

<b>COURSE TITLE</b>	<b>GENERATIVE AI</b>
<b>COURSE CODE</b>	<b>01CT0711</b>
<b>COURSE CREDITS</b>	<b>4</b>

**Objective:**

- 1 To introduce students to the fundamentals and applications of Generative Artificial Intelligence, including core techniques such as Generative Adversarial Networks (GANs), image and text generation, and the evolving impact of generative models across industries. The course aims to equip students with practical skills for implementing and evaluating generative models, with an emphasis on ethical considerations and real-world deployment.

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Apply the concepts of Generative and Non-Generative AI to analyze and classify real-world AI applications based on their underlying architecture, capabilities, and use cases
- 2 Analyze the architecture and training processes of Generative Adversarial Networks (GANs) and identify common challenges and variants.
- 3 Apply Generative AI models for image generation tasks using GANs and Variational Autoencoders (VAEs), and evaluate their outputs.
- 4 Develop and fine-tune generative models for text generation using LSTM and Transformer-based approaches.
- 5 Evaluate current trends and real-world applications of Generative AI in sectors such as healthcare, design, entertainment, and research, while assessing associated ethical and infrastructural implications.

**Pre-requisite of course:**Artificial Intelligence, Python

**Teaching and Examination Scheme**

<b>Theory Hours</b>	<b>Tutorial Hours</b>	<b>Practical Hours</b>	<b>ESE</b>	<b>IA</b>	<b>CSE</b>	<b>Viva</b>	<b>Term Work</b>
3	0	2	50	30	20	25	25

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Introduction to Generative AI</b> How does Generative AI work, Use Cases of Generative AI, what is Non Generative AI, What is Non-Generative AI, Advantages of Non-Generative AI, Disadvantages of Non-Generative AI, Difference in Output Between Generative and Non Generative AI, Difference in Output Between Generative and Non-Generative AI, Applications of Non-Generative AI, Applications of Non-Generative AI, Image Synthesis, Text Generation, Creative Design, Music Composition, Augmentation, Drug Discovery	9

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
2	<b>Understanding Generative Adversarial Networks (GAN)</b> GANs including Generator and Discriminator networks, Adversarial learning and minimax game formulation, Training process and loss functions, Challenges in training GANs such as mode collapse and vanishing gradients, Variants of GANs including DCGAN, CycleGAN, StyleGAN, and Conditional GAN (cGAN),, Ethical concerns and limitations in deploying GAN-based systems	9
3	<b>Image Generation with Generative AI</b> Introduction to Image Generation, Implementing GANs for Image Generation Training and Fine-Tuning GANs, Generating Images with VAEs, Advanced Techniques in Image Generation, Image and Video Generation Applications	10
4	<b>Text Generation with Generative AI</b> Introduction to Text Generation, LSTM-based Text Generation, Transformer-based Text Generation, Fine-Tuning Language Models, Text Generation Applications	7
5	<b>The Evolution of Generative AI</b> The Impact of Generative AI on Various Sectors, The Impact of Generative AI on Various Sectors, Trends in Generative AI, Trends in Generative AI: AI Enabling Creativity, Trends in Generative AI: Enhanced Personalization, Advancements in Gans, Conversational AI, Strengthened AI infrastructure, Scientific Research, NLP Applications	8
<b>Total Hours</b>		<b>43</b>

### Suggested List of Experiments:

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Experiments</b> Write Python scripts to implement basic operations and TensorFlow 2 tensors, Preprocess and clean datasets for Generative AI applications using Python libraries such as Pandas and NumPy. Handle missing data, normalize features, and encode categorical variables, Use Matplotlib or Seaborn to visualize data distributions and patterns in Generative AI datasets. Plot histograms, scatter plots, and heatmaps to analyze data characteristics., Implement a Generative Adversarial Network (GAN) architecture using TensorFlow 2. Train the GAN model on a dataset such as MNIST or CIFAR-10 for image generation tasks., Train a GAN model on a custom dataset for image generation. Experiment with hyperparameters, loss functions, and optimization techniques to optimize GAN training., Explore advanced techniques such as Wasserstein GANs, Progressive GANs, or StyleGANs for image generation. Implement and compare these techniques for generating high-quality images, Develop applications for image and video generation using trained Generative AI models. Use the models to generate art, create deep fakes, or synthesize video content., Text Generation: Implement a Long Short-Term Memory (LSTM)	38

network using TensorFlow 2 for text generation tasks. Train the LSTM model on a dataset of text sequences and generate new text samples., Text generation: Implement a Transformer-based language model (e.g., GPT) using TensorFlow 2 for text generation. Fine-tune the model on a text corpus and generate coherent and contextually relevant text, Text generation: Fine-tune a pre-trained language model (e.g., GPT, BERT) using transfer learning techniques. Fine-tune the model on a domain-specific dataset and evaluate its performance for text generation tasks., Text generation: Develop applications for text generation tasks such as story generation, dialogue generation, or code generation using trained Generative AI models., Music Generation: Preprocess music data and represent it in a suitable format for music generation tasks. Explore MIDI or audio representations for training Generative AI models, Music Generation: Implement a Long Short-Term Memory (LSTM) network using TensorFlow 2 for music generation. Train the LSTM model on a dataset of music sequences and generate new musical compositions., Generate Novel Music Compositions: Transformer-based Music Generation: Implement a Transformer-based architecture (e.g., MusicBERT, MusicGPT) using TensorFlow 2 for music generation. Fine-tune the model on a music dataset and generate novel music compositions., Use GANs or VAEs to augment a small dataset with synthetic samples. Evaluate the improvement in downstream task performance (e.g., classification accuracy) using augmented data., Implement and train a Conditional GAN (cGAN) where generation is controlled by class labels or attributes. Apply it on datasets like Fashion-MNIST to generate category-specific images., Apply neural style transfer using models such as CycleGAN or StyleGAN. Generate new images by blending content from one image and style from another., Use existing tools or train a simple classifier to detect GAN-generated images (deepfakes). Analyze the model's accuracy and discuss ethical considerations in deploying generative models., Combine a GAN-generated image with a transformer-based model to generate a descriptive caption. Explore how visual and textual generative models can be integrated for multimodal tasks.

**Total Hours**

**38**

**Textbook :**

- 1 Learn Python Generative AI: Journey from Autoencoders to Transformers to Large Language Models, Zonunfeli Ralte & Indrajit Kar, BPB Publications, 2024
- 2 The Potential of Generative AI: Transforming Technology, Business, and Art Through Innovative AI Applications, Divit Gupta & Anushree Srivastava, BPB Publications, 2024

**References:**

- 1 Generative Deep Learning, Generative Deep Learning, David Foster, O'Reilly Media, 2019
- 2 Grokking Deep Learning, Grokking Deep Learning, Andrew W. Trask, Manning Publications, 2019
- 3 Hands-On Generative Adversarial Networks with Keras, Hands-On Generative Adversarial Networks with Keras, Rajalingappaa Shanmugamani, Packt Publishing, 2019

### References:

- 4 Deep Learning, Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 2016

### Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
15.00	20.00	30.00	20.00	10.00	5.00

### Instructional Method:

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

### Supplementary Resources:

- 1 <https://huggingface.co/>
- 2 <https://learn.microsoft.com/en-us/training/paths/get-started-generative-ai/>
- 3 <https://www.coursera.org/learn/generative-ai-with-llms>
- 4 <https://cloud.google.com/learn/what-is-generative-ai>