SYLLABUS OF MINORS AND HONORS SPECIALIZATIONS IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Objectives

- To present an overview of the principles, practices and working of AI and ML.
- To develop a basic understanding of problem solving, knowledge discovery and learning methods of AI.
- To address and solve real-world problems using AI and ML.

Course Curriculum

A total of 6 courses spread across 6 semesters (starting from 3rd Semester) will be offered in these specializations. The details are as follows:

Semester Wise Course Breakup

Semester 3

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Introduction to Artificial Intelligence and Machine Learning**	2	1	0	3	3
	Total	**2**	**1**	**0**	**3**	**3**

Semester 4

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Introduction to Data Mining & Data Analytics**	2	1	0	3	3
	Total	**2**	**1**	**0**	**3**	**3**

Semester 5

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Deep Learning and Neural Networks**	2	1	0	3	3
	Total	**2**	**1**	**0**	**3**	**3**

Semester 6

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Special topics in Artificial Intelligence**	2	1	0	3	3
	Total	**2**	**1**	**0**	**3**	**3**

Semester 7

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Applications of AI**	2	1	0	3	3
	Total	**2**	**1**	**0**	**3**	**3**

Semester 8

S.No.	Course Title	Credits			Total Credits	Contact Hours per Week
		L	T	P		
1	**Python for AI**	1	0	2	3	5
	Total	**1**	**0**	**2**	**3**	**5**

Grand Total	**18 Credits**

Definition of Credit

1 hour Lecture (L) per week	1 Credit
1 hour Tutorial (T) per week	1 Credit
1 hour Practical (P) per week	0.5 Credit
2 hours Practical (P) per week	1 Credit

Course Code: **CSE201S**	Course Title: **Introduction to Artificial Intelligence and Machine Learning**	Credits: **03** L – **3** P – **0**

Course Outcomes (COs):

- Identify and pose classification and regression problems.
- Implement various machine learning algorithms using different libraries to gain hands-on experience and enhance your understanding of the field.
- Compare and study the performance of various algorithms
- Work on a machine learning project from data organization to selection of proper ML algorithm for problem solving.

Unit – I **(12)**

Approaches to AI: Turing Test and Rational Agent Approaches; State Space Representation of Problems, Heuristic Search Techniques, Game Playing, Min-Max Search, Alpha Beta Cutoff Procedures.
Neural Networks Basics: Introduction to biological neural networks, Artificial neural networks (ANN). Analogy between biological and artificial neural networks, Neuron as a basic building element of an ANN, Activation functions. Perceptron.

Unit – II **(8)**

Inductive learning algorithms, Categories of inductive learning algorithms, Rule extraction with inductive learning algorithms, ID3 algorithm, AQ algorithm, Applications of inductive learning algorithms, Decision Trees.

Unit – III **(9)**

Introduction to Machine Learning. Types of Learning. Generative and Discriminative Algorithms. Review of basic concepts of Probability Theory, Linear Algebra and Optimizations.
Introduction to machine learning libraries – scikit learn, pandas, numpy, matplotlib, seaborn, tensorflow, keras, pytorch.

Unit – IV **(10)**

Linear Regression, Logistic Regression, Naïve Bayes Classifier, Support Vector Machines, K-Nearest Neighbors, Ensemble Techniques, Bias-variance trade-off, overfitting and underfitting. training, validation and test split, Cross validation,

Unit – V **(9)**

Clustering, Euclidean and Mahalanobis Distances, K-Means and k-Means++ Algorithm, Feature selection Techniques, Eigenvalues and Eigenvectors, PCA (Principal components analysis), ICA (Independent components analysis.

Textbooks:

1. Artificial Intelligence: A Modern Approach by Stuart Russell
2. *Machine Learning. Tom Mitchell*. First Edition, McGraw- Hill, 1997.
3. *Introduction to Machine Learning*, Edition 2, by Ethem Alpaydin
4. Pattern recognition and machine learning by Christopher Bishop
5. Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly, Aurélien Géron

Reference Books:

1. AI and Machine Learning for Coders by Laurence Moroney.
2. Machine Learning with Python Cookbook

Online Resources:

1. **https://www.coursera.org/specializations/machine-learning**
2. **https://course.fast.ai**

Course Code: **CSE250S**	Course Title: **Introduction to Data Mining and Data Analytics**	Credits: **04** L – **3** P – **2**

Course Outcomes (COs):

- Can define what data mining and data warehousing is and what it can be used for.
- Can determine the different steps followed in Data mining and pre-processing for data mining.
- Can describe and apply at least two of the algorithms used for generating frequent patterns and association rules for data mining.
- Can apply at least two of the Classification methods for data mining.

UNIT – I: **(10)**

Introduction: What is data mining, Kinds of data that can be mined, Kinds of patterns that can be mined; Introduction to Data Mining Processes and Knowledge Discovery,

Knowing data: Types of Data (Structured vs. Unstructured**)** Types of attributes, Basic statistical descriptions of data, Measuring data similarity and dissimilarity (for each attribute type), cosine similarity;

UNIT – II: **(6)**

Data pre-processing: Data cleaning Handling Missing Values, Noise, and Outliers, Data integration Data reduction: Dimensionality Reduction, Data transformation, Data discretization.

Data warehouse: What is a data warehouse, Operational database system verses data warehouse, Data warehousing architecture;

UNIT – III: **(10)**

Frequent pattern mining: Basic concepts, Market basket analysis, Frequent itemset mining algorithms (Apriori algorithm, FP-growth algorithm), Mining closed and maximal patterns, Association rule mining, Correlation analysis**.**

UNIT – IV: **(10)**

Classification: What is classification, Decision tree induction, Attribute selection measures, Tree pruning, Bayes' theorem, Naive Bayesian classification, Rule-based classification, Metrics for evaluating classifier performance, Ensemble methods, K-nearest-neighbour (KNN) classifier**,** Basic Introduction to SVM.

UNIT – V: **(9)**

Clustering: What is clustering; Partitioning methods for clustering: K-Means clustering, Bisecting k-Means, K-Medoids clustering; Hierarchical methods: AGNES, DIANA, BIRCH; Density-based method: DBSCAN.

Recommended Textbook

1. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Elsevier, Third Edition.

References

1. Aggarwal C, "Data Mining", Springer.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Addison-Wesley, Pearson.
3. Mohammed J. Zaki, Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press**.**

Online resources:

1. **https://hanj.cs.illinois.edu/bk3/bk3_slidesindex.htm**
2. **https://onlinecourses.nptel.ac.in/noc21_cs06/preview**
3. **https://archive.nptel.ac.in/courses/106/105/106105174/**

Course Code: **CSE301S**	Course Title: **Deep Learning and Neural Network**	Credits: **03** L –2 P-0

Course Outcomes (COs):

- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- understand the theory behind deep learning algorithms such as Convolutional Neural Networks,
- Learn how to apply deep learning algorithms to various learning problems.
- Know the open issues in deep learning, and have a grasp of the current research directions.
- Implement deep learning algorithms and solve real-world problems.

Unit – I **(9)**

Neural Networks Basics: Introduction to biological neural networks, Artificial neural networks (ANN). Analogy between biological and artificial neural networks, Neuron as a basic building element of an ANN, Activation functions. Perceptron. Learning with a perceptron, Limitations of a perceptron, Multilayer neural networks,

Unit – II **(8)**

FeedForward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and Eigenvectors, Eigenvalue Decomposition, Basis.

Unit – III **(10)**

Principal Component Analysis and its interpretations, Singular Value
Decomposition, Autoencoders and relation to PCA, Regularization in autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout.

Unit – IV **(9)**

Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Convolutional Neural Networks, (Le-Net, AlexNet, ResNet),

Unit – V **(9)**

Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, GRU, LSTMs, Encoder Decoder Models.

Textbooks:

1. *Deep Learning*, MIT Press, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org.
2. Deep Learning for Coders with fastai and PyTorch by Sylvain Gugger and Jeremy Howard.
3. *Neural Networks and Deep Learning* by Michael Nielsen
4. Deep Learning for Vision Systems by Mohamed Elgendy

Reference Books:

1. Deep Learning with Python Francois Chollet
2. TensorFlow Deep Learning Cookbook, Packt, Antonio Gulli and Amita Kapoor.
3. Deep Learning with TensorFlow 2 and Keras by Antonio Gulli, Sujit Pal.

Online Resources:

1. http://www.cse.iitm.ac.in/~miteshk/CS6910
2. https://www.coursera.org/specializations/deep-learning

Course Code: **CSE350S**	Course Title: **Special Topics in Artificial Intelligence**	Credits: **03** L –2 P-0

Course Outcomes (COs):

- Gain foundational knowledge of artificial intelligence, including understanding of various AI models.
- Participants will develop the ability to implement basic AI solutions using popular programming languages and tools
- Critically analyze and evaluate AI technologies, considering their ethical implications and potential biases in real-world scenarios.
- Acquire the skills to effectively communicate AI concepts and their applications to both technical and non-technical audiences.

Unit – I **(9)**

Advanced neural network architectures, Optimization and regularization techniques, Unsupervised learning and deep generative models

Unit – II **(9)**

Transformer models and BERT architecture, NLP applications: translation, summarization, and sentiment analysis Ethical considerations in NLP.

Unit – III **(9)**

Convolutional neural networks (CNNs) for image and video analysis, Recent trends in computer vision: GANs, zero-shot learning, Applications in facial recognition, autonomous vehicles, and healthcare

Unit – IV **(9)**

Fundamentals of reinforcement learning, Deep reinforcement learning algorithms and their applications, Multi-agent systems and game theory

Unit – V **(9)**

Ethical considerations and societal impacts of AI technologies, Techniques for bias detection and mitigation in AI models, Explainable AI (XAI) methods and their importance

Textbooks:

1. Deep Learning, MIT Press, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org.
2. Deep Learning for Coders with fastai and PyTorch by Sylvain Gugger and Jeremy Howard.
3. Loukides, Mike, Hilary Mason, and D. J. Patil. Ethics and data science. O'Reilly Media, 2018.

Reference Books:

1. Deep Learning with Python Francois Chollet

Course Code: **CSE401S**	Course Title: **Applications of AI**	Credits: **03** L –2 P-0

Course Outcomes (COs):

- Understand the core principles and applications of AI across various industries, including healthcare, finance, and autonomous systems.
- Gain practical experience in designing and implementing AI solutions using industry-standard tools and methodologies.
- Ability to critically assess the ethical implications and societal impacts of AI technologies in real-world applications.
- Ability to effectively communicate complex AI concepts and their applications to both technical and non-technical audiences.
- Prepared to innovate and apply AI technologies in diverse sectors, driving forward the development of intelligent solutions.

Unit – I **(9)**

AI in Healthcare

Overview of AI applications in diagnostics, treatment planning, and patient monitoring, Case studies on AI-driven medical imaging and drug discovery, Ethical considerations and data privacy in healthcare AI.

Unit – II **(9)**

AI in Finance

AI for algorithmic trading, fraud detection, and risk management., Personalized banking services with chatbots and AI. Challenges and future trends in fintech AI applications, AI techniques for detecting fraudulent transactions and anomalies.

Unit – III **(9)**

Autonomous Systems

Fundamentals of autonomous vehicles and drones, AI in robotics: manufacturing, logistics, and service robots. Safety, ethics, and regulatory considerations in autonomous systems.

Unit – IV **(9)**

AI in Customer Service and CRM

Introduction to chatbots and virtual assistants, AI for personalized customer experiences and predictive analytics in CRM, Case studies on successful AI integrations in customer service.

Unit – V **(9)**

AI in art, music, and content creation, Generative AI models for design and entertainment, Ethical implications of AI in content generation and copyright issues.

Text Books:

1. Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems" by Bernard Marr
2. AI Superpowers: China, Silicon Valley, and the New World Order" by Kai-Fu Lee .

Course Code: **CSE4550**	Course Title: **Python for AI**	Credits: **03** L –2 P-0

Course Outcomes (COs):

- Gain a solid understanding of Python programming language basics.
- Demonstrate proficiency in using control structures.
- Acquire the skills to manipulate common data structures in Python.

Unit – I **(9)**

Introduction to Python: Why Python?, History, Features, and Applications, Python 2 vs. Python 3, Setting up Python Environment; Installation of Python, Introduction to IDEs (Integrated Development Environments), Python Basics; Variables, Data Types, and Operators, Basic Input and Output.

Unit – II **(7)**

Control Flow and Functions: Control Structures; Conditional Statements (if, elif, else), Loops (for, while), Functions; Defining Functions, Parameters.

Unit – III **(9)**

Data Structures in Python: Lists and Tuples; Operations and Methods, Dictionaries and Sets; Key-Value, String Manipulation; String Operations and Methods.

Unit – IV **(11)**

Introduction to NumPy :Overview of NumPy and its significance in scientific computing., Basics of NumPy arrays: creation, attributes, and indexing, Array types and conversions, Array operations, Arithmetic operations, Array reshaping, Using NumPy for mathematical computations: algebra, trigonometry, and statistics, Introduction to matrices and matrix operations.

Unit – V **(9)**

Data manipulation and analysis with Pandas, Basic data visualization with Matplotlib and Seaborn, Introduction to scikit-learn for implementing ML models. Building and evaluating models: regression, classification, and clustering.

Textbooks:

1. "Python Cookbook" by David Beazley and Brian K. Jones
2. "Fluent Python" by Luciano Ramalho

Reference Books:

1. "Python for Data Analysis" by Wes McKinney.
2. "Automate the Boring Stuff with Python" by Al Sweigart