INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

DEEP LEARNIG TECHNIQUES								
VII Semester: CSE(DS)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACDD25	Elective	3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisites: Basic knowledge of linear algebra, calculus, probability, machine learning fundamentals, and proficiency in Python programming.								

I. COURSE OVERVIEW:

This course provides an in-depth introduction to deep learning concepts and their practical applications in solving real-world problems. It covers essential deep learning architectures such as feedforward neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and advanced models like autoencoders and transformers. The course emphasizes hands-on implementation using Python frameworks like TensorFlow and PyTorch for tasks in computer vision, natural language processing, and generative modeling. Students will learn how to design, train, evaluate, and deploy deep learning models effectively.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The theoretical foundations and mathematical principles of deep learning models.
II. The architectures and mechanisms of neural networks including CNNs, RNNs, and autoencoders.
III. Techniques for training deep models, avoiding overfitting, and optimizing performance.
IV. Real-world applications of deep learning in image processing, speech recognition, and text analytics.

III. COURSE OUTCOMES:

CO1 **Explain** the structure, function, and training process of basic artificial neural networks.
CO2 **Design** and **implement** multilayer perceptron's, convolutional and recurrent networks using deep learning frameworks.
CO3 **Analyze** the challenges in training deep networks and apply techniques such as regularization, dropout, and batch normalization
CO4 **Develop** solutions for computer vision tasks using CNN architectures such as LeNet, AlexNet, and ResNet.
CO5 **Build** and **evaluate** sequence models using RNN, LSTM, and GRU for NLP applications.
CO6 **Apply** autoencoders, GANs, and transformer models in advanced deep learning tasks like generation, summarization, and translation.

IV. COURSE CONTENT:

MODULE I: INTRODUCTION TO DEEP LEARNING (9)
Overview of Deep Learning, Neural Networks vs Traditional Machine Learning, Biological Inspiration, Perceptron, Multilayer Perceptrons (MLP), Activation Functions, Forward and Backpropagation, Loss Functions, Gradient Descent Variants (SGD, Adam)

MODULE II: CONVOLUTIONAL NEURAL NETWORKS (CNNs) (10)
Image Processing Basics, Convolution Operation, Padding, Stride, Pooling Layers, Popular CNN Architectures: LeNet, AlexNet, VGG, ResNet, Applications in Image Classification, Object Detection, and Segmentation

MODULE III: TRAINING AND REGULARIZATION TECHNIQUES (9)
Vanishing and Exploding Gradients, Initialization Techniques, Dropout, Batch Normalization, Early Stopping.

Data Augmentation, Hyperparameter Tuning, Model Evaluation Metrics: Accuracy, Precision, Recall, F1-score.

MODULE IV: RECURRENT NEURAL NETWORKS AND NLP (10)
Introduction to Sequential Data, Recurrent Neural Networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), Applications in Text Generation, Sentiment Analysis, Machine Translation, Limitations of RNNs

MODULE V: ADVANCED MODELS AND APPLICATIONS (10)
Autoencoders: Sparse, Denoising, Variational Autoencoders (VAE), Generative Adversarial Networks (GANs), Transformer Architecture, BERT Overview, Applications in Image Generation, Text Summarization, Speech Recognition, Deployment using TensorFlow Lite/ONNX

V. TEXTBOOKS:

1. **Ian Goodfellow, Yoshua Bengio, and Aaron Courville**, Deep Learning, MIT Press, **2016**
2. **François Chollet**, Deep Learning with Python, 2nd Edition, Manning Publications, **2021**
3. **Michael Nielsen**, Neural Networks and Deep Learning, Free online book, **2015**

VI. REFERENCE BOOKS:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, 2023
2. Josh Patterson & Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.

VII. WEB REFERENCES

1. NPTEL – Deep Learning by IIT Ropar
2. DeepLearning.ai - Specialization by Andrew Ng
3. PyTorch Official Tutorials
4. TensorFlow Developer Guide
5. Kaggle – Deep Learning Datasets & Competitions

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open-ended experiments

5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)