Course Code: CSE3720 Core Elective – 6th Sem, CSE	**Course Name:** Generative AI and LLMs	
Credits: 3 (L-D-P-3-0-0)	**Contact Hours:** *3 sessions* per week *[Each session is of 55 minutes]*	
Course Faculty: Dr. Manisha Saini	**Course Coordinator:** Dr. Manisha Saini **Email:** manisha.saini@bmu.edu.in	

Course Overview and Context:: This course aims to provide students with a comprehensive understanding of generative artificial intelligence, focusing on large language models. Students will learn how to design, train, and deploy generative AI systems, with a particular emphasis on Large Language Models. They will explore the principles, applications, and ethical considerations surrounding these technologies. The course describes in detail the transformer architecture that powers LLMs, how they're trained, and how fine-tuning enables LLMs to be adapted to a variety of specific use cases.

Course Outcomes:

CO1	Develop a deep understanding of generative AI principles, encompassing various generative models and their practical applications for diverse real-world scenarios.
CO2	Apply Generative Adversarial Networks (GANs), LLMs, and Sequence Models specifically Seq2Seq models and Variational Autoencoders (VA2Es), strategies for designing effective prompts.
CO3	Evaluate frameworks that ensure the responsible deployment of generative models, fostering a commitment to ethical considerations.

Course Content:

Generative AI: What is generative AI, Different types of generative AI models, Understand the principles and applications of Generative AI in creating new data instances, Understand the principles behind Generative AI: Get familiar with building and tweaking generative models for any real-world use case. Generative AI Project Lifecycle.

Seq2Seq Models and Variational Autoencoders (VAEs): Sequence-to-Sequence models, Variational AutoencodersText-to-Text generation, Image and text-based VAE applications.

Generative Adversarial Networks (GANs): Understanding GAN architecture,GAN training process, GAN applications in image and video generation.

Transformers: Learn about the architecture of Transformer models, including attention mechanisms, encoders, and decoders, Understand pre-training and fine-tuning strategies. Dive into popular Transformer

models: BERT (encoder-only), GPT (decoder-only), and T5 (encoder-decoder) etc, Gain deeper insights into the capabilities and potential of Transformer technology.

LLMs: Learn about Language Models (LLMs) and their role in understanding and generating human-like text, Different types of LLMs, Different training datasets for LLMs, Training methods for LLMs, Challenges in training LLMs, Different evaluation metrics for LLMs, Challenges in evaluating LLMs, Practical Implementation of LLMs, and how fine-tuning enables LLMs to be adapted to a variety of specific use cases.

Prompts Module: Understanding the concept and significance of prompt engineering,strategies for designing effective prompts,Techniques for controlling model behavior and output quality, Introduction to LangChain and its objectives, Overview of the LangChain framework and its component.

Ethical Considerations of Generative AI and LLMs: Potential biases in generative AI models, Misinformation and disinformation generated by LLMs and Other ethical concerns Addressing bias and fairness in generative AI systems Ensuring responsible use and deployment of generative models.

Course Competencies and Instruction Schedule:

	Competency	CO	No of sessions
1	What is generative AI, Different types of generative AI models, Understand the principles and applications of Generative AI in creating new data instances.	CO1	2 sessions
2	Understand the principles behind Generative AI: Get familiar with building and tweaking generative models for any real-world use case, Generative AI Project Lifecycle.	CO1	2 sessions
3	Sequence-to-Sequence models. Variational AutoencodersText-to-Text generation, Image and text-based VAE applications.	CO2	3 sessions
4.	Understanding GAN architecture, GAN training process, GAN applications in image and video generation.	CO2	2 sessions
5	Learn about the architecture of Transformer models, including attention mechanisms, encoders, and decoders.	CO2	2 sessions
6	Understand pre-training and fine-tuning strategies. Dive into popular Transformer models: BERT (encoder-only), GPT (decoder-only), and T5 (encoder-decoder) etc.Gain deeper insights into the capabilities and potential of Transformer technology.	CO2	3 sessions
7	Learn about Language Models (LLMs) and their role in understanding and generating human-like text. Different types of LLMs, Different training datasets for LLMs, Training methods for LLMs.	CO2	3 sessions
8	Challenges in training LLMs, Different evaluation metrics for LLMs, Challenges in evaluating LLMs.Practical Implementation of LLMs, and how fine-tuning enables LLMs to be adapted to a variety of specific use cases.	CO2	3 sessions

9	Understanding the concept and significance of prompt engineering, Strategies for designing effective prompts.	CO2	2 sessions
10	Techniques for controlling model behavior and output quality, Introduction to LangChain and its objectives, Overview of the LangChain framework and its components.	CO2	3 sessions
11	Potential biases in generative AI models.	CO3	3 sessions
12	Misinformation and disinformation generated by LLMs and Other ethical concerns.	CO3	2 sessions
13	Addressing bias and fairness in generative AI systems Ensuring responsible use and deployment of generative models.	CO3	2 sessions

CO/PO Mapping:

CO- PO and PSO Mapping

CO/PO Mapping	P01	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO4
CO1			3	3	3	2				3		3	3	3		
CO2	2	3		3	3	2					1		3	3		
CO3		2	3	3	2			3	3	1		3	3	3	1	1

Experiential Learning Component:

Project as mentioned in the above table, is the experiential learning component for this course. Students will be given challenging real-life problems. They will be asked to build solutions by applying suitable learning algorithms. The students are also expected to implement and show results of the proposed solution and perform a comparative analysis with different available algorithms. A separate assessment will be conducted for evaluating the solution provided by each student. The students are also expected to implement and show the results of the proposed solution or attempt to reimplement and improve on a research paper on a topic of their choice. Approximately 60-70% is experiential learning.

Assessment Pattern: The final grade will be based on the marks/ grades obtained in the mid-semester and end-semester evaluation and other assessments defined in the assessment table. The relative grading method described in the university's academic regulations will be followed to grade the students. The student must secure a minimum of 40% of marks after completing all the assessments in the following table to become eligible for grading.

Assessment:

Component	Duration	Weightage (%)	Evaluation Week	Remarks
Assignment	2 Weeks	20 %	Continuous	Participation +Viva

Quiz	20 mins	20 %	After Mid semester	Assess understanding of theoretical concepts
Mid-Semester Project Evaluation	As per the University norms	20%	Continuous	Project proposal, Literature survey, Methodology, and Preliminary Results
End Term Project Evaluation	As per the University norms	40%	During the last two weeks of the course	Project-Based

Recourse Examination Policy: In case a student fails the course, a one-time recourse is permitted as per the academic regulations of the University. Recourse is allowed **only for the End Semester examination** with 20% weightage.

Student Responsibilities:

Attend lectures and do the given Assignments as per instructions.

Attendance Policy: Students are expected to attend classes regularly. Failure to follow the classes regularly and adhere to the expected attendance percentage will result in losing quiz and other marks and a reduction of the grade as per the University's grading policy.

Learning Resources:

Text Book:

1) Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster, O'Reilly Media.Second edition: June 6, 2023 (ISBN: 978-1098134181).
2) Generative AI with LangChain: Build large language model (LLM) apps with Python, ChatGPT, and other LLMs" by Ben Auffarth, Packt Publishing, first edition : December 22, 2023 (ISBN-13: 978-1835083468).

Reference Book/Other Resources:

1) Vaswani, Ashish, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. "Attention is all you need." Advances in neural information processing systems 30 (2017). [Research Paper]
2) Yenduri, Gokul, Gautam Srivastava, Praveen Kumar Reddy Maddikunta, Rutvij H. Jhaveri, Weizheng Wang, Athanasios V. Vasilakos, and Thippa Reddy Gadekallu. "Generative Pre-trained Transformer: A Comprehensive Review on Enabling Technologies, Potential Applications,

Emerging Challenges, and Future Directions." arXiv preprint arXiv:2305.10435 (2023). [Research Paper]
3) Liu, Yang, Yuanshun Yao, Jean-Francois Ton, Xiaoying Zhang, Ruocheng Guo Hao Cheng, Yegor Klochkov, Muhammad Faaiz Taufiq, and Hang Li. "Trustworthy LLMs: a Survey and Guideline for Evaluating Large Language Models' Alignment." arXiv preprint arXiv:2308.05374 (2023). [Research Paper]

Note: Instructors will regularly post the necessary learning resources such as lecture resources to the online course management portal i.e. Maitri/Google-classroom.

Student Responsibilities:

- Attend lectures regularly and get access to the course materials shared by the instructors.
- Check announcements at LMS/Google-classroom and emails on a regular basis.
- Submit assignments on time.
- Regularly, check your marks on the LMS and make sure they are up to date.
- You should participate in class and do whatever it takes for you to grasp this material. Never hesitate to ask questions.
- Please communicate any concerns by talking to the instructor or writing email.

Attendance Policy: Students are expected to attend the classes regularly and be present in class in time. Late coming in class is not permitted. Failure to attend the classes regularly and adhere to the expected attendance percentage will result in a reduction of the grade as per the University's grading policy.

Make-up policy: No make-up exam will be conducted for unexcused absences. The faculty needs to be informed in advance in case the student is not going to appear for any evaluation component, and it is at the discretion of the faculty to sanction makeup for an evaluation component.

Behavior Expectations: No mobile phones and other destructive gadgets are permitted in the class.

Academic Dishonesty/Cheating/Plagiarism: Plagiarism and dishonesty in any form in any evaluation component will lead to appropriate disciplinary action.