

SYLLABUS – ALGEBRAIC GEOMETRY I
MATH 552, FALL 2024 (CRN 31610 - 4 CREDIT HOURS),
MWF 12:00PM - 12:50PM, GH 204, ON CAMPUS

COURSE DESCRIPTION: Welcome to Math 552! This course serves as an introduction to Algebraic Geometry. Algebraic Geometry is a central subject in modern mathematics, with close connections with number theory, combinatorics, representation theory, differential and symplectic geometry. We will study basic properties of projective algebraic varieties such as dimension, degree and singularities. At the same time, we will develop a large body of examples that motivate the study of the subject. Depending on time, we will develop the classical theory of curves and surfaces. This course should be enough preparation for a course on the theory of schemes.

PREREQUISITE: Grade of C or better in MATH 516 and Grade of C or better in MATH 517; and graduate standing; or consent of the instructor.

COURSE GOALS AND STUDENT LEARNING OBJECTIVES:

- (1) Define and describe the important properties of affine and projective varieties.
- (2) Understand how to relate algebraic concepts, such as localization, regularity, zero divisors, radicals, integral closedness, module-finiteness, tensor product, Krull dimension, differentials, etc with the corresponding geometric concepts.
- (3) Construct clear and logical mathematical proofs, and critically assess the validity of proofs and arguments.
- (4) Participate in class to reinforce lecture material and discuss mathematical arguments and proofs.

DROP-IN & OFFICE HOURS:

- **Instructor:** Philip Engel, pengel@uic.edu
Wednesday 10AM-12PM in SEO 535, or by appointment

IMPORTANT DATES:

- **Final:** due Monday, December 9, take home
- **Homeworks:** due weekly, on Fridays, by the start of class
- **Add/Drop Deadline:** September 5
- **Withdraw Deadline:** October 29
- **Last Day of Classes:** December 6

WEBSITES:

- **Blackboard:** <https://philip-engel.github.io/courses/>
- **Course Assignments & Announcements:** <https://philip-engel.github.io/courses/>

RECOMMENDED TEXTS:

- **Notes for Algebraic Geometry**, by Andreas Gathmann, available at <https://agag-gathmann.math.rptu.de/class/alggeom-2002/alggeom-2002.pdf>
- **Algebraic Geometry**, Chapter I, by Robin Hartshorne
- **Basic Algebraic Geometry I**, by Igor Shafarevich

The exercises for problem sets will be selected from the recommended texts.

WEEKLY SCHEDULE: Below is a *tentative* schedule of the material to be covered each week. To be prepared for each class, make sure to read the appropriate section of the text before coming to lecture.

	M	W	F
Week 1 (Aug 26–)	Affine varieties	Zariski topology	Examples, HW 1
Week 2 (Sep 2–)	No class (Labor Day)	Morphisms	Rational maps, HW 2
Week 3 (Sep 9–)	Projective varieties	Products	Examples, HW 3
Week 4 (Sep 16–)	Properness	Finite maps	Dimension, no HW due
Week 5 (Sep 23–)	Dimension	Hilbert polynomial	Degree, HW 4 & 5
Week 6 (Sep 30–)	Degree	Bezout's theorem	Examples, HW 6
Week 7 (Oct 7–)	Tangent spaces	Smoothness	Examples, HW 7
Week 8 (Oct 14–)	Blow-ups	Blow-ups	Normality, HW 8
Week 9 (Oct 21–)	Algebraic curves	Riemann surfaces	Elliptic curves, no HW due
Week 10 (Oct 28–)	Elliptic curves	Examples	Divisors, HW 9
Week 11 (Nov 4–)	Divisors	Line bundles	Line bundles, HW 10
Week 12 (Nov 11–)	Differential forms	Differential Forms	Canonical bundle, HW 11
Week 13 (Nov 18–)	Serre Duality	Riemann-Roch	Applications HW 12
Week 14 (Nov 25–)	Overflow time	W No class (Wellness Day)	F No class (Thanksgiving)
Week 15 (Dec 2–)	Surfaces	Surfaces	Cubic surfaces

HOMEWORK PROBLEMS:

- HW1: Exercise 1.4.1, 1.4.2, 1.4.4, 1.4.5, 1.4.6 of Gathmann. Exercise 1.1.12 of Hartshorne.
HW2: Exercise 2.6.1, 2.6.4, 2.6.5, 2.6.6 of Gathmann. Exercise 1.3.2, 1.3.15(a,b,c) of Hartshorne.
HW3: Exercise 3.5.1, 3.5.2, 3.5.3, 3.5.6 of Gathmann. Exercise 1.2.2, 1.2.4, 1.2.14, 1.2.15 of Hartshorne.
HW4: Exercise 4.6.1, 4.6.2, 4.6.3, 4.6.5 of Gathmann.
HW5: Exercise 6.7.1, 6.7.2, 6.7.3, 6.7.4, 6.7.6 of Gathmann.
HW6: Exercise 6.7.7, 6.7.9 of Gathmann. Exercise 1.7.2, 1.7.7, 1.7.8 of Hartshorne.
HW7: Exercise 4.6.13 of Gathmann. Exercise 1.5.1, 1.5.2, 1.5.3, 1.6.3, 1.6.4 of Hartshorne.
HW8: Exercise 4.6.4, 4.6.7, 4.6.8, 4.6.9, 4.6.10, 4.6.12 of Gathmann. Exercise 1.6.2, 1.6.5, 1.6.6 of Hartshorne.
HW9: Exercise 6.7.10, 6.7.11, 6.7.12, 6.7.13, 6.7.14 of Gathmann.
HW10: Shafarevich "Basic Algebraic Geometry", Exercise 3.1.7.1, 3.1.7.2, 3.1.7.3, 3.1.7.4, 3.1.7.5 and 3.2.4.1.
HW11: Shafarevich "Basic Algebraic Geometry", Exercise 3.5.5.1, 3.5.5.2, 3.5.5.4, 3.5.5.5, 3.5.5.6, 3.5.5.7.
HW12: Exercise 7.8.9, 7.8.10 of Gathmann. Exercise 4.3.2, 4.3.6 of Hartshorne.

REQUIREMENTS: Students are expected to make a serious commitment to prepare for and attend each and every lecture. Students with unexcused absences for more than 10% of the regularly scheduled class meetings are subject to a one letter grade penalty. There will be weekly homework. Homework is a very important component of this course, and will count for 70% of your final grade. You may (and are encouraged to) collaborate on the homework problems, but you must write your own solutions and properly acknowledge any help you receive from others. Students who fail to submit 3 or more homework assignments are subject to failing the course. There will be a take home final exam counting for 30% of your final grade. Note that students who fail to turn in the final exam are subject to failing the course.

POINTS BREAKDOWN: 100 points (*i.e.* percent) total

- Homework - 70 points (equally distributed amongst the assignments)
- Final Exam - 30 points

ACADEMIC INTEGRITY: As a student and member of the UIC community, you are expected to adhere to the [Community Standards](#) of academic integrity, accountability, and respect. Please review the [UIC Student Disciplinary Policy](#) for additional information.

DISABILITY ACCOMODATIONS: To receive accommodations, you will need to complete an interactive registration process with the Disability Resource Center (<http://drc.uic.edu/>), and provide me with a Letter of Accommodation (LOA). Upon receipt of an LOA, I will gladly work with you and the DRC to implement approved accommodations.

Course Lecture Overview

Our course will primarily take place synchronously in person, with the possibility that the course format could change at any time during the semester if campus health and safety guidelines change. We will all meet at the same time as indicated in the schedule of classes, MWF -1:00-1:50pm. These sessions will be interactive and your participation is highly encouraged. In addition, these sessions may at times be recorded (for details, please see our Video Recording Policy below). Please email me if you have concerns about being recorded and we will work together to find ways to accommodate or assist you so you can still participate in the course without appearing on video.

Homework (Gradescope)

Homework will be assigned most weeks of the semester, and students will be expected to upload their own solutions via Gradescope. You may (and are encouraged to) collaborate on the homework problems, but you must write your own solutions and properly acknowledge any help you receive from others. As a general rule, homework will be due at the beginning of class on Wednesday; Gradescope will not accept submissions more than 24 hours after the deadline. If you experience extenuating circumstances that prohibit you from submitting your assignments on time, please let me know. I will evaluate these instances on a case-by-case basis and attempt to provide accommodation. Note that students who fail to submit 3 or more homework assignments are subject to failing the course.

Lecture Attendance Policy (Acadly)

Students are expected to make a serious commitment to prepare for and attend each and every lecture. Please email me in advance or as soon as you are able in order to request an excused absence. Students with unexcused absences for more than 10% of the regularly scheduled class meetings are subject to a one letter grade penalty. Students are encouraged to make a point to reach out to the instructor at least once a week. We will be using [Acadly](#) for attendance tracking, which can only be done via the mobile application. Please download the app to your smartphone by following the appropriate link:

[Acadly for iOS users](#)

[Acadly for Android users](#)

Final Exam

There will be one take-home final exam during due at the beginning of finals week on Monday December 9. Note that students who fail to submit the final exam are subject to failing the course.

Policy for Missed or Late Work

Late assignments will generally not be accepted without prior approval. If you experience extenuating circumstances that prohibit you from submitting your assignments on time, please let me know. I will evaluate these instances on a case-by-case basis and attempt to provide accommodation.

Electronic Communication

The absolute best ways to reach me are: to catch me before & after class, or in my office hours, or by email. I will generally try to reply to emails within 1-2 days; please feel free to resend again after that.

Academic Deadlines

See the [UIC Academic Calendar](#).

Disclaimer

This syllabus is intended to give the student guidance in what may be covered during the semester and will be followed as closely as possible. However, as the instructor, I reserve the right to modify, supplement and make changes as the course needs arise.

General Principles

Towards the goal of making learning as impactful as possible this semester, we will strive to abide by two overarching principles in this class:

1. engage in clear and frequent two-way **communication** regarding my expectations of you, the class workflow, and unexpected challenges arising that may impede your participation in required class sessions, including exams, or timely completion of assignments;
2. build an **inclusive learning community** in which we all abide by the same ground rules and ethical code of conduct.

I look forward to connecting with you this fall. I will do my best to support your learning experience by listening to your needs and by conducting this course with compassion, empathy, and patience.

Learning Environment

UIC values diversity and inclusion. Regardless of age, disability, ethnicity, race, gender, gender identity, sexual orientation, socioeconomic status, geographic background, religion, political ideology, language, or culture, we expect all members of this class to contribute to a respectful, welcoming, and inclusive environment for every other member of our class. If there are aspects of the instruction or design of this course that result in barriers to your inclusion, engagement, accurate assessment or achievement, please notify me as soon as possible.

Community Agreement

- Be present (turn off cell phones and remove yourself from other distractions)
- Be respectful
- Assume good will
- Challenge with care -- approach discussion as a "think out loud"
- Be flexible when things don't work
- Share helpful tips
- Use preferred names and gender pronouns
- No side conversations
- Be willing to work together
- Be mindful of one another's privacy --do not invite outsiders into our classroom
- Commit to upholding a class honor code in which we trust one another and engage only in behaviors that reflect our community standards of academic integrity

Policy for Video Recording

At times, we may be recording the class sessions, or portions of the class, for your use and benefit throughout the semester. The recorded class sessions will be posted on our Blackboard class website unless otherwise notified. Recording by other means is not permitted. If you have questions or concerns about this video recording policy, please contact me before the end of the first week of class.

Required Technology

It is recommended that you have regular access to a personal computer that runs on a broadband Internet connection to use online course resources. You will also need to either type up your homework solutions or have the ability to scan and upload your written work to gradescope. You will also need a mobile phone to make use of the attendance application acadly.

Respect for Copyright

Please protect the integrity of all course materials and content. By enrolling in this course, you agree to honor this request. Be mindful of the hard work and time that instructors put into creating course materials such as homework questions, videos, and other course materials. Please do not upload course materials not created by you onto third-party websites or share content with anyone who is not enrolled in our course. I am grateful for your cooperation in honoring this important request.

Disability Accommodation Procedures (repeated from above with more detail)

UIC is committed to full inclusion and participation of people with disabilities in all aspects of university life. If you face or anticipate disability-related barriers while at UIC, please connect with the Disability Resource Center (DRC) at drc.uic.edu, via email at drc@uic.edu, or call (312) 413-2183 to create a plan for reasonable accommodations. In order to receive accommodations, you will need to disclose the disability to the DRC, complete an interactive registration process with the DRC, and provide me with a Letter of Accommodation (LOA). Upon receipt of a LOA, I will gladly work with you and the DRC to implement approved accommodations.

Grievance Procedures

UIC is committed to the most fundamental principles of academic freedom, equality of opportunity, and human dignity involving students and employees. Freedom from discrimination is a foundation for all decision making at UIC. Students are encouraged to study the University's "[Nondiscrimination Statement](#)". Students are also urged to read the document "[Public Formal Grievance Procedures](#)". Information on these policies and procedures is available on the University web pages of the Office of Access and Equity: <http://oae.uic.edu/>.

Student Evaluation of Teaching Program (Course Evaluations)

Student evaluations of teaching play a fundamental role in improving course content, format, and delivery (teaching) at UIC. Students are invited to share feedback on the course with the instructor throughout the semester and should complete the online course evaluation form emailed to them at the end of the semester before 12am on the first day of finals.

Academic Integrity Policy

UIC is an academic community committed to providing an environment in which research, learning, and scholarship can flourish and in which all endeavors are guided by academic and professional integrity. In this community, all members including faculty, administrators, staff,

and students alike share the responsibility to uphold the highest standards of academic honesty and quality of academic work so that such a collegial and productive environment exists.

As a student and member of the UIC community, you are expected to adhere to the Community Standards of integrity, accountability, and respect in all of your academic endeavors. When accusations of academic dishonesty occur, the Office of the Dean of Students investigates and adjudicates suspected violations of this student code. Unacceptable behavior includes cheating, unauthorized collaboration, fabrication or falsification, plagiarism, multiple submissions without instructor permission, using unauthorized study aids, coercion regarding grading or evaluation of coursework, and facilitating academic misconduct. Please review the UIC Student Disciplinary Policy for additional information about the process by which instances of academic misconduct are handled towards the goal of developing responsible student behavior.

For written assignments in the course (both homework and daily recap summaries), students are encouraged to work together. However, the final write-up must be done individually. By submitting your assignments for grading you acknowledge these terms. Let's embrace what it means to be a UIC community member and together be committed to the values of integrity.

Religious Holidays

I will make every effort to avoid scheduling exams or requiring student projects be submitted on religious holidays. If you wish to observe your religious holidays, please notify me by the tenth day of the semester of the date when you will be absent unless the religious holiday is observed on or before the tenth day of the semester. In such cases, please notify me at least five days in advance of the date when you will be absent. I will make every reasonable effort to honor your request and not penalize you for missing the class. If an examination or project is due during your absence, you will be given an exam or assignment equivalent to the one completed by those students in attendance. Students may appeal through campus grievance procedures for religious accommodations.

Emergency Response Systems and Guides

The emergency response guide can be found at the UIC Ready. Please review and acquaint yourself with the guide and recommendations for various emergency situations.

The *Campus Advocacy Network* provides information and offers resources to all UIC students, faculty, and staff. Under the Title IX law you have the right to an education that is free from any form of gender-based violence and discrimination. Crimes of sexual assault, domestic violence, sexual harassment, and stalking are against the law and can be prevented. For more information or for confidential victim-services and advocacy, contact UIC's Campus Advocacy Network at 312-413-1025 or visit <http://can.uic.edu/>. To make a report to UIC's Title IX office, email TitleIX@uic.edu or call (312) 996-5657.