1.1 Description and Activities

Catalog Description: MAT 5530-5549 - Selected Topics (1-4). When Offered: On Demand

Course Description and Activities: We consider the differential geometry of curves, surfaces, and spacetime, including theoretical and computational components, intrinsic and extrinsic viewpoints, and numerous applications. Prerequisite: linear algebra, multivariable calculus, differential equations, analysis, analytical physics. Graduate students who are enrolled in selected topics will attend the undergraduate course 4140. They will complete that work as well as extra graduate problems and assignments. For example, for the final project graduate students will have an additional component to research the literature (mathematics and/or physics and/or cs journals) and discuss some recent work, and if possible an open problem, that relates to the topic. See the individual assignments on the main webpage for details. In addition to extra graduate problems on assignments and an additional component on the final project, graduate students will have one additional graduate project. In the past graduate students choose some aspect they were interested in, and often this was something to help the class, but not always. Here are some examples (choose one project, but it doesn’t have to be from the following list):

- Prepare a presentation on a topic related to curves, and one related to surfaces for the class
- Create a few glossary/Wiki entries on topics that we would post on ASULearn
- Create Maple applets
- Consider and research the ways that advanced topics connect and report back

1.2 Learning Goals

Graduate students satisfy the undergraduate learning goals for the course as well as some additional goals.

Undergraduate Learning Goals
- To develop geometric skills and 3-D spatial visualization skills.
- To develop a greater appreciation for connections between various disciplines of mathematics, including geometry, linear algebra, complex analysis, and differential equations, along with an introduction to these subjects as they apply to differential geometry.
- To understand the importance of differential geometry in various scientific fields, including physics.
- To practice critical and creative thinking and to communicate effectively with your peers

(Additional) Graduate Learning Goals
- To build off of existing coursework in analysis, differential equations and analytical physics
- Research, review and interpret literature related to topics in differential geometry
1.3 Required Resources

- printouts of your Maple and other work
- access to a web browser and to library editions and Maple (on-campus access is sufficient as long as you have the time to work on campus while the labs are open). There are a number of advanced books on this topic in the e-book collection such as *Differential Geometry: Theory And Applications* by Daqian Li and Philippe Ciarlet, 2008, 9789812771469, 9789812771476.

1.4 Tentative Calendar of Topics and Major Activities

Details are on the course web page [http://cs.appstate.edu/~sjg/class/4140/s18.html](http://cs.appstate.edu/~sjg/class/4140/s18.html)

Week 1: lines and curves
  - Homework 1: Review

Week 2: arc length and Frenet Frame
  - Homework 2: Curves

Week 3: Frenet formulas

Week 4: curvature and torsion
  - Homework 3: More Curves

Week 5: fundamental theorem of curves
  - Test 1 on curves

Week 6: isoperimetric inequality, surfaces

Week 7: curvatures and geodesics
  - Homework 4: Intrinsic Geometry of Cones

Week 8: metrics and first and second fundamental form
  - Homework 5: Flat Donuts and Round Donuts

Week 9: applications

Week 10: surface area

Week 11: Gauss-Bonnet
  - Homework 6: Research and Investigate a Surface
  - Test 2 on surfaces

Week 12: Christoffel symbols
  - graduate project

Week 13: spacetime and metric tensors

Week 14: applications to general relativity
  - Homework 7: Research and Investigate a Metric Form: Create a Video

Final exam period: final project

1.5 Course Communication

- Office Hours and ASULearn: My office hours are in 326 on Monday 12:30-1:45, and Tuesday/Thursday 12-1:45. I am always around and happy to help you during office hours unless otherwise posted to the web page. You do not need to make an appointment to use office hours—just drop by! If you can’t make office hours, contact me on ASULearn, which I’ll try to answer at least once a day, including the weekends.

- Check the main calendar web page often for homework and for access to the other class web pages.

- Communicating about Work for Missed or Excused Absences: If there is some reason you must miss a class, then keep me informed, with any appropriate documentation, and obtain the assignment and class activities from the web pages to turn the work in early or on time, if possible (you can send it with another student to class, slide it under my office door sometime before I leave for class, or even turn it in on ASULearn if need be, but I prefer printed work). These include responses to i-clicker questions and other class activities.
• Inclement weather: If the university cancels classes, check the class web pages for updated info, which may include plans for the missed class such as additional readings, problems, video meetings, Chat, and/or Forum sessions in ASULearn. Homework may still be due onto the private ASULearn forum.

1.6 Assignment Types and Grades

• Effective Class Engagement 5%
  You are expected to contribute to discussions and i-clicker questions in a meaningful way and actively engage the material in class. You must be prepared for each class and check the main web page regularly for hw. These will include readings from the book, Maple applets, paper folding activities, as well as the following short readings: Curves and Surfaces, both by Dogan Gomez, myself and Jill Thomley, How Flies Fly: Kappatau Space Curves by Rudy Rucker, How to Create Your Own Universe in Three Easy Steps by Lawrence Brenton, and Relativity by David Brink. These kinds of baseline activities will result in a participation grade of 3.5/5. Other activities can increase or decrease this grade. Utilizing office hours and ASULearn, asking and answering thought-provoking questions, coming up with creative ways of thinking about the material, and explaining the material to others are some examples of positive participation that will increase your grade. On the other hand, performing activities that detract from the professional classroom environment or distract your neighbors or me will result in a lowered participation grade. Many activities and class discussions are designed to be completed during class. Thus, attendance is required at ALL classes, and will form a portion of your grade. If you must be late to a class, or must leave early, then do still attend.

• Homework 30%
  Work will not be accepted without explanation and must also be turned in on or before the due date. If there is some reason you must miss a class, then obtain the assignment from the web pages. The lowest graded homework will be dropped—save this for emergencies. No lates allowed*. If all of your homework is turned in AND you have received at least a grade of 70% for all work, then you will receive a work completion credit of +1 added on to your final average. No lates allowed*.

• Exams 50%
  You should view exams primarily as a learning experience. This means that exams are not only an opportunity for you to demonstrate your mastery of the material, but are also an opportunity for you to be challenged with new material in order for you to make new connections. To encourage exams as a learning experience some extra points will be granted for complete and correct test corrections. No lates allowed*.

• Final Project 15%
  You must participate to pass the class *

  * Accommodations in the determination of your final grade will be made for extenuating circumstances that are documented to prevent you from completing work early/on time. The grading scale is: $A \geq 93; 90 \leq A- < 93; 87 \leq B+ < 90$...

1.7 Academic Affairs Policies

We adhere to the University-wide syllabus and policy statements:

https://academicaffairs.appstate.edu/resources/syllabi-policy-and-statement-information

1.8 Where to Get Help and Additional Policies

My office hours are in 326 on Monday 12:30-1:45, and Tuesday/Thursday 12-1:45. Check ASULearn often for homework. ASULearn is the easiest way to ask a question outside of class and office hours. You are also responsible for all assignments and announcements made on the web pages, so check them often. I prefer that you use office hours since it is easier to discuss material in person, but if you can not make them, then ASULearn is a great alternative. If the university cancels classes, check the web pages for updated info, as we may meet by
videoconference and homework may still be due. Snapshots from your phone attached onto the private ASULearn forum are acceptable, for example. If there is some reason you must miss a deadline, then keep me informed, with any appropriate documentation, and turn the work in early or on time, if at all possible. I encourage you to talk to me often in office hours, and on the ASULearn forums and I am always happy to help. I also 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 what students tell us 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. It also functions as the most up-to-date clearinghouse of information, resources and support available. http://appcares.appstate.edu/
- The University Writing Center (UWC) offers free services to students, faculty, and staff of Appalachian State University and the Boone community: http://writingcenter.appstate.edu/
- The library offers Research Advisory Program (RAP) sessions. http://library.appstate.edu/gethelp/rap
- The Learning Assistance Program provides five core services. Two services, University Tutorial Services and Academic Strategy Instruction, are offered to all undergraduate students, and three services, ACCESS, Student Support Services, and Academic Services for Student Athletes, serve specific groups of students identified as needing comprehensive support. In Fall 2016, the ASU-R program joined the Learning Assistance Program. http://lap.appstate.edu/welcome-learning-assistance-program-1
- AppSync is your one-stop connection to engagement and leadership opportunities at Appalachian State. https://appsync.appstate.edu/

You should explore the course material and write out your thinking in a way that can be shared with others. 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. 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, which defines: “Plagiarism includes, but is not limited to, borrowing, downloading, cutting and pasting, and paraphrasing without acknowledgement, including from online sources, or allowing an individual’s academic work to be submitted as another’s work.”

1.9 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), investigating the connections between mathematics and society. In Spring 2018 I am Interim Director of GWS. I am married to the bassist Joel Landsberg. In our spare time, we like to travel, hike 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.

1.10 Acknowledgements

Star Wars™ and © Lucasfilm Ltd., Twentieth Century Fox, Walt Disney and its companies. For educational use only. I adapted the idea from my friend Amy Ksir at the Naval Academy.