

Branch Name:	Bachelor of Technology (Computer Engineering / Information Technology)
Program Code:	ET103/ET105
Course Title:	Elective -IV Theory: Generative Artificial Intelligence
Course Code:	2ET1030706T
Pre-requisite Course:	Basic of Machine Learning and Artificial Intelligence

Course Objectives: The objectives of generative artificial intelligence are designed to equip students with the ability to create, rather than just analyze, complex data patterns. By the end of this course, students will be able to understand the fundamentals of generative AI, master modern generative models (GANs, VAEs, Transformers, Diffusion, and Flows), develop practical AI applications, and apply ethical and responsible AI practices.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Unit No	Topics	Total Hours	Weightage (%)
1	Introduction of Generative Modeling: Introduction to Generative vs. Discriminative Models, Taxonomy of Generative AI, Probability Distributions, Maximum Likelihood Estimation (MLE), Latent Space Representation, Manifold Hypothesis, and Evaluation Metrics (Inception Score, FID).	4	10%
2	Variational Autoencoders : Autoencoder architecture , The Reparameterization trick, Evidence Lower Bound , KL-Divergence in VAEs, Beta-VAEs, Applications in image denoising and dimensionality reduction.	5	15%
3	Generative Adversarial Networks : The Minimax Game theory, Generator and Discriminator dynamics, Training stability issues (Mode Collapse, Vanishing Gradients), GAN Variants: DCGAN (Deep Convolutional), CycleGAN (Style Transfer), StyleGAN, and Conditional GANs (cGAN).	7	20%
4	Autoregressive & Flow-based Models: PixelCNN and PixelRNN logic, Masked Language Modeling (MLM), Normalizing Flows, Invertible 1x1 convolutions, Coupling layers, and Applications in audio and speech synthesis.	5	10%
5	Large Language Models & Transformers: The Transformer revolution: Self-Attention and Cross-Attention, Positional Encoding, Encoder-only (BERT), Decoder-only , and Encoder-Decoder (T5) architectures, Prompt Engineering, Zero-shot/Few-shot learning, Fine-tuning strategies (LoRA, QLoRA).	8	25%
6	Diffusion Models & Multimodal AI: Forward & Reverse Diffusion, Denoising Diffusion Probabilistic Models , Stable Diffusion architecture, Contrastive Language-Image Pre-training, Text-to-Image synthesis, Ethics in GenAI.	7	20%

Reference Books:

1. Generative Deep Learning by David Foster, O'Reilly Media
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, MIT Press
3. Hands-On Generative AI with Transformers by Savonix & Arunkumar, Packt

List of Open-Source Software/learning website:

1. <https://developers.openai.com/cookbook>
2. <https://www.cloudskillsboost.google/paths/118>
3. <https://huggingface.co/learn/nlp-course>
4. <https://course.fast.ai/>
5. <https://docs.langchain.com/oss/python/langchain/overview>

Course Outcomes (CO):

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Explain the mathematical principles of latent space and generative theory.	Understanding (2)
CO2	Implement VAEs and GANs for image generation and style transfer.	Applying (3)
CO3	Analyze the architecture of Transformer-based models and LLMs.	Analyze (4)
CO4	Develop text-to-image or text-to-text systems using pre-trained APIs.	Create (6)
CO5	Evaluate the ethical implications and biases in generated content.	Evaluate (5)
CO6	Design and integrate Generative AI models to solve real-world applications.	Create (6)

Mapping of CO with PO and PSO

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	M	-	-	-	-	-	-	-	-	-	L	M	-	-	-
CO2	H	M	H	M	H	-	-	-	-	-	-	-	H	H	-	-
CO3	H	H	H	M	M	-	-	-	-	-	-	M	M	H	-	-
CO4	M	H	H	H	H	-	-	-	-	-	-	M	H	H	-	-
CO5	-	-	-	-	-	H	-	-	-	-	-	M	-	L	-	-
CO6	H	M	-	-	-	-	-	H	-	-	-	L	M	-	-	-

H: High, M: Medium, L: Low