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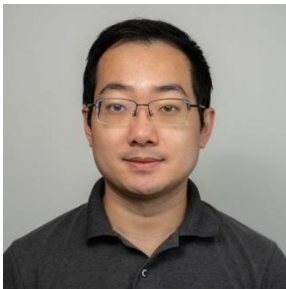
ECE 592-119 Course Syllabus

Generative AI: Introduction and Applications

2026 Spring

Instructor Information

Name	Office Phone	Mobile Phone	Email	Office Location
Kaixiong Zhou		979.393.2564	Kzhou22@ncsu.edu	2060 EBII



Office Hours

I am available for in-person or virtual office hours. I recommend using office hours for 4.30-5.30PM, Tue and Thur.

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Preferred Method of Communication & Response Time

- **Preferred method of communication:** If you need to contact me directly, my preferred method of communication is email. You can expect to receive a response within two business days (i.e. not over the weekend). If I email you directly, please strive to respond within two business days. It is recommended that you check your NC State email at least once a day to stay on top of course communications.
- **Asking questions about the course:** If you have a question about the course or its content, you can email me or post your question after the course. You can expect to receive a response within two business days from emails (i.e. not over the weekend).
- **Email guidelines:** Always include a descriptive, specific but concise subject. Include your course number and section in your email, and provide adequate context for your question in order to ensure full understanding of your email. Be sure to use your NC State email account.

Course Information

Course Website: [NC State WolfWare](#)

Meeting Time and Location: Undetermined yet.

Course Credit Hours: 3

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Catalog Description

Generative AI has rapidly emerged as a transformative force in machine learning, enabling systems to create text, images, molecules, and other complex data modalities with unprecedented fidelity and control. This course offers a comprehensive introduction to the principles, models, and applications of generative AI, with a particular focus on recent advances in foundation models, large language models (LLMs), and cross-modal generation.

Students will explore core generative modeling techniques, including autoencoders, diffusion models, and modern architectures such as Mamba and 3D geometric learning models. The course also delves into prompt engineering, agent-based systems, retrieval-augmented generation (RAG), and model customization through pre-training, fine-tuning, and editing. Trustworthy AI topics—such as model interpretability, privacy, and security—will be addressed in depth to prepare students for responsible deployment of generative technologies.

In the final portion of the course, students will investigate cutting-edge applications of generative AI across multi-modal domains, including text-to-image synthesis, video generation, and biomolecular design for synthetic biology. The course culminates in student-led presentations and a capstone project showcasing original research or applications in generative AI.

This course combines lectures, paper discussions, hands-on assignments, and an open-ended project to equip students with both theoretical grounding and practical skills in building and analyzing generative models.

Structure

The majority of this course is **synchronous**, delivered through real-time, face-to-face class sessions. Additional materials and activities are delivered through **Moodle**, a secure and easy-to-use online learning platform. Learning activities in this course will include coding homework, narrated PowerPoint presentations, individual projects, and exams.

This course consists of six modules, including introduction of generative AI, review of foundation models, prompt engineering, training techniques, trustworthy generative models, and applications. Most modules last ≥ 2 weeks. Each assignment is due after two or three weeks from the release date.

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Meeting Time and Tool Used

In-person weekly lectures, the lecture time and classroom will be determined later.

In-person or virtual office hours. I recommend using office hours for 4.30-5.30PM, Tue and Thur after the class. The office-hour discussion will be hold either after the class in the office or through zoom (determined later).

Prerequisites/Corequisites

Prerequisites. Basic knowledge of linear algebra (e.g., matrix computations), machine learning (e.g., supervised learning and deep learning), access to GPU (e.g., Colab), and proficiency in Python programming.

Co-requisites. None.

Restrictions. None.

Minimum Technical and Digital Information Literacy Skills

Required technical skills

- Navigate and use Moodle, NC State's Learning Management System.
- Use Gmail, including attaching files to email messages
- Create and submit files in commonly used word processing program formats (Overleaf, Google Docs, Colab).
- Use web conferencing tools including Zoom.

General Education Program (GEP) Information

GEP Category Fulfilled

None

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GEP Corequisites

None

Learning Outcomes

By engaging with the foundational models, cutting-edge architectures, and diverse applications of generative AI, students will develop a comprehensive understanding of this rapidly evolving field. This course equips students with both theoretical insights and practical skills to design, implement, and critically evaluate generative models across multiple domains. Upon completion of this course, student learning outcomes include:

- Understand the core concepts, architectures, and training paradigms of generative AI models (e.g., autoencoders, diffusion models, large language models)
- Analyze and apply prompt engineering, retrieval-augmented generation, and agent-based systems for task-specific generation;
- Evaluate and improve the trustworthiness of generative models with respect to interpretability, privacy, security, and fairness;
- Explore and implement multi-modal generative tasks, including text-to-image, video, and biomolecular generation;
- Design and develop novel generative AI applications or research prototypes, informed by current advances and responsible AI principles.

Course Materials

Required textbook

None.

Other required materials

The recommended papers and tutorials will be posted before/in the classes.

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Technology Requirements

NC State University Libraries offers [Technology Lending](#), where many devices are available to borrow for a 7-day period. [Computer labs](#) are available in various locations around campus for student use.

Computer

A laptop computer is required for students taking this course. NC State's Office of Information Technology provides recommendations for [your computer at NC State](#).

Other devices

The access to HPC with GPUs will be requested to support the homework of deep learning.

Software and digitally-hosted course components

The following software and tools will be used in this course. Some tools are a part of NC State's enterprise tools. See [information about their purpose, how to access them, accessibility information, and privacy policies](#). The same information for any other tools required in this course is provided in the list below.

- Visual Studio Code or Pycharm
- Colab

Other Student Expenses

- None.

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Communication Guidelines

Respecting our learning community

The [NC State Code of Student Conduct](#) outlines expectations for behavior in the classroom (whether virtual or physical) and the consequences for students who violate these expectations. Any behavior that impacts other students' ability to learn and succeed will be addressed, but expressing diverse viewpoints and interpretations of course content is welcome.

Community guidelines for this course include:

- Use a respectful tone in all forms of communication (email, written, oral, visual)
- Maintain professionalism (avoid slang, poor grammar, etc.) in your written communication.
- Respect regional dialects and culturally embedded ways of oral communication.
- Stay home or in your dorm room if you are exhibiting symptoms of a contagious illness (fever, chills, etc.).
- Enter our virtual and/or physical classroom community respectfully by refraining from lewd or indecent speech or behavior, helping to maintain a safe physical environment, not using your cell phone for voice or text communication except when explicitly given leave to do so, and not attending class under the influence of any substance.
- Treat each community member with respect by not recording others without their consent or engaging in any form of hazing, harassment, intimidation, or abuse.
- Respect cultural differences that may influence communication styles and needs.

Plan for interaction between instructors and students

Emails to answer questions, feedback on homework.

Expectations for learner participation and interaction

Communication expectations including frequency and content are detailed in the information about each assignment or activity when it appears in the course.

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Grading and Feedback

Grading criteria, details, and timing of feedback

Component	Weight	Details
Homework	40%	There will be four homework assignments containing both written and programming components. The total number of points for each assignment may be different.
Paper presentation	10%	The paper presentation will be conducted after the lectures, and before the project presentations.
Project	20%	There will be one semester-long project. The project is for individual student. In the end, each student needs to submit their results (code and prediction results) and a report summarizing the methods and results.
Exam	20%	There will be a final exam covering the foundations of neural networks and deep learning

- Letter Grades. This Course uses Standard NCSU Letter Grading and will be on the curve.
- Requirements for Auditors (AU). Information about and requirements for auditing a course can be found at <http://policies.ncsu.edu/regulation/reg-02-20-04>. The main requirement is attending/viewing the lectures, which will be evaluated via participation (quizzes).
- Policies on Incomplete Grades. If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at <http://policies.ncsu.edu/regulation/reg-02-50-03>. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at http://www.fis.ncsu.edu/grad_publicns/handbook/
- Late Assignments. 1) For homework assignment, 25% is deducted for each late day for up to three days (including weekends) after which submissions are not accepted. Late project submissions will not be

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accepted. 2) Excused absence will not be counted towards late days. If an exam overlaps with an excused absence, the instructor will provide the student an opportunity to make up an exam by a date agreed upon by the student and instructor. If the instructor has a regularly scheduled make up exam, students are expected to attend unless they have a university approved excuse. 3) Unexpected excused absences: In cases where prior notification of excused absence is not feasible (e.g., accident or emergency) the student must provide notification by the end of the second working day after the absence, including an explanation of why notice could not be sent prior to the class.

- Attendance Policy. For complete attendance and excused absence policies, please see <http://policies.ncsu.edu/regulation/reg-02-20-03>. Attending lectures synchronously is strongly recommended, as questions can be asked to the benefit of all students. Recorded lectures may only be viewed on an exceptional basis (with justification).
- Makeup Work Policy. Please see the late assignments before.
- Additional Excuse Policy. None.

Grading scale

This course uses this grading scale:

Low	Letter	High
97 ≤	A+	≤ 100
93 ≤	A	< 97
90 ≤	A-	< 93

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≤ 87	B+	< 90
≤ 83	B	< 87
≤ 80	B-	< 83
≤ 77	C+	< 80
≤ 73	C	< 77
≤ 70	C-	< 73
≤ 67	D+	< 70
≤ 63	D	< 67
≤ 60	D-	< 63
≤ 0	F	< 60

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Course Schedule

NOTE: The course schedule is **subject to change**.

Date	Topic	Papers/Slides/Events
Week1-1,	Introduction to Generative AI, Part I	
Week1-2,	Introduction to Generative AI, Part II	
Review of Foundation models		
Week2-1,	Large Language Models, Part I	HW1 release
Week2-2,	Large Language Models, Part I	
Week3-1,	Autoencoders	
Week3-2,	Diffusion Models	
Week4-1,	3D Geometric Learning Models	
Week4-2,	Mamba	HW1 Due
One-page Project Proposal		Due
Prompt Engineering		
Week5-1,	Prompt, Part I	HW2 release
Week5-2,	Prompt, Part II	
Week6-1,	AI Agents, Part I	
Week6-1,	AI Agents, Part II	HW2 Due
Advanced Techniques beyond Prompt		
Week7-1,	Retrieval Augmented Generation	HW3 release
Week7-2,	Pre-training and Fine-tuning	
Week8-1,	Post-training	

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Week8-2,	Model Editing	HW3 Due
Trustworthy Generative AI		
Week9-1,	Model explanation	
Week9-2,	Model Security	
Week10-1,	Model Privacy	
Week10-2,	Model evaluation	
Project Progress Report		Due
Multi-modal Applications		
Week10-1,	Text-to-image Generation	HW4 release
Week10-2,	Video Generation	
Week11-1,	Protein, Molecule, and Natural Language	
Week11-2,	Protein, Molecule, and Natural Language	
Application for Synthetic Biology		
Week12-1,	Molecule Generation	
Week12-2,	RNA Sequence Generation	HW 4 Due
Paper Presentation		
Week13-1,	Paper Reading Presentations 1	
Week13-2,	Paper Reading Presentations 2	
Week14-1,	Paper Reading Presentations 3	
Project final report		Due
Project Presentation and Final Exam		

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Week14-2,	Project Presentations 1	
Week15-1,	Project Presentations 2	
Week15-2,	Project Presentations 3	
	Final Exam	

Course Policies

Late assignments

See above grading policies.

Incomplete grades, withdrawals

Information on incomplete grades can be found at [REG 02.50.03 – Grades and Grade Point Average](#). If you encounter a serious disruption to your work not caused by you and you would have otherwise successfully completed the course, contact your instructor as soon as you can to discuss the possibility of earning an incomplete in the course for the semester, including an agreement on when the remaining work must be done in order to change the grade to the appropriate letter grade.

If your student must withdraw from a course or from the University due to hardship beyond their control, see [Withdrawal Process and Timeline | Student Services Center](#) for information and instructions.

Attendance

See above grading policies.

Related NC State Policy: [REG 02.20.03 – Attendance Regulations](#)

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University Policies

Academic integrity and honesty

Students are required to comply with the university policy on academic integrity found in the [Code of Student Conduct 11.35.01 sections 8 and 9](#). Therefore, students are required to uphold the Pack Pledge: "I have neither given nor received unauthorized aid on this test or assignment." Violations of academic integrity will be handled in accordance with the [Student Discipline Procedures](#).

Please refer to the [Academic Integrity](#) web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Student privacy

Originality Checking Software

Software is not used in this course to detect the originality of student submissions.

Class recording statement:

In-class sessions are recorded in such a way that might also record students in this course. These recordings will NOT be used beyond the current semester or in any other setting outside of the course.

Class privacy statement:

This course requires online exchanges among students and the instructor, but NOT with persons outside the course. Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Student information in this course may be accessible to persons beyond the instructor and students in the course. This course may involve electronic sharing or posting of personally identifiable student work or other information with persons not taking or administering the course. Students will be asked to sign a

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consent form allowing disclosure of their personally identifiable work. No student must sign the consent form as a condition of taking the course. If a student wants to avoid signing the consent form, he or she has the right to ask the instructor for an alternative, private means of completing the coursework.

Other Policies

Students are responsible for reviewing the NC State University PRR's which pertain to their course rights and responsibilities:

- [Equal Opportunity and Non-Discrimination Policy Statement](#) and [additional references](#)
- [Code of Student Conduct](#)
- [Grades and Grade Point Average](#)
- [Credit-Only Courses](#)
- [Audits](#)

Student Resources

Academic and Student Affairs maintains a website with links for student support on campus, including academic support, community support, health and wellness, financial hardship or insecurity, and more. [Find Help on Campus.](#)

Disability resources

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the [Disability Resource Office \(DRO\)](#). For more information on NC State's policy on working with students with disabilities, please see the [Policies, Rules and Regulations page maintained by the DRO](#) and [REG 02.20.01 Academic Accommodations for Students with Disabilities](#).

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Safe at NC State

At NC State, we take the health and safety of students, faculty and staff seriously. [The Office of Equal Opportunity](#) supports the university community by providing services and resources to support and guide individuals in obtaining the help they need. See the [Safe at NC State webpage](#) for resources.

Supporting Fellow Students in Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remain a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you, either for the classmate's well-being or yours. If you feel this way, I would encourage you to report this behavior to the [NC State CARES website](#). Although you can report anonymously, it is preferred that you share your contact information so they can follow up with you personally.

Course Evaluations

ClassEval is the end-of-semester survey for students to evaluate the instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students' responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full-semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8 am on the first day of finals.

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- Contact ClassEval Help Desk: classeval@ncsu.edu
- [ClassEval website](#)
- [More information about ClassEval](#)

Syllabus Modification Statement

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order in which we will cover them. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction.