

# Differential Geometry Final Project

You may work alone or in a group of up to 2 people and turn in one video per group, although each person conducts their own peer review and a self-evaluation. Choose a topic related to differential geometry as evidenced by its inclusion in a differential geometry publication and connection to one or more topics we covered.

## Contents

1.1	Rubric and Your Tasks . . . . .	1
1.1.1	Using the Language of Our Class and Proper Referencing . . . . .	2
1.2	Sample Topics . . . . .	3
1.3	For 4040 Capstone Students . . . . .	4
1.4	Conduct 4 Peer Reviews . . . . .	4
1.5	Conduct a Self-Evaluation . . . . .	4
1.6	Resources: ASU Options to Record and Share Your Video . . . . .	4

## 1.1 Rubric and Your Tasks

Your project will be graded on your differential geometry connections and the clarity and creativity of:

extension of course content in the video	extend class content in some creative way by presenting material orally and in writing. You could explain new material, examine connections to your field, other classes or your interests, code, visualize existing material in creative ways, describe historical connections, or make other new connections
alphabetized bullet point list of related class topics near the beginning of your video	present an alphabetized bullet point list of topics we covered that relate to your topic orally and in writing—at least one topic from our class is on it. Say your extension incorporates Christoffel symbols in some way. Then include in your list. If not, then do not
video aimed at a peer who needs a refresher	explain differential geometry we covered to a peer who needs a refresher using the language of our class
depth of differential geometry connections in the video	present rich differential geometry connections orally and in writing with correct mathematics, connecting to the language of our class when possible. depth can be achieved by reviewing related differential geometry we already covered and connecting it to your extension if the extension is a program you create, history, real-life applications, etc., or it can be achieved with the differential geometry extensions themselves, if the topic is one we haven't covered.
personalization and reflection in your video on your process, tools and/or content	personalize your video, like reflecting on your favorite aspects or the reason you selected your topic. if applicable, describe what you did and how, explaining any research conducted, papers read, or coding and specifying tools like Maple, LaTeX or by-hand work for professional formatting or image creation, if used
if applicable, professional reference list, including authors, and disclosures in your slides	if applicable, cite credible, relevant sources and/or evidence that are situated within the context and purpose of the presentation and are listed professionally and cited appropriately, including authors (see 1.1.1 below for full details)

if applicable, cite image references in your slides	images are referenced by their original source but do not need authors. Place these and any other citations or disclosures in your slides
overall writing and speaking	writing and speaking is clear, well organized, and professionally presented (it is ok to have some imperfect flow in your speech). Your video includes balanced voice narration from <b>each</b> member of your group, if you work in a group of 2, or includes your voice narration otherwise
own words/self creation	aside from external images, all components are products that you create yourself in your own words. If you are showing any mathematics symbols or notation then include screenshots of your by-hand work or professionally type it yourself
share final project ideas during class	on our last day together before finals, you will briefly present your name and final project plans to classmates and hear theirs. If you are unsure, you can present more than one idea and decide later.
video presentation	a video which satisfies the final project criteria. You should take as long or short as you need to meet these rubric items although staying on point is important and part of a professional presentation. If you find that your video is longer than 20 minutes, please consider whether you can trim it
forum posting	by Friday May 1st at 11am, post in the final project forum <ul style="list-style-type: none"> <li>• your preferred name for peers to use in their peer review</li> <li>• your final project title/topic</li> <li>• a link to your video that we can access which satisfies the final project criteria unless you work with a partner in which case one of you posts that and the other posts a message naming your partner.</li> </ul>
4 peer reviews	in-depth peer review of 4 classmates' presentations with some topics different than yours (if possible) and detailing strengths, suggestions and what you learned (see below for questions)
self-reflection	in-depth self-reflection (see below for questions)

### 1.1.1 Using the Language of Our Class and Proper Referencing

For your final project and extension, you must respond in your own words—both in your video and your written work. As you develop your extension, you are expected to connect, as much as possible, to the language of our class. By language, I mean the definitions, concepts, notation, formulas, reasoning, justifications, approaches, and explanations we've explored in our readings, class discussions, activities, and videos. In other words, use the ways we engaged with the material to deepen and support your project.

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). 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. Give proper credit to anyone you talked to, other than me, tools you used, such as AI, and how you used them, specifying how they/it contributed to your work

You are responsible for the accuracy and relevance of your submissions, regardless of your sources.

Regardless of any additional help, your project 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.

## 1.2 Sample Topics

Here are some final project ideas, just to name a few possibilities—there are many others!

- Topic from class: You could expand on a topic from class such as a curve, a surface, a metric form, tensors, or other topics
- Visualization: You could work to create a differential geometry visualization in GeoGebra, Maple, or another programming language to visualize in a creative way something we covered or something new that connects. For instance, as part of an independent study, Matt Hefner coded <https://editor.p5js.org/hefnermw/full/gUkZJ1tN>. You could work on a new visualization or program and report back on how that went or find one we didn't cover, like Rudy Rucker's Software related to "How Flies Fly," to explore and report on.
- Textbook: You could explore a theorem, topic, or visualization in the textbook we didn't cover, or expand on one we did, such as one of the following, and summarize what you learned:
  - pp. 453–454 lists some final project ideas, including a Mylar Balloon
  - 1.6 has Green's Theorem and the Isoperimetric Inequality
  - 3.6 has Surfaces of Delaunay
  - Chapter 4 has Minimal Surfaces
  - 5.2 has the Clairaut Relation for geodesics
  - 5.7 in our textbook has an industrial application of wrapping and unwrapping
  - Chapter 7 has Calculus of Variations and Geometry
  - The index lists various pages on the Gauss map
- Article: You could read an article or part of a book and summarize what you learned, like
  - "The Center of Population of the United States" by David Austin
  - "Curvature and Uniqueness of Equilibrium" [Mathematical Economics] by Andrea Loi and Stefano Matta
  - "Designing a Baseball Cover" by Richard B. Thompson
  - *Differential Geometry For Physicists And Mathematicians: Moving Frames And Differential Forms: From Euclid Past Riemann* by Jose G Vargas
  - "How a 19th Century Math Genius Taught Us the Best Way to Hold a Pizza Slice" by Aatish Bhatia
  - "Hyperbolic Basketball" by Bernadette Boyle, Andrew Lazowski and Michael Watt
  - "The Klein Bottle as an Eggbeater" by Richard L. W. Brown
  - *Subdivision Surfaces (Geometry and Computing)* by Jorg Peters and Ulrich Reif

**There are lots of possibilities to extend content—I encourage creativity!**

### 1.3 For 4040 Capstone Students

Students in MAT 4040, the capstone course, create a video presentation that relates to their capstone project. In addition, as per the goals of the capstone, instead of the option of including screenshots of by-hand work that the rest of the class may use, you will professionally type all mathematics yourself.

### 1.4 Conduct 4 Peer Reviews

After you post in the final project forum there is typically a delay, like 15 minutes, and then your classmates' postings will open to you so that you can work on 4 peer reviews and a self evaluation. You submit a PDF of that in the (separate) hand in assignment link (not this forum), which goes just to me. Try to select classmates' videos who selected a different topic than you did.

1. Name of the person/people
2. List the project title
3. List the topics from class that relate
4. List one or more strengths of the project
5. Give one or more constructive suggestions for the project, if any, or write N/A
6. How much time and effort does it look like they put into their work, as compared to your own effort? [2 = more than me, 1 = about the same as me, 0 = less than me]
7. What did you learn OR What is your favorite part of their project?

### 1.5 Conduct a Self-Evaluation

1. Your name and topic
2. What would you have improved about your project with more time and/or resources?
3. What did you feel went well?
4. If you worked alone, discuss what you learned about yourself through this project.  
If you worked with a partner discuss how you worked together or divided up the work. Do you deserve the same grade as your partner? Why or why not?

### 1.6 Resources: ASU Options to Record and Share Your Video

1. The library offers help via <https://library.appstate.edu/services-search/digital-media-studio>.  
The university has Zoom as well as Kaltura pro accounts. Access your Zoom pro account at <https://appstate.zoom.us/>. Zoom cloud recordings are automatically copied to your private Kaltura My Media directory, so you can use your Zoom pro account and embed it using the Kaltura button . During finals this could be slow, so you might want to download to your computer and then upload to Google Drive or YouTube and then change the permissions to share it with us (see below). For Kaltura, see <https://confluence.appstate.edu/display/ATKB/Kaltura+in+AsULearn> and install Kaltura from My Media/Kaltura Capture to record you and your screen. This page also shows how to embed a Kaltura video to a forum post using the same Kaltura button
2. You can use your ScreenPal pro account  
<https://screenpal.com/appstate>

3. You could create a recording with your phone or some other recording software and then use YouTube or Google Drive to host and share your work. Review <https://www.youtube.com/embed/9dLI002DeTo> to see a quick introduction to sharing your work on YouTube. You can read detailed instructions about how to share your video file on Google Drive at <https://www.businessinsider.com/how-to-share-a-video-on-google-drive>. I think using the share link option (step 6) with permissions set to "anyone at appstate" is the easiest way to share.

© Sarah J. Greenwald. For personal course use only. The content may not be uploaded elsewhere or distributed.