# CS4490: GENERATIVE AI ESSENTIALS AND APPLICATIONS

## New Syllabus Proposal

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**Effective Term**
Semester A 2025/26

## Part I Course Overview

**Course Title**
Generative AI Essentials and Applications

**Subject Code**
CS - Computer Science
**Course Number**
4490

**Academic Unit**
Computer Science (CS)

**College/School**
College of Computing (CC)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
B1, B2, B3, B4 - Bachelor's Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
CS4487 Machine Learning

**Precursors**
Nil

**Equivalent Courses**
Nil

**Exclusive Courses**
Nil

# Part II Course Details

**Abstract**

This course introduces core algorithms, techniques and applications in generative artificial intelligence (GenAI). It covers the theory of classic generative models—such as VAEs, GANs, autoregressive transformers, and diffusion models—and their applications across text, audio, image, video, 3D and multimodal generation. Students will engage in hands-on projects (e.g., chatbots, AI art) to learn practical GenAI implementation. By the end of the course, students will master designing, implementing, and evaluating generative models and apply these techniques to solve real-life challenges.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Demonstrate a comprehensive understanding of the principles of various GenAI models including VAEs, GANs, autoregressive transformers, and diffusion models, and accurately discern their applicable scenarios and limitations. | | x | | |
| 2 | Master the core techniques for modeling and generating sequential data such as text and audio, and apply them to natural language generation and speech synthesis tasks. | | | x | |
| 3 | Master the core techniques for modeling and generating visual data such as image and video, and apply them to image generation and editing, video generation and editing tasks. | | | x | |
| 4 | Master the core techniques for 3D representation, including mesh, NeRF, and Gaussian splatting, and apply them to 3D reconstruction, generation, and editing tasks. | | | x | |
| 5 | Utilize cross-modal models to construct multimodal generation systems, enabling complex tasks and addressing multimodal interaction requirements in real-world scenarios. | | | | x |

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

**Learning and Teaching Activities (LTAs)**

| | LTAs | Brief Description | CILO No. | Hours/week (if applicable) |
|---|---|---|---|---|
| 1 | Lecture | Students will engage in lectures about the learning principles behind different GenAI models and their applications to text, audio, image, video, 3D models, and multi-modal generation. At the end of the semester, students will present their GenAI projects in the form of a seminar and participate in discussions to further explore the GenAI topics they are interested in. | 1, 2, 3, 4, 5 | 3 hours per week |
| 2 | Tutorial | Students will work on implementing GenAI models to gain a better understanding of the lecture material. | 1, 2, 3, 4, 5 | 8 hours per semester |
| 3 | Assignment | Students will solve both theoretical and practical problems related to GenAI. This includes implementing selected GenAI models, applying them to text, image, video, 3D, and multimodal generation tasks, and interpreting the results. Through this process, students can gain a better understanding of the theory behind GenAI models, understand how they work, and analyze the performance of different models. | 1, 2, 3, 4 | After class, 2 times |
| 4 | Project | Students will design a system based on GenAI models to solve a real-world problem. They will report their results in a course report and present during a poster/ presentation session held at the end of the semester. | 1, 2, 3, 4, 5 | After class, 1 time |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks ("-" for nil entry) | Allow Use of GenAI? |
|---|---|---|---|---|---|
| 1 | Assignment | 1, 2, 3, 4 | 30 | Two assignments with programming elements for model implementation. | Yes |
| 2 | Project and presentation | 1, 2, 3, 4, 5 | 30 | Around 1-3 students in a group to finish the project. | Yes |

**Continuous Assessment (%)**

60

**Examination (%)**

40

**Examination Duration (Hours)**

2

**Minimum Continuous Assessment Passing Requirement (%)**

30

**Minimum Examination Passing Requirement (%)**

30

**Additional Information for ATs**

For a student to pass the course, at least 30% of the maximum mark for the continuous assessment and 30% of the maximum mark for the examination must be obtained.

**Assessment Rubrics (AR)**

**Assessment Task**

Assignment

**Criterion**

1. The ability to analyze and explain the principles of GenAI models.
2. The ability to implement GenAI models and apply them to different tasks.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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**Assessment Task**

Project and presentation

**Criterion**

1. The ability and creativity in designing and implementing appropriate algorithms and techniques to solve real-life problems.
2. The ability to analyze the project through a report and oral presentation.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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**Assessment Task**

Examination

**Criterion**

1. The ability to explain the principles of GenAI models and interpret the results.
2. The ability to evaluate, analyze, and compare different GenAI models.
3. The ability to apply and design GenAI models for text, audio, image, video, 3D, and multimodal generation and real-life challenges.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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# Part III Other Information

**Keyword Syllabus**

- Classical GenAI models
  - Variational autoencoder (VAE).
  - Generative adversarial network (GAN).
  - Autoregressive transformer
  - Diffusion model
- Application of GenAI models
  - Large language model (LLM)
  - Audio generation
  - Image generation
  - Video generation
  - 3D generation
  - Multimodal large language model (MLLM)
- Others
  - Prompting engineering
  - In-context learning
  - Model distillation
  - Model customization

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | Nil |

**Additional Readings**

| | Title |
|---|---|
| 1 | David Foster, “Generative Deep Learning: Teaching Machines To Paint, Write, Compose, and Play (2nd Ed.)”, O'Reilly, 2023. |
| 2 | Omar Sanseviero, Pedro Cuenca, Apolinário Passos, Jonathan Whitaker, “Hands-On Generative AI with Transformers and Diffusion Models”, O'Reilly, 2024. |
| 3 | “Basic Generative AI: Beginner's Guide to Artificial Intelligence, ChatGPT and Machine Learning, Practical AI Applications”, Freeman Publishing, 2024. |