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 2024-25]

ख़्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

M. TECH. CSE (AI & ML)
FIRST SEMESTER

TML-101: MATHEMATICAL ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSE OUTCOMES:	
CO 1	Gain foundation in mathematical concepts related to Linear algebra necessary for ML.
CO 2	Understands the concepts related to Orthogonality and rotations.
CO 3	Learns different forms of matrix decompositions.
CO 4	Understands the concepts of differentiation for finding gradients and curvatures.
CO 5	Learns various optimization methods.
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, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation. **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.
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,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 Book (s):

- 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 by 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 Scienceby E. T. Jaynes Source: https://bayes.wustl.edu/etj/prob/book.pdf

TML-102: ADVANCED DATA STRUCTURES AND ALGORITHMS

COURSE OUTCOMES:	
CO 1	Understand concepts of advanced data structures.
CO 2	Understand and apply divide and conquer algorithms, greedy methods, dynamic programming and backtracking approach for problem solving.
CO 3	Discuss and understand genetic algorithms and artificial neural networks.
CO 4	Understand and analyze complexity theory of algorithms.
CO 5	Understand Randomized and Approximation Algorithms and solve real world problems.
UNIT	**CONTENTS**
Unit – I	Advanced Data Structure**:** Array, Linked-List, Stack and Queue ADTs, Priority queue (abstract data type) ADT, implementation using Heaps Hashing-Hash functions, Collision Resolution Methods-Open Addressing, Chaining. Heaps, Binary tree ADT, representations, recursive and non-recursive traversals, Graph ADT, representations, graph traversals/search methods.
Unit – II	Abstract Algorithms**:** Divide and Conquer, Greedy methods Dynamic Programming, Backtracking, Branch and Bound method, Elementary Graph Algorithms.
Unit – III	Complexity Theory: Introduction to Complexity theory,Diagonalization Theorem, Tractable and Non-Tractable problems; Few NP and NPC problems
Unit – IV	Advanced Topics**:** Randomized and Approximation Algorithms , Introduction to Computational Geometry
Unit – V	Natural Algorithms**:** Genetic Algorithms, Simulated Annealing, Artificial Neural Networks, Markov chains and random walks, Particle Swarm optimization (PSO), Ant Colony optimization

Text Book (s):

- E. Horowitz, S.Sahni and Dinesh Mehta, “Fundamentals of Data structures in C++”, University Press, 2007
- E. Horowitz, S. Sahni and S. Rajasekaran, “Computer Algorithms/C++”, Second Edition, University Press, 2007
- Introduction to Algorithms by Cormen, Licerson, Steina and Rivest
- Aho, Hopcroft and Ullman. “Design and Analysis of Algorithm”.
- The Design of Approximation Algorithms by Williamson and Shmoys.
- Approximation Algorithms by Vazirani.
- Randomized Algorithms by Motwania and Raghavan.

TML-103: INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS

COURSE OUTCOMES:	
CO 1	Gain a historical perspective of Artificial Intelligence (AI) and its foundations.
CO 2	Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
CO 3	Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO 4	Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
CO 5	Explore the current scope, potential, limitations, and implications of intelligent systems.
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 Book (s):

- Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.
- Artificial Intelligence, 2nd Edition, E. Rich and K. Knight (TMH).
- Artificial Neural Networks and Multi-Criteria Decision Making Approaches by Mrinmoy Majumder, Ganesh D. Kale
- Artificial Intelligence – A Modern Approach (3rd Edition) – *By Stuart Russell & Peter Norvig*
- Machine Learning for Dummies– *By John Paul Mueller and Luca Massaron*

TML-104: MACHINE LEARNING USING PYTHON

COURSE OUTCOMES:	
CO 1	Develop an appreciation for what is involved in learning from data.
CO 2	Study a wide variety of learning algorithms.
CO 3	Demonstrate how to apply a variety of learning algorithms to data.
CO 4	Demonstrate how to perform evaluation of learning algorithms and model selection.
CO 5	Ability to analyze data prediction and classification models
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, 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 Book (s):

- Christopher Bishop. Pattern Recognition and Machine Learning. 2e.
- Machine Learning , Peter Flach, Cambridge University Press
- Introduction to Machine Learning with Python: A Guide for Data Scientist By Andreas C. Müller, Sarah Guido
- Building Machine Learning Systems with Python - Willi Richert, Luis Pedro Coelho
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems (First Edition) **Author:** Aurelien Geron **Publisher** — O'Reilly Media
- Machine Learning for Absolute Beginners: A Plain English Introduction, Oliver Theobald, Scatterplot Press

ELECTIVE COURSE – I

TMLE-011: 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

Text Book (s):

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

TMLE-012: 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	Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self-service, Broad network access,Comparing cloud providers with traditional IT service providers, Roots of cloud computing
II	Architectural influences – High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability, simplicity, vendors, security, Limitations – Sensitive information
III	Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.
IV	Introduction to Simulator, understanding CloudSim simulator, CloudSimArchitecture (User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud
V	Basics of VMWare, advantages of VMware virtualization, using VMware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

Text Book (s):

- Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications, Cambridge.
- Cloud computing a practical approach - Anthony T.Velte, Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill, New Delhi – 2010.
- Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online - Michael Miller - Que 2008.
- Cloud computing for dummies- Judith Hurwitz, Robin Bloor, Marcia Kaufman,Fern Halper, Wiley Publishing, Inc, 2010
- Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011

TMLE-013: WEB AND BIG DATA MINING

Course Outcomes (CO)	
CO1	Discuss and explain various concepts of Data Mining and Web Mining.
CO2	Discuss and understand various methods of Supervised and Unsupervised learning methods.
CO3	Discuss and analyse Information Retrieval and Web Search.
CO4	Understand Web crawling and implementation of Web Crawler and Page.
CO5	Discuss and explain Sentiment Analysis and Opinion Mining.
Unit	**Topic**
I	Introduction to Web Data Mining and Data Mining Foundations, Introduction – World Wide Web(WWW), A Brief History of the Web and the Internet, Web Data Mining - Data Mining, Web Mining.Data Mining Foundations–Association Rules And Sequential Patterns – Basic Concepts of Association Rules, A priori Algorithm - Frequent Item set Generation, Association Rule Generation, Data Formats for Association Rule Mining, Mining with multiple minimum supports, Mining Sequential Patterns on GSP, Mining Sequential Patterns on Prefix Span, Generating Rules from Sequential Patterns.
II	Supervised and Unsupervised Learning Supervised Learning – Basic Concepts, Decision Tree Induction – Learning Algorithm, Impurity Function, Handling of Continuous Attributes, Classifier Evaluation, Rule Induction – Sequential Covering, Rule Learning, Classification Based on Associations, Naïve Bayesian Classification, Naïve Bayesian Text Classification – Probabilistic Framework, Naïve Bayesian Model Unsupervised Learning – Basic Concepts, K-means Clustering–K-means Algorithm, Representation of Clusters, Hierarchical Clustering – Single link method, Complete link Method, Average Link Method, Strength and Weakness.
III	Information Retrieval and Web Search: Basic Concepts of Information Retrieval. Information Retrieval Methods – Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures, Text and Web Page Preprocessing– Stop word Removal, Stemming, Inverted Index and Its Compression–Inverted Index, Search using Inverted Index, Index Construction, Index Compression, Latent Semantic Indexing–Singular Value Decomposition, Query and Retrieval, Web Search, Meta Search, Web Spamming.
IV	Analysis, Co-Citation and Bibliographic Coupling, PageRank Algorithm, HITS Algorithm, Community Discovery-Problem Definition, Bipartite Core Communities, Maximum Flow Communities, Email Communities. Web Crawling – A Basic Crawler Algorithm - Breadth First Crawlers, Preferential Crawlers, Implementation Issues–Fetching, Parsing, Stop word Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts
V	Sentiment Analysis and Opinion Mining – Sentiment Classification – Classification based on Sentiment Phrases, Classification Using Text Classification Methods, Feature based Opinion Mining and Summarization –Opinion Search and Opinion Spam. Aspect Based Sentiment Analysis, Supervised and Unsupervised Spam Detection, Group Spam Detection.

Text Book (s):

- Web Data Mining: Exploring Hyperlinks, Contents and usage data by Bing Liu (Springer Publication)
- Data Mining: Concepts and Techniques, Second Edition by Jiawei Han, Micheline Kamber (Elsevier Publications)
- Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti (Morgan Kaufmann Publishers)

TMLE-014: ADVANCED BIOMEDICAL IMAGING

Course Outcomes (CO):	
CO1	To define the principles of image sampling, quantization, enhancement and filtering
CO2	To discover the different image compression methods and morphological based
CO3	To develop the methods of image registration and visualization for medical applications
CO4	To acquire the student with the techniques of shape analysis and image classification
CO5	To develop algorithms to process and visualize images from different modalities for
CO6	To define the principles of image sampling, quantization, enhancement and filtering
Unit	**Topic**
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.
II	Image compression - Lossy and lossless Compression, Predictive techniques - Dilation, Erosion, Open, Close, Skeleton operations, Top-hat algorithm - Morphology based segmentation
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
IV	Image Registration - Medical image Fusion, SPECT/CT, MR/CT, PET/CT - Image visualization - Volume Rendering, Surface rendering and Maximum Intensity Projection
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.

Text Book (s):

- Reiner Salzer, “Biomedical Imaging: Principles and Applications”, 2012, 1st Edition, Wiley, New Jersey.
- Pears, Nick, Liu, Yonghuai, Bunting, Peter (Eds.) “3D Imaging, Analysis and Applications”, 2012, 2nd Edition, Springer, Berlin.
- Jonathan Wolpaw, Elizabeth Winter, (Eds.) “Brain-Computer Interfaces: Principles and Practice”, 2012, 1st Edition, Oxford University Press, Oxford.

ELECTIVE COURSE – II

TMLE-015: 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

Text Book (s):

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

TMLE-016: 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):

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

TMLE-017: DATA ANALYTICS AND VISUALIZATION

COURSE OUTCOMES:	
CO 1	Discuss various concepts of data analytics pipeline.
CO 2	Discuss and apply various data analytic methods.
CO 3	Discuss and apply text and sentiment analysis.
CO 4	Apply R tool for Data Analytics problem solving.
CO 5	Understand NoSQL and Data Visualization methods and implementation in tools.
UNIT	**Topic**
I	Introduction: Data, Types of Data, Big Data, Big data Characteristics, Business Intelligence, Levels of measurement, Introduction to Statistical Learning, Mean, Median, Mode, Standard deviation. Life cycle of Data centric projects.
II	Basic Analysis Techniques: Chi-Square, t Test, Correlation Analysis, Analysis of Variance. Advanced Analytics Techniques: Regression, Clustering, Classification, Association Mining.
III	Text Analytics & Web Mining: Process of Text Analytics, Topic Modelling, Sentiment Analysis, Web Mining. Time Series Analysis: Overview of Time Series Analysis, Forecasting Models, ARMA and ARIMA Models
IV	R language: Introduction to R., Basic Syntax, Implementation basic and advanced Data analytic methods, Data visualization using R, Text Analysis Process in R.
V	NoSQL: Introduction to NoSQL, Principles of NoSQL Data Models, CAP,NoSQL Data Model .Data Visualization: Plots and graphs for data visualization..

Text Book (s):

- Michael Berthold, David J. Hand, Intelligent DataAnalysis, Springer
- Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
- Michael Minelli, Michelle Chambers, and Ambika Dhiraj," Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley
- Mark Gardner, “Beginning R: The Statistical Programming Language”, Wrox Publication.
- Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier

TMLE-018: FINANCIAL ANALYTICS

COURSE OUTCOMES:	
CO 1	Understand foundation in financial analytics for complex financial data.
CO 2	Analyze and model financial data.
CO 3	Evaluate and model Risk on various financial assets.
CO 4	Construct and optimize asset portfolios.
CO 5	Use the most powerful and sophisticated routines in R for analytical finance.
UNIT	**Topic**
I	Introduction to financial analytics, business forecasting, and time-series data.
II	Basic forecasting models, moving averages, exponential smoothing, and Holt-Winter's forecasting model.
III	Modeling Volatility and Risk: Characteristics of volatility, Modeling of volatility using ARCH/GARCH. Measuring and modeling risk.
IV	High frequency data Analysis: Non synchronic trading, Bid-Ask spread of trading price, Emperical characteristics of trading data, models for price changes.
V	Financial Risk Measurements -Measurement of Risk – credit risk measurement, market risk measurement, interest rate risk measurement, Asset liability management, measurement of operational risk.

Text Book (s):

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

ADVANCED DATA STRUCTUE & ALOGIRTHM DESIGN LAB (TML151)

LIST OF EXPERIMENTS

1. Implement dependent task scheduling via Knapsack / TSP / Genetic Algorithm. Discuss the efficiency of the implementation.
2. Write a program to implement flow Min Cut problem using the Ford Fulkerson algorithm. The implementation must exhibit limitations of the problem. Also, should explain whether the algorithm works for bipartite matching or not.
3. Write a program to implement string matching using Rabin Karp algorithm, Knuth Morris algorithm, and Boyer Moore algorithm
4. Write a program to find all pair shortest path using Johnson's algorithm for sparse graphs.
5. Implementation of randomized quick sort algorithm. Also discuss its complexity in all cases.
6. Implementation of Edmonds-Karp algorithm. Discuss its complexity.
7. Write a program to implement Travelling salesperson using branch and bound, dynamic programming & genetic algorithm.
8. Write a program to implement Graph Coloring using a backtracking method. Discuss its complexity.
9. Write a program to implement Simple optimization problem using soft computing approaches (GA, PSO, ACO & NN).

TML152: ARTIFICIAL INTELLIGENCE LAB

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. Write a Program to Implement Travelling Salesman Problem
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.

TML153: PYTHON PROGRAMMING LAB

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.

ख़्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

M. TECH. CSE (AI & ML)
SECOND SEMESTER

TML-201: RESEARCH METHODOLOGY AND IPR

COURSE OUTCOMES:	
CO 1	Understand research problem formulation.
CO 2	Analyze research related information
CO 3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruledby ideas, concept, and creativity.
CO 4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. Field
CO 5	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D,which leads to creation of new and better products, and in turn brings about, economic growth and social benefits
UNIT	**CONTENTS**
I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, scope, and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
II	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
III	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.
IV	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
V	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Book (s):

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- Mayall, "Industrial Design", McGraw Hill, 1992.
- Niebel, "Product Design", McGraw Hill, 1974.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

TML-202: 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 on the 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 Charts, Scatterplots, working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction
III	Mathematical Foundations: Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation, Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, the Central Limit Theorem, Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Bayesian Inference.
IV	Machine Learning: Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks- Learning And Generalization, Overview of Deep Learning.
V	Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

Text Book (s):

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

TML-203: SELF-DRIVEN DEVICES USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSE OUTCOMES:	
CO 1	Demonstrate advanced machine learning techniques, including deep learning and reinforcement learning
CO 2	Understand core AI and ML concepts and their applications to autonomous systems.
CO 3	Collect, preprocess, and utilize data effectively for machine learning models.
CO 4	Architecture and components of self-driven devices and Identify key challenges in autonomous system design.
CO 5	Evaluate and optimize system performance while adhering to safety and ethical standards.
UNIT	**CONTENTS**
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
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
III	Self-Driving Devices Hardware and Software Architectures, Hardware configuration Design, Software Architecture, Environment Representation
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
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
- Artificial Intelligence – A Modern Approach By – Stuart Russell and Peter Norvig
- "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies",*By John D. Kelleher, Brian Mac Namee, Aoife D'Arcy*
- "Machine Learning for Dummies", *By John Paul Mueller and Luca Massaron*
- "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies", *By John D. Kelleher, Brian Mac Namee, Aoife D'Arcy*
- "Machine Learning for Absolute Beginners: A Plain English Introduction", *By Oliver Theobald*

TML-204: Advanced Database Management System

COURSE OUTCOMES:	
CO 1	Understand and implement the concepts of database systems in real world, relational model and ER diagram.
CO 2	Apply query processing techniques to automate their all-time problems of databases and understand and implement normalization.
CO 3	Understand the concepts of transactions and database management issues including data integrity, security and recovery.
CO 4	Understand the concepts of distributed systems and techniques forms sage ordering.
CO 5	Understand the concepts of distributed transactions and concurrency control in distributed environment.
UNIT	**CONTENTS**
I	Data Modelling using the Entity Relationship Model, diagram, Relational data model concepts, integrity constraints, relational algebra, ERD, DFD using tools, e.g. Power designer
II	Database Systems Design and SQL: Querying Database Using SQL, Database Design Concepts, FDs, MVDs, JD and concepts in Normalization.
III	Transaction and Concurrency Control, Schedules, testing serializability of schedules, conflict & view serializable, recoverability, Recovery from transaction failures, log-based recovery, checkpoints, deadlock handling.
IV	Theoretical Foundation for Distributed System, Logical Clocks, Lamport's Vectors logical clocks. Message Passing Systems: causal order, total order, total causal order, Techniques for Message Ordering.
V	Distributed Transactions, Commit protocols, Concurrency control in distributed transactions, Distributed Deadlocks, Transaction Recovery. Replication: System Model and Group Communication, Fault-tolerant services.

Text Book (s):

- R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004
- A. Silberschatz, H. Korth, S. Sudarshan, Database system concepts, 5/e, McGraw Hill, 2008.
- S Ceri and G Pelagatti, “Distributed databases principles and systems”, 1st Edition, TMH, 2008.
- Elmasri R, Navathe S B, Somayajulu D V L N, and Gupta S K, “Fundamentals of Database Systems”, 5th Edition, Pearson Education, 2009.
- C. J. Date, “Introduction to Database Systems”, 8th Edition, Pearson Education, 2009.

ELECTIVE COURSE – III

TMLE-021: 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 Map Reduce
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 Map Reduce -, 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):

- Boris lublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley.
- Chris Eaton,Dirk derooset al. , "Understanding Big data ", McGraw Hill.
- Big Data and Analytics, Sima Acharya, Subhashini Chaliapin, Willey.
- MongoDB in Action, Kyle Banker,Piter Bakkum , Shaun Verch, Dream tech Press.

TMLE-022: BLOCK CHAIN TECHNOLOGY

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, Hashcash PoW, 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):

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

TMLE-024: PATTERN RECOGNITION THEORY AND APPLICATIONS

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 and discriminant functions.
III	Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, 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 Neighbor Estimation, 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):

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

TMLE - 024: REINFORCEMENT LEARNING

COURSE OUTCOMES:	
CO 1	Demonstrate various Components of Reinforcement Learning.
CO 2	Make use of various exploration and exploitation strategies
CO 3	Apply Model based and Model Free Prediction techniques.
CO 4	Make use of different value-based Reinforcement Learning Algorithms.
CO 5	Demonstrate various Policy based Reinforcement Learning Algorithms.
UNIT	**CONTENTS**
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 Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.
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 evaluation and value iteration algorithms, DP extensions.
III	**Model Free Reinforcement Learning:** Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to estimate from multiple steps, N-step TD learning, Forward-view TD(λ), Backward-view TD(λ), Generalized policy iteration(GPI), Monte Carlo control, SARSA: On-Policy TD control, Q-learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). **Model Based Reinforcement Learning:** Dyna-Q, Trajectory sampling.
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.
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
- "Programming Collective Intelligence: Building Smart Web 2.0 Applications", Toby Segaran,1ST Edition, O'Reilly Media
- "The Hundred-Page Machine Learning Book", Andriy Burkov, 1ST Edition, Publisher – Andriy Burkov
- "Deep Reinforcement Learning: Frontiers of Artificial Intelligence", Publisher: Springer Publishing Company, Incorporated by Mohit sewak

ELECTIVE COURSE – IV

TMLE-025: 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.

TMLE - 026: NATURAL LANGUAGE PROCESSING

COURSE OUTCOMES:	
CO 1	To learn the fundamentals of natural language processing
CO 2	To understand the use of CFG and PCFG in NLP
CO 3	To understand the role of semantics of sentences and pragmatic
CO 4	To introduce speech production and related parameters of speech.
CO 5	To show the computation and use of techniques such as short time fourier transform, linear predictive coefficients and other coefficients in the analysis of speech.

Unit	Topic
I	Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance. Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.
II	Context Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.
III	Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.
IV	Speech Fundamentals: Articulatory Phonetics – Production and Classification Of Speech Sounds; Acoustic Phonetics – Acoustics Of Speech Production; Review Of Digital Signal Processing Concepts; Short-Time Fourier Transform, Filter-Bank And LPC Methods.
V	Features, Feature Extraction and Pattern Comparison Techniques: Speech Distortion Measures– Mathematical and Perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion Using A Warped Frequency Scale, LPC, PLP And MFCC Coefficients, Time Alignment And Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths. Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-Estimation, Implementation Issues.

Text Book (s):

- Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
- Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python, First Edition, OReilly Media, 2009.
- Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals Of Speech Recognition", Pearson Education, 2003.
- Daniel Jurafsky And James H Martin, "Speech And Language Processing – An Introduction To Natural Language Processing, Computational Linguistics, And Speech Recognition", Pearson Education, 2002.
- Frederick Jelinek, "Statistical Methods Of Speech Recognition", MIT Press, 1997.

TMLE-027: 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):

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

TMLE-028: DEEP LEARNING

Course Outcome (CO) :	
CO 1:	Understand and Analyze concepts of Bayesian Learning, Neural networks, Perceptron convergence theorem, Back propagation.
CO 2:	Understand and Apply Deep Learning, CNN and Transfer Learning
CO 3:	Understand and analyse PCA and Deep learning architectures.
CO 4:	Explain and Understand Gradient Descent, Normalization & LSTM
CO 5:	Implementation of Case Studies in Deep Learning.

Unit	Topic
I	Introduction to Bayesian Learning, Decision Surface, Linear Models (SVM, Perceptron, Logistic Regression), Optimization Techniques, Gradient Descent, Linear and nonlinear separable problems, Perceptron Convergence Theorem, Introduction to Neural Network.
II	History of Deep Learning, Introduction to Probability, Continuous and Discrete Distributions, Probabilistic Theory of Deep Learning, Deep Vs Shallow Networks, Multilayer Perceptron, Back Propagation Learning, Convolutional Neural Network (CNN), Building Blocks CNN, Transfer Learning
III	Principal Component Analysis (PCA), Auto encoders, Deep Learning Architectures- AlexNet, VGG, ResNet etc.
IV	Revisiting Gradient Descent, Momentum Optimizer, RMSPrOP, ADAM, Loss Functions, Effective Training Deep Net-Early Stopping, Drop-Out, Batch Normalization, Instance Normalization, Group Normalization, Recurrent Networks, LSTM.
V	ImageNet, WaveNet, Generative Modelling with DL, Generative Adversarial Networks, Case studies of DL models with some real-life applications.

Text Book (s):

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press,2016.
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
3. Pattern Classification-Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.
4. Cosma Rohilla Shalizi, Advanced Data Analysis from Elementary Point of View, 2015
5. DengYu, Deep Learning: Methods and Applications, Now Publishers, 2013

TML251: DAT SCIENCE LAB

List of Experiments:

1. Write a program to demonstrate the basic applications of working using numpy arrays, panda data frames and plot using matplotlib.
2. Write a program for Frequency distribution, Variability and Averages.
3. Develop a python program for Normal Curves.
4. Write a program for Correlation, Correlation coefficient and scatter plots
5. Develop a python program for Simple Linear regression.
6. Considering "US Crime Dataset in "MASS " package in R, use t-test to analyze the difference between southern group (So=1) Andno southern group (So=0) on the probability of imprisonment (Probe). Discuss hypothesis and results.
7. Considering "Loblolly" dataset in R determine mean, median, quartiles of age and height. Determine the correlation between age and height. Also apply the chi-square test to determine whether there is an association between age and height of a tree. hypothesis and result.
8. Considering the "cholesterol" dataset in the "multicomp" package in R, use ANOVA to analyze the difference between trt and response. Discuss the hypothesis and result
9. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

TML252: MACHINE LEARNING LAB

List of Experiments:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

M. TECH. CSE (AI & ML)
THIRD & FOURTH SEMESTER

TML-253/351: SEMINAR – I/II

To encourage and motivate the students to read and collect recent and reliable information from their area of interest confined to the relevant discipline from technical publications including peer reviewed journals, conference, books, project reports etc., prepare a report based on a central theme and present it before a peer audience. Each student shall present the seminar for about 10 minutes duration on the selected topic. The report and the presentation shall be evaluated by a team of internal members comprising three senior faculty members based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the report.

TML-352/451: DISSERTATION

GUIDELINES FOR PREPARATION OF DISSERTATION REPORTS

Preamble

While utmost attention must be paid to the content of the Dissertation report, which is being submitted in partial fulfilment of the requirements of the B. Tech Degree, it is imperative that a standard format be prescribed. The same format shall also be followed in preparation of the final soft copies to be submitted to the Department in future.

1. Topic of the Dissertation

The Dissertation report shall be presented in a number of chapters, starting with Introduction and ending with Summary and Conclusions. Each of the other chapters will have a precise title reflecting the contents of the chapter. A chapter can be subdivided into sections, subsections and sub-subsection so as to present the content discretely and with due emphasis. When the work comprises two or more mutually independent investigations, the Dissertation report may be divided into two or more parts, each with an appropriate title. However, the numbering of chapters will be continuous right through, for example Part 1 may comprise Chapters 2 - 5, Part 2, Chapters 6 - 9.

1.1 Abstract

A dissertation abstract is research summary. Abstract should outline the main points of work and show its purpose. Usually, it is about one or two pages long (300-500 words) and also expected to show the importance of work through abstract.

1.2 Introduction

The title of Chapter 1 shall be Introduction. It shall justify and highlight the problem posed, define the topic and explain the aim and scope of the work presented in the Dissertation report. It may also highlight the significant contributions from the investigation.

1.3 Review of Literature

This shall normally form Chapter 2 and shall present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation. The extent and emphasis of the chapter shall depend on the nature of the investigation.

1.4 Report on the present investigation

The reporting on the investigation shall be presented in one or more chapters with appropriate chapter titles. Due importance shall be given to experimental setups, procedures adopted, techniques developed, methodologies developed and adopted. While important derivations/formulae should normally be presented in the text of these chapters, extensive and long treatments, copious details and tedious information, detailed results in tabular and

graphical forms may be presented in Appendices. Representative data in table and figures may, however, be included in appropriate chapters. Figures and tables should be presented immediately following their first mention in the text. Short tables and figures (say, less than half the writing area of the page) should be presented within the text, while large table and figures may be presented on separate pages. Equations should form separate lines with appropriate paragraph separation above and below the equation line, with equation numbers flushed to the right.

1.5 Results and Discussion

This shall form the penultimate chapter of the Dissertation report and shall include a thorough evaluation of the investigation carried out and bring out the contributions from the study. The discussion shall logically lead to inferences and conclusions as well as scope for possible further future work.

1.6 Summary and Conclusions

This will be the final chapter of the Dissertation report. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the Results and Discussions Chapter shall be presented and clearly enumerated, each point stated separately. Scope for future work should be stated lucidly in the last part of the chapter.

1.7 Appendix

Detailed information, lengthy derivations, raw experimental observations etc. are to be presented in separate appendices, which shall be numbered in Roman Capitals (e.g. “Appendix IV”). Since reference can be drawn to published/unpublished literature in the appendices these should precede the “Literature Cited” section.

1.8 Literature Cited

This should follow the Appendices, if any, otherwise the Summary and Conclusions chapter. The candidates shall follow the style of citation and style of listing in one of the standard journals in the subject area consistently throughout his/her report, for example, IEEE in the Department of Electrical Engineering, Materials Transactions in Department of Metallurgical Engineering and Materials Science. However, the names of all the authors along with their initials and the full title of the article/monogram/book etc. have to be given in addition to the journals/publishers, volume, number, pages(s) and year of publication. Citation from websites should include the names(s) of author(s) (including the initials), full title of the article, website reference and when last accessed. Reference to personal communications, similarly, shall include the author, title of the communication (if any) and date of receipt.

1.9 Acknowledgements

The acknowledgments by the candidate shall follow the citation of literature, signed by him/her, with date.

DISSERTATION REPORT FORMAT

2.1 Paper

2.1.1 Quality: The Dissertation report shall be printed / photo copied on white bond paper, whiteness 95% or above, weight 70 gram or more per square meter.

2.1.2 Size: The size of the paper shall be standard A4; height 297 mm, width 210 mm.

2.1.3 Type Setting,Text Processing and Printing: The text shall be printed employing Laserjet or Inkjet printer, the text having been processed using a standard text processor. The standard font shall be Times New Roman of 12 pts with 1.5 line spacing.

2.1.4 Page Format: The Printed Sheets shall have the following written area and margins:

Top Margin 15 mm

Head Height 3 mm

Head Separation 12 mm

Bottom Margin 22 mm

Footer 3 mm

Foot Separation 10 mm

Text Height 245 mm

Text Width 160 mm

When header is not used the top margin shall be 30 mm.

Left and Right Margins

Single sided

Left Margin 30mm

Right Margin 20 mm

2.1.5 Pagination: Page numbering in the text of the report shall be Hindu Arabic numerals at the centre of the footer. But when the candidate opts for header style the page number shall appear at the right and left top corner for the odd and even number pages, respectively. Page number "1" for the first page of the Introduction chapter shall not appear in print, only the second page will bear the number "2". The subsequent chapters shall begin on a fresh page. When header style is chosen the first page of each chapter will not have the header and the page number shall be printed at the centre of the footer. Pagination for pages before the Introduction chapter shall be in lower case Roman numerals, e.g., "iv".

2.1.6 Header: When the header style is chosen, the header can have the Chapter number and Section number (e.g., Chapter 2, Section 3) on even numbered page headers and Chapter title or Section title on the odd numbered page header.

2.1.7 Paragraph format: Vertical space between paragraphs shall be about 2.5 line spacing. The first line of each paragraph should normally be indented by five characters or 12mm. A candidate may, however, choose not to indent if he/she has provided sufficient paragraph separation. A paragraph should normally comprise more than one line. A single line of a paragraph shall not be left at the top or bottom of a page (that is, no windows or orphans should be left). The word at the right end of the first line of a page or paragraph should, as far as possible, not be hyphenated.

2.2 Chapter and Section Format

2.2.1 Chapter: Each chapter shall begin on a fresh page with an additional top margin of about 75mm. Chapter number (in Hindu-Arabic) and title shall be printed at the centre of the line in 6mm font size (18pt) in bold face using both upper and lower case (all capitals or small capitals shall not be used). A vertical gap of about 25mm shall be left between the Chapter number and Chapter title lines and between chapter title line and the first paragraph.

2.2.2 Sections and Subsections: A chapter can be divided into Sections, Subsections and Sub-sub Sections so as to present different concepts separately. Sections and subsections can be numbered using decimal points, e.g. 2.2 for the second section in Chapter 2 and 2.3.4 for the fourth Subsection in third Section of Chapter 2. Chapters, Sections and Subsections shall be included in the contents with page numbers flushed to the right. Further subsections need not be numbered or included in the contents. The Section and Sub-Section titles along with their numbers in 5 and 4mm (16 and 14 pt) fonts, respectively, in bold face shall be flushed to the left (not centred) with 15 mm space above and below these lines. In further subdivisions character size of 3 and 3.5 with bold face, small caps, all caps and italics may be used for the titles flushed left or centred. These shall not feature in the contents.

2.2.3 Table / Figure Format: As far as possible, tables and figures should be presented in portrait style. Small size table and figures (less than half of writing area of a page) should be incorporated within the text, while larger ones may be presented on separate pages. Table and figures shall be numbered chapter wise.

For example, the fourth figure in chapter 5 will bear the number Figure 5.4 or Fig 5.4 Table number and title will be placed above the table while the figure number and caption will be located below the figure. Reference for Table and Figures reproduced from elsewhere shall be cited in the last and separate line in the table and figure caption, e.g. (after McGregor[12]).

Auxiliary Format

3.1 Binding: The evaluation copies of the Dissertation report may be spiral bound or soft bound. The final hard bound copies to be submitted after the viva-voce examination will be accepted during the submission of Dissertation report with the following colour specification:

B.Tech. Dissertation Grey

3.2 Front Covers: The front covers shall contain the following details:

Full title of report in 6 mm 22 point's size font properly centred and positioned at the top. Full name of the candidate in 4.5 mm 15 point's size font properly centred at the middle of the page. A 40 mm dia replica of the Institute emblem followed by the name of department, name of the Institute and the year of submission, each in a separate line and properly centred and located at the bottom of page.

3.2.1 Lettering: All lettering shall be embossed in gold.

3.2.2 Bound back: The degree, the name of the candidate and the year of submission shall also be embossed on the bound (side) in gold.

3.3 Blank Sheets: In addition to the white sheets (binding requirement) two white sheets shall be put at the beginning and the end of the report.

3.4 Title Sheet: This shall be the first printed page of the Dissertation and shall contain the submission statement: the Dissertation Report submitted in partial fulfilment of the requirements of the M.Tech Degree, the name and Roll No. of the candidate, name(s) of the Supervisor and Co-supervisor(s) (if any), Department, Institute and year of submission.

Sample copy of the 'Title Sheet' is appended (Specimen 'A').

3.5 Dedication Sheet: If the candidate so desires(s), he/she may dedicate his/her report, which statement shall follow the title page. If included, this shall form the page 1 of the auxiliary sheets but shall not have a page number.

3.6 Approval Sheet: In the absence of a dedication sheet this will form the first page and in that case shall not have a page number. Otherwise, this will bear the number two in Roman lower case “ii” at the centre of the footer. The top line shall be: Dissertation Approval for M.Tech

A sample copy of the Approval Sheet is appended (Specimen `B')

3.7 Abstract: The 500 word abstract shall highlight the important features of the Dissertation report and shall correspond to the electronic version to be submitted to the Library for inclusion in the website. The Abstract in the report, however, shall have two more parts, namely, the layout of the report giving a brief chapter wise description of the work and the key words.

3.8 Contents: The contents shall follow the Abstract and shall enlist the titles of the chapters, section and subsection

using decimal notation, as in the text, with corresponding page number against them, flushed to the right.

3.8.1 List of Figures and Tables: Two separate lists of Figure captions and Table titles along with their numbers and corresponding page numbers against them shall follow the Contents.

3.9 Abbreviation Notation and Nomenclature: A complete and comprehensive list of all abbreviations, notations and nomenclature including Greek alphabets with subscripts and superscripts shall be provided after the list of tables and figures. As far as possible, generally accepted symbols and notation should be used.

Auxiliary page from dedication (if any) to abbreviations shall be numbered using Roman numerals in lower case, while the text starting from the Introduction shall be in Hindu Arabic.

The first pages in the both the cases shall not bear a page number.

3.10 A Declaration of Academic Honesty and Integrity: A declaration of Academic honesty and integrity is required to be included along with every Dissertation report after the approval sheet. The format of this declaration is given in Specimen ‘C' attached.

****

Specimen 'A': Title Sheet

(Title)

Submitted in partial fulfilment of the requirements of the degree of (Bachelor of Technology)

by

(Name of the Student)

(Roll No._____)

Supervisor (s):

_____

_____

_____

(Name of the Department)

(FACULTY OF ENGINEERING AND TECHNOLOGY)

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY

(Year)

Specimen `B' – Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

_____

(Signature)

_____

(Name of the student)

_____

(Roll No.)

Date: _____

Specimen `C' – Certificate

This is to certify that the Dissertation work entitled " ----------" is a bonafide record of work carried out by "Mr. / Ms. ----------(Roll No.)", submitted to the faculty of "----------Department", in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in "*name of the program*" at Khwaja Moinuddin Chishti Language University, Lucknow during the academic year ----------.

Faculty Name

Designation,
Department of Computer Science & Engineering,
Faculty of Engineering & Technology,
Khwaja Moinuddin Chishti Language University