LIST OF COURSES OFFERED FOR MINOR DEGREE IN AI&DS

S.No	Course Code	Course Title	Contact hours/week				Credits
			L	T	P	Total	
1	23ADM1	Introduction to Artificial Intelligence and Data Science	3	1	0	4	3
2	23ADM2	Introduction to Artificial Intelligence and Data Science Lab	0	0	3	3	1.5
3	23ADM3	Predictive Machine Learning Algorithms	3	1	0	4	3
4	23ADM4	Predictive Machine Learning Algorithms Lab	0	0	3	3	1.5
5	23AMM3	Fundamentals of Deep Learning	3	1	0	4	3
6	23ADM5	Introduction to Natural Language Processing	3	1	0	4	3
7	23ADM6	Introduction to Generative AI	3	1	0	4	3

B.Tech-AI&DS

23ADM1- Introduction to Artificial Intelligence and Data Science

L	T	P	Cr.
3	1	0	3

Pre-requisite: Knowledge of Computer fundamentals & Data structures & algorithms.

Course Educational Objective: The objective of the course is to provide a strong foundation of fundamental concepts in Artificial Intelligence and a basic exposition to the goals and methods of Artificial Intelligence and provide fundamentals of Data Science.

Course Outcomes: At the end of this course, the student will be able to

CO1: Enumerate the history and foundations of Artificial Intelligence. **(Understand-L2)**
CO2: Apply the basic principles of AI in problem solving. **(Apply-L3)**
CO3: Choose the appropriate representation of Knowledge. **(Understand-L2)**
CO4: Enumerate the fundamentals of data science and NumPy. **(Understand-L2)**
CO5: Summarize and compute descriptive statistics using pandas. **(Understand-L2)**

UNIT I:

Introduction: What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

UNIT II: Problem Solving: Problem-Solving Agents, Example Problems, searching for Solutions, Uninformed Search Strategies (BFS, DFS, DLS,IDDFS,UCS and BS), Informed (Heuristic) Search Strategies (BestFS,A* and AO*), Local Search Algorithms.

UNIT III: Knowledge Representation Techniques: Knowledge-Based Agents, Logic, Propositional Logic: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories.

UNIT IV: What is Data Science? Datafication, Exploratory Data Analysis, The Data science process, A data scientist role in this process.

NumPy Basics: The NumPyndarray: A Multidimensional Array Object, Creating ndarrays , Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing.

UNIT V: Getting Started with pandas: Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, DataFrame, Index Objects, Essential Functionality Reindexing, Dropping entries from an axis, Indexing and selection. Sorting and ranking, Summarizing and Computing Descriptive Statistics, Handling Missing Data, filtering out missing data.

Textbooks:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach" , 3rd Edition, Prentice Hall
2. Wes McKinney, "Python for Data Analysis",O'REILLY, ISBN:978-1-449-31979-3, 1st edition, October 2012.
3. Rachel Schutt&O'neil, "Doing Data Science", O'REILLY, ISBN:978-1-449-35865-5, 1st edition,October 2013.

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
3. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010.
4. Trivedi, M.C., "A Classical Approach to Artifical Intelligence", Khanna Publishing House, Delhi.
5. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015
6. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O'Reilly, 2016.

Web Resources:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/106106126
3. https://aima.cs.berkeley.edu
4. https://ai.berkeley,edu/project_overview.html

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B.Tech-AI&DS	23ADM2- Introduction To Artificial Intelligence and Data Science Lab	L	T	P	Cr.
		0	0	3	3

Pre-requisite: Knowledge of Computer fundamentals & Data structures& Algorithms

Course Educational Objective: The objective of the course is to provide a strong foundation of fundamental concepts in Artificial Intelligence and a basic exposition to the goals and methods of Artificial Intelligence and also provide fundamentals of Data Science.

Course Outcomes: At the end of this course,

CO1 : Apply the basic principles of AI in problem solving using Python **(Apply – L3)**

CO2 : Implement different algorithms using Python(**Apply – L3)**

CO3 : Perform various operations using numpy and pandas**(Understand - L2)**

CO4 : Improve individual / teamwork skills, communication & report writing skills with ethical values.

List of Experiments (Artificial Intelligence)

1. Implementation of DFS for water jug problem using python
2. Implementation of BFS for tic-tac-toe problem using python
3. Implementation of Hill-climbing to solve 8- Puzzle Problem using python
4. Implementation of Monkey Banana Problem using PROLOG

List of Experiments (Data Science)

1. Creating a NumPy Array
    a. Basic ndarray
    b. Array of zeros
    c. Array of ones
    d. Random numbers in ndarray
2. The Shape and Reshaping of NumPy Array
    a. Dimensions of NumPy array
    b. Shape of NumPy array
    c. Size of NumPy array
    d. Reshaping a NumPy array
3. Indexing and Slicing of NumPy Array
    a. Slicing 1-D NumPy arrays
    b. Slicing 2-D NumPy arrays
    c. Slicing 3-D NumPy arrays
    d. Negative slicing of NumPy arrays
4. Perform following operations using pandas
    a. Creating dataframe
    b. concat()
    c. Adding a new column

5. Read the following file formats using pandas
    d. Text files
    e. CSV files
    f. Excel files
    g. JSON files
6. Perform following visualizations using matplotlib
    h. Bar Graph
    i. Pie Chart
    j. Box Plot
    k. Histogram
    l. Line Chart and Subplots

Web References:

1. https://www.analyticsvidhya.com/blog/2020/04/the-ultimate-numpy-tutorial-for-data-science- beginners/
2. https://www.analyticsvidhya.com/blog/2021/07/data-science-with-pandas-2-minutes-guide-to-key- concepts/
3. https://www.analyticsvidhya.com/blog/2020/04/how-to-read-common-file-formats-python/
4. https://www.analyticsvidhya.com/blog/2016/07/practical-guide-data-preprocessing-python-scikit- learn/
5. https://www.analyticsvidhya.com/blog/2020/02/beginner-guide-matplotlib-data-visualization- exploration python/

B.Tech-AI&DS	23ADM3- Predictive Machine Learning Algorithms	L	T	P	Cr.
		3	1	0	3

Pre-requisite: Probability and Statistics

Course Educational Objective: The objective of the course is to provide the basic concepts and techniques of Machine Learning and help to use recent machine learning approaches for solving practical problems. It enables students to gain experience to do independent study and research.

Course Outcomes: At the end of this course, the student will be able to

CO1: Identify the characteristics of machine learning. **(Understand- L2)**
CO2: Understand the Model building and evaluation approaches. **(Understand- L2)**
CO3: Apply regression algorithms for real-world Problems. **(Apply- L3)**
CO4: Handle classification problems via supervised learning algorithms. **(Apply- L3)**
CO5: Learn advanced learning techniques to deal with complex data. **(Apply- L3)**

UNIT I: Introduction to Machine Learning - Introduction, Types of Machine Learning, Applications of Machine Learning, Issues in Machine Learning. Preparing to Model- Introduction, Machine Learning Activities, Basic Types of Data in Machine Learning, Exploring Structure of Data.

UNIT II: Modeling -Introduction, Model Representation and Interpretability, Evaluating Performance of a Model.
Basics of Feature Engineering- Introduction, Feature Transformation – Feature Construction, Feature Extraction, Principal Component Analysis (PCA), Feature Subset Selection

UNIT III: Regression: Introduction to regression analysis, Simple linear regression, Multiple linear regression, Assumptions in Regression Analysis, Main Problems in Regression Analysis, Polynomial Regression Model, Logistic Regression, Regularization, Regularized Linear Regression, Regularized Logistic Regression.

UNIT IV: Supervised Learning: Classification- Introduction, Example of Supervised Learning, Classification Model, and Classification Learning Steps. Common Classification Algorithms - k-Nearest Neighbor (kNN), Support vector Machines (SVM), Random Forest model.Evaluating Performance of a Model.

UNIT-V: Other Types of Learning : Ensemble Learning- Bagging, Boosting, Stacking and its impact on bias and variance, AdaBoost, Gradient Boosting Machines, XGBoost.

Reinforcement Learning - Introduction, Q Learning

Textbooks:

1. Subramanian Chandramouli,Saikat Dutt, Amit Kumar Das, "Machine Learning", Pearson Education India ,1st edition,2015.
2. Tom M. Mitchell, "Machine Learning', MGH, 1997.

Reference Books:

1. Shai Shalev-Shwartz, ShaiBen David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge.
2. Peter Harington, "Machine Learning in Action" , Cengage, 1st edition, 2012.
3. Peter Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge university press,2012.
4. Jason Brownlee, "Machine Learning Mastery with Python Understand Your Data, Create Accurate Models and Work Projects End-To-End", Edition: v1.4, 2011.

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23ADM4- Predictive Machine Learning Algorithms Lab

L	T	P	Cr.
0	0	3	3

Pre-requisite : Probability and Statistics, Python Programming

Course Educational Objective: The objective of this lab is to Make use of Data sets in implementing the machine learning algorithms in any suitable language of choice.

Course Outcomes (CO): At the end of this course, the student will be able to:

CO1: Apply the appropriate pre-processing techniques on dataset. (**Apply – L3**)

CO2: Implement supervised Machine Learning algorithms. (**Apply – L3)**

CO3: Implement advanced Machine Learning algorithms (**Apply – L3)**

CO4: Improve individual / teamwork skills, communication & report writing skills with ethical values

Experiments:

1. Basic statistical functions for data exploration.
2. Data Visualization: Box plot, scatter plot, histogram.
3. Data Pre-processing: Handling missing values, outliers, normalization, Scaling.
4. Principal Component Analysis (PCA).
5. Linear Discriminant Analysis (LDA).
6. Regression Analysis: Linear regression, Logistic regression, Polynomial regression.
7. K-Nearest Neighbour (kNN) Classifier.
8. Support Vector Machines (SVMs).
9. Random Forest model.
10. AdaBoost Classifier and XGBoost.

B.Tech-AI&DS **23AMM3- Fundamentals of Deep Learning**

L	T	P	Cr.
3	1	0	3

Pre-requisite : Probability and Statistics, LATT, Machine Learning.

Course Educational Objective: The objective of the course is to make students learn the frameworks of deep learning and their application.

Course Outcomes: At the end of this course, the student will be able to

CO1: Apply the fundamentals of linear algebra to machine learning algorithms**. (Apply- L3)**

CO2: Understand the fundamental building blocks of deep learning **(Understand- L2)**

CO3: Apply the concepts of Convolutional Neural Networks to computer vision applications**.**

(Apply- L3)

CO4: Apply the concepts of Recurrent Neural Networks to Natural Language Processing**.**

(Apply- L3)

CO5: Apply the regularization techniques to improve the model performance**. (Apply- L3**)

UNIT-I: Mathematical foundations of Deep Learning: Scalars, Vectors, Matrices and Tensors, Multiplying Matrices and Vectors, Identity and Inverse Matrices, Linear dependence and span, Norms, Special kinds of matrices and vectors, Trace operations, Eigen value decomposition.

UNIT-II: Fundamentals of Deep Learning: Anatomy of Neural Networks: Layers, Models, Loss functions and optimizers Training Deep Networks: Cost Functions, Optimizers.**Types of Deep Neural Networks**

UNIT-III: Convolutional Neural Networks: Motivation, Convolution Operation, Types of layers, Pooling, LENET5 Architecture

UNIT-IV: Recurrent Neural Networks: Architecture of traditional RNN, Types and applications of RNN, Variants of RNNs, Word Embedding using Word2vec

UNIT-V: Regularization and Autoencoders: Regularization for Deep Learning: L1 and L2, Dropout, Data Augmentation, Early Stopping, Case study on MNIST data. **Autoencoders:** Architecture, Implementation, Denoising Autoencoders, Sparse Autoencoders, Use cases

Textbooks:

1. Deep Learning, Ian Goodfellow, YoshuaBengio and Aaron Courvile, MIT Press, 2016
2. Deep Learning with Python, Francois Chollet, Manning Publications, Released December 2017.

3. Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence – Jon Krohn, Grant Beyleveld, AglaéBassens, Released September 2019, Publisher(s): Addison-Wesley Professional, ISBN: 9780135116821.
4. Deep Learning from Scratch - Seth Weidman, Released September 2019, Publisher(s): O'Reilly Media, Inc., ISBN: 9781492041412

Reference Books:

1. Artificial Neural Networks, Yegnanarayana, B., PHI Learning Pvt. Ltd, 2009.
2. Matrix Computations, Golub, G.,H., and Van Loan,C.,F, JHU Press,2013.
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-HillEducation, 2004.

Web Link:

1. Swayam NPTEL: https://onlinecourses.nptel.ac.in/noc22_cs22/preview B.Tech.(Artificial Intelligence and Data Science) Deep Learning:

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23ADM5- Introduction to Natural Language Processing

L	T	P	Cr.
3	1	0	3

Prerequisite: Knowledge of Python Programming, linear algebra, probability, calculus, Machine Learning and linguistics.

Course Educational Objectives (CEOs):

To equip students with the knowledge and skills to understand and analyze human language using computational methods, allowing them to process and interpret text data for various applications like sentiment analysis, machine translation, text summarization, and question answering, by teaching them the fundamentals of linguistics, algorithms, and machine learning techniques used in NLP tasks.

Course Outcomes: After successful completion of the course the students are able to

CO1: Understand the key concepts from NLP which are used to describe and analyze language. **(Understand-L2)**

CO2: Explain POS tagging and context free grammar for English language. **(Understand-L2)**

CO3: Make use of the rule-based system to tackle morphology/syntax of a language. **(Appy-L3)**

CO4: Demonstrate semantics and pragmatics of a language for processing. **(Apply-L3)**

CO5: Compare the use of different statistical approaches for different types of NLP Applications. **(Understand-L2)**

Unit – I: Introduction to NLP: Origins and challenges of NLP – Language Modelling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.

Unit – II: Word Level Analysis: Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

Unit – III: Syntactic Analysis: Context-Free Grammars, Grammar rules for English, Treebank's, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.

Unit – IV: Semantics and Pragmatics: Requirements for representation, First-Order Logic, Description Logics – Syntax Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selection restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

Unit – V: Discourse Analysis And Lexical Resources: Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Co reference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WorldNet ,Prop Bank, FrameNet, Brown Corpus, British National Corpus (BNC).

TEXTBOOKS:

1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, O'Reilly Media, 2009.

REFERENCE BOOKS:

1. Richard M Reese, Natural Language Processing with Java, O'Reilly Media, 2015
2. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second, Chapman and Hall/CRC Press, 2010
3. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008

B.Tech-AI&DS **23ADM6- Introduction to Generative AI**

L	T	P	Cr.
3	1	0	3

Pre-requisite: Prior knowledge of Calculus, Linear Algebra, Probability Theory, and Python programming are essential.

Course Objectives: This course aims at enabling students,

- To learn the fundamentals of Neural Networks and their various types.
- To explore Generative AI models like GANs, VAEs, and Transformers.
- To analyze the limitations of traditional RNNs and LSTMs.
- To discuss current trends and future directions in Generative AI research.

Course Outcomes: After learning the course, the students should be able to:

CO1: Understand the evolution of AI and the significance of Deep Learning. **(Understand-L2)**

CO2: Understand the various Neural Network architectures for tasks. **(Understand-L2)**

CO3: Apply various Neural Network architectures for tasks like image recognition and sequence modeling**. (Apply-L3)**

CO4: Analyzed at a preprocessing and training techniques for neural networks. **(Apply-L3)**

CO5: Understand the solutions using advanced neural networks for diverse applications.

(Understand-L2)

UNIT-I: Foundations of AI and Neural Networks: History and evolution of AI and ML, Deep learning revolution, Transfer learning ,History of Neural, Natural Language Processing, Structure of Artificial Neural Networks ,Steps in Training an Artificial Neural Network, Parameters and Hyper parameters, Back propagation.

UNIT-II: Introduction to advanced architectures: Introduction to Generative AI Models : Generative Adversarial Networks(GANs),Variational Autoencoders(VAEs)

UNIT-III: Advanced Neural Network Architectures: Transformers, Attention Mechanism in detail Long Short-Term Memory Networks (LSTMs).

UNIT-IV: Data Preprocessing: Probability and Statistics, Data Preprocessing Techniques, Model Training Techniques.

UNIT-V: Generative AI Applications: Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare Finance. Real-world use cases and challenges in deploying generative AI models.

Textbooks:

1. “Generative AI for every one: Understanding the essentials and applications of this break through technology". Altaf Rehmani.
2. "Introduction to Generative AI”, Numa Dhamani, Kindle Edition,2024. 3. "Neural Networks and Deep Learning :A Text book "by Charu C. Aggarwal.

Reference Books:

1. "Generative Adversarial Networks Cook book: Over 100 recipes to build generative models using Python, Tensor Flow, and Keras "by Josh Kalin.
2. “Generative AI in Software Development: Beyond the Limitations of Traditional Coding ”Jesse Sprinter,2024.

e-sources:

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-course s/?v=c86ee0d9d7ed.
2. https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-language-models/?v=c86ee0d9d7ed.