SARDAR PATEL UNIVERSITY, BALAGHAT

School of Engineering and Technology

Syllabus

Course: B.Tech **Semester: V**

Branch: Computer Science and Engineering (AI & ML) **w.e.f. Academic Session: 2024-25**

AIML501 Deep Learning

Course Objectives:

1. To introduce neural networks and deep learning concepts.
2. To study activation and loss functions.
3. To explore neural network architectures for classification and clustering.
4. To learn gradient descent and back-propagation.
5. To study optimization techniques like mini-batch and Adam.

Unit I: Introduction to Neural Networks and Deep Neural Networks:
Neural Networks Basics - Functions in Neural networks – Activation function, Loss function - Function approximation - Classification and Clustering problems - Deep Networks basics - Shallow Neural Networks – Activation Functions – Gradient Descent – Back Propagation – Deep Neural Networks – Forward and Back Propagation – Parameters – Hyper parameters.

Unit II: Improving Deep Neural Networks:
Mini-batch Gradient Descent – Exponential Weighted Averages – Gradient Descent with Momentum– RMSProp and Adam Optimization – Hyperparameter tuning – Batch Normalization- Softmax Regression – Softmax classifier – Deep Learning Frameworks – Data Augmentation - Under-fitting Vs Over-fitting.

Unit III: Convolution Neural Networks and Recurrent Neural Networks:
Foundations of Convolutional Neural Networks – CNN operations – Architecture – Simple Convolution Network – Deep Convolutional Models – ResNet, AlexNet, InceptionNet and others. Recurrent Neural Networks - Bidirectional RNNs, Encoder, Decoder, Sequence-to-Sequence Architectures, Deep Recurrent Networks, Auto encoders - Bidirectional Encoder Representations from Transformers (BERT).

Unit IV: Recursive Neural Networks and Advanced Neural Networks:
Long-Term Dependencies - Echo State Networks - Long Short-Term Memory and Other Gated RNNs - Optimization for Long-Term Dependencies - Explicit Memory. Transfer Learning – Transfer Learning Models – Generative Adversarial Network and their variants – Region based CNN – Fast RCNN - You Only Look Once – Single shot detector.

Unit V: Deep Reinforcement Learning:
Q-Learning – Deep Q-Learning – Policy Gradients - Advantage Actor Critic (A2C) and Asynchronous Advantage Actor Critic (A3C) – Model based Reinforcement Learning – Challenges.

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Reference Books:

1. Ian Goodfellow Yoshua Bengio Aaron Courville, Deep Learning, MIT Press, 2017.
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, first Edition, 2013.
3. N D Lewis, Deep Learning Step by Step with Python, 2016.
4. Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
5. Umberto Michelucci, Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Apress, 2018.
6. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Deep Learning with TensorFlow: Explore neural networks with Python, Packt Publisher, 2017.

Course Outcome:

At the end of the course, students should be able to:

1. Understand neural network basics.
2. Apply activation and loss functions.
3. Implement gradient descent and back-propagation.
4. Use optimization methods to improve models.
5. Work with deep neural networks for real-world problems.

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Course: B.Tech **Semester: V**

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AIML502 Internet of Things

Course Objectives:

1. To understand the Basics of IoT and its Applications.
2. To explore IoT Communication Protocols.
3. To study IoT system design using sensors and actuators.
4. To understand IoT Architecture and Challenges.
5. To learn IoT security and privacy solutions.

Unit I: Introduction to IOT:
Introduction: Definition, Characteristics of IOT, IOT Conceptual framework, IOT Architectural View, Physical design of IOT, Logical design of IOT, Application of IOT.

Unit II: IOT Communication:
Machine-to-Machine (M2M), SDN (Software Defined Networking) and NFV (Network Function Virtualization) for IOT, Data Storage in IOT, IOT Cloud Based Services.

Unit III: IOT Protocols:
Design Principles for Web Connectivity: Web Communication Protocols for connected devices, Message Communication Protocols for connected devices, SOAP, REST, HTTP Restful and Web Sockets. Internet Connectivity Principles: Internet Connectivity, Internet based Communication, IP addressing in IOT, Media Access Control.

Unit IV: Sensor Technology:
Sensor Technology , Participatory Sensing, Industrial IOT and Automotive IOT , Actuator, Sensor data Communication Protocols , Radio Frequency Identification Technology, Wireless Sensor Network Technology.

Unit V: Design Methodology:
IOT Design methodology: Specification -Requirement, process, model, service, functional & Operational View. IOT Privacy and Security Solutions, Raspberry Pi & Arduino Devices. IOT Case Studies: Smart City streetlights control & monitoring.

Reference Books:

1. Rajkamal, “Internet of Things”, Tata McGraw Hill publication.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of things (A-Hand-on-Approach)” 1st Edition, Universal Press
3. Hakima Chaouchi “The Internet of Things: Connecting Objects”, Wiley publication.
4. Charless Bell “MySQL for the Internet of things”, Apress publications.

5. Francis dacosta “Rethinking the Internet of things:A scalable Approach to connecting everything”, 1st edition, Apress publications 2013.
6. Donald Norris “The Internet of Things: Do-It-Yourself at Home Projects for Arduino,
7. Raspberry Pi and Beagle Bone Black”, McGraw Hill publication.
8. “Learning Internet of Things” by Peter Waher.

Course Outcome:

At the end of the course, students should be able to:

1. Understand IoT concepts and applications.
2. Apply IoT communication protocols.
3. Design IoT systems with sensors and actuators.
4. Address IoT security and privacy issues.
5. Develop IoT solutions for smart cities and industries.

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AIML503 Natural Language Processing

Course Objectives:

1. To introduce NLP and language models.
2. To study tokenization and POS tagging.
3. To explore syntactic and semantic analysis.
4. To understand word sense disambiguation.
5. To apply NLP in real-world tasks like translation and speech recognition.

Unit I: Introduction:

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

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, Viterbi algorithms and EM training.

Unit III: Syntactic Analysis:

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

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, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods. Compositional Semantics.

Unit V: Application of NLP:

Intelligent work processors: Machine translation, user interfaces, Man-Machine interfaces, natural language querying, tutoring and authoring systems, speech recognition, and commercial use of NLP.

Reference Books / Text Books:

1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication.

2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, OReilly Media.
3. Manning and Schutze "Foundations of Statistical Natural Language Processing", MIT Press.
4. Breck Baldwin, Language Processing with Java and LingPipe Cookbook, Atlantic Publisher.
5. Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, Chapman and Hall/CRC Press.
6. Tanveer Siddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University Press.
7. Richard M Reese, Natural Language Processing with Java, OReilly Media.

Course Outcome:

At the end of the course, students should be able to:

1. Understand NLP techniques like tokenization and POS tagging.
2. Implement syntactic and semantic analysis.
3. Apply algorithms for word sense disambiguation.
4. Use statistical models in NLP tasks.
5. Develop NLP applications for translation and speech recognition.

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AIML504 Computer Vision Techniques

Course Objectives:

1. To study image processing and computer vision basics.
2. To explore depth estimation and 3D reconstruction.
3. To learn feature extraction techniques.
4. To study motion analysis and object tracking.
5. To understand shape reconstruction methods.

Unit I: 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.

Unit II: Depth Estimation and Multi-Camera Views:
Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework, Auto-calibration.

Unit III: Feature Extraction:
Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

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

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

Reference Books:

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. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006.
4. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second

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

Course Outcome:

At the end of the course, students should be able to:

1. Understand image formation and processing techniques.
2. Implement depth estimation and 3D reconstruction.
3. Apply feature extraction methods like SIFT and SURF.
4. Use motion analysis for tracking and video processing.
5. Apply shape reconstruction methods for 3D modeling.

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Elective-I AIML5051 Artificial Neural Network

Course Objectives:

1. To introduce neural network architecture.
2. To study learning rules like Hebb‟s and LMS.
3. To explore networks like Adaline and Madaline.
4. To apply neural networks for adaptive filtering.
5. To implement neural networks for pattern recognition**.**

Unit I: Perceptron:
Perceptron Architecture, Single-Neuron Perceptron, Multi-Neuron Perceptron.

Unit II: Perceptron Learning Rule:
Perceptron Learning Rule, Constructing Learning Rules, Training Multiple-Neuron Perceptrons.

Unit III: Hebb Rule:
Simple Associative Networks- Unsupervised Hebb Rule- Hebb Rule with Decay-Instar Rule-Outstar Rule- Kohonen Rule.

Unit IV: Adaline & Madaline Networks:
Adaline Network, Madaline Network, Mean Square Error, LMS Algorithm, Back-Propagation Neural Networks, Hopfield Networks.

Unit V: Adaptive Filtering:
Adaptive Filtering, Adaptive Noise Cancellation, Forecasting, Neural Control Applications, Character Recognition.

Text Books / Reference Books:

1. Hagan Demuth Beale, „Neural network design‟, PWS publishing company, 1995
2. Freeman, J.A and Skapura, D.M., „Neural Networks-Algorithms, Applications and Programming Techniques‟ Addison Wesley, 1991
3. Satish Kumar, Neural Networks – A classroom approach‟, Tata McGraw-Hill Publishing Company Limited, 2004.
4. S. Raj sekaran, Vijayalakshmi Pari - Neural networks, Fuzzy logic and Genetic Algorithms
5. Kevin L. Priddy, Paul E. Keller -Artificial Neural Networks: An Introduction - SPIE Press,2005
6. Mohammad H. Hassoun – Fundamentals of artificial neural networks - MIT Press,1995.

7. Bishop, C. M., Neural Networks for Pattern Recognition, Oxford University Press.
8. Zurada, J. M., Introduction to Artificial Neural Systems, Jaico Publishing House.
9. Anderson, J. A., An Introduction to Neural Networks, MIT Press.

Course Outcome:

At the end of the course, students should be able to:

1. Understand neural network architecture.
2. Implement learning rules like Hebb‟s and back-propagation.
3. Work with Adaline and Madaline Networks.
4. Apply neural networks in filtering and forecasting.
5. Solve pattern recognition problems using neural networks.

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Elective-I AIML5052 Expert Systems

Course Objectives:

1. To understand expert system components.
2. To explore rule-based and non-production systems.
3. To study knowledge engineering and representation.
4. To understand inference mechanisms.
5. To develop expert systems for real-world applications.

Unit I: Overview of Expert System:
Introduction to Expert System, Major characteristics of Expert System ,Components of Expert System, Conventional Systems vs. Expert Systems, Advantages and limitations of Expert Systems.

Unit II: Architecture of Expert System:
Architecture of Expert System, Rule Based Expert System, Non Production System, Expert System Development Life Cycle, Application of Expert System, Various Expert System Shell.

Unit III: An Introduction to Knowledge Engineering:
Knowledge Base- Knowledge Engineering, Nature of Expert Knowledge, Knowledge Acquisition and Knowledge Representation, Predicate Logic, Reasoning Under Uncertainty, Semature Nets, Frames, Validity Nature Base, Working Memory.

Unit IV: Inference Engine in AI:
Inference Engine and User Interface, Techniques for Inference Mechanism, Forward Chaining and Backward Chaining, Interface Language, Terminal Interface, Inferencing and explanation.

Unit V: Development of Expert Systems:
Development of Expert Systems- Problem Formulation, Search Spaces, Task for Expert System, Application to Engineering Analysis and Design, Consideration, Case Studies of Typical Expert System.

Text Books / Reference Books:

1. A Guide to Expert System-Waterman D.A
2. Introduction to Expert System, Jackson, P, International Computer Science Series
3. Expert System: Design and Development, Macmillan.
4. Expert System: Design and Development, John Durkin, PHI.
5. Hayes-Roth, F., Lenat, D. B., Waterman, D. A., Building Expert Systems, Addison-Wesley.

6. Weiss, S. M., Kulikowski, C. A., A Practical Guide to Designing Expert Systems, Morgan Kaufmann.

Course Outcome:

At the end of the course, students should be able to:

1. Understand expert system components and architecture.
2. Design rule-based expert systems.
3. Apply knowledge engineering for knowledge acquisition.
4. Implement inference techniques like forward and backward chaining.
5. Develop expert systems for problem-solving in engineering.

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AIML506P AIML Workshop – I

Course Objectives:

1. To build a strong foundation in **Python programming** and essential libraries for AIML.
2. To develop skills in **data preprocessing, feature engineering, and exploratory data analysis**.
3. To provide hands-on experience with **machine learning algorithms** and their evaluation.
4. To introduce **deep learning concepts** and practical implementation using TensorFlow/Keras.
5. To expose students to **applied AI domains** such as NLP, Computer Vision, and Reinforcement Learning.

Unit I: Python Foundations for AIML

Python programming essentials: variables, loops, functions, OOP basics. Data structures: lists, tuples, dictionaries, sets. Libraries: NumPy (numerical computing), Pandas (data handling), Matplotlib/Seaborn (visualization). Jupyter Notebook for interactive coding. Exception Handling. File I/O. Working with CSV/JSON data.

Practicals: 1. Matrix operations with NumPy. 2. Data visualization: scatter plots, histograms, heatmaps. 3. Mini-project: Analyze student marks dataset and visualize performance trends

Unit II: Data Preprocessing & Feature Engineering

Data cleaning: missing values, duplicates, outliers. Feature scaling: normalization, standardization. Encoding categorical variables (Label Encoding, One-Hot Encoding). Exploratory Data Analysis (EDA) with Pandas and Seaborn. Feature selection techniques (correlation, chi-square, mutual information). Handling imbalanced datasets (SMOTE, undersampling/oversampling).

Practicals: 1. Preprocess Titanic dataset for survival prediction. 2. Apply feature scaling on housing dataset. 3. Perform EDA on a sales dataset. 4. Feature selection on a medical dataset (e.g., diabetes dataset).

Unit III: Machine Learning Algorithms

Supervised learning: Linear Regression, Logistic Regression, Decision Trees, Random Forest, SVM. Ensemble methods: Bagging, Boosting (AdaBoost, XGBoost). Model evaluation: accuracy, precision, recall, F1-score, confusion matrix, ROC-AUC. Unsupervised learning: K-Means clustering, Hierarchical clustering, PCA. Hyperparameter tuning (GridSearchCV, RandomizeSearchCV).

Practicals: 1. Predict house prices using Linear Regression. 2. Classify emails as spam/ham using Logistic Regression. 3. Customer segmentation using K-Means clustering. 4. Apply PCA for dimensionality reduction on image dataset. 5. Implement ensemble methods for improved accuracy.

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Unit IV: Deep Learning & Neural Networks

Basics of Neural Networks: perceptron, activation functions, backpropagation. Introduction to TensorFlow/Keras. Feedforward neural networks. Convolutional Neural Networks (CNN) basics for image data. Recurrent Neural Networks (RNN) basics for sequential data. Transfer learning, fine-tuning pre-trained models (ResNet, VGG, BERT).

Practicals: 1. Build a handwritten digit classifier using MNIST dataset. 2. Train a CNN for image classification (CIFAR-10 dataset). 3. Experiment with activation functions and optimizers. 4. Implement a simple RNN for text sequence prediction.

Unit V: Applied AI & Mini Projects

Natural Language Processing (NLP): tokenization, stemming, lemmatization, sentiment analysis, text classification. Computer Vision: image recognition, object detection basics (YOLO, Faster R-CNN overview). Reinforcement Learning basics (Q-learning, applications in games/robotics). Model deployment: saving/loading models, Flask/Django integration, cloud deployment basics. Ethical AI, bias in datasets. Explainable AI (XAI).

Practicals: 1. Sentiment analysis on movie reviews dataset. 2. Image classification using transfer learning (ResNet, VGG). 3. Build a chatbot using NLP techniques. 4. Deploy a ML model with Flask API. 5. Final Mini-Project (choose one): Spam detection system. Face recognition prototype. Chatbot for FAQs. Sales prediction model. Game-playing agent using reinforcement learning.

Reference Books

1. **Sebastian Raschka & Vahid Mirjalili –** ***Python Machine Learning*** Practical ML with Python, Scikit-Learn, and TensorFlow.
2. **Aurélien Géron –** ***Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*** Step-by-step projects with modern ML/DL frameworks.
3. **François Chollet –** ***Deep Learning with Python*** Focused on Keras and deep learning applications.
4. **Christopher M. Bishop –** ***Pattern Recognition and Machine Learning*** Theoretical foundation for ML concepts.
5. **Daniel Jurafsky & James H. Martin –** ***Speech and Language Processing*** Comprehensive text for NLP applications.

Course Outcomes:

- Strong foundation in **Python for AIML**
- Ability to **clean, preprocess, and analyze data**
- Hands-on experience with **ML & DL algorithms**
- Exposure to **NLP, Computer Vision, and Reinforcement Learning**
- Skills in **model deployment and integration**
- Completion of a **mini-project portfolio** demonstrating practical skills and real-world applications.