MAT 4040: Mathematics Capstone in Differential Geometry

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1.1 Catalog Description

MAT 4040 satisfies the general education capstone requirement for mathematics majors with concentrations other than education. Students will explore current, relevant, or advanced undergraduate topics in mathematics and the relationships of mathematics with other fields. Oral and written communication skills are emphasized. Graded on an S/U basis. Prerequisites: either MAT 3110 or MAT 3220, and senior standing in mathematics or permission of the instructor.

1.2 Learning Goals, Objectives, Grades, Assignment Types and Capstone Calendar

Learning Goals

1. research, analyze and reflect on discipline-specific materials. The idea is to incorporate different levels and areas as appropriate to investigate mathematical knowledge from MAT 4140 in order to recognize the development of mathematical ideas from the past and the breadth of mathematics covered in MAT 4140, its impact on mathematical study, and its relation to the global mathematical community
2. write effectively in formats appropriate to an advanced level of the discipline and practice oral communication
3. document correctly in the conventions of the discipline
4. reflect on your own development in the areas of thinking critically and creatively, communicating effectively, making local to global connections, and understanding responsibilities of community membership, which are the four general education goals at Appalachian

Critical and Creative Thinking & Local to Global Connections

We will engage in increasingly sophisticated research activities, which include historical and other connections to the global mathematical community. The readings, homework, reflections and research project will focus on

critical thinking and creative products. You will focus on collecting and analyzing information and recognizing scholarly versus other types of sources.

Communicating Effectively & Understanding the Responsibilities of Community Membership
ASU's General Education Program prepares students to employ various modes of communication. Successful communicators interact effectively with people of both similar and different experiences and values and you will practice oral and written communication by interacting with your peers and me. You will present to your peers in the paired 4140 class and will peer review each other's work to help each other. Sometimes it is only after we present and see other models that we have ideas for improvement on our work. Regardless of gender, political party, race, religion, sexuality, or more this is to be a welcoming environment, and so I want you to be sensitive and respectful to each other in upcoming work with each other. Part of the responsibilities of community membership is to keep an open mind as you engage in our class activities.

Assignment Types, Capstone Calendar and Grades

Work is due in ASULearn by 11:55pm Thursday unless otherwise noted. Here is a calendar.

Thursday 1/15	Introduction to LaTeX and the course ☐ capstone course intro interactive video ☐ LaTeX intro interactive video ☐ read LaTeX software and compile template1.tex ☐ read the syllabus
Thursday 1/22	Introduction to the capstone project and careers in mathematics ☐ examine Appalachian's Career Development Center upcoming events ☐ read the capstone project guidelines ☐ selection of preliminary topic for capstone project: first-come, first-served ☐ introductions and careers (post and reply) forum
Thursday 1/29	Scholarly peer-reviewed sources ☐ finding and evaluating quality sources (optional but recommended) Make library RAP appointment ☐ reflection on finding and evaluating quality sources
Thursday 2/5	Part 1 of the capstone project ☐ instructions and template for part 1 of the course project (optional but recommended) meet with me to discuss progress and challenges ☐ submit PDF of LaTeX'ed part 1 of the course project
Monday 2/9	Project 1 presentation due in 4140 11–11:50
Thursday 2/12	Reflect on "How to Write Mathematics" ☐ read "How to write mathematics" by Paul Halmos ☐ reflection on how to write mathematics
Thursday 2/19	Part 2 of the capstone project ☐ instructions and template for part 2 of the capstone project ☐ submit PDF of LaTeX'ed part 2 of the capstone project
Thursday 2/26	Reflect on "Guidelines for Good Mathematical Writing" ☐ read "Some Guidelines for Good Mathematical Writing" by Francis Edward Su ☐ reflection on good mathematical writing (optional but recommended) meet with me to discuss progress and challenges if you did not yet achieve Jedi or Jedi master on part 2 then resubmit back in that same assignment Page
Thursday 3/5	Capstone survey ☐ read general education courses and goals at Appalachian ☐ capstone survey

Thursday 3/19	LaTeX symbols and work on first draft ☐ skim LaTeX mathematical symbols and test some of them ☐ read through the capstone project rubric ☐ begin work on the first draft by modifying the template in this link
Wednesday 3/25	Project 2 presentation due in 4140 11–11:50
Thursday 3/26	Continue working on first draft (optional but recommended) take a draft to the writing center (optional but recommended) meet with me to discuss progress and challenges ☐ submit LaTeX'ed PDF under next week for a preliminary first draft—you will continue working on your first draft next week, but this will ensure that you have a submission in next week's strict deadline assignment
Thursday 4/2 **strict deadline**	First draft is due ☐ submit PDF of final first draft of the capstone project LaTeX'ed
Thursday 4/9	Introduction to Beamer ☐ capstone beamer intro interactive video (optional but recommended) discuss your first draft with a peer or friend
Thursday 4/16	Reflect on communication in mathematics ☐ read feedback on first draft ☐ read "How to give a good 20 minute math talk" by William T. Ross ☐ look through "How to give a Talk" by Tammy Kolda ☐ in 4140, look back at "How to Create Your Own Universe in Three Easy Steps," by Lawrence Brenton ☐ reflect on communication in "How to Create Your Own Universe in Three Easy Steps," "How to give a good 20 minute math talk" and "How To Give a Talk"
Monday 4/20	Project 3 presentation due in 4140 11–11:50
Thursday 4/23	Second draft is due ☐ second draft is due as a LaTeX'ed PDF. Incorporate feedback to make improvements ☐ begin LaTeX beamer for presentation by modifying the beamer template
Wednesday 4/29	Share your final project idea or title in 4140 11–11:50
Friday 5/1	Final presentation due in 4140 by 11am
Thursday 5/7 **strict deadline** **strict deadline**	Final paper is due ☐ Final draft that satisfies all items in the rubric is due as a LaTeX'ed PDF. Incorporate feedback to make improvements ☐ to pass the capstone, all items must achieve completion by Thur 5/9 although some items have strict deadlines before then

Assignment details, including the capstone project, are described on ASULearn and turned in there.

We'll be engaging in standards-based learning, where success is tied to meeting specific learning goals in assignments, rather than a percentage correct or point system. This will allow you (and I) to identify strengths and weaknesses early and you'll have multiple chances to revise and succeed. We'll employ Star Wars terminology as a metaphor—Padawans are training to one day become a Jedi. Jedi is a rank within the Jedi Order, referring to Jedi who complete their training and pass the Jedi Trials to become full members.

A course grade of S means that all work has been completed at the Jedi level or higher and is required to pass the capstone.*** A Jedi Master is a leader who has demonstrated exceptional achievement.

	Padawan still training	Jedi	Jedi Master
I can make a good faith effort in readings, homework, and reflections to satisfy learning goals a)–b).			
I can turn in a quality research project in differential geometry to satisfy the capstone project rubric and learning goals a)–c).			
I can complete the course survey to satisfy learning goal d).			

***Accommodations in the final grade may be made for extenuating circumstances that are officially documented to prevent you from completing work, including the level of achievements in the learning targets.

1.3 Required Resources

- reliable access to technology, software, and high speed connectivity: The work you're going to do for class you'll be accessing though your internet connection with a device, so it will be really important to have access to a dependable high-speed internet connection and a good computer that can run everything we'll need. The software is free, including Maple—any student with a valid Appstate email address can access Maple on their own computer or on campus computers. For optional office hours, we'll use Zoom videoconference software with breakout rooms. Flexible browsers that will play common media formats from various sources such as from webpages, Google Drive, YouTube, and ASULearn, including interactive videos, are also something we'll use. ASULearn components work best from scrolling through the activities themselves on a computer—the Moodle mobile app does not always show everything as designed, both for visibility and for due dates. Online students are expected to have or acquire proficient computer skills and to resolve their own technology problems related to computers or internet access to turn things in before deadlines. Work early and leave yourself enough time before any strict deadlines to allow for technical issues that may arise. For example, ASULearn will typically be undergoing monthly system maintenance on the last Thursday of each month. `https://asulearn.appstate.edu/?redirect=0` announces downtime and `http://Support.appstate.edu` and `https://confluence.appstate.edu/display/ATKB/Appalachian+Technology+Knowledge+Base` can help.

1.4 Where to Get Help, Academic Integrity, Course Language, Sources and Citations, AI Policies, and Additional Policies

- **Help Hours and ASULearn Forums** You are responsible for announcements made on ASULearn, so check them often. I encourage you to talk to me and your classmates often. Outside of the paired class, I can help in Zoom, internet allowing, Sunday, Tuesday, and Thursday 7–7:45pm and Monday and Wednesday 9:45–10:30am and 12–12:30pm via the link in the Need Help Forum on ASULearn from `https://asulearn.appstate.edu/course/view.php?id=202567`

  You can come in to Zoom to work on future assignments, working along and asking questions as they arise, or you can ask me questions about items you already turned in, ask me questions related to course content or structure, or ask me to go over a concept. Keep me informed about any problems and I also want to hear when things are going well! We can both write on a whiteboard and share our screens. You do not need to make an appointment to meet with me in Zoom, just drop by and I am happy to help! During the paired class and in online communication, use standards of professionalism and collegial communication. This

course is to be an environment in which everyone feels comfortable asking questions, making mistakes, offering good guesses and ideas, and is respectful to one another.

Please use a salutation of Dr. Sarah, my preferred name, in communications with me. If you can't make it to Zoom, for quick questions you can contact me with a professional message on the Need Help Forum on ASULearn. The department has a policy that defines timely communication as generally within 3 working days, but I aim to respond to you and get items back to you sooner when possible. If you haven't heard back from me yet, only message again if you are addressing a new and separate issue or retracting a previous message. During Zoom hours, I can set up individual breakout rooms for private conversation with me. What I like to do is have conversations with you about what you are thinking of and unsure of. The forum is for quick questions. Except for extreme emergencies, all private written communication must be handled through your private forum, with just you and I, on ASULearn rather than e-mail. I prefer that you use the Zoom hours as it is easier to discuss material in real time.

- **Help for Productive Struggle** The Conference Board of the Mathematical Sciences (CBMS) published a statement titled "Active Learning in Post-Secondary Mathematics Education" about the importance of "classroom practices that engage students in activities, such as reading, writing, discussion, or problem solving, that promote higher-order thinking" and our course is modeled after that. The purpose of engagement is to learn and practice course content and learning goals, and develop critical thinking and problem-solving skills. Making mistakes is integral to the learning process—the key is to try to continue to engage rather than give up—and this course is to be an environment in which you ask questions and offer good guesses. It is on purpose that there are problems that don't look exactly like what we did previously in order to provide you with rich settings to explore and learn deeply.

  I do not expect you to be able to solve all the issues immediately. Instead, I want to see what you can do on your own. Out in the real world, this is important, since no matter what job you have, you will be expected to seek out information and answers to new topics you have not seen before. This may feel uncomfortable and frustrating. I understand this and want to help you through the process. It helps to remember that there are no mathematical dead-ends! Each time we get stuck, it teaches us something about the problem we are working on and leads us to a deeper understanding of the mathematics. In the real world though, you are not expected to face your work alone, and this class is similar.

  Asking questions, and explaining things to others is one of the best ways to improve your understanding of the material. I am always happy to help and will try to give you hints and direction to help you understand the material. At times though, to encourage the exploration process, I may direct you to rethink a problem and to come back to discuss it with me again afterwards. This occurs when I believe that the struggle to understand is imperative for your deep understanding of the material.

  I believe that you have the capability to succeed in this course.

  If you find that you are spending fewer hours than the university recommends, you can probably improve your understanding and grade by studying more. If you are (on average) spending more hours than these guidelines suggest, you may be working inefficiently; in that case, you should come to see me.

- **Academic Integrity, Language of our Course, Using Additional Sources and AI Tools, and Citing Sources Properly**

  Academic Integrity is a fundamental part of the course, which includes meeting deadlines, regular communication, and giving proper reference where it is due. These are essential to course integrity. Feel free to talk to me or each other if you are stuck, but when writing up work, be sure to give acknowledgment where it is due. Submitting someone else's work as your own (PLAGIARISM) is a serious violation of the University's Academic Integrity Code. Violations include, but are not limited to, borrowing, downloading, cutting and

pasting, and paraphrasing without acknowledgement, including from online sources, giving unauthorized assistance or allowing an individual's academic work to be submitted as another's work.

Language of Our Course: You are to respond to assignments and projects in your own words while specifically using the language of our course. By "language," I mean the ideas, definitions, concepts, notation, formulas, approaches, explanations, reasoning, proofs and justifications from our course. Engaging with course-specific language ensures effective and meaningful participation that strengthens collaboration in presentations and peer reviews. Additionally, our course material builds on itself, and we'll continue using the same language in upcoming activities.

Using Additional Sources and AI Tools, and Citing Sources Properly: You are welcome to consult additional sources—including people, published materials, websites, or tools—but you must provide appropriate credit for any ideas, wording, images, or tools that influence your work. If you use AI or sources for anything beyond minor grammar or editing help, you must disclose this in your references and specify how it contributed to your work. This includes any use of artificial intelligence tools (such as large language models, chatbots, or generative AI systems). Be aware: as of this writing, generative AI systems often produce incorrect, overly general, misleading, or unfamiliar-to-our-course responses. You are responsible for the accuracy and relevance of your submissions, regardless of your sources. Regardless of any additional help, your work must be written and spoken in your own words and demonstrate your understanding by explicitly connecting your work to the language and content of our course.

	Appropriate Use for Academic Integrity	What to Avoid
AI Help	input draft wording, explanations, computations or similar into AI, ask for help, and then revise and independently check the output so that it is in your own words and based on our course content and language	use full sentences, paragraphs, computations or other items generated by AI without proper editing, quotation marks or citation
Sources	use an AI-generated or Wikipedia source but verify it in library resources or elsewhere	unverified sources
Citations	provide the sources in a way that is professionally formatted (author, date, title, and publisher for all sources plus either publication and page numbers or full web address...) and that I can access	incomplete or missing citation
Disclosures	give proper credit to anyone you talked to, tools you used, such as AI, and how you used them, specifying how they/it contributed to your work and any prompts used	incomplete or missing disclosure

If any AI tools or anything else contributed in a non-trivial way to any content, wording, or images, they are clearly acknowledged.

- **Where to Get University Help** I want you to be informed about your choices regarding what you tell me about certain types of sensitive information. In situations where students disclose experiencing an act of interpersonal violence to their instructor, faculty are required to report that to the campus Title IX Coordinator, who then reaches out to the student by email offering support services. I care about you and want you to get the resources you need. I'm happy to talk with you if you decide you want that, but please be aware that if instead you'd like to explore options with someone who can keep your information totally confidential, I highly recommend the Counseling Center at 828-262-3180. They offer walk-in hours as well as after-hours coverage: `http://counseling.appstate.edu`.

- Appalachian Cares is a place to find updates about matters of student health and safety `http://appcares.appstate.edu/`.

- Belk Library offers a wide array of research services including access to their digital media studio (with assistance available), video and audio recording rooms, Research Advisory Program sessions in which you meet individually to work with a librarian, Library guides, study spaces, and online workshops, like `http://library.appstate.edu/gethelp/rap`
- The writing center can help you with drafts of your reflections `https://writingcenter.appstate.edu/`
- Disco Student Learning Center offers academic resources that will complement and enhance classroom experiences by helping students become acquainted with their studies and learn how to learn effectively. For example, you can meet with a study skills specialist to discuss your goals and develop strategies and study plans to meet those goals or arrange for tutoring. "D.D.," or Dauphin Disco, was one of the three people who, in 1899, founded Watauga Academy – known as App State today. The word disco is Latin for learn. `https://studentlearningcenter.appstate.edu/`
- **Recordings and Permission Required for Sharing Materials** Photos, video or audio recordings may not be taken without prior permission. Sharing our course materials, ASULearn items, photos, video or audio recordings may not occur without prior permission.

1.5 Academic Affairs and University Policies

We adhere to the University-wide syllabus and policy statements:
`https://academicaffairs.appstate.edu/resources/syllabi-policy-and-statement-information`
and University policies like on `https://policy.appstate.edu/Policy_Manual`

1.6 Advice from Previous Students

- It is easy to forget about it. Block a regular time in your schedule for homework.
- Make sure the topic you choose for the course project is something you are interested in. If it isn't, you can change it at the end, but it is better to choose something good from the beginning.
- I had fun with the readings and activities. The reflections are as interesting as you make them.
- Remember that some weeks will have less homework than others. Spend any spare time on the course project so that your last weeks of class are not too crazy. The workload overall was fine.
- Dr. Sarah has set up the course project to be completed in steps to help you. Take advantage of these and her help. I hadn't realized that I could bring coding problems in to her office hours.
- Do not procrastinate and keep a regular checking period of the syllabus.

1.7 Instructor Bio

My PhD is from the University of Pennsylvania in the Riemannian geometry of orbifolds. I am a full Professor of Mathematics, and I am also an affiliate of Gender, Women's and Sexuality Studies (GWS) and the Math and Science Education Center (MSEC), investigating the connections between mathematics and society. I am married to the bassist Joel Landsberg. In our spare time, we like to travel, hike, kayak and conduct genealogy research. In addition to my own personal genealogy, I like to give back to the broader community, and in this context, I am affiliated with ASU's center for Judaic, Holocaust and Peace Studies. Some of what I like about mathematics is also what I enjoy about genealogy—the sense of exploration, discovery and aha moments that come with lots of patience and effort. For more information, see `http://cs.appstate.edu/sjg/`.

1.8 Acknowledgements

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