensorFlow 2 and the Keras API, 2nd Edition by by Antonio Gulli ,Amita Kapoor and Sujit Pal, Packt Books

MAM-202: REINFORCEMENT LEARNING

UNIT	CONTENTS
Unit – I	Introduction: Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence. Markov Decision Process Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.
Unit – II	Prediction and Control by Dynamic Programing Overview of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evalutation and value iteration algorithms, DP extensions.
Unit – III	Monte Carlo Methods for Model Free Prediction and Control Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. TD Methods Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.
Unit – IV	Function Approximation Methods Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares, Experience replay in deep Q-Networks.
Unit – V	Policy Gradients Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Text Books:

Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition

MAM-203: SELF DRIVEN DEVICES USING AI & ML

UNIT	CONTENTS
Unit – I	Elements of Reinforcement Learning, Multi-armed Bandits, Finite Markov Decision Processes: The Agent-Environment Interface, Goals and Rewards, Returns and Episodes, Dynamic Programming: Policy Evaluation, Policy Improvement, Policy Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration
Unit – II	Autonomous systems, Autonomous cars, trucks, drones, special vehicles,mobile robots, Development of autonomous vehicles, processors and sensors that can detect the environment, performing sensor fusion for decision making; Bayesian Thinking
Unit – III	Self-Driving Devices Hardware and Software Architectures, Hardware configuration Design, Software Architecture, Environment Representation
Unit – IV	Self Driving Cars: Taxonomy of Driving, Perception, Driving Decisions and Actions Safety Assurance for Autonomous Vehicles, Industry Methods for Safety Assurance and Testing, Safety Frameworks for Self-Driving
Unit – V	Vehicle Dynamic Modeling, Kinematic Modeling in 2D, The Kinematic Bicycle Model, Dynamic Modeling in 2D, Longitudinal Vehicle Modeling, Lateral Dynamics of Bicycle Model, Vehicle Actuation, Tire Slip and Modeling Vehicle Longitudinal and Lateral Control, Proportional-Integral-Derivative (PID) Control, Longitudinal Speed Control with PID, Feedforward Speed Control, Geometric Lateral Control, Advanced Steering Control

Text Books:

Bertsekas, Dynamic Programming and Optimal Control, Vols I and II

ADVANCED DEEP LEARNING AND IMAGE PROCESSING

UNIT	CONTENTS
Unit – I	Generative Adversarial Network(GAN), Understanding GAN, How does GAN work, Step by step Generative Adversarial Network implementation, Types of GAN, Recent Advances: GAN
Unit – II	Emotion and Gender Detection, Where do we use Emotion and Gender Detection, How does it work, Emotion Detection architecture, Face/Emotion detection using Haar Cascade
Unit – III	RNN and GRU, Issues with Feed Forward Network,Recurrent Neural Network (RNN), Architecture of RNN, Calculation in RNN, Backpropagation and Loss calculation, Applications of RNN, Vanishing Gradient, Exploding Gradient, What is GRU, Components of GRU, Update gate, Reset gate, Current memory content, Final memory at current time step
Unit – IV	LSTM, What is LSTM, Structure of LSTM, Forget Gate, Input Gate, Output Gate, LSTM architecture, Types of Sequence-Based Model, Sequence Prediction, Sequence Classification, Sequence Generation, Types of LSTM, Vanilla LSTM, Stacked LSTM, CNN LSTM, Bidirectional LSTM, How to increase the efficiency of the model, Backpropagation through time, Workflow of BPTT
Unit – V	Auto Image Captioning Using CNN LSTM, Auto Image Captioning, COCO dataset, Pre-trained model, Inception V3 model, Architecture of Inception V3, Modify last layer of pre-trained model,Freeze model, CNN for image processing, LSTM or text processing

Elective Course – I

MEAM-11:AGENT BASED INTELLIGENT SYSTEMS

COURSE OUTCOMES:	
CO 1	Understand *Agent* development
CO 2	Gain Knowledge in Multi *agent* and *Intelligent agents*
CO 3	Understand *Agents* and security
CO 4	Understand development of software agents
CO 5	Gain Knowledge in Agent Applications

Unit	Topic
I	**INTRODUCTION** Definitions - Foundations - History - Intelligent Agents- Problem Solving-Searching - Heuristics -Constraint Satisfaction Problems - Game playing.
II	**KNOWLEDGE REPRESENTATION AND REASONING** Logical Agents-First order logic-First Order Inference-Unification-Chaining- Resolution Strategies Knowledge Representation-Objects-Actions-Events.
III	**PLANNING AGENTS** Planning Problem-State Space Search-Partial Order Planning-Graphs-Nondeterministic Domains Conditional Planning-Continuous Planning-MultiAgent Planning.
IV	**AGENTS AND UNCERTAINITY** Acting under uncertainty – Probability Notation-Bayes Rule and use - Bayesian Networks-Other Approaches-Time and Uncertainty-Temporal Models- Utility Theory - Decision Network – Complex Decisions.
V	**HIGHER LEVEL AGENTS:** Knowledge in Learning-Relevance Information-Statistical Learning Methods-Reinforcement Learning Communication-Formal Grammar-AugmentedGrammars-FutureofAI

Book (s):

1. Stuart Russell and Peter Norvig, “Artificial Intelligence - A Modern Approach”, 2nd Edition, Prentice Hall, 2002
2. Michael Wooldridge, “An Introduction to Multi Agent System”, John Wiley, 2002.
3. Patrick Henry Winston, Artificial Intelligence, III Edition, AW, 1999.
4. Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House, 1992.

MEAM-12:CLOUD COMPUTING

Course Outcome (CO) :	
CO 1:	To provide an in-depth and comprehensive knowledge of the Cloud Computing fundamental.
CO 2:	To expose the students to the frontier areas of Cloud Computing
CO 3:	To shed light on the working with Cloud- Infrastructure as a Service.
CO 4:	Identify the appropriate cloud platform and software environment for the given application.
CO 5:	Use and Examine different cloud computing services

Unit	**Topic**
I	Introduction - Shift from distributed computing to cloud computing; principles, and characteristics of cloud computing- IaaS, PaaS, SaaS; service oriented computing and cloud environment.
II	Cloud Computing Technology - Client systems, Networks, server systems andsecurity from services perspectives; Accessing the cloud with platforms and applications; cloud storage.
III	Working with Cloud- Infrastructure as a Service – conceptual model and working Platform as a Service – conceptual model and functionalities Software as a Service – conceptual model and working Technologies and Trends in Service provisioning with clouds.
IV	Using Cloud Services- Cloud collaborative applications and services – technology, applications and case studies with calendars, schedulers and event management; cloud applications in project management.
V	Case studies-Microsoft Azure, Google App Engine and Open source clouds-Open-Nebula and Eucalyptus , Current trends and research.

Text Book (s):

1. Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications, Cambridge.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach.
3. Dimitris N. Chorafas, Cloud Computing Strategies.

MEAM-13: Internet of Things

Course Outcomes (CO)	
CO1	Able to understand the application areas of IOT
CO2	Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
CO3	Able to understand building blocks of Internet
Unit	**Topic**
I	Introduction to IoT :Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.
II	Elements of IoT Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.
III	Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.
IV	IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.
V	IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Text Book (s):

1. Vijay Madisetti, ArshdeepBahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

Elective Course – II

MEAM-21: Robotics

Course Outcomes (CO) :

CO1 Upon completion of this course, the students can able to apply the basic engineering
CO2 To learn about knowledge for the design of robotics.
CO3 Will understand robot kinematics and robot programming.
CO4 Will understand application of Robots
CO5 To learn about force and torque sensing
CO6 To learn about application of robot

Unit	Topic
I	Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and openloop control systems, Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.
II	Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modelling: Equations of motion: Euler-Lagrange formulation
III	Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc, Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.
IV	Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls, Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.
V	Control Hardware and Interfacing :Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

References:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi, 2009

MEAM22: Virtual Reality

COURSE OUTCOMES:	
CO 1	To make students know the basic concept and understand the framework of virtual reality.
CO 2	To understand principles and multidisciplinary features of virtual reality and apply it in developing applications.
CO 3	To know the technology for multimodal user interaction and perception VR, in particular the visual, audial and haptic interface and behavior.
CO 4	To understand and apply technology for managing large scale VR environment in real time.
CO 5	To understand an introduction to the AR system framework and apply AR tools in software development.
UNIT	**Topic**
II	**Introduction to Virtual Reality:** Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark **3D Computer Graphics:** Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Color theory, Simple 3D modeling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.
III	**Geometric Modeling:** Geometric Modeling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.
IV	**Virtual Environment:** Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in battening, free from deformation, particle system. **Physical Simulation:** Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.
V	**VR Hardware and Software:** Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML

Text Book (s):

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia.
2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill.
4. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science.

MEAM-23: Data Science

COURSE OUTCOMES:	
CO 1	To understand the need for data sciences learning for various applications
CO 2	To understand a wide variety of learning algorithms and how to evaluate models generated from data
CO 3	To understand the latest trends in Data Sciences
CO 4	To design appropriate algorithms and apply them to real-world problems
CO 5	To optimize the models learned and report onthe expected accuracy that can be achieved by applying the models
Unit	**Topic**
I	Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.
II	Introduction to Programming Tools for Data Science : Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK, Visualizing Data: Bar Charts, Line
III	Mathematical Foundations: Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation
IV	Machine Learning: Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised,
V	Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

Text Book (s):

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. AurélienGéron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.

Python ProgrammingLAB
(ACS552)

CO 1: To provide the students a broad exposure to the advance object-oriented programming field in order to be prepared for follow-on study.

LIST OF EXPERIMENTS

1. Implement a sequential search.
2. Create a calculator program.
3. Explore string functions.
4. Implement Selection Sort.
5. Implement Stack.
6. Read and write into a file.
7. Demonstrate usage of basic regular expression.
8. Demonstrate use of List.
9. Demonstrate use of Dictionaries.

ARTIFICIAL INTELLIGENCELAB
(ACS452)

CO1: To understand the basic principles of Artificial Intelligence in various applications.

LIST OF EXPERIMENTS

1. WAP in Prolog to have an introduction of Prolog fundamentals: constants, predicates, arguments, variables.
2. WAP in Prolog to have an introduction of Tests, Backtracking.
3. WAP in Prolog to have an introduction of Recursion.
4. WAP in Prolog to have an introduction of State-Space Search: DFS
5. WAP in Prolog to have an introduction of State-Space Search: BFS
6. Write a program to implement supervised learning on IRIS Dataset using Bayes classifier.

7-8. Write a program to implement Genetic Algorithm to find out the optimal solution of different equation.

9. Write a program to implement Nearest Neighbour classification technique.
10. Write a program to implement k-means clustering on IRIS Dataset.

Elective Course – III

MEAM-31: BIG DATA ANALYTICS

Course Outcome (CO) :

CO 1:	Understand Data Analysis and apply Algorithms using map reduce.
CO 2:	Understanding Data Analysis with Spark
CO 3:	To understand inputs and outputs of MapReduce
CO 4:	To Introduce the student to analytical tools and methods, which are currently used in bioinformatics as applied to biological information for human beings.
CO 5:	To understand principles of schema design.

Unit	Topic
I	Introduction - distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce.
II	Big Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization.
III	HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper , how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.
IV	Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDDs, Machine Learning with MLlib, What is it?, Where It is Used Types of NoSQL databases, Why NoSQL?, Advantages of NoSQL, Use of NoSQL in Industry, SQL vs NoSQL, NewSQL.
V	Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language.

Text Book (s):

1. Boris lublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley.
2. Chris Eaton,Dirkderooset al. , "Understanding Big data ", McGraw Hill.
3. Big Data and Analytics ,Sima Acharya, Subhashini Chhellappan, Willey.
4. MongoDB in Action, Kyle Banker,PiterBakkum , Shaun Verch, Dream tech Press.

MEAM-32: Block Chain

COURSE OUTCOMES:	
CO 1	Understand how blockchain systems (mainly Bitcoin and Ethereum) work
CO 2	To securely interact with them
CO 3	Design, build, and deploy smart contracts and distributed applications
CO 4	Integrate ideas from blockchain technology into their own projects.
CO 5	Explain cryptographic building blocks and reason about their security

Unit	Topic
I	**Introduction:** Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain **Basic Crypto Primitives:** Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic crypto currency.
II	**Understanding Block chain with Crypto currency:** Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin**:** Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, HashcashPoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.
III	**Understanding Block chain for Enterprises:** Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.
IV	**Enterprise application of Block chain:** Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain
V	**Block chain application development:** Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda

Text Book (s):

1. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015
2. Daniel Drescher, "Block Chain Basics", Apress; 1st edition, 2017

MEAM-33:PATTERN RECOGNITION

COURSE OUTCOMES:	
CO 1	Understand the basic pattern recognition.
CO 2	Understand Statistical pattern recognition.
CO 3	Understand the basic concept involved in structural and statistical pattern recognition.
CO 4	Define the relationship between pattern and feature.
CO 5	Explain supervised and unsupervised pattern recognition approaches.

Unit	Topic
I	Basics of pattern recognition, Design principles of pattern recognition system,Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test.
II	Statistical Patten Recognition: Bayesian Decision Theory, Classifiers, Normal density anddiscriminant functions.
III	Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameterestimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models.
IV	Nonparametric Techniques: Density Estimation, Parzen Windows, K-Nearest NeighborEstimation, Nearest Neighbor Rule, Fuzzy classification.
V	Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques:Iterative square - error partitional clustering – K means, agglomerative hierarchical clustering, Cluster validation.

Text Book (s):

1. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2009.
2. S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, Academic Press, 2008.

Elective Course – IV

MEAM-41: DIGITAL IMAGE PROCESSING

Course Outcomes (CO):	
CO 1:	The purpose of this course is to impart knowledge on various Digital Image Processing Techniques and their Applications..
CO 2:	Apply image processing techniques for image enhancement in both the spatial and frequency domains.
CO 3:	Understand the Fourier Transform and the Frequency
CO 4:	Understand Model of Restoration Process

Unit	Topic
I	**Introduction and Fundamentals:** Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization. Image Enhancement in Spatial Domain: Introduction; Basic Gray Level Functions – Piecewise-Linear Transformation Functions: Contrast Stretching; Histogram Specification; Histogram Equalization; Local Enhancement; Enhancement using Arithmetic/Logic Operations – Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.
II	**Image Enhancement in Frequency Domain:** Fourier Transform and the Frequency Domain, Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters – Gaussian Low-pass Filters; Sharpening Frequency Domain Filters – Gaussian High-pass Filters; Homomorphic Filtering.
III	**Image Restoration:** A Model of Restoration Process, Noise Models, Restoration in the presence of Noise only-Spatial Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters – Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering– Band-pass Filters; Minimum Mean-square Error Restoration.
IV	**Color Image Processing:** Color Fundamentals, Color Models, Converting Colors to different models, Color Transformation, Smoothing and Sharpening, Color Segmentation. Morphological Image Processing: Introduction, Logic Operations involving Binary Images, Dilation and Erosion, Opening and Closing, Morphological Algorithms – Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening.
V	**Image Compression:** Fundamentals, image compression models, Compression methods: Huffman coding, Golomb Coding, Arithmetic Coding, LZW coding, Run-Length coding, Symbol based coding.error-free compression, lossy predictive coding, image compression standards. **Image Segmentation:**Fundamentals, Point, Line and edge detection. Thresholding: foundation, Basic Global Thresholding, Otsu's Method, Image smoothing to improve global thresholding.

Text Book (s):

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Tata McGraw Hill Pvt. Ltd.
2. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning.

MEAM-42:3D Printing and design

COURSE OUTCOMES:	
CO 1	Develop CAD models for 3D printing.
CO 2	Import and Export CAD data and generate .stl file.
CO 3	Learn the selection of material, equipment and development of a product for Industry 4.0 environment.
CO 4	Understand the various software tools, process and techniques for digital manufacturing
CO 5	Apply these techniques into various applications.

Unit	**Topic**
I	**3D Printing (Additive Manufacturing):** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.
II	**CAD for Additive Manufacturing :** CAD Data formats, Data translation, Data loss, STL format, **Additive Manufacturing Techniques:** Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Process, Process parameter, Process Selection for various applications, Additive Manufacturing Application Domains: Aerospace, Electronics, HealthCare, Defense, Automotive, Construction, Food Processing, Machine Tools
III	**Materials:** Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties, Support Materials
IV	**Additive Manufacturing Equipment:** Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design
V	**Post Processing:** Requirement and Techniques **Product Quality:** Inspection and testing, Defects and their causes

Text Book (s):

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
4. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific.
5. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science.
6. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press.

MEAM-43:CLUSTER COMPUTING

Course Outcome (CO) :	
CO 1:	Understand the fundamental principles of distributed computing.
CO 2:	Understand the concept of cluster computing
CO 3:	Understand the importance of Cluster Technology
CO 4:	To Introduce the student to analytical tools and methods, which are currently used in bioinformatics as applied to biological information for human beings.
CO 5:	To Introduce the student to System Infrastructure

Unit	**Topic**
I	Basic concepts in Distributed Systems: Notion of time Distributed Mutual exclusion, Consensus, Failure models Paradigms for process interaction in distributed programs, Programming Paradigms, Shared memory, Message passing, Workflows.
II	Introduction to Cluster Computing, Cluster Middleware: An Introduction, Early Cluster Architecture and High Throughput Computing Clusters, Networking, Protocols and I/O for Clusters, Setting Up and Administering a Cluster.
III	Cluster Technology for High Availability, Performance Models and Simulation, Process Scheduling, Load Sharing and Load Balancing, Distributed Shared Memory.
IV	Introduction to Grid Architecture, Characterization of Grid, and Grid related standard bodies, Grid types, Topologies, Components and Layers, Comparison with other approaches.
V	System Infrastructure, Traditional paradigms for distributed computing, Web Services, Grid standards: OGSA and WSRF, Case Studies of Cluster Systems: Beowulf, COMPaS, NanOS and PARAM.

Text Book (s):

1. High Performance Cluster Computing: Architectures and Systems, Prentice Hall.
2. Grid and Cluster Computing, Prabhu C.S.R, PHI Learning Private Limited.