INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

DEEP LEARNING								
VII Semester: CSE (AI&ML)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACAD22	Core	3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisites: Python Programming / Applied Artificial Intelligence / Machine Learning Algorithms								

I. COURSE OVERVIEW:

A deep learning techniques course will cover the basics of deep learning, including how to build and train neural networks, and how to use them to solve problems. Deep learning techniques use multiple hidden layers to learn abstract features from data automatically. They can handle large datasets and perform feature extraction and selection efficiently. The course includes multilayer perception, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).

II. COURSE OBJECTIVES:

The students will try to learn:

I. Fundamental concepts of deep learning and neural networks.
II. Techniques for training, optimizing, and regularizing models.
III. Various advanced deep learning architectures and their applications.
IV. Practical implementation of deep learning algorithms using modern tools
V. Problem-solving challenges in computer vision, natural language processing, and other domains

III. COURSE OUTCOMES:

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

CO1 Describe the fundamental concepts and components of deep learning architecture.
CO2 Analyze optimization techniques and their role in training deep learning models.
CO3 Implement convolutional and recurrent neural networks for domain-specific applications.
CO4 Explore generative models and use them to synthesize data.
CO5 Evaluate real-world case studies in deep learning for practical insights.
CO6 Investigate emerging trends and ethical considerations in deep learning research.

IV. COURSE CONTENT:

MODULE – I: INTRODUCTION TO DEEP LEARNING (09)

Introduction to Deep Learning: Basics: Biological Neuron, Idea of computational units, McCulloch-Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

MODULE – II: OPTIMIZATION AND REGULARIZATION TECHNIQUES (10)

Optimization algorithms: Stochastic Gradient Descent (SGD), Momentum, Adam, RMSProp, Regularization techniques: Dropout, weight decay (L2 regularization), data augmentation, Batch normalization: Theory and practical advantages, learning rate scheduling: Cyclical learning rates and warm restarts, Addressing overfitting and underfitting: Practical guidelines.

MODULE – III: OPTIMIZATION AND REGULARIZATION TECHNIQUES (10)

Introduction to CNNs: Motivation and basic principles, Components of CNNs: Convolutional layers, pooling layers, padding, strides, Deep CNN architectures: AlexNet, VGGNet, ResNet, Inception Net,

Advanced techniques: Transfer learning, dilated convolutions, depthwise separable convolutions, Applications: Image classification, object detection (YOLO, SSD), and segmentation (U-Net).

MODULE – IV: RECURRENT NEURAL NETWORKS AND VARIANTS (09)

Recurrent Neural Networks: Architecture and challenges (vanishing gradient), Advanced variants: Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRUs), Attention mechanisms: Scaled dot-product attention, multi-head attention, Transformers: GPT, and applications, Use cases: Sentiment analysis, language translation, speech recognition.

MODULE – V: GENERATIVE MODELS AND ADVANCED TOPICS (10)

Generative Models: Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Applications of GANs: Data augmentation, image synthesis, style transfer, Introduction to reinforcement learning: Deep Q-learning and policy gradients, Emerging trends: Zero-shot and few-shot learning, federated learning, edge AI. Ethical considerations: Bias, interpretability, adversarial attacks, societal impact.

V. TEXTBOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, The MIT Press, 2016.
2. N. Buduma, N. Buduma and J Papa, “Fundamentals of deep learning”, O'Reilly Media, Inc,2022.

VI. REFERENCE BOOKS:

1. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2017.
2. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, First Edition, O'Reilly Media, 2017.
3. J. Patterson, and A. Gibson, “Deep learning: A practitioner's approach”, O'Reilly Media, Inc, 2017.
4. Michael Nielsen, Neural Networks and Deep Learning, Online Book.

VII. WEB REFERENCES

1. http://www.cse.msstate.edu/~ioana/Courses/CSE9133.html
2. www.cse.msstate.edu/academics/gradstud/honesty.php
3. https://www.analyticsvidhya.com/blog/2021/04/artificial-neural-network-its-inspiration-and-the-working-
4. https://nptel.ac.in/courses/106/105/106105173/
5. http://www.ai.eecs.umich.edu/.

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)