Generative AI

Course Code: AD470
First Lecture: Course Introduction

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Acknowledgements

Course Development
This course has been developed by integrating my research experience and educational resources from several outstanding educators and academic communities.

The course design and content have been inspired by:

- Prof. Sudeshna Sarkar, IIT Kharagpur
- Prof. Pawan Goyal, IIT Kharagpur
- NPTEL courses offered by faculty from IIT Delhi, IIT Delhi, IISC Bengaluru
- Research papers, textbooks, open-source educational resources, and documentation from the NLP and Generative AI community.

Transparency
Some explanations, figures, examples, and wording may have been refined or rephrased with the assistance of Generative AI tools (e.g., ChatGPT, Claude, Gemini) under the instructor's review and verification.

Today's Agenda

Part A: Logistics

- Class culture & expectations
- Marks distribution
- Academic integrity
- AI usage policy

Part B: The Course

- Course overview & modules
- Week-wise timeline
- What is Generative AI?
- Why do we focus on LLMs?

Course Logistics

Course at a Glance

Course Title	Generative AI and Large Language Models
Course Code	AD470
Credits	3-0-3
Instructor	Dr. Alapan Kuila

Prerequisites

Machine Learning · Python Programming · Deep Learning · Linear Algebra · Probability · Basic NLP

Class Culture & Expectations

- **Be on time and be present** — attendance reflects respect for your peers and the instructor.
- **Ask questions freely** — no question is "too basic" in a fast-moving field like GenAI.
- **Discussion is encouraged** — concepts are best learned by debating and explaining them to each other.
- **Collaborate, but stay honest** — discuss ideas openly, but every submission must reflect your own understanding.
- **Respect the room** — minimize distractions so everyone can focus and learn.
- **Curiosity over competition** — we are building a community of learners, not just chasing marks.

Laptop & Device Policy

- Students using laptops should sit towards the **back rows**, so that screens do not distract classmates seated behind or beside them.
- Phones should be on silent.

Evaluation Scheme

Component	Weight	Details
End Semester Exam	50%	Comprehensive written exam
Semester Project	15%	Implementation, experiments, demo
Mid Semester Exam	30%	Covers first half of course
Programming Assignments	5%	Programming exercises
Class Performance	Extra Credits	Participation in class discussion

Semester Project Roadmap (15 Marks)

Stage	Deliverables	Marks
01. Problem Definition	Literature survey, dataset collection	4
02. Baseline Experiments	Implementation, initial results	4
03. Final Submission	Proposed Model and code in GitHub, poster, demo	7
Total		**15**

Academic Integrity

- Every submission must reflect **your own** (or your team's) original understanding and work.
- Any collaboration or external source must be **explicitly acknowledged**.
- Violations may lead to negative marking, course deregistration, and disciplinary action per institute policy.

AI Usage Policy

- Tools like ChatGPT, Claude, Gemini, and Copilot are treated as **learning companions**.
- Use them to understand concepts, learn syntax, debug code, brainstorm ideas, or improve writing.
- Do not copy AI-generated code or text into submissions without understanding it and disclosing its use.
- Every submission must include an **AI Usage Statement** describing how AI tools were used.

Important
Failure to disclose AI assistance, or inability to explain your own submitted work during evaluation, will be treated as academic misconduct.

Course Overview

Course Objectives

- Understand Generative AI fundamentals.
- Learn Transformer architecture.
- Build RAG (Retrieval-Augmented Generation) systems.
- Fine-tune LLMs.
- Study AI Safety and Ethics.

Learning Outcomes
Understand Transformers · Fine-tune LLMs · Develop RAG Systems · Vision Language Models · Responsible AI

Course Modules

01. Foundations of NLP

NLP fundamentals, Language Models, Deep Learning, PyTorch, Word2Vec, GloVe, FastText, Tokenization

02. Neural Language Models

RNN, LSTM, GRU, Seq2Seq, Attention, Beam Search, Decoding Strategies

03. Transformers

Self-Attention, BERT, GPT, T5, Llama, Mistral, Gemini, Hugging Face

04. Prompt Engineering

Prompt Engineering, Instruction Tuning, RLHF, DPO, LoRA, QLoRA, Planning & Reasoning

05. RAG & Agentic AI

RAG, Vector Databases, GraphRAG, Knowledge Graphs, Tool Calling, AI Agents

06. Vision Language Models

CLIP, BLIP, LLaVA, Qwen-VL, Diffusion Models, AI Safety, Ethics, Efficient Inference

14-Week Course Timeline i

Wk 1 Intro to Generative AI & NLP

Wk 2 Language Models & Probability Foundations

Wk 3 Deep Learning Fundamentals using PyTorch

Wk 4 RNN, LSTM, GRU, Sequence Models

Wk 5 Attention & Seq2Seq Models

Wk 6 Transformer Architecture & Self-Attention

Wk 7 BERT, GPT, T5, Llama, Foundation Models

Wk 8 Prompt Engineering, LoRA, QLoRA

Wk 9 RLHF, Alignment, Instruction Tuning

Wk 10 Retrieval Augmented Generation (RAG)

Wk 11 Knowledge Graphs & Agentic AI

Wk 12 Vision Language Models & Diffusion Models

Wk 13 Evaluation, Hallucinations, AI Safety & Ethics

Wk 14 Project Presentation & Course Revision

Books & References

- *Foundations of Large Language Models* — Tong Xiao & Jingbo Zhu
- *Speech and Language Processing* — Jurafsky & Martin
- *Natural Language Processing* — Jacob Eisenstein
- Research papers from **ACL, EMNLP, NeurIPS, ICML, ICLR**

What is AI? What is Generative AI?

What is Artificial Intelligence?

- AI is the broad field of building systems that perform tasks normally requiring **human intelligence**: perception, reasoning, language, planning, decision-making.
- Traditional AI systems were largely **discriminative** — they classify or predict: *Is this email spam? What object is in this image?*
- Machine Learning $\rightarrow$ Deep Learning $\rightarrow$ Generative AI marks an evolution from **recognizing** patterns to **creating** new content.

What is Generative AI?

Definition
Generative AI refers to models that learn the underlying distribution of data and can **generate new, original content** — text, images, audio, video, or code — rather than just classifying or predicting a label.

- Discriminative: $P(y \mid x)$ — predict a label y given input x.
- Generative: $P(x)$ or $P(x \mid \text{prompt})$ — model and sample from the data distribution itself.
- Examples: GPT (text), DALL-E / Stable Diffusion (images), AlphaFold-style generative models (structures), MusicLM (audio).

Why Does This Course Focus on LLMs?

- **Language is the interface**: text is how humans communicate, reason, and record knowledge — LLMs make this interface programmable.
- **Foundation for everything else**: modern Vision-Language Models, Agentic AI, and multimodal generative systems are almost all **built on top of transformer-based LLMs**.
- **Generality**: a single pretrained LLM can be adapted (via prompting, fine-tuning, RAG) to translation, summarization, coding, reasoning, and tool use.
- **Industry relevance**: LLMs (GPT, Llama, Gemini, Claude) currently drive the most impactful real-world GenAI applications.
- **Course design**: understanding LLMs deeply (Modules 1–4) gives you the foundation to quickly grasp RAG, Agents, and Vision-Language Models (Modules 5–6).

Course Webpage:

https://genaicourse-dr-alapan.github.io/genai-course/

See you next class!