Math 401-001 Mathematics Through 3D Printing, Fall 2021

Lectures: MW: 12-1:15pm, Innovation Hall 333

Lecturer: Dr. E. Sander, *esander@gmu.edu*
Office Hours: Posted on Blackboard

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Office Hours: Posted on Blackboard.

Prerequisite: MATH 290 and at least 3 credits of Mathematics above MATH 300. This is a capstone course, so it is expected that a student will have taken at least 85 credits before enrolling in this course.

Course Text: There will be weekly reading materials posted on Blackboard.

Laptop Requirements: This course will involve a lot of computational intensity, including in class work. Therefore you should expect to **bring your laptop to class**

Software: We will be using a number of software packages. Please immediately download the following pieces of software. All of them are either free to all or free to you as a GMU student.

Coding software:

- OpenSCAD: http://www.openscad.org
- Mathematica: https://cos.gmu.edu/mathematica/

Mesh viewing software:

- Meshlab: http://www.meshlab.net
- Meshmixer: http://www.meshmixer.com

Slicer software:

- Ultimaker Cura: https://ultimaker.com/software/ultimaker-cura
- Makerbot Print: https://www.makerbot.com/3d-printers/apps/makerbot-print/download/

Course goals: Incorporates new mathematics from a large variety of fields into the design and creation of 3D printed models, as well as the written and oral communication of these mathematical ideas. Topics vary but might include regular and quasiregular tilings, Platonic and Archimedean solids and their duality, orientable and non-orientable surfaces, fractals, chaotic attractors, Riemann surfaces, and data visualization.

Course assignments: This course introduces students to the software required to create actual physical models of mathematical objects. After this introduction, each week you will be creating and explaining a 3D printed mathematical object in the spirit of a weekly mathematical theme.

1. **3D printed object:** Your course assignments will be in the form of weekly prints highlighting a given mathematical theme. This will necessarily involve you designing the objects in a software package and printing these objects on a 3D printer.
2. **Presentation:** Students will incorporate the mathematics they have learned and the print they have created to explain it in a variety of both written and oral forms using blog posts, public code sharing, oral presentations, and traditional writeups. As outreach opportunities arise, students are encouraged to present their poster or talk. For more details of each type of presentation, see Presentation descriptions.
3. **Code and STL file:** You will be turning in a working code and a working STL file that both produce the object you turn in. This will be turned in on Blackboard.
4. **Attendance:** You need to be present for all lectures.
5. **Weekly print slot:** As stated above, students will turn in a file of objects that they have designed. Each student does their own printing with the aid of the course learning assistants. You are required to create a printable working file. You will then come to the MathMakerLab Exploratory Hall room 4462 during your print slot to print the object. You also have the option of creating the print in another location if you choose. An on campus option is the Mix Lab: https://themixlab.org/lab-hours. More details on how to know will be covered in class.
6. **Public display and display card creation:** Your prints will be displayed publicly. Placement will be in places like the departmental display case on the ground floor of Exploratory Hall, the math Tutoring Center, and the Math Department Office. These printed objects will be accompanied by a brief description on a museum-style placard prepared by the student.

Further expectations: Here are a few other notes so you know what to expect.

- **No identical creations:** Designing involves creativity and is a form of artistic expression. Each student will find a different way to objectify the weekly mathematical theme.
- **Breadth over depth:** Since we will focus on a new theme each week, you will not have the chance to become an expert on each topic as you would in a disciplinary class. However, you will need to read the provided readings and to become sufficiently knowledgable to be able to present the topic as described above.
- **Patience required:** 3D printing is an exciting cutting edge technology. Sometimes things go wrong even when you have done everything right, and you will have to redo portions of your work.

Grading: Your grade will be based on weekly assignments, according to the course rubric. (Course rubric is available on Blackboard). In general, 90%-100% = A, 80%-89% = B, 70%-79% = C, 60%-69% = D, below 60% = F. Plus and minus grades will be approximately 2 or 3 percentage points above or below these boundaries (e.g. 88% would correspond to a B+). I reserve the right to lower the curve, but will not raise the curve.

Missed work: There will be no makeups for missing assignments or weekly print slots. If more than one assignments is missed and (1) a valid, documented excuse is given in writing to the instructor at the time of the absence and (2) the student provides sufficient evidence to the instructor that he/she is keeping up with the topics in the course, then a second weekly assignment will be dropped.

Blackboard: This class will be using Blackboard. Other than this syllabus, all handouts or information will be on Blackboard.

Tips for success in this class:

- Attend class, be on time, and pay attention. This is also a courtesy to other students!
- Bring laptops to class and talk to classmates and LAs while participating in active learning.
- Read all written assignments. While designing prints is a different type of process than reading about math, you will not be able to design until you know the math.
- Prepare all designs and create an STL file well in advance of your due date. Before turning it in, you are responsible for checking your STL file in the slice software to make sure it is printable.

Honor Code: It is expected that students in this class will conduct themselves within the guidelines of the Honor Code. All academic work should be done with the level of honesty and integrity that this University demands. Any violations will be sent to the Honor Committee and will result in a grade of zero. You can speak to each other about ideas and concepts, and you can help each other with finding bugs in codes, but the actual code and the writeups of your projects must be done alone. You may not copy code from outside sources, although you can use it to get ideas. If you use ideas from a source outside of class, you must give a citation.

COVID Specific information: Everyone must fill out the Mason Covid Health Check Form every day before coming to class. Everyone is required to wear masks as per the university guidelines. Any student who is unable to come to class due to (any) health problem must contact the instructor immediately to make arrangements to make up the work.

Office of Disability Services If you are working with ODS, make sure to inform me immediately so we can work out arrangements.

Schedule:

The following schedule is tentative, and all changes will be announced on Blackboard. Unless otherwise specified, the following are the due dates:

- Written portions of assignments are due Fridays at 11:59pm on the week given in the chart below. Late assignments will be accepted (with late penalties) until Sunday at 11:59pm. After that, no assignments are accepted.
- Prints are turned in the Monday after the written portion is done, at the beginning of class. Prints will be accepted on the Wednesday, at the beginning of class (with a late penalty). After that, no prints are accepted.
- Oral presentations occur the Monday and Wednesday after the written portion is done.

Week starting on	Material	Assignment
8/23	TUTa. Introduction to OpenSCAD	Nothing due
8/30	1. Pentagonal tilings	Assignment TUTa
9/6	2. Plane tilings *Labor Day: No class Monday*	Assignment 1
9/13	2. Plane tilings	Assignment 2

9/20	3. Iterated function systems	Assignment 3
9/27	TUTb. Introduction to Mathematica	Assignment TUTb
10/4	4. Optical illusions	Assignment 4
10/11	TUTc. Intro to complex numbers *Fall Break: Class Meets Tuesday*	Assignment TUTc
10/18	5. Mandelbrot and Julia sets	Assignment 5
10/25	6. Chaotic attractors	Assignment 6
11/1	7. Saddles and discontinuous surfaces	Assignment 7
11/8	TUTd. Data structures	Assignment TUTd
11/15	8. Data visualization	Assignment 8
11/22	9. Riemann surfaces *Thanksgiving: No class Wednesday*	Happy Thanksgiving
11/29	9. Riemann surfaces	Assignment 9
12/13	Final Exam Period Attendance is mandatory but virtual.	Remaining oral presentations