**Old Dominion University**

**Fall 2025. Generative Artificial Intelligence.**

**Course Number CS795/CS895/DASC795/DASC895.**

**Catalogue Description:** This course offers a comprehensive exploration of advanced concepts in generative artificial intelligence (AI) for Master’s and PhD students. The topics include theoretical foundations, a broad spectrum of applications, and the ethical considerations associated with leading-edge generative models.

**Prerequisite:** Proficiency with Python is expected.

**Instructor:** Hong Qin, hqin@odu.edu, <https://www.lions.odu.edu/~hqin/>

**Schedule & Location**:

Engineering & Computer Science Building 2120, 6pm – 8:40pm Thursday

ZOOM meeting: <https://odu.zoom.us/j/97307140245>

**Office hours:** Zoom by appointment

**Communication**: All course-related communication should use the messages inside of Canvas.

**Course Materials (recommended):**

Generative Deep Learning: Teaching Machines To Paint, Write, Compose, and Play 2nd Edition. by David Foster, ISBN-10 1098134184

**Course Outline (subject to change)**

* **Week 1:** *Generative Modeling*
  + Big picture of generative AI, applications, and motivation.
  + Setup environment, test repo notebooks.
* **Week 2:** *Variational Autoencoders*
  + Theory + coding a simple VAE.
* **Week 3:** *Generative Adversarial Networks*
  + Train a DCGAN; discuss stability.
* **Week 4:** *Autoregressive Models*
  + Character-level text generation.
* **Week 5:** *Normalizing Flows and Energy-Based Models*
  + Likelihood-based generative models.
  + Free energy concepts; RBMs.
* **Week 6:** *Diffusion Models*
  + Forward/backward process; train a toy diffusion model.
* **Week 7:** *Transformers and Large Language Models*
  + Attention mechanism, transformer architecture.
  + Scaling laws, pretraining/fine-tuning.
  + Build a small GPT-style model.
* **Week 8:** *Reinforcement Learning*
  + Policy gradients, deep Q-learning, RL in generative modeling.
  + Intro to RLHF (Reinforcement Learning with Human Feedback).
* **Week 9:** *Advanced GANs*
  + StyleGAN, BigGAN, conditional GANs.
* **Week 10:** *Music, Audio, and Speech AI*
  + Symbolic music generation (MIDI).
  + Audio synthesis (WaveNet, diffusion-based TTS).
  + Speech recognition and voice cloning basics.
* **Week 11:** *World Models*
  + Model-based RL + imagination agents.
* **Week 12:** *Multimodal, Reasoning, and Agentic AI*
  + Text-to-image, CLIP-style learning.
  + Agents built on LLMs + multimodal models.
  + Reasoning, planning, memory, tool use.
* **Week 13:** *Ethical AI: Safety, Fairness, and Trustworthiness*
  + Navigating the ethical terrain of AI.
  + Bias, explainability, alignment, and robustness.
  + Case studies and contemporary issues.
* **Week 14:** *Recent Advances in Agentic AI and reasoning AI in autonomous driving and robotics.*

**Weeks 1-14: Student Course Projects**

* Students choose a domain (e.g., genomics, medical imaging, drug discovery)
* Work on a semester-long project applying gAI techniques
* Assignments:
  + Project proposal
  + Mid-term progress report
  + Final project presentation

**Evaluation:**

* Assignments: 15%.
* Presentations based on primary research papers: 20%. Each student should present two primary research papers on gAI approved by the instructor.
* Final course team project: 50% (Proposal: 5%, Progress Report: 20%, Final Report: 25%)
* Final project presentation (team): 10% (record video)
* Participation: 5%

Course Grading Policy will be posted on ODU Canvas.

Late submission will receive 5% penalty daily.

Final project reports should be written in IEEE full paper format. Students can work as groups with prior approval.

# Course Polices

**AI Usage.** Generative AI should be used responsively. Coding work can be assisted by generative AI. Report can be polished by generative AI, but its contents cannot be generated by AI.

**Cell Phone Usage:** Talking on the phone during class will be reported and handled according to ODU student handbook and/or honor code.

# Please note:

**This syllabus is subject to change with notification on Canvas, email, or other written notification.**