NATIONAL INSTITUTE OF ELECTRONICS AND INFORMATION TECHNOLOGY
DEEMED TO BE UNIVERSITY UNDER DISTINCT CATEGORY
(AN AUTONOMOUS INSTITUTION UNDER MINISTRY OF ELECTRONICS & IT, GOVT. OF INDIA)

Curriculum and Syllabi for

M.Tech - Artificial Intelligence

(2026-27 Scheme)

रा.इ.सू.प्रौ.सं
NIELIT
Deemed to be University

Main Campus at Ropar and Constituent Units at Aizawl, Agartala, Aurangabad, Calicut, Gorakhpur, Imphal, Itanagar, Kekri, Kohima, Patna and Srinagar

Vision

To position the institute as a premier destination for advanced learning in Artificial Intelligence, fostering a dynamic ecosystem of education, research, and entrepreneurship.

Mission

To provide a strong foundation in theoretical and applied aspects of Artificial Intelligence.

To cultivate a research-oriented and ethical mindset among students.

To empower learners with the skills to solve complex real-world problems using advanced AI and ML tools.

To promote industry-academia collaboration for innovation and technology transfer.

Program Education Objectives

Equip students with deep knowledge in mathematical foundations, machine learning, and optimization techniques.

Foster innovation and independent research in AI and related domains.

Instill ethical values, effective communication, and a commitment to continuous learning for sustainable development.

Program Outcomes

Solve complex machine learning problems with advanced algorithms and AI tools.

Communicate effectively and collaborate across interdisciplinary teams.

Demonstrate a commitment to lifelong learning and adaptability to emerging trends.

Contribute to innovative AI solutions with research competence and ethical responsibility.

Adhere to ethical standards, societal responsibilities, and respect for intellectual property.

Program Specific Outcomes

Apply AI models and techniques to domains such as cybersecurity, healthcare, natural language processing, and computer vision.

Design, implement, and optimize intelligent systems for real-world applications using modern AI tools.

Conduct applied research and develop scalable AI-driven solutions to emerging challenges.

CATEGORY WISE CREDIT DISTRIBUTION

Category	Category Code	Credits
Audit Courses (without grade or credit)	AU	0
Open Elective Courses	OE	8
Professional Elective Courses	PE	16
Program Core Courses	PC	20
Skill / Employment Enhancement Courses (Project/Internship/Seminar/Dissertation/Research)	EE	36
Total Credits (Common track)		**80**

EVALUATION AND ASSESSMENT

1. Performance of a student in a semester shall be evaluated through continuous Class assessment, Tutorial/Lab assessment, Mid-Semester Examination (MSE) and End-Semester Examination (ESE). Both the MSE and ESE shall be the University examination and will be conducted as notified by the Controller of Examinations (CoE) of the University.

2. The continuous assessment shall be based on assignments, tutorials, paper presentation / quizzes/ viva-voce / flipped classes, lab work / projects / fieldwork and attendance, etc.

3. The MSE/ESE shall be comprising of written papers.

4. The overall assessment of the students will be done as per the following scheme:

S. No.	Assessment Type	Marks Weightage
1.	Mid Semester Examination	20
2.	End Semester Examination	40
3.	Continuous Assessment - Practical /Lab/ Tutorial	25
4.	Continuous Assessment - Theory	15
Total		**100**

For more details, please refer the applicable ordinance for this programme and Assessment SOPs.

CURRICULUM

Semester 1						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PC-MTECAI-101	DASH250074	Mathematical Foundations of Machine Learning	3	1	0	4
PC-MTECAI-102	DOAI250032	Machine Learning	3	0	2	4
PE-MTECAI-103	Elective	Program Elective				4
OE-MTECAI-104	Elective	Open Elective				4
PC-MTECAI-105	DASH250095	Research Methodology and IPR	3	1	0	4
AU-MTECAI-106	Elective	Audit Elective				0

Semester 2						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PC-MTECAI-201	DOAI250042	Optimisation Techniques	3	1	0	4
PC-MTECAI-202	DOAI250006	Deep Learning Techniques	3	0	2	4
PE-MTECAI-203	Elective	Program Elective				4
PE-MTECAI-204	Elective	Program Elective				4
AU-MTECAI-205	Elective	Audit Elective				0
EE-MTECAI-206	EE	Mini project with Seminar				4

Semester 3						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
PE-MTECAI-301	Elective	Program Elective				4
OE-MTECAI-302	Elective	Open Elective				4
EE-MTECAI-303	EE	Dissertation-I/ Industrial project				12

Semester 4						
Semester Code	**Course Code**	**Course Title**	**L**	**T**	**P**	**Cr**
EE-MTECAI-401	EE	Dissertation-II				20

Elective Courses

Elective Courses for PE Category

Course Code	Course Title	L	T	P	Cr	For Sem./Code
DOAI260001	AI (Industry)-Applied Ethics for AI	3	0	2	4	
DOAI260002	AI (Industry)-Introduction to Artificial Intelligence	3	0	2	4	
DOAI260003	AI (Industry)-Introduction to Generative AI	3	0	2	4	
DOAI260004	AI (Industry)-Introduction to Machine Learning	3	0	2	4	
DASH250015	Cognitive Systems	3	1	0	4	
DCSA250009	Blockchain Technology	3	1	0	4	
DCSA250020	Computer Vision	3	0	2	4	
DCSA250068	Soft Computing	3	0	2	4	
DCSE250001	Advanced Algorithms and Analysis	3	1	0	4	
DCSE250086	Health Care and Data Analytics	3	1	0	4	
DOAI250004	Artificial Intelligence	3	1	0	4	
DOAI250009	Big Data Analytics	3	0	2	4	
DOAI250019	Data Mining and Warehousing	3	0	2	4	
DOAI250028	Information Retrieval	3	1	0	4	
DOAI250031	Introduction to High Performance Computing	3	1	0	4	
DOAI250043	Pattern Recognition	3	0	2	4	
DOAI250045	Problem Solving Methods in Artificial Intelligence	3	0	2	4	
DOAI250049	Social Media Analytics	3	1	0	4	
DOAI250052	Video Analytics using AI	3	0	2	4	
DOAI260041	Natural Language Processing	2	0	4	4	

Elective Courses for OE Category

Students may opt courses under MOOC, NPTEL, SWAYAM, NSQF/NCVET aligned courses or other relevant technical subjects not included in their core curriculum. The exercise of option shall be subject to the Course Schedule of the respective Constituent Unit, the credit requirements and availability of seats. Guidelines for choosing MOOC/Online courses are given separately and shall have to be adhered to.

Elective Courses for AU (Audit) Category

Course Code	Course Title	L	T	P	Cr
DASH240027	Disaster Management	2	0	0	0
DASH240047	English for Research Paper Writing	2	0	0	0
DASH240052	Environmental Science	3	0	0	0
DASH240085	Pedagogy Studies	2	0	0	0
DASH240086	Personality Development through Life Enlightenment Skills	2	0	0	0
DASH240097	Sanskrit for Technical Knowledge	2	0	0	0
DASH240103	Stress Management by Yoga	2	0	0	0
DASH240104	Technical Presentation and Report Writing	0	0	2	0

DASH240106	Value Education	2	0	0	0
DASH240124	Constitution of India - AU	2	0	0	0
DASH250023	Constitution of India	2	1	0	0
DASH250027	Disaster Management	3	0	0	0
DASH250034	Energy and Environmental Engineering	3	0	0	0
DASH250047	English for Research Paper Writing	2	0	0	0
DASH250054	Essence of Indian Knowledge and Tradition	2	0	0	0
DASH250085	Pedagogy Studies	2	0	0	0
DASH250086	Personality Development	2	0	0	0
DASH250097	Sanskrit for Technical Knowledge	3	0	0	0
DASH250103	Stress Management by Yoga	3	0	0	0
DASH250106	Value Education	2	0	0	0
DASH250117	Innovative Thinking and Entrepreneurship Skills	1	0	0	0
DASH250118	Intellectual Property Rights	2	0	0	0
DCSA240080	Training on Computer Networking	0	0	2	0
DCSA240304	Lab Based on Statistical Package	0	0	2	0
Any other Scheduled Course as per the Course Schedule of the respective Constituent Unit can also be chosen, subject to availability of seats. However, there shall be no assessment and grading for the course chosen as Audit Course.					

The choice of all type of Electives available shall be as per the Course Schedule of the respective Constituent Unit.

Guidelines for Massive Open Online Courses (MOOC) / approved Online Courses

1. Relevant Swayam, MOOC, NPTEL, NIELIT NSQF and any other online courses approved by UGC/AICTE shall also be allowed as Open Electives(OE).

2. One credit of MOOC course should be minimum of 30 hours.

3. A student can choose any approved online course as Open Elective, subject to minimum credit requirements.

4. The students willing to opt OE under MOOC in their next semester, will submit their request to the MOOC Coordinator at their respective campus.

5. Once approved, the campus shall display the list of accepted courses.

6. The student has to submit certificate issued by the institution offering the MOOCs course, along with the number of credits and grades, to get credits transferred into his/her marks certificate issued by NDU.

7. The transfer of credits shall be as adopted by NDU.

Detailed Syllabus

Course Code	Course Name	L	T	P	Cr
DASH250074	Mathematical Foundations of Machine Learning	3	1	0	4

Course Outcomes:

CO1: Apply linear algebra concepts such as matrix operations, eigenvalues, and eigenvectors to solve machine learning problems including regression and dimensionality reduction.
CO2: Analyze probabilistic models and statistical measures to interpret datasets and implement algorithms like Naïve Bayes.
CO3: Utilize optimization techniques such as gradient descent to minimize loss functions and improve machine learning model performance.
CO4: Evaluate information-theoretic measures and statistical learning bounds to assess classification, regression, and decision tree models.
CO5: Integrate mathematical tools including distance metrics, norms, and probabilistic models to design and implement machine learning algorithms for various applications

Module 1:

Linear Algebra for Machine Learning (9 Hours)
Scalars, vectors, matrices: definitions and notation; Matrix operations: addition, multiplication, transpose, inverse; Special matrices: identity, diagonal, symmetric, orthogonal; Rank, determinant, linear independence;Eigenvalues and eigenvectors (basic applications);Applications: Linear regression, Principal Component Analysis

Module 2:

Probability and Statistics (9 Hours)
Probability basics: sample space, events, conditional probability; Bayes' Theorem; Random variables: discrete and continuous; Expectation, variance, standard deviation; Covariance, correlation, joint and marginal distributions; Common distributions: Bernoulli, Binomial, Normal; Applications in ML: Naive Bayes, probabilistic modeling

Module 3:

Optimization for Learning (9 Hours)
Optimization in Machine Learning, Loss functions (MSE, Cross-Entropy – intuitive level),Convex vs non-convex functions, Basics of gradient descent and stochastic gradient descent, Learning rate and convergence, Applications: Optimization in linear models and neural networks

Module 4:

Information Theory and Learning Bounds (9 Hours)
Entropy: definition and intuition; Cross-entropy and KL-divergence; Mutual information and its significance; Maximum Likelihood Estimation (MLE) and Maximum A Posteriori (MAP); Bias-variance trade-off; Loss functions for classification and regression; Applications: Classification, decision trees, model evaluation

Module 5:

Mathematical Tools in Practice (9 Hours)
Distance metrics: Euclidean, Manhattan, cosine similarity; Norms (L1, L2), feature scaling and normalization; Linear models: least squares, logistic regression, decision theory and loss functions, perceptron algorithm, basics of kernels; Role of math in k-means clustering, SVM; Probabilistic models: Naïve Bayes

Labs / Practicals:

N/A

References:

1. Pankaj Jalote – Mathematical Foundations of Computer Science, Wiley India.
2. B. Yegnanarayana – Artificial Neural Networks, PHI Learning.
3. S. Kumaran & A. Rajesh – Mathematical Foundations for Machine Learning and AI, McGraw Hill India.
4. S. Kumaresan – Linear Algebra: A Geometric Approach, Prentice-Hall of India.
5. Veerarajan T. – Probability, Statistics and Random Processes, McGraw Hill Education India.
6. S. Venkatesh – Foundations of Machine Learning, Universities Press (India)

Course Code	Course Name	L	T	P	Cr
DOAI250032	Machine Learning	3	0	2	4

Course Outcomes:

CO1: Identify and extract relevant features from raw IoT data suitable for applying appropriate Machine Learning (ML) techniques.
CO2: Evaluate and compare the strengths and limitations of various ML algorithms across diverse application domains, particularly in IoT.
CO3: Select and implement appropriate ML models based on data characteristics and application requirements.
CO4: Mathematically formulate and analyze ML models and algorithms, including their underlying assumptions and performance metrics.
CO5: Design and validate machine learning-based solutions for real-world problems in IoT, demonstrating practical understanding and technical proficiency.

Module 1:

Module 1
Introduction: Introduction to Machine Learning: Introduction. Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance.
Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.

Module 2:

Module 2
Decision tree learning: Introduction, Decision tree representation, appropriate problems for decision tree learning, the basic decision tree algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning, Python exercise on Decision Tree.
Instance based Learning: K nearest neighbor, the Curse of Dimensionality, Feature Selection: forward search, backward search, univariate, multivariate feature selection approach, Feature reduction (Principal Component Analysis), Python exercise on KNN and PCA. Recommender System: Content based system, Collaborative filtering based.

Module 3:

Probability and Bayes Learning: Bayesian Learning, Naïve Bayes, Python exercise on Naïve Bayes, Logistic Regression.
Support Vector Machine: Introduction, the Dual formulation, Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem.

Module 4:

Artificial Neural Networks: Introduction, Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, multilayer networks and the back propagation algorithm.

Module 5:

Ensembles: Introduction, Bagging and boosting, Random forest, Discussion on some research papers.
Clustering: Introduction, K-mean clustering, agglomerative hierarchical clustering, Python exercise on k-mean clustering.

Labs / Practicals:

1 Write a Python program that imports a dataset of your choice, displays the first five rows, and prints the data type of the DataFrame as a whole. Then, generate and display the statistical summary (mean, median, standard deviation, etc.) for each column and provide complete information about the DataFrame.

2 Write a Python program to import (or create) a dataset with missing values, display the count of missing values per column, and handle them using both imputation and dropping methods. Then, compare the dataset before and after handling missing values, and display the final cleaned dataset.

3 Write a Python program to load (or create) a dataset, split it into training and testing sets, and standardize the features using StandardScaler from sklearn. preprocessing. Finally, display the dataset before and after standardization to observe the changes.

4 Write a Python program to load (or create) a dataset, separate it into predictor variables (X) and target variable (y), and then split the dataset into training and testing sets. Finally, print both the training and testing datasets.

5 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 Python ML library classes in the program.

6 Write a Python program to load (or create) a dataset with missing values, count missing values in each column, and handle them by replacing with NaN, the column mean, and the most frequent value. Finally, display the dataset before and after performing the replacements.

7 Write a Python program to load (or create) a dataset, split it into training and testing sets, and apply feature scaling to the data. Finally, display the dataset before and after scaling to observe the changes.

8 Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.

9 Implement the working principle of Artificial Neural Network with feed forward and feed backward principle.

10 Implement and demonstrate the working of SVM algorithm for classification.

References:

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

2. C. M. Bishop. Pattern Recognition and Machine Learning. First Edition. Springer, 2006. (Second Indian Reprint, 2015).

3. Tom M. Mitchell, “Machine Learning”, McGraw-Hill, 2010

4. P. Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition, Cambridge University Press, 2012.

Course Code	Course Name	L	T	P	Cr
DASH250095	Research Methodology and IPR	3	1	0	4

Course Outcomes:

CO1: Understand the principles and process of research methodology.
CO2: Apply appropriate research design and data collection methods in computing projects.
CO3: Analyze and interpret qualitative and quantitative data using statistical tools.
CO4: Develop ethically sound, well-documented research or project reports conforming to academic and industrial standards.
CO5: Understand various forms of intellectual property and apply processes for protection and patent filing.

Module 1:

Introduction to Research and Research Ethics
Definition and objectives of research, types of research – fundamental, applied, exploratory, empirical, significance of research in computer applications, research ethics and integrity, plagiarism, citation styles (APA, IEEE), tools for plagiarism check.

Module 2:

Research Design and Data Collection
Research problem identification and formulation, hypothesis generation, literature review techniques, types of research design: experimental, descriptive, analytical, sampling techniques, primary and secondary data sources, survey design, case study design.

Module 3:

Data Analysis and Interpretation
Quantitative and qualitative data analysis, measures of central tendency and dispersion, t-test, ANOVA, correlation and regression, chi-square test, software tools: Excel, R, SPSS (demo-level), data visualization and result interpretation.

Module 4:

Technical Writing and Project Report Preparation
Structure of research papers and reports, abstract, introduction, literature review, methodology, results, and conclusions, referencing tools (Mendeley/Zotero), IEEE/ACM/SCI journal guidelines, thesis and dissertation formatting, proposal writing basics.

Module 5:

Intellectual Property Rights and Patent Process
Introduction to IPR: patents, copyrights, trademarks, industrial design, Indian and international patent systems (WIPO, TRIPS), criteria for patentability, patent filing process in India (IPINDIA portal), open-source licenses, patent drafting basics, IPR in software and AI innovations.

Labs / Practicals:

N/A

References:

1. C.R. Kothari & Gaurav Garg – Research Methodology: Methods and Techniques, New Age International.
2. Ranjit Kumar – Research Methodology – A Step-by-Step Guide, Sage Publications India.
3. P. Narayan – Intellectual Property Law, Eastern Book Company.
4. Neeraj Pandey & Khushdeep Dharni – Intellectual Property Rights, PHI Learning.
5. Yogesh Kumar Singh – Fundamentals of Research Methodology and Statistics, New Age International.
6. Bharat Bhushan – Research Methodology in Computer Science, Himalaya Publishing.
7. WIPO and IPIndia Manuals – Guidelines for Filing Patents in India.

Course Code	Course Name	L	T	P	Cr
DOAI250042	Optimisation Techniques	3	1	0	4

Course Outcomes:

CO1: Understand mathematical foundations and unconstrained optimization methods for solving optimization problems.
CO2: Apply gradient-based optimization techniques and analyze their applications in machine learning and neural networks.
CO3: Implement constrained optimization methods using Lagrange multipliers, KKT conditions, and duality theory.
CO4: Analyze and apply nature-inspired metaheuristic algorithms for AI and ML optimization tasks.
CO5: Utilize optimization techniques in supervised and unsupervised ML applications, including PCA, regression, and SVMs.

Module 1:

Mathematical Foundations and Unconstrained Optimization:
Mathematical Preliminaries: Vector Spaces and Matrices, Calculus Concepts- Gradients, Hessians, Taylor series.
Optimization Basics: Definitions, problem formulation, Necessary and sufficient conditions for local optima, Convex sets and convex functions.
One-Dimensional Optimization: Golden Section Search, Fibonacci Method, Newton’s and Secant Methods.

Module 2:

Gradient-Based Optimization and Applications in ML:
Multidimensional Optimization: Steepest Descent Method and convergence analysis, Newton’s and Quasi-Newton Methods- DFP, BFGS.
Conjugate Gradient Methods for Quadratic and Non-Quadratic functions.
Solving Systems of Equations via Optimization.
Application in Neural Networks- Backpropagation as gradient descent.

Module 3:

Constrained Optimization Techniques:
Equality and Inequality Constraints: Lagrange Multipliers, Karush-Kuhn-Tucker (KKT) conditions.
Convex Optimization: Duality Theory: Weak and Strong Duality.
Algorithms for Constrained Problems: Projected Gradient Methods, Penalty Methods

Module 4:

Nature-Inspired Metaheuristics for AI & ML:
Introduction to Metaheuristics, Simulated Annealing, Genetic Algorithms, Differential Evolution.
Swarm Intelligence: Particle Swarm Optimization, Ant Colony Optimization, Bee Colony Optimization, Firefly and Bat Algorithms, Comparison with classical methods

Module 5:

Optimization in Machine Learning Applications: Optimization in Supervised and Unsupervised ML, Feature Engineering: PCA and Linear Autoencoder, Stochastic Gradient Descent and Variants (SVRG), Regularized Linear and Logistic Regression, Support Vector Machines (SVM) and Hinge Loss, Kernel Methods and Optimization

Labs / Practicals:

NA

References:

1. Edwin K. P. Chong, Wu-Sheng Lu, Stanislaw H. Zak. – An Introduction to Optimization with Applications to

Machine Learning, 5th Ed., Wiley, 2024.
2. Xin-She Yang – Nature-Inspired Metaheuristic Algorithms, 2nd Ed., Luniver Press, 2010
3. Hamdy A. Taha, Operations Research, Prentice Hall, Pearso.
4. J. S Arora, Introduction to optimum design, 2nd edition, Elsevier India Pvt. Ltd.,
5. S. S Rao, Optimization: theory and application, Wiley Eastern Ltd., New Delhi.

Course Code	Course Name	L	T	P	Cr
DOAI250006	Deep Learning Techniques	3	0	2	4

Course Outcomes:

CO1: Understand basics of machine learning and implement regression models using TensorFlow and Keras.
CO2: Apply activation functions and perceptron models to solve linear and non-linear problems.
CO3: Design CNN architectures and address underfitting and overfitting issues.
CO4: Develop RNN, LSTM, and GRU models for sequential data processing.
CO5: Apply deep learning techniques to vision, NLP, speech, and video analytics applications.

Module 1:

Introduction: Overview of machine learning, linear classifiers, loss functions Introduction to Tensor Flow: Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, Tensor Board, Modularity, Sharing Variables, Keras

Module 2:

Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Soft max Perceptrons: What is a Perceptron, XOR Gate Artificial Neural Networks: Introduction, Perceptron Training Rule, Gradient Descent Rule, vanishing gradient problem and solution

Module 3:

Convolutional Neural Networks: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, problem and solution of under fitting and over fitting

Module 4:

Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, GRU, Encoder Decoder architectures

Module 5:

Deep Learning applications: Image segmentation, Object detection, Attention model for computer vision tasks, Natural Language Processing, Speech Recognition, Video Analytics

Labs / Practicals:

List of Experiment

1. Loading and Visualizing the MNIST Handwritten Digit Dataset
2. Classification of MNIST handwritten digits.
3. Developing a Binary Classification Model for Disease Risk Prediction using ANN
4. Image classification using CNN, 2 Convolutional layers on MNIST and CIFAR-10 dataset.
5. Handling and evaluating imbalance data using resampling, ensemble method and custom loss function.
6. Image data augmentation using Keras.
7. Implementation of ANN using backpropagation with different activation function.
8. Implementation of deep feed forward ANN with 4 hidden layer backpropagation.
9. Time series forecasting using deep learning network using LSTM.
10. Image data comparison using autoencoder neural network on CIFAR-10 dataset.
11. Implementation of deep CNN for multiclass image classification and comparison of CPU-vs-GPU training performance.

References:

1. Satish Kumar, Neural Networks - A Class Room Approach, Second Edition, Tata McGraw-Hill, 2013
2. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.
3. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep learning, MIT Press, Available online: http://www.deeplearningbook.org, 2016

Course Code	Course Name	L	T	P	Cr
DOAI260001	AI (Industry)-Applied Ethics for AI	3	0	2	4

Course Outcomes:

CO1. Understand and be able to define and explain the terms 'AI for good' and 'responsible AI'. Describe the significance of responsible AI and recognize the potential benefits of AI in society.
CO2. Discuss and examine the impact of ethics on AI decision-making processes. Identify common ethical pitfalls in AI development and deployment. Explore methods for ethical AI practices.
CO3. Understand to apply an ethics-first approach to AI project planning and development. Compare different approaches to ethical AI design which include design of rules based on ethics and virtues. Identify factors influencing ethical decisions in AI development.
CO4. Apply Utilitarian and Kantian ethical principles to AI case studies, scenarios, and dilemmas. Explain the purpose and benefits of AI ethics codes. Develop a code of ethics for AI within an organization.
CO5. Identify the importance of interpretability in AI models. Evaluate the strengths and weaknesses of three different explainable AI tools: SHAP, LIME, and Tree Interpreter.
CO6. Conduct impact assessments for AI solutions. Apply ethical considerations in designing an AI system or solution. Implement measures to mitigate ethical risks and challenges post deployment.

Module 1:

Introduction to AI Ethics – meaning and importance, Role of Ethics in Responsible AI – defining 'AI for good' and 'responsible AI', significance of responsible AI in society, Common Ethical Pitfalls in AI – bias, fairness, accountability, transparency issues in AI development and deployment, Principles of Ethical AI – core principles guiding ethical AI, methods for ethical AI practices in development and deployment.

Module 2:

Ethics-First Approach in the AI Project Cycle – applying ethics at every stage of AI project planning and development, Approaches for Designing Ethical AI – rules-based ethics, values-based design, Introduction to Ethical Frameworks – overview of major ethical frameworks applied to AI, Virtue-Based Ethics – virtue ethics principles and the 4-box method for analysing ethical dilemmas, Applying Bio-Ethics Framework in AI – bioethical principles applied to AI in healthcare and biotechnology.

Module 3:

Utilitarianism for Ethical AI – utilitarian principles applied to AI case studies and dilemmas, Kantianism for Ethical AI – Kantian ethical principles applied to AI scenarios, Code of AI Ethics for Organizations – purpose, benefits and development of an organizational AI code of ethics, Data Protection and AI – risks of data breaches, privacy violations, responsible data handling.

Module 4:

Explainable AI – importance of interpretability in AI models, Intel XAI Toolkit, impact of explainability on decision-making and trust, Explainable AI in Practice – SHAP, LIME and Tree Interpreter tools: strengths, weaknesses and methods for applying them to analyze and interpret AI applications.

Module 5:

Impact Assessment of AI Solutions – conducting impact assessments for AI systems, Mitigating Ethical Issues Post Deployment – strategies to identify and resolve ethical risks after deployment, Project Creation – creating an AI startup with data card, model card, code of ethics, explainability report, impact self-assessment and transparency report.

Labs / Practicals:

1. Develop comprehensive Data Cards for datasets, as outlined in the Data Cards Playbook by Google, to ensure transparency and accountability in AI training data.
2. Design Responsible AI Best Practices.

3. Apply Human-Centered AI Canvas to design AI systems that address user needs and ethical considerations.
4. Learn to use The Box to embed AI principles into organizational workflows and operations.
5. Apply bio-ethics principles to AI case studies, scenarios, and dilemmas; evaluate the impact of virtue-based ethics on AI systems.
6. Develop AI ethics cards for given AI scenarios. Analyse a variety of ethical dilemmas by following the 4-box method from Virtue Ethics.
7. Analyse a variety of ethical dilemmas by walking through the ethical frameworks: Virtue Ethics, Bioethics, Utilitarian, Kantian, and Moral System Agnostic.
8. Develop an AI Code of Ethics for a fictitious company.
9. Use the UXAI Toolkit to brainstorm and plan different explainable interfaces for AI applications. Use the explainable AI library SHAP to create an explainability report for income prediction on the standard adult census income dataset.
10. Conduct impact assessments for AI solutions; create your own AI startup, develop business documents, write documentation (data card, model card, code of ethics, explainability report, impact self-assessment) and create and analyze transparency report.

References:

1. Intel AI for Future Workforce – Applied Ethics for AI Course Content, Intel Digital Readiness Program.
2. Virginia Eubanks – Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor, St. Martin's Press.
3. Cathy O'Neil – Weapons of Math Destruction, Crown Publishers.
4. Kate Crawford – Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence, Yale University Press.
5. Google Data Cards Playbook – https://pair-code.github.io/datacardsplaybook/

Course Code	Course Name	L	T	P	Cr
DOAI260002	AI (Industry)-Introduction to Artificial Intelligence	3	0	2	4

Course Outcomes:

CO1. Describe what AI is and what it is not. Appreciate the history of AI and its evolution over time.
CO2. Identify and analyze current trends in AI by correlating them with other technologies like IoT, Big Data and 5G.
CO3. Identify 3 common domains of AI – Natural Language Processing, Computer Vision and Statistical Data – based on the type of underlying data.
CO4. Examine and appreciate typical steps involved in an AI Project through the AI Project Cycle.
CO5. Examine the immediate impacts of AI practices on society and appreciate the ethical concerns of AI applications.
CO6. Classify Supervised Learning, Unsupervised Learning and Reinforcement Learning with the help of examples. Discuss the roles played by different key stakeholders in a typical AI team.

Module 1:

Demystification of AI – what AI is and what it is not, History and Evolution of AI, Current trends in AI, AI and Technology convergence, Industry 4.0 and Digitalization, Role of IoT, Big Data and 5G in AI, Domains of AI – Natural Language Processing, Computer Vision and Statistical Data.

Module 2:

AI Project Cycle-I – Problem Scoping and Data Acquisition, AI Project Cycle-II – Modelling and Evaluation, Societal Impact of AI – ethical concerns and responsible practices, Elements of ML – Supervised Learning, Unsupervised Learning and Reinforcement Learning with examples.

Module 3:

Elements of AI – types and characteristics, Data as Fuel for AI – structured and unstructured data, methods of data mining and data storage, AI/Data Science Team – roles and responsibilities of key stakeholders.

Module 4:

Tools to implement AI – No-Code tools (Teachable Machine, Orange, Roboflow, Chatfuel) and Code-based tools, Introduction to Neural Networks – working of simple Neural Networks, difference between common Deep Learning models with examples and applications.

Module 5:

AI Project-I – Natural Language Processing use case using no-code tool Chatfuel, AI Project-II – Statistical Data use case using no-code tool Orange Data Mining, AI Project-III – Computer Vision use case using no-code tool Roboflow, Future Possibilities of AI – emerging software and hardware technology trends and their direct impact on development of AI.

Labs / Practicals:

1. Familiarize with AI tools and techniques, including statistical data analysis using raw graphs, computer vision applications like Vision API, and generative AI tools such as DALL·E, Stable Diffusion, Gemini, and ChatGPT.
2. Apply the AI Project Cycle to real-world scenarios by identifying problems, collecting data, developing models, and evaluating their effectiveness to propose impactful AI-based solutions.
3. Deconstruct the working behind simple Neural Networks and outline the difference between some common DL models with the help of examples and applications.
4. Explore and utilize no-code tools, such as Teachable Machine, to build AI projects.
5. Project Building using No-code tool – Orange Data Mining for Statistical Data Use cases.
6. Project Building using No-code tool – Roboflow for Computer Vision Use cases.
7. Project Building using No-code tool – Chatfuel for Natural Language Processing Use cases.
8. Classify the type of data into structured and unstructured and evaluate data quality using real datasets.

9. Explore various AI domains by running Vision API experiments and comparing outcomes from NLP, CV, and Statistical Data use cases.
10. Demonstrate the AI Project Cycle on a chosen real-world problem from an industrial or social impact perspective and present findings.

References:

1. Intel AI for Future Workforce – Introduction to AI Course Content, Intel Digital Readiness Program.
2. Stuart Russell and Peter Norvig – Artificial Intelligence: A Modern Approach, Pearson Education.
3. Andreas Mueller and Sarah Guido – Introduction to Machine Learning with Python, O'Reilly Media.
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville – Deep Learning, MIT Press.
5. Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media.

Course Code	Course Name	L	T	P	Cr
DOAI260003	AI (Industry)-Introduction to Generative AI	3	0	2	4

Course Outcomes:

CO1. Define Gen AI and distinguish its role in the broader context of AI. Describe how the basic model of Gen AI works. Discuss the wider societal impact of Gen AI.
CO2. Understand how NLP has evolved over time and the shift from Traditional AI to Gen AI. Understand Prompt Engineering and its impact on the output of NLP tasks.
CO3. Learn the limitations of current AI generation tools for video and audio. Recognize the challenges in ethical considerations and responsibilities when using generative AI tools.
CO4. Describe the stages of a generative AI project and learn to select and use appropriate AI tools for development.
CO5. Understand the basic structure of neural networks, architecture of transformer models, workings of diffusion models, and the pre-training process for generative AI models.
CO6. Learn to fine-tune generative AI models, understand RLHF, prototype Gen AI applications, and apply principles of responsible and ethical use of LLMs.

Module 1:

Introduction to Gen AI – definition and scope, role of Gen AI in the broader context of AI, how the basic model of Gen AI works, societal impact of Gen AI, Demystifying Gen AI Models – types of generative models (GANs, VAEs, Diffusion Models, LLMs), evolution of NLP to Gen AI, shift from Traditional AI to Gen AI.

Module 2:

Prompt Engineering-I – introduction to prompt engineering, basic applications and impact on NLP task outputs, text generation and conversation initiation, Prompt Engineering-II – advanced prompt engineering techniques for diverse NLP applications, real-world examples such as Mint Mobile Commercial, Basics of Video and Audio for Generation using Gen AI for Productivity-I – introduction to video generation tools (Runway ML, Genmo), text-to-video and image-to-video generation, limitations of current AI generation tools for video and audio.

Module 3:

Basics of Video and Audio for Generation using Gen AI for Productivity-II – audio and music generation using AIVA, code generation using Codeium, text generation using ChatGPT, Gemini and Perplexity, Generative AI-Ethics – ethical considerations, responsibilities and challenges when using generative AI tools, Generative AI Project Lifecycle – stages of a Gen AI project, selection of appropriate AI tools, Gen AI Tools for Development – open-source tools such as Stable Diffusion XL, proprietary tools such as Bing Image Creator powered by DALLE3.

Module 4:

Neural Network Fundamentals – basic structure and functioning of neural networks, how neural networks process data to make predictions, Transformers and the Evaluation of LLMs – architecture of transformer models, methods to evaluate large language models for performance and reliability, walkthrough of OpenAI Playground and parameter exploration, Diffusion Models and the Evaluation of Text to Image Generation – workings of diffusion models, evaluation of quality of text-to-image generation, Pre-Training Gen AI Models-I – pre-training process for generative AI models, importance of pre-training in building effective AI systems, modifying classification labels of Cohere datasets and its impact on fine-tuning and model confidence.

Module 5:

Fine-Tuning Gen AI Models – techniques for fine-tuning generative AI models to adapt them for specific tasks and applications, RLHF – Evaluating and Optimizing Gen AI Models: reinforcement learning with human feedback, evaluation and improvement of performance of generative AI models, Prototyping Gen AI Applications – skills to design, develop and test prototypes of generative AI applications, LangChain components – LLM, Agents, Prompts, Chains, Document loaders and utils with code-based implementation, LLM Application and Responsible use of AI – practical applications of large language models, ethical and responsible use of LLMs, building an AI

Tutor using open-source models such as Dolly 3B and Intel Neural Chat 7B.

Labs / Practicals:

1. Apply prompt engineering skills in basic NLP tasks, such as text generation, conversation initiation, and simple problem-solving.
2. Develop advanced prompt engineering skills for diverse NLP applications. Examine real-world prompt engineering examples, such as the Mint Mobile Commercial, to discern its role in marketing.
3. Explore cutting-edge Gen AI tools, their features, and capabilities for content generation including video and audio.
4. Explore open-source models such as Stable Diffusion XL and proprietary tools such as Bing Image Creator (powered by DALLE3) for image generation.
5. Text-to-video generation and image-to-video generation using tools like Runway ML and Genmo. Generate audio and music files using the tool AIVA.
6. Generate code by prompts using the tool Codeium. Generate text using tools like ChatGPT, Gemini, and Perplexity.
7. Walkthrough of OpenAI Playground. Explore how changing parameters can affect responses generated by different models.
8. Explore how modifying classification labels of Cohere datasets impacts fine-tuning and model confidence.
9. Explore basic components of LangChain like LLM, Agents, Prompts, Chains, and Document loaders and utils, along with a code-based implementation.
10. Utilize open-source text generation models such as Dolly 3B and Intel Neural Chat 7B for building an AI Tutor application.

References:

1. Intel AI for Future Workforce – Introduction to Generative AI Course Content, Intel Digital Readiness Program.
2. Antony Hagiwara – Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, O'Reilly Media.
3. Ashish Vaswani et al. – Attention is All You Need, Advances in Neural Information Processing Systems.
4. OpenAI – GPT-4 Technical Report, OpenAI.
5. Harrison Chase – LangChain Documentation – https://docs.langchain.com/

Course Code	Course Name	L	T	P	Cr
DOAI260004	AI (Industry)-Introduction to Machine Learning	3	0	2	4

Course Outcomes:

CO1. Describe Machine Learning and how Deep Learning is a subset of the wider field of Machine Learning.
CO2. Understand the importance of dashboards and discuss various applications of dashboards across different industries.
CO3. Explain the mathematical working behind different ML models. Implement different classification and regression ML models using Python.
CO4. Outline the difference between supervised, unsupervised and reinforcement learning algorithms. Examine the working of different reinforcement learning models.
CO5. Describe the working of Neural Networks and contrast it with biological Neurons. Describe various applications of neural networks. Outline different methods to overcome variance and bias in DL models.
CO6. Discuss and interpret the future of ML based on current and upcoming trends. Develop Python-based AI Projects incorporating Supervised Learning, Unsupervised Learning and Deep Neural Networks.

Module 1:

Introduction to Machine Learning – definition, types and applications, Relationship between AI, ML and Deep Learning, Tools to Implement AI (Python & Mathematics) – I: Python basics for ML, NumPy, Pandas, data manipulation.

Module 2:

Tools to Implement AI (Python & Mathematics) – II: mathematical foundations – linear algebra, statistics and probability, No-Code tool for Data Exploration – Tableau dashboard creation, data visualization techniques, statistical concepts implementation using no-code visualization tools.

Module 3:

AI (Modeling) Supervised Learning-I – Linear Regression, Logistic Regression, mathematical working behind models, classification and regression using Python, AI (Modeling) Supervised Learning-II – SVM, Decision Tree, industrial applications of ML models, AI (Modeling) Unsupervised Learning-I – K-Means Clustering, mathematics of clustering algorithms, AI (Modeling) Unsupervised Learning-II – Recommendation Systems, mathematics behind recommendation system, applications of recommendation systems.

Module 4:

Reinforcement Learning – definition, difference from supervised and unsupervised learning, working of reinforcement learning models with applications, Neural Network and Deep Learning-I – biological vs artificial Neurons, working of Neural Networks, applications of neural networks, Deep Learning-II – Convolutional Neural Networks, Recurrent Neural Networks, methods to overcome variance and bias in DL models, implementation using Python and deep learning frameworks, exploring OpenAI's Gym for reinforcement learning.

Module 5:

ML Project – Supervised Learning AI models: end-to-end Python project using classification/regression, ML Project – Unsupervised Learning AI models: end-to-end Python project using clustering, ML Project – Deep Neural Networks: building and training DNN in Python, Future of Machine Learning and Deep Learning – current and upcoming trends in ML and DL.

Labs / Practicals:

1. Interpret and understand the basic tools required for building ML Projects through a selected list of topics from Mathematics and Python Programming.
2. Develop and create a simple dashboard for visualizing data through Tableau.
3. Implement statistical concepts using the no-code visualization tool and create your own dashboard with the help of a no-code visualization tool.

4. Implement supervised machine learning algorithms, such as SVM and Decision Tree, using Python to develop a deeper understanding of their practical applications.
5. Implement unsupervised machine learning algorithms, such as K-Means, using Python to develop a deeper understanding of their practical applications.
6. Implement neural networks and create simple generative AI models using Python and deep learning frameworks, including exploring OpenAI's Gym for hands-on experience with AI and reinforcement learning.
7. Develop Python-based use cases and AI Projects incorporating Supervised Learning methods.
8. Develop Python-based use cases and AI Projects incorporating Unsupervised Learning methods.
9. Develop Python-based use cases and AI Projects incorporating Deep Neural Networks.
10. Implement a recommendation system using Python and evaluate its performance on a real-world dataset.

References:

1. Intel AI for Future Workforce – Introduction to Machine Learning Course Content, Intel Digital Readiness Program.
2. Andreas Mueller and Sarah Guido – Introduction to Machine Learning with Python, O'Reilly Media.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville – Deep Learning, MIT Press.
4. Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media.
5. Christopher Bishop – Pattern Recognition and Machine Learning, Springer.

Course Code	Course Name	L	T	P	Cr
DASH250015	Cognitive Systems	3	1	0	4

Course Outcomes:

CO1 : Demonstrate a thorough understanding of cognitive systems principles.
CO2 : Apply knowledge of cognitive science concepts to analyze and solve complex problems.
CO3 : Design and implement computational models of cognitive processes.
CO4 : Develop cognitive robotics systems capable of sensorimotor integration, spatial cognition, and human-robot interaction.
CO5 : Critically evaluate the ethical, societal, and practical implications of cognitive systems and their applications.

Module 1:

Introduction
Introduction to Cognitive Systems Overview of cognitive systems, Historical development, Interdisciplinary nature, Basic concepts in cognitive science, Cognitive architectures, Applications of cognitive systems, Cognitive system modeling approaches, Cognitive development across the lifespan, Neural correlates of cognition, Ethical considerations in cognitive systems, Future trends in cognitive science.

Module 2:

Foundations of Cognitive Psychology
Cognitive Psychology Fundamentals Human cognition and perception, Memory systems, Attention and consciousness, Language processing, Problem-solving and decision-making, Learning and adaptation, Emotion and cognition, Social cognition, Cognitive biases and heuristics, Cognitive development theories, Cognitive neuroscience methods.

Module 3:

Foundations of Cognitive Robotics
Cognitive Robotics Cognitive robotics fundamentals, Embodied cognition, Sensorimotor integration, Spatial cognition, Navigation and mapping, Human-robot interaction, Cognitive architectures for robots, Developmental robotics, Robot learning and adaptation, Multi-robot systems, Ethical considerations in cognitive robotics.

Module 4:

Professional Communication and Career Development
The role of Business Presentations, Planning and organizing presentations, Team Presentations, online Presentations. Understanding yourself, Career, Goal Setting, Preparing Resume, Resume Formats, Writing Covering Letters, and Enquiry mails, Preparing for the job interview.

Module 5:

Advanced Topics in Cognitive Computing and Applications
Applications and Advanced Topics Cognitive computing applications, Autonomous systems, Cognitive modeling and simulation, Brain-computer interfaces, Ethical considerations in cognitive systems, Future trends and challenges in cognitive science, Cognitive augmentation technologies, Cognitive rehabilitation techniques, Computational psychiatry, Neuromorphic computing, Human-centered AI design principles.

References:

1)Boden, M. A. (Ed.). "Handbook of Cognitive Science: An Embodied Approach." Elsevier.
2)Russel, S., & Norvig, P. "Artificial Intelligence: A Modern Approach." Pearson.
3)Thrun, S., Burgard, W., & Fox, D. "Probabilistic Robotics." MIT Press.
4)Luger, G. F., & Stubblefield, W. A. "Artificial Intelligence: Structures and Strategies for Complex Problem Solving." Pearson.
5)Hutto, D. D., & Myin, E."Evolutionary Robotics and the Reach of Embodiment." Frontiers in Psychology.

Course Code	Course Name	L	T	P	Cr
DCSA250009	Blockchain Technology	3	1	0	4

Course Outcomes:

Upon completion of the course, the learners will be able to:
CO1: Understand the concept of blockchain and its need.
CO2: Analyze methods of cryptography for application with blockchain.
CO3: Evaluate the working of blockchain.
CO4: Understand the underlying technology of transactions, blocks, proof-of-work, and consensus building.
CO5: Identify real world problems that blockchain can solve and analyze a use case.

Module 1:

Fundamentals of Blockchains Technology, The Structure of Blockchains, Blockchain Applications, The Blockchain Life Cycle, Distributed Ledger vs Centralized System, Merkel Root, Nonce Value, Hash Algorithm, and its applications.

Module 2:

Block Ciphers; Encryptions; Secret Keys; Elliptic Curve Cryptography; Hash cryptography; Encryption vs hashing; Digital Signature; Memory Hard Algorithm, Zero Knowledge Proof.

Module 3:

Introduction: Transactions, blocks, hashes, consensus, verify and confirm blocks, peer to peer networks, blocks of data in a chain, decentralization of networks, processes & workflows, cryptocurrencies, nodes, assets, consensus; types of blockchain; chain policy; working of blockchain; life of blockchain application; privacy, anonymity and security of blockchain.

Module 4:

Hyperledger: Introduction, where can Hyperledger be used, Hyperledger architecture, Hyperledger Fabric, features of Hyperledger; Open source blockchain platform technology; Tools & services; Cloud options in blockchains AWS; Azure workbench; Hyperledger console; Consensus: Proof of work, proof of stake, delegated proof of stake, proof of burn, BlocBox Protocol.

Module 5:

History; Distributed ledger; Smart contracts; Cryptocurrency; Bitcoin protocols; Mining strategy and rewards; Ethereum – construction; DAO; GHOST; Vulnerability; Attacks; Sidechain; Namecoin

Labs / Practicals:

NA

References:

1. D. Tapscott, A. Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, Portfolio Publishers.
2. A. Antonopoulos, Mastering Bitcoin: Programming the Open Blockchain, O'Reilly.
3. P. Champagne, The Book of Satoshi: The Collected Writings of Bitcoin Creator Satoshi Nakamoto, e53 Publishing, LLC.
4. M. Swan, Blockchain: Blueprint for a New Economy, O'Reilly.

5. R. Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing.
6. R. Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Pack

Course Code	Course Name	L	T	P	Cr
DCSA250020	Computer Vision	3	0	2	4

Course Outcomes:

CO1: Explain the fundamentals of digital image formation, transformations, and low-level image processing techniques such as filtering, enhancement, and restoration.
CO2: Apply various feature extraction and representation methods (edges, corners, histograms, texture, SIFT, SURF, etc.) for image analysis and recognition.
CO3: Analyze depth estimation, multi-view geometry, and segmentation techniques to perform object detection and 3D reconstruction.
CO4: Evaluate motion analysis approaches including optical flow, spatio-temporal modeling, and background subtraction for dynamic scene interpretation.
CO5: Design computer vision solutions by integrating shape-from-X methods, reflectance models, and photometric techniques for real-world applications.

Module 1:

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, introduction to computer vision

Module 2:

Feature Extraction: Shape, histogram, color, spectral, texture, Feature analysis, feature vectors, distance /similarity measures, data preprocessing, Edges - Canny, LOG, DOG; Scale-Space Analysis-Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram, SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.

Module 3:

Depth estimation and Multi-camera views: Perspective, Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Binocular Stereopsis: Camera and Epipolar Geometry; Auto-calibration.
Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Module 4:

Motion Analysis: Optical Flow, KLT, Spatio-Temporal Analysis, Background Subtraction and Modeling, Dynamic Stereo; Motion parameter estimation.

Module 5:

Shape from X: Light at Surfaces; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges Albedo estimation; Photometric Stereo; Phong Model; Reflectance Map

Labs / Practicals:

Preparing

References:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition,

Cambridge University Press, March 2004.
4. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
5. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

Course Code	Course Name	L	T	P	Cr
DCSA250068	Soft Computing	3	0	2	4

Course Outcomes:

After completion of course, students would be able to:
CO1: Identify and describe soft computing techniques and their roles in building intelligent machines.
CO2: Apply genetic algorithms to combinatorial optimization problems.
CO3: Explain the basic concepts, components, and paradigms of neural networks, and compare them with other information processing methods.
CO4: Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
CO5: Evaluate and compare solutions by various soft computing approaches for a given problem.

Module 1:

Introduction: What is computational intelligence?- Biological basis for neural networks- Biological versus Artificial neural networks- Biological basis for evolutionary computation- Behavioral motivations for fuzzy logic, Myths about computational intelligence- Computational intelligence application areas, Evolutionary computation, computational intelligence-Adoption, Types, self-organization and evolution, Historical views of computational intelligence, Computational intelligence and Soft computing versus Artificial intelligence and Hard computing.

Module 2:

Evolutionary computation concepts and paradigms- History of evolutionary computation & overview, Genetic algorithms, Evolutionary programming &strategies, Genetic programming, Particle swarm optimization, Evolutionary computation implementations-Implementation issues, Genetic algorithm implementation, Particle swarm optimization implementation.

Module 3:

Neural Network Concepts and Paradigms- What Neural Networks are? Why they are useful, Neural network components and terminology- Topologies - Adaptation, Comparing neural networks and other information Processing methods- Stochastic- Kalman filters - Linear and Nonlinear regression - Correlation - Bayes classification -Vector quantization -Radial basis functions -Preprocessing - Post processing.

Module 4:

Fuzzy Systems concepts and paradigms - Fuzzy sets and Fuzzy logic - Approximate reasoning, Developing a fuzzy controller - Fuzzy rule system implementation.

Module 5:

Performance Metrics- General issues- Partitioning the patterns for training, testing, and validation-Cross validation - Fitness and fitness functions - Parametric and nonparametric statistics, Evolutionary algorithm effectiveness metrics, Receiver operating characteristic curves, Computational intelligence tools for explanation facilities, Case Studies for implementation of practical applications in computational intelligence.

Labs / Practicals:

preparing

References:

1. David B. Fogel and Charles J. Robinson; Computational Intelligence: The experts speak. Wiley - Intersciece 2003.
2. Neuro Fuzzy & Soft Computing - J.-S.R.Jang, C.-T.Sun, E.mizutani, Pearson Education
3. Digital Neural Network - S.Y.Kung, Prentice Hall International Inc.
4. Spiking Neural Networks - Wulfram Gerstner, Wenner Kristler, Cambridge University Press.
5. Neural Networks and Fuzzy Systems: Dynamical Systems Application to Machine Intelligence - Bart Kosko,

Prentice Hall, 1992.

Course Code	Course Name	L	T	P	Cr
DCSE250001	Advanced Algorithms and Analysis	3	1	0	4

Course Outcomes:

CO1: Learn core algorithmic techniques: greedy, dynamic programming, backtracking, and branch-and-bound.
CO2: Understand computational complexity (P, NP, NP-hard, NP-complete) and heuristic/randomized methods.
CO3: Apply analytical tools like probabilistic inequalities, amortized analysis, and competitive analysis.
CO4: Explore advanced applications in geometry, graph algorithms, network flows, and string processing.
CO5: Gain exposure to approximation and parallel algorithms, including linear programming, heuristics, and PRAMs.

Module 1:

Defining Key Terms: Algorithm complexity, Greedy method, Dynamic Programming, Backtracking, Branch-and-bound Techniques; Examples for understanding above techniques; Memory model, linked lists and basic programming skills.

Module 2:

Overview - Class P - Class NP - NP Hardness - NP Completeness - Cook Levine Theorem - Important NP Complete Problems. Heuristic and Randomized algorithms.

Module 3:

Use of probabilistic inequalities in analysis, Amortized Analysis - Aggregate Method - Accounting Method - Potential Method, competitive analysis, applications using examples.

Module 4:

Point location, Convex hulls and Voronoi diagrams, Arrangements, graph connectivity, Network Flow and Matching: Flow Algorithms - Maximum Flow – Cuts - Maximum Bipartite Matching - Graph partitioning via multi-commodity flow, Karger'r Min Cut Algorithm, String matching and document processing algorithms.

Module 5:

Approximation algorithms for known NP hard problems - Analysis of Approximation Algorithms Use of Linear programming and primal dual; local search heuristics; Parallel algorithms: Basic techniques for sorting, searching, merging, list ranking in PRAMs and Interconnection.

Labs / Practicals:

NA

References:

1. Michael T Goodric and Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples”, John Wiley and Sons, 2002.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Third Edition, The MIT Press, 2009.
3. Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, “Algorithms”, Tata McGraw-Hill, 2009.
4. Cormen, Leiserson, Rivest, and Stein. Introduction to Algorithms. 2nd ed. Cambridge, MA: MIT Press, 2001.David P. Williamson and David B. Shmoys, The Design of Approximation Algorithms

Course Code	Course Name	L	T	P	Cr
DCSE250086	Health Care and Data Analytics	3	1	0	4

Course Outcomes:

CO1. Describe the basics of healthcare data analytics.
CO2. Use biomedical image features and perform data analytics.
CO3. Apply natural language processing for data analytics
CO4. Use prediction models for healthcare data analytics.
CO5. Interpret genomic and clinical data for healthcare data analytics.
CO6. Explain data analytics applications for healthcare.

Module 1:

Introduction to Healthcare Data Analytics- Electronic Health Records– Components of EHR- Coding Systems-Benefits of EHR- Barrier to Adopting HER, Challenges- Phenotyping Algorithms.

Module 2:

Biomedical Image Analysis
Biomedical image modalities, Object detection, image segmentation, image registration, feature extraction
Genomic Data Analysis for Personalized Medicine
Genomic data generation, methods for data analysis, types of computational genomics studies towards personalized medicine.

Module 3:

Data Analysis using Natural language Processing for healthcare.
Natural Language Processing, Mining information from Clinical Text, challenges of processing clinical reports, applications.

Module 4:

Clinical Prediction Models and Data Mining for Healthcare data
Basic Statistical Prediction Models, Alternative Clinical Prediction Models, Survival Models. Association Analysis, Temporal Pattern Mining: Sequential Pattern Mining, Time-Interval Pattern Mining.

Module 5:

Visual Analytics and Integrating data for Healthcare
Medical data visualization, visual analytics for public health and population research, clinical workflow, clinicians, patients.

Labs / Practicals:

NA

References:

1. Chandan K. Reddy and Charu C Aggarwal, “Healthcare data analytics”, Taylor & Francis, 2015
2. Hui Yang and Eva K. Lee, “Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.
3. Tinglong Dai, Sridhar Tayur , “Handbook of Healthcare Analytics”, Wiley, 2018.
4. Anand J Kulkarni, Patrick Siarry,”Big Data Analytics in healthcare”,Springer,Studies in Big Data

Course Code	Course Name	L	T	P	Cr
DOAI250004	Artificial Intelligence	3	1	0	4

Course Outcomes:

CO1: Understand AI foundations, intelligent agents, and problem-solving formulations.
CO2: Apply uninformed and heuristic search strategies, and adversarial game-playing techniques.
CO3: Represent knowledge using logic, rules, and reasoning methods.
CO4: Analyze different learning approaches including neural networks and connectionist models.
CO5: Design and evaluate expert systems for domain-specific knowledge representation and reasoning.

Module 1:

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.

Module 2:

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.

Module 3:

Knowledge Representation: Using Predicate logic, representing facts in logic, functions and predicates, Conversion to clause form, Resolution in propositional logic, Resolution in predicate logic, Unification.
Representing Knowledge Using Rules: Procedural Versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning

Module 4:

Learning: What is learning, Rote learning, Learning by Taking Advice, Learning in Problem-solving,
Learning from example: induction, Explanation-based learning.
Connectionist Models: Hopfield Networks, Learning in Neural Networks, Applications of Neural Networks, Recurrent Networks. Connectionist AI and Symbolic AI.

Module 5:

Expert System: Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition-examples.

Labs / Practicals:

NA

References:

1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.
2. Artificial Intelligence, Kevin Knight, Elaine Rich, B. Shivashankar Nair, 3rd Edition,2008
3. Artificial Neural Networks B. Yagna Narayana, PHI.
4. Artificial Intelligence, 2nd Edition, E.Rich and K.Knight (TMH)
5. Artificial Intelligence and Expert Systems – Patterson PHI.
6. Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.
7. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
8. Neural Networks Simon Haykin PHI.
9. Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition.

Course Code	Course Name	L	T	P	Cr
DOAI250009	Big Data Analytics	3	0	2	4

Course Outcomes:

CO1: Describe big data characteristics, challenges, and applications across industries and domains.

CO2: Evaluate and apply NoSQL databases and distributed storage architectures for big data management.

CO3: Install, configure, and operate Hadoop and HDFS for batch-oriented big data processing.

CO4: Develop and implement data analysis workflows using Hadoop ecosystem tools including Hive, Pig, and HBase.

CO5: Design and implement real-time data processing and analytics using Spark Streaming and PySpark.

CO6: Apply visualization and regression techniques for analytical insights from large-scale data.

Module 1:

Introduction to Big Data Ecosystem

Big Data Characteristics: Volume, Variety, Velocity, Veracity, and Value, Business applications and case studies of big data analytics, Challenges in conventional systems, Big Data Analytics Lifecycle, Tools and Technologies in Big Data, Hadoop vs. Traditional Systems, NoSQL Overview (Key-Value, Document, Columnar, Graph databases), Basics of MongoDB and Cassandra for big data storage.

Module 2:

Hadoop Framework for Big Data

History and Evolution of Hadoop, Hadoop Distributed File System (HDFS): Architecture, Internals, and Operations, Block-level Storage, Fault Tolerance, MapReduce Paradigm: Concepts, Anatomy of a MapReduce Job, Failures, Scheduling, Shuffle, Sort, and Task Execution, Input / Output Formats in MapReduce, Hadoop Streaming and Integrations, Developing MapReduce Applications with Java and Python APIs.

Module 3:

Data Analysis with Hadoop Ecosystem

Hive: Data Modeling, Data Types, File Formats, HiveQL (DDL, DML, DQL), Querying Structured Data, Hive Services and Optimization.
Pig: Data Flow Language, Pig Latin Programming, Grunt Shell, Data Models, Operators, Joins, Developing and Testing Pig Scripts.
HBase: Architecture, Data Model, Integration with Hadoop, Use Cases.
Introduction to Data Lakes using Hadoop.
Hands-on with Hadoop Ecosystem for ETL pipelines.

Module 4:

Real-Time Big Data Analytics and Streaming

Stream Processing Fundamentals, Stream Data Models, Stream Architecture, Concepts of Sampling, Filtering, Counting in Streams, Real-time Sentiment Analysis, Stock Market Analysis using Streams, Introduction to Apache Kafka for Streaming Data Ingestion, Spark Basics: RDD, DataFrames, Spark SQL, In-Memory Computing, PySpark APIs, Spark Streaming for Real-Time Processing, Real-Time Analytics Applications, Case

Studies.

Module 5:

Analytical Models and Visualization for Big Data

Regression Techniques: Simple Linear Regression, Multiple Linear Regression, Model Interpretation for Large-Scale Data, Feature Engineering for Big Data, Visualization Techniques: Interactive Dashboards, Graphical Tools for Big Data (Tableau / PowerBI concepts), Visual Analytics: Trends, Patterns, Correlations, Interaction Models, Real-World Applications of Big Data Visualizations.

Labs / Practicals:

1. Setting up Hadoop, HDFS, and YARN on local and cloud-based environments (AWS / Azure / GCP).

2. Developing basic MapReduce jobs using Java and Python.

3. Implementing ETL pipelines using Hive and Pig.

4. Performing analytics with HBase and Hive.

5. Real-time data streaming with Apache Kafka and Spark Streaming (using PySpark).

6. Implementing basic ML pipelines over Spark (MLlib).

7. Visualizing Big Data using interactive tools (Matplotlib, Plotly, Tableau / PowerBI).

8. Group Project: Building and deploying an end-to-end Big Data Analytics pipeline on a real-world dataset.

References:

1. Tom White, Hadoop: The Definitive Guide, 4th Edition, O’Reilly Media, 2015.

2. Anand Rajaraman, Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd Edition, 2020.

3. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons, 2012.

4. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann / Elsevier, 2011.

5. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, Learning Spark: Lightning-Fast Big Data Analysis, 2nd Edition, O’Reilly Media, 2020.

6. Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, Harness the Power of Big Data – The IBM Big Data Platform, Tata McGraw Hill, 2012.

7. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

8. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, Intelligent Data Mining, Springer, 2007.

Official Documentation (Highly Recommended for Labs / Practical Work):

9. Official documentation for Hadoop: https://hadoop.apache.org/

10. Official documentation for Spark: https://spark.apache.org/docs/latest/

11. Official documentation for Hive: https://cwiki.apache.org/confluence/display/Hive/Home

12. Official documentation for Pig: https://pig.apache.org/

13. Official documentation for HBase: https://hbase.apache.org/

14. Official documentation for Kafka: https://kafka.apache.org/documentation/

15. Official documentation for PySpark: https://spark.apache.org/docs/latest/api/python/

Course Code	Course Name	L	T	P	Cr
DOAI250019	Data Mining and Warehousing	3	0	2	4

Course Outcomes:

CO1: Understand and apply data warehousing concepts and architectures.

CO2: Perform clustering, classification, and prediction for pattern discovery.

CO3: Address issues related to data streams and implement stream mining techniques.

CO4: Analyze and apply web mining methodologies for real-world applications.

CO5: Explore current trends and advancements in distributed warehousing and pattern mining.

Module 1:

Data warehousing components, Building a data warehouse, Data warehouse architecture, DBMS schemas for decision support, Data extraction, cleanup, and transformation tools, Metadata, Reporting, Query tools and applications, Online Analytical Processing (OLAP), OLAP and multidimensional data analysis.

Module 2:

Data mining functionalities, Data preprocessing: cleaning, integration, transformation, reduction, discretization, Concept hierarchy generation, Architecture of typical data mining systems, Classification of data mining systems, Efficient and scalable frequent itemset mining methods, Mining various kinds of association rules, From association mining to correlation analysis, Constraint-based association mining.

Module 3:

Issues in classification and prediction, Classification methods: Decision Trees, Bayesian classification, Rule-based classification, Neural networks: backpropagation, Support Vector Machines (SVM), Associative classification, Lazy learners, Other classification methods, Prediction techniques, Accuracy and error measures, Evaluating classifiers/predictors, Ensemble methods, Model selection.

Module 4:

Types of data in clustering, Categorization of major clustering methods, Partitioning methods, Hierarchical methods, Density-based methods, Grid-based methods, Model-based clustering methods, Clustering high-dimensional data, Constraint-based clustering, Outlier analysis.

Module 5:

Mining objects, Spatial data mining, Multimedia data mining, Text mining, Mining the World Wide Web, Multidimensional analysis of complex data, Descriptive mining of complex data objects.

Labs / Practicals:

1. Design a Data Warehouse Schema

Create Star Schema and Snowflake Schema for business data (sales, e-commerce, etc.).

2. ETL Process Implementation

Perform Extract, Transform, Load (ETL) operations on structured data using SQL-based tools (MySQL / PostgreSQL).

3. Association Rule Mining

Apply the Apriori Algorithm for mining frequent itemsets and generating association rules from transactional datasets.

4. Classification Using Decision Trees

Build, visualize, and evaluate Decision Tree Classifiers on datasets like Iris or Titanic.

5. Clustering Using K-Means

Apply K-Means Clustering on multi-dimensional datasets and visualize the results.

6. Data Preprocessing & Dimensionality Reduction

Handle missing values, normalize data, and apply Principal Component Analysis (PCA).

7. OLAP Operations and Cube Construction

Perform OLAP operations (Roll-up, Drill-down, Slice, Dice) using sample datasets.

8. Web Mining Basics

Analyze web log files for pattern discovery (frequent user paths, sessions).

References:

1. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining Concepts and Techniques, Third Edition, Elsevier, 2011.

2. Alex Berson, Stephen J. Smith, Data Warehousing, Data Mining & OLAP, Tata McGraw-Hill, 10th Reprint, 2007.

3. K.P. Soman, Shyam Diwakar, V. Ajay, Insight into Data Mining: Theory and Practice, PHI, 2006.

4. G.K. Gupta, Introduction to Data Mining with Case Studies, PHI, 2006.

5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Education, 2007.

Course Code	Course Name	L	T	P	Cr
DOAI250028	Information Retrieval	3	1	0	4

Course Outcomes:

CO1: Understand information retrieval concepts, search engine architecture, data acquisition, and text processing techniques.
CO2: Apply ranking models, indexing, query processing, refinement, and result presentation methods.
CO3: Analyze retrieval models including Boolean, vector space, probabilistic, and machine learning-based approaches.
CO4: Evaluate search engines using test collections, effectiveness metrics, and statistical validation.
CO5: Explore advanced retrieval methods including social search, feature-based models, LSI, and multimedia retrieval.

Module 1:

Introduction: Overview of Information Retrieval, Architecture of a Search Engine,
Acquiring Data : Crawling the Web, Document Conversion, Storing the Documents, Detecting Duplicates, Noise Detection and Removal.
Processing Text: Text Statistics, Document Parsing, Tokenizing, Stopping, Stemming, Phrases, Document Structure, Link Extraction, More detail on Page Rank, Feature Extraction and Named Entity Recognition, Internationalization.

Module 2:

Ranking with Indexes Abstract Model of Ranking, Inverted indexes, Map Reduce, Query Processing: Document-at-a-time evaluation, Term-at-a-time evaluation, Optimization techniques, Structured queries, Distributed evaluation, Caching.
Queries and Interfaces: Information Needs and Queries, Query Transformation and Refinement: Stopping and Stemming Revisited, Spell Checking and Query Suggestions, Query Expansion, Relevance Feedback, Context and Personalization. Displaying the Results: Result Pages and Snippets, Advertising and Search, Clustering the Results; Translation; User Behavior Analysis.

Module 3:

Retrieval Models: Overview of Retrieval Models; Boolean Retrieval, The Vector Space Model. Probabilistic Models: Information Retrieval as Classification, The BM25 Ranking Algorithm. Ranking based on Language Models: Query Likelihood Ranking, Relevance Models and Pseudo-Relevance Feedback. Complex Queries and Combining Evidence: The Inference Network Model, The Galago Query Language. Models for Web search, Machine Learning and Information Retrieval: Learning to Rank (Le ToR), Topic Models

Module 4:

Evaluating Search Engines: Test collections, Query logs, Effectiveness Metrics: Recall and Precision, Averaging and interpolation, focusing on the top documents. Training, Testing, and Statistics: Significance tests, setting parameter values Classification and Clustering

Module 5:

Social Search: Networks of People and Search Engines: User tagging, searching within Communities, Filtering and recommending, Meta search. Beyond Bag of Words: Feature-Based Retrieval Models, Term Dependence Models, Question Answering, Pictures, Pictures of Words, etc., XML Retrieval, Dimensionality Reduction and LSI

Labs / Practicals:

NA

References:

1. Search Engines: Information Retrieval in Practice. Bruce Croft, Donald Metzler, and Trevor Strohman, Pearson Education, 2009.
2. Modern Information Retrieval. Baeza-Yates Ricardo and BerthierRibeiro-Neto. 2nd edition, Addison-Wesley, 2011.
3. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schtze, Introduction to Information Retrieval, Cambridge University Press. 2008
4. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison Wesley, 1st edition, 1999.

Course Code	Course Name	L	T	P	Cr
DOAI250031	Introduction to High Performance Computing	3	1	0	4

Course Outcomes:

CO1: Understand instruction-level parallelism, pipelining techniques, hazards, and compiler/hardware methods for ILP exploitation.
CO2: Analyze multiprocessors, thread-level parallelism, vector architectures, GPU architectures, and CUDA programming concepts.
CO3: Evaluate cache performance, virtual memory, and advanced memory optimization techniques.
CO4: Apply parallel programming platforms (OpenMP, MPI, OpenCL, OpenACC) for performance improvement in AI/ML applications.
CO5: Explain interconnection networks, clusters, SoC interconnects, and NoC architectures for parallel systems.

Module 1:

Introduction to pipelining – Types of pipelining – Hazards in pipelining - Introduction to instruction level parallelism (ILP) – Challenges in ILP - Basic Compiler Techniques for exposing ILP - Reducing Branch costs with prediction - Overcoming Data hazards with Dynamic scheduling - Hardware-based speculation - Exploiting ILP using multiple issue and static scheduling - Exploiting ILP using dynamic scheduling, multiple issue and speculation - Tomasulo’s approach, VLIW approach for multi-issue

Module 2:

Introduction to multi processors and thread level parallelism - Characteristics of application domain - Systematic shared memory architecture - Distributed shared – memory architecture – Synchronization
– Multithreading - Multithreading-fined grained and coarse grained, superscalar and super pipelining, hyper threading. Vector architectures; organizations and performance tuning; GPU architecture and internal organization, Elementary concepts in CUDA programming

Module 3:

Introduction to cache performance - Cache Optimizations - Virtual memory - Advanced optimizations of Cache performance - Memory technology and optimizations - Protection: Virtual memory and virtual machines - multi-banked caches, critical word first, early restart approaches, hardware pre-fetching, write buffer merging.

Module 4:

Introduction to parallel computing platforms; (Open MP, MPI, Open CL, Open ACC) with performance improvement analysis done using real-life AI and ML applications

Module 5:

Introduction to inter connection networks and clusters - interconnection network media - practical issues in interconnecting networks- examples - clusters - designing a cluster – System on Chip (SoC) Interconnects – Network on Chip (NOC).

Labs / Practicals:

NA

References:

1. Wang, Endong, Qing Zhang, Bo Shen, Guangyong Zhang, Xiaowei Lu, Qing Wu, and Yajuan Wang. "High-performance computing on the Intel Xeon Phi." Springer 5, 2014.
2. Sanders, Jason, and Edward Kandrot. “CUDA by example: an introduction to general-purpose GPU programming”, Addison-Wesley Professional, 2010.
3. Chandra, Rohit, Leo Dagum, David Kohr, Ramesh Menon, Dror Maydan, and Jeff McDonald. Parallel programming in Open MP. Morgan kaufmann, 2001.

4. Kaeli, David R., Perhaad Mistry, Dana Schaa, and Do

Course Code	Course Name	L	T	P	Cr
DOAI250043	Pattern Recognition	3	0	2	4

Course Outcomes:

CO1: Understand the fundamentals of pattern recognition, probability, discriminant functions, and supervised learning methods.
CO2: Apply clustering techniques for unsupervised learning and validate cluster quality.
CO3: Perform feature extraction and selection using statistical, transform-based, and dimensionality reduction methods.
CO4: Implement classification techniques using HMMs, SVMs, and feature selection methods.
CO5: Apply fuzzy logic and genetic algorithms for pattern classification in real-world case studies.

Module 1:

Overview of Pattern recognition – Basics of Probability and Statistics, Linear Algebra, Linear Transformations, Components of Pattern Recognition System, Learning and adaptation Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.

Module 2:

Clustering for unsupervised learning and classification–Clustering concept – C Means algorithm – Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.

Module 3:

Feature Extraction and Feature Selection: Feature extraction – discrete cosine and sine transform, Discrete Fourier transform, Principal Component analysis, Kernel Principal Component Analysis. Feature selection – class separability measures, Feature Selection Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms. Principle component analysis, Independent component analysis, Linear discriminant analysis, Feature selection through functional approximation – Elements of formal grammars.

Module 4:

State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.

Module 5:

Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception

Labs / Practicals:

1. Implementation of Minimum Distance Classifier
   - o Classify patterns using Euclidean distance-based decision rules.
2. Supervised Learning using Bayesian Classifier with Gaussian Assumptions
   - o Implement Bayesian classification with maximum likelihood parameter estimation.
3. Unsupervised Learning using C-Means Clustering Algorithm
   - o Perform clustering on multivariate data using the C-Means algorithm.
4. Hierarchical Clustering and Dendrogram Visualization
   - o Apply hierarchical clustering and plot dendrograms for visual analysis.
5. Feature Extraction using PCA and Kernel PCA
   - o Extract features and reduce dimensionality using PCA and Kernel PCA.
6. Sequential Forward Feature Selection Algorithm
   - o Implement and evaluate sequential forward feature selection technique.
7. Design and Training of Hidden Markov Model (HMM)
   - o Train an HMM and use it for classification of sequential data.

8. Support Vector Machine Classification using scikit-learn
o Train an SVM with linear and nonlinear kernels for binary/multi-class classification.
9. Pattern Classification using Fuzzy Inference Systems
o Implement a fuzzy rule-based classifier using membership functions.
10. Feature Selection using Genetic Algorithms
• Apply genetic algorithm for optimal feature subset selection in classification problems.

References:

1. Andrew Webb, “Statistical Pattern Recognition”, Arnold publishers, London,1999.
2. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
3. M. Narasimha Murthy and V. Susheela Devi, “Pattern Recognition”, Springer 2011.
4. Menahem Friedman, Abraham Kandel, “Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches”, World Scientific publishing Co. Ltd, 2000.
5. Robe

Course Code	Course Name	L	T	P	Cr
DOAI250045	Problem Solving Methods in Artificial Intelligence	3	0	2	4

Course Outcomes:

CO1: Understand problem-solving concepts, representations, and logic-based approaches in AI.
CO2: Apply uninformed and informed search strategies, including A* and heuristic methods, to solve problems.
CO3: Model and solve Constraint Satisfaction Problems (CSPs) using backtracking, arc consistency, and related algorithms.
CO4: Analyze combinatorial optimization problems and apply exact, heuristic, and approximation techniques.
CO5: Implement metaheuristic approaches such as Genetic Algorithms, Ant Colony Optimization, Particle Swarm, and other evolutionary algorithms for optimization.

Module 1:

Problem solving and artificial intelligence; Puzzles and games; What is a solution? Problem states and operators; Reducing problems into sub problems; Problem representation; The use of logic in problem solving; Representation and search problems.

Module 2:

State descriptions; Operators; Goal states; Graph notation; Problem reduction; Problem Solving as Search; Uninformed or blind search; Informed search; Graph searching process: Breadth-first methods, Depth first methods, Optimal search algorithms, A* search - admissibility, optimality; heuristics

Module 3:

Constraint Satisfaction Problems (CSPs); Constraints as relations; Constraint modelling and solving; Map-Coloring Problem; Constraint Graph; Methods to solve CSPs - backtracking, Forward checking, Look ahead, Arc consistency algorithms; Implementation issues of CSP algorithms.

Module 4:

Combinatorial Optimization Problems; Discrete optimization techniques: exact algorithms (linear programming), approximation algorithms heuristic algorithms. Identifying various instances of problems such as Resource allocation, Knapsack, travelling salesman etc

Module 5:

Local search and met heuristics; Single-solution based algorithms vs population based algorithms; Simulated Annealing; Tabu search; Genetic Algorithms; Scatter Search; Ant Colony Optimization; Adaptive Memory Procedures; Variable Neighborhood Search; Evolutionary Algorithms; Memetic Algorithms; Particle Swarm, The Harmony Method etc

Labs / Practicals:

NA

References:

1. Problem Solving Methods in Artificial Intelligence - Nils Nilson (McGraw-Hill).
2. How to solve it by computer - R. G. Dromey.
3. Artificial Intelligence for Humans Volume-1,2,3 - Jeff Heaton.

Course Code	Course Name	L	T	P	Cr
DOAI250049	Social Media Analytics	3	1	0	4

Course Outcomes:

CO1: Understand foundations of analytics, social media data sources, and methods of data gathering.
CO2: Apply visualization and data mining techniques in social media analytics.
CO3: Implement keyword search, classification, clustering, and transfer learning methods for social media data.
CO4: Analyze network centrality, similarity, and structural measures in social media networks.
CO5: Model and predict individual and collective behavior using social media data.

Module 1:

The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics.

Module 2:

Introduction, A Taxonomy of Visualization, The convergence of Visualization, Interaction and Analytics. Data mining in Social Media: Introduction, Motivations for Data mining in Social Media, Data mining methods for Social Media, Related Efforts

Module 3:

Introduction, Keyword search, Classification Algorithms, Clustering Algorithms Greedy Clustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.

Module 4:

Centrality: Degree Centrality , Eigenvector Centrality, Katz Centrality , Page Rank, Betweenness Centrality, Closeness Centrality ,Group Centrality ,Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence

Module 5:

Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction

Labs / Practicals:

NA

References:

1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press,ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.
3. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
4. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
5. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860- 901-6.
6. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Editio

Course Code	Course Name	L	T	P	Cr
DOAI250052	Video Analytics using AI	3	0	2	4

Course Outcomes:

CO1: Understand fundamentals of video formation, perception, and sampling techniques.
CO2: Apply digital video processing, compression, and coding standards for video analytics.
CO3: Implement vector quantization, fractal compression, and subband coding methods.
CO4: Analyze AI-based video analytics techniques for detection, tracking, and recognition.
CO5: Apply video analytics in real-world domains such as industry, retail, transportation, and business intelligence.

Module 1:

Video Formation, Perception, and Representation
Color Perception and Specification. Video Capture and Display. Analog Video Raster. Analog Color Television Systems. Digital Video. Video Sampling- Basics of the Lattice Theory. Sampling over Lattices. Sampling of Video Signals. Filtering Operations in Cameras and Display Devices

Module 2:

Video Analytics
Analog Video signal, Analog video standards, Analog video equipment, Digital Video Signal, Digital video Standards, digital Video Processing. Video Compression: Basic Concepts and Techniques of Video Coding and the H.264 Standard, MPEG1and MPEG-2Video Standards.

Module 3:

Vector Quantization, Subband Coding
Structure of vector quantizer, VC Codebook Design, Practical VQ Examples, Fractal Compression, Subband Coding: sub band decomposition, coding of subbands

Module 4:

AI Based Application of Video Analytics
Object Tracking , object detection, Loitering detection, People counting, Automatic number plate detection, motion detection, Automatic number plate recognition , crowd detection, Facial detection and recognition, optical character recognition

Module 5:

Object Detection and Recognition in Video
Texture models Image and Video classification models- Object tracking in Video. Applications and Case studies- Industrial- Retail-Transportation& Travel Remote sensing. Video Analytics for business Intelligence using AI.

Labs / Practicals:

NA

References:

1. R.G.Gupta, Audio and Video Systems, McGraw Hill l Education (India), 2nd Edition,2010.
2. Kelthjack, Video Demystified: A Handbook for the Digital Engineer,5th Edition, Newnes, 2007.
3. Intelligent Video Surveillance Systems Jean-Yves Dufour
4. Akramullah, S. (2014). Video Coding Standards. In: Digital Video Concepts, Methods, and Metrics. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4302-6713-3_3
5. Maheshkumar H Kolekar , Intelligent Video Surveillance Systems An Algorithmic Approach , Chapmanand Hall/CRC208 Pages 94 B/W Illustrations, ISBN 9781498767118, 2018

6. Video Processing and Communications, Yao Wang, J. Osternann and QinZhang, Pearson Education
7. A.M. Dhake, Televisi

Course Code	Course Name	L	T	P	Cr
DOAI260041	Natural Language Processing	2	0	4	4

Course Outcomes:

CO1. Develop the ability to collect, preprocess, and analyze textual data using NLP techniques and Python libraries
CO2. Apply text representation techniques and machine learning algorithms to build, train, and evaluate NLP classification models using appropriate performance metrics.
CO3. Develop and apply advanced NLP techniques for information extraction, text summarization, question answering, sentiment analysis, and topic modelling in real-world applications.
CO4. Design, develop, and deploy intelligent chatbot systems using rule-based and neural network-based NLP techniques following the AI project development cycle.
CO5. Evaluate and apply modern NLP concepts including Large Language Models, prompt engineering, ethical AI practices, and model interpretability techniques for responsible deployment of NLP solutions

Module 1:

Introduction to NLP, Data Collection and Processing for NLP – definition and current applications of Natural Language Processing, exploration of text data, text preprocessing pipeline – sentence segmentation, tokenization, stop word removal, stemming, lemmatization, part-of-speech tagging, handling and cleaning raw text data in Python.

Module 2:

Classification for NLP – Bag of Words (BoW) representation of text data, TF-IDF (Term Frequency-Inverse Document Frequency) format, Introduction to word embeddings. Model building for text classification – Naive Bayes classifier, Logistic Regression classifier, training and evaluating the classification model, performance metrics – precision, recall, F1-score, confusion matrix. Roadmap from MLP to LSTM and LSTM to Transformers. Attention Mechanism, Transformer architecture (BERT and GPT). Transformer-based text representation using BERT.

Module 3:

Advanced NLP Tasks and Applications - Named Entity Recognition (NER) and Relation Extraction, Text Summarization: Extractive and Abstractive Approaches, Advanced Question Answering Systems (Open-Domain, Generative QA), Sentiment Analysis and Opinion Mining, Topic Modelling. Applications of BERT in NER, sentiment analysis, and question answering, Coreference resolution, Information extraction.

Module 4:

Chatbot architecture, cosine similarity for rule-based chatbots, neural network-based intent recognition, chatbot training, and building/testing chatbots in Python. Application of the AI Project Cycle for chatbot development, including problem scoping, Data Preprocessing, Classification Model Development, and Evaluation.

Module 5:

Current Topics, Ethics, and Deployment, Large Language Models (LLMs), Capabilities and Prompt Engineering, Bias, Fairness, and Ethical Considerations in NLP Models, Model Debugging, NLP Interpretability and Explainability.

Labs / Practicals:

Explore text data that has been downloaded and processed from a given corpus.
2. Process textual data by sentence segmentation, tokenization, and stop word removal using NLTK/spaCy in Python.
3. Express data in a bag of words format and use the TFIDF format to represent text features.
4. Construct a separate dataset for model training, including train-test split and cross-validation.
5. Construct and train a text classification model using Naive Bayes or Logistic Regression in Python.

6. Evaluate the classification model using precision, recall, F1-score, and confusion matrix.
7. Implement Named Entity Recognition and relation extraction for identifying entities and relationships in text.
8. Perform text summarization using extractive and abstractive techniques, and compare the generated summaries.
9. Develop NLP applications for sentiment analysis, topic modelling, and question answering using sample datasets.
10. Use cosine similarity to build and train a simple rule-based Chatbot.
11. Use a neural network to train a more advanced Chatbot capable of intent recognition.
12. Apply the AI Project Cycle for the Hotel Chatbot problem: data collection, pre-processing, model training, and deployment.
13. Apply AI Project Cycle to develop a complete AI solution for an NLP project of choice, documenting all stages from data collection to evaluation.
14. Explore LLM capabilities using prompt engineering for NLP tasks and analyze ethical issues such as bias and fairness.
15. Apply SHAP and LIME for NLP model interpretability, debugging, and ethical analysis.

References:

Intel AI for Future Workforce – Natural Language Processing Course Content, Intel Digital Readiness Program.
2. Steven Bird, Ewan Klein, and Edward Loper – Natural Language Processing with Python, O'Reilly Media.
3. Delip Rao and Brian McMahan – Natural Language Processing with PyTorch, O'Reilly Media.
4. Yoav Goldberg – Neural Network Methods for Natural Language Processing, Morgan and Claypool Publishers.
5. Jacob Devlin et al. – BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding, Google AI.
6. Practical Natural Language Processing, Sowmya Vajjala et al. O’Reilly
7. “Attention Is All You Need”, 31st Conference on Neural Information Processing Systems (NIPS 2017), Long Beach, CA, USA.