GENERATIVE ARTIFICIAL INTELLIGENCE

Code: CS31124CS	Course Type: Elective	Semester: I
Evolution Scheme (TA-MSE-ESE): 20-30-100	Total Marks: 150	L-T-P (Credits): 3-0-0 (3)

Pre-Requisites: Basic Python programming, Fundamentals of Machine Learning, Mathematics for Machine Learning (Linear Algebra, Calculus, Probability & Statistics), Foundations of Deep Learning Concepts , Basics of NLP.

Course Objective: To understand neural networks, generative AI models, transformer architectures, limitations of RNNs and LSTMs, and emerging research trends in generative artificial intelligence systems.

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

CO-1	Understand the evolution of AI and the significance of Deep Learning.
CO-2	Apply various Neural Network architectures for tasks like image recognition and sequence modeling.
CO-3	Delve into concrete examples and case studies illustrating how Generative AI is reshaping our world.
CO-4	Grasp its wide-ranging applications spanning from creative arts and design to groundbreaking healthcare solutions.

Course Articulation Matrix:

PO	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
CO-1	3	2	2	1	2
CO-2	3	3	1	-	3
CO-3	3	3	2	1	3
CO-4	3	3	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Unit-1: Foundations of AI and Neural Networks

History and evolution of AI/ML, Deep learning revolution, Transfer learning, Structure of Artificial Neural Networks, Steps in Training anArtificial Neural Network, Parameters and Hyperparameters, Backpropagation.

Unit-2: Generative AI & Advanced AI Models

Introduction to advanced architecture, Introduction to Generative AI Models: Discriminative vs. Generative Modeling, Taxonomy of Generative AI (Autoregressive, Flow-based, VAEs, GANs, Diffusion). Mathematical formulation of generative tasks, GenerativeAdversarial Networks (GANs), Variational Autoencoders (VAEs), Transformers, AttentionMechanism in detail Long Short-Term Memory Networks (LSTMs).

Unit-3: Introduction to Large Language Models and Prompt Engineering

Introduction to LLMs, History of NLP, Overview of Generative AI and Large Language Models. Basics of attention mechanisms and Transformer architecture. Deep Dive into

Attention and Transformers, Pretraining techniques and transfer learning strategies, Types of LLMs. Intro to Prompt Engineering, LLM with Prompt Engineering. Intro to Retrieval-Augmented Generation (RAG),Building applications using RAG, Fine Tuning LLMs, Parameter-Efficient Fine-Tuning (PEFT).

Unit-4: Generative AI Applications

Applications in Various Fields : Education, Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare, Agriculture, Digital Marketing and Finance. Real-world use cases and challenges in deploying generative AI models, Promt Engineering. Ethical implications and regulatory considerations in implementing Generative AI.

Learning Resources:

Textbooks:

1. Generative AI for everyone: Understanding the essentials and applications of this breakthrough technology. Altaf Rehmani.
2. Deep Generative Modeling, Tomczak J.M. Springer 2024 (2nd Edition).
3. Ripples of generative AI: Navigating AI's impact on society. Emerson, J. (2023). AI Press.
4. Generative AI (Hardcover). Pandit, R. (2024). Notion Press.
5. Introduction to Generative AI, Numa Dhamani, Kindle Edition, 2024.

Reference Books:

1. Probabilistic Machine Learning: Advanced Topics, Murphy K.P. MIT Press 2023
2. Generative Deep Learning, Foster D. O'Reilly Media 2023 (2nd Ed.)
3. Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python,TensorFlow, and Kerasy, Josh Kalin.
4. Deep Learning, Ian Good fellow, Yoshua Bengio, and Aaron Courville
5. Generative AI with Python and Tensor Flow2: Create images, text, and music with VAEs, GANs,LSTMs, Transformer models", Joseph Babcock and Raghav Bali, 2024.
6. *Generative Deep Learning* by David Foster, Forwarded by Karl Friston, 2nd Edition, (O'Reilly Media).