MATH 488 : Senior Capstone : Fall 2021 (4 credits)

TR 8-11:40 am, CST 316

Instructor Anand Pardhanani
CST 210
Email: pardhan@earlham.edu
Phone: 765-983-1683

Office hours The following hours are tentative - I'll finalize office hours after the 1st week

M: 1-2 pm. T: 1-2 pm. W: 1-2 pm.

And by appointment or walk-in. The best way to contact me, in order of preference, is: [1] in person, [2] by email, [3] by phone.

Open door policy: I keep my posted office hours to a bare minimum, to avoid being locked into a rigid schedule all semester. However, I am happy to assist students well beyond my office hours. Students are encouraged to just drop by whenever needed. Anytime my office door is open you're welcome to stop by and check whether I am available. Also, please do not hesitate to make an appointment if my posted office hours don't work for you.

Class website http://cs.earlham.edu/~pardhan/courses/capstone/

Textbook/ Reference TBA

Course credits

This course is worth 4 credits, and will meet for in-person classes for 400 minutes each week for 7 weeks. This is consistent with the standard practice of 4-credit courses meeting for 200 minutes per week during a regular 14-week semester. In addition, students should expect a workload outside class of about 15 hours each week.

Requirements this class fulfills

This class is required for majoring in math.

Description & objectives

In its broadest sense, the goal of a capstone experience is to help you transition from being a math student to becoming a math practitioner. There are 3 specific proficiencies related to this goal we will strive to develop through this course:

1. Learn new mathematics independently.
2. Make connections between different areas of mathematics, and between mathematics and other disciplines.
3. Communicate mathematics verbally and in writing.

This course will also include a component designed to help students explore and develop their post-baccalaureate mathematics career options.

These objectives broadly support all the learning goals of the Mathematics Department, and also those of an Earlham education (see the Appendix attached to this Syllabus). We will work towards these objectives through a combination of guided work and independent study. Although some class time will be spent in traditional lecture format, covering topics of common interest, most of the time will be spent on presenting and discussing independent work done by students.

Throughout the semester, there will be a strong emphasis on student participation in writing, presenting, discussing and critiquing.

In a course of this type, neither your instructor, nor any specific reference sources are experts in the subject areas we will cover. For the most part, we will all be learning new materials, and new ways to synthesize and connect familiar materials. The primary role of the instructor and the reference materials will be to serve as facilitator and coach, to help us accomplish the above goals.

The course will strive to place an equal emphasis on the pure and the applied sides of mathematics. That means there will be new theorems to learn and prove, and new mathematical methods to learn, based on new application areas.

Course pre/co-requisites: MATH 420 and 430.

Assessment & grading policy

Seventy five percent of the assessment and grading in this course will be based on student presentations and papers, and the remaining 25% on contributions to class discussions. While specific details will be finalized with the help of student input, I anticipate each student will give at least 3 presentations, and write at least 3 papers. Grades will be approximately equally distributed between all the presentations and papers.

Letter grade boundaries for this course are not set in advance. They will be determined at the end of the semester based on overall class performance, level of difficulty of assigned work, and other such factors. At a minimum, the following standard scale for letter grades will be honored:

A+: 97.0-100; A: 93.0-96.9; A-: 90.0-92.9;
B+: 87.0-89.9; B: 83.0-86.9; B-: 80.0-82.9;
C+: 77.0-79.9; C: 73.0-76.9; C-: 70.0-72.9;
D+: 67.0-69.9; D: 63.0-66.9; D-: 60.0-62.9; F: below 60.

Important dates

* Last day to add this course: October 6.
* Last day to drop: November 5.
* Date of final exam: November 23.

NOTE: Last drop date applies to Earlham students only. Students cross-registered through IU-East or other institutions must follow the dates and rules of their own institution.

Academic integrity

After several years of writing standard, boiler-plate stuff in this section, I have decided to replace it with a more authentic message from my heart to yours. Before getting into details, I would like to share 3 key ideas that profoundly shape my thinking, and prompt me to explore more effective ways towards academic integrity:

1. Academic infractions are a much bigger problem at Earlham than many of us would like to believe or admit.
2. The problem is **NOT** our students! Earlham students are as good (or better!) than their peers at other institutions in terms of moral values and ethical standards.
3. Infractions at Earlham can be significantly reduced using a combination of strategies, collectively developed by students and faculty.

These three points summarize my overall perspective, and will frame the rest of my discussion on this subject.

By far the single biggest phenomenon that has radically transformed today's academic integrity / infraction landscape is technology -- particularly the internet and cell phones. In my view, Earlham's traditional approach to academic integrity has been rendered completely obsolete by these technologies. If I were an Earlham student today, I would encounter many situations where the temptation to infract would be extremely high, because these technologies make it so easy, and the risk of getting caught is virtually zero. This is the main reason why I say that you, the student, are not the problem. You are human, just like me and my faculty colleagues. It is a fact of life that many humans succumb to temptation when the rewards are sufficiently high, and the risks sufficiently low.

Yet, the fact remains, a growing rate of academic infractions is a terrible thing to ignore: They sink an institution's reputation, decrease the value of students' education, lower student & faculty morale, and more. Clearly, we need to explore and develop new strategies that are more effective for our times, and also preserve Earlham's distinctive approach to such matters. We will set aside some class time to discuss and formulate specific policies for helping students (joyfully!) meet and exceed the highest standards of integrity in this class. In the meantime, I invite you to reflect on some practical ways that would most help and support you in avoiding the use of inappropriate sources for completing and turning in your graded work.

I would like to conclude with the following excerpt from the Earlham Academic Integrity Policy: "The College trusts students who enroll at Earlham to be honest seekers of truth and knowledge. This trust is extended to all students by other students and by teachers ... Giving or receiving aid inappropriately on assignments and tests, or plagiarizing by using another person's words or ideas without credit, constitutes a serious breach of our trust in one another and in the integrity of the search for truth. Those who believe they have witnessed violations of academic integrity should feel the obligation to speak about this to the suspected offender. The witness also should feel obligated to report the suspected offender to the instructor if the person fails to offer a satisfactory explanation and refuses to report him or herself. ... Violations of academic integrity, because they undermine our trust in one another and in the credibility of the academic enterprise, are taken very seriously. Penalties for violations range from failing assignments or tests to suspension or expulsion from the College. "

Academic accommodations

Students with a documented disability (e.g., physical, learning, psychiatric, visual, hearing, etc.) who need to arrange reasonable classroom accommodations must request accommodation memos from the Academic Enrichment Center (main floor of Lilly Library) and contact their instructors each semester. For greater success, students are strongly encouraged to visit the Academic Enrichment Center within the first two weeks of each semester to begin the process. For further details, please visit
https://earlham.edu/academics/academic-support-and-special-programs/academic-enrichment-center/accessibility-services/

Other sources of help

1. **The Academic Enrichment Center:** The Academic Enrichment Center (AEC), located in Lilly Library, provides assistance with study habits and skills as well as a peer tutoring service. The AEC is staffed by trained peer tutors for either pre-arranged group tutoring sessions (provided for many math, science and social science courses) or one-on-one tutoring sessions for other courses. Peer tutoring is a free service offered to all Earlham

students. Please visit https://earlham.edu/academics/academic-support-and-special-programs/academic-enrichment-center/peer-tutoring/ for more information.

2. **The Earlham Writing Center:** The Writing Center is dedicated to providing students with advice and resources about writing. Students can meet one-on-one with trained consultants who will contribute feedback to writers at any stage of the writing process: brainstorming, drafting, researching, revising, and polishing. This is a free, walk-in service on the main level of Lilly Library. In addition to dropping by, students may also schedule an appointment in advance using the online scheduler found at: http://www.earlham.edu/writing-center/. Also, if you want help with specific grammar topics related to your own writing, https://www.grammarly.com/edu is available for all Earlham students to proofread their papers and learn more about grammatical errors.

Syllabus Appendix (click here to view)

Appendix to the Syllabus

Math department student learning goals

Curiosity: an encounter with mathematical meaning, beauty, and joy.

Mathematics is an art as well as a craft. Depending on how one counts, somewhere between five and all of the classical seven liberal arts have significant mathematical content. We'd like to help students encounter seriously both the beauty and the utility of an art without which neither the world around us nor the last two and a half millennia of human culture are at all intelligible.

Craft: using mathematical tools.

Mathematics is a craft as well as an art. Much of our work involves exposing our students to the concrete mathematical tools they need to succeed in other disciplines and in a world shot through by mathematics. Those tools range from fancy machinery for quantum physicists to using simple algebraic or differential equations to model phenomena in biology and economics to techniques to manage randomness in data in the social sciences to the basic vocabulary needed to read newspaper stories with numbers in them.

Confidence: an ability to create and use mathematics themselves.

Mathematics is also the product of human beings, who work individually and collectively to discover or invent mathematical truth. We work to inculcate in our students a spirit of inquiry and to empower them to discover that they are able as individuals and working with others to make mathematical discoveries and to utilize mathematics in creative ways. Math is the work of humans, and as humans, our students have all the prerequisites they need to do and to use mathematics.

Communal Inquiry: mathematical community and communication.

Mathematics is a communal enterprise, and even a glance at the words shows that one can't have community without communication. We'd like our students to practice mathematical communication. This means that they need to learn to verify and to convey to others the results of their mathematical inquiries by writing precise, concise, and completely persuasive arguments in idiomatic mathematical language. In mathematics, the products of this writing are called *proofs*. It also means that students need to practice reading carefully and critically the mathematical works of others so as to be able to share in a community of inquiry and to learn new mathematics on their own.

Continuity: lasting mathematical experience.

Mathematics does not end with what one learns in four years at college. We wish to equip our majors for further study in mathematics at the post-

baccalaureate level, though we accept that with our current program, the path available to most students wishing to do graduate work will require them using as a stepping stone a Masters program at something other than a first-tier university. We would also hope that our non-majors might carry the spirit of joy, skill, confidence, and cooperative inquiry with them after they leave Earlham.

Earlham College learning goals

(See `https://earlham.edu/registrar/curriculum-guide/learning-goals/`)

Students should be able to:

- **Communicate** effectively and work collaboratively across diverse contexts via multiple media. Effective communication involves both social and expressive skills and the ability to communicate in multiple settings and cultures.
- **Investigate** and analyze information, materials, problems and texts using a variety of techniques. Thoughtful and careful analysis requires the ability to collect, understand, interpret and evaluate multiple pieces of evidence, with systematic understanding and overt application of qualitative, quantitative, analytical and abstract reasoning.
- **Integrate** knowledge, experience, and skills across domains and contexts. Integration involves connecting and developing ideas, as well as synthesizing and transferring learning to new and complex situations.
- **Diversify** personal and cultural experiences, ways of knowing, and social relationships. The practice of diversity involves embracing opportunities to explore outside their interests and typical frame of reference.
- **Create** and innovate across a variety of disciplines. Creativity and innovation require a willingness to take risks, be open to new possibilities, and produce new knowledge and artistic and social forms.
- **Reflect** critically on their learning experiences, ethical and vocational choices, lifestyle, and beliefs in light of multiple understandings of the world. Reflection involves the ability to examine past experiences and apply their lessons to future contexts.
- **Apply** knowledge and skills to real world problems and situations as well as to improve their own mental, spiritual and physical well-being. Applying learning effectively is a key skill of a lifelong learner.