Math 109: Mathematics for Design

Summary of goals for the course

In our contemporary culture the dialogue between math and art, while sometimes strained by misunderstandings, is a dynamic and living one. Art continues to inspire and inform mathematical thinking, and mathematics helps artists develop additional insight when reasoning about the content and structure of their work. The tools of mathematics also aid in the construction of conceptual frameworks that are useful in all aspects of life.

This course will introduce students to ideas in mathematical thinking that are related to artistic considerations. Students will need to show proficiency with some mathematical ideas and then apply those ideas in creating their own works of art. In the process, students will also be called to analyze existing artwork with a mathematical eye. In this way, students will be provided a new tool to use in their approach to art and aesthetics.

Course details

Time: MWF 10:20 – 11:30am
Place: Mon, Wed PPHAC 235
Fri PPHAC 112

Instructor: Kevin Hartshorn
Office: PPHAC 215
Hours: Mon/Wed 2:30-3:30pm,
Tue/Thu 8:30-9:30am,
or by appointment

e-mail: hartshornl@moravian.edu
Web: https://sites.google.com/a/moravian.edu/math-109-spring-2015

Text: *Squaring the Circle: Geometry in Art and Architecture*, by Paul Calter

Key ideas for this course

Each assignment and class discussion will be aimed at expanding on these key notions:

- Mathematics and mathematical thinking involve a *creative* effort, not just rote memorization.
- There is a rich and complex connection between mathematics and art.
- Very basic mathematical concepts can be used to solve seemingly complex real-world problems.

Course goals

As an F2 course, students are expected to gain a sense of how mathematics can be used for presenting and interpreting data. In this course specifically, I propose the following goals:

1. Students will be able to create an effective representation of data – this may be graphical, verbal, or numerical, depending on the data. Students will be able to effectively choose the appropriate method for presenting data, and will be able to create a presentation that is both useful and aesthetic.

2. Students will be able to recognize and discuss relevant mathematical content in new artwork. They will be able to discuss the intentionality of the mathematical content.

3. Students be able to create an original piece of art utilizing and/or illustrating mathematical concepts introduced in the class.

Materials for class

Students are responsible for bringing materials to class. Each student should purchase the following materials for use during the course. Items in bold should be brought to class every day.

1. **Required text** – *Squaring the Circle: Geometry in Art and Architecture*, by Paul Calter
2. **Pencils** – either mechanical pencils or wood pencils with a portable sharpener.
3. **Eraser** – the little nub on the back of your pencil is not enough. Buy a pink eraser.

4. **Ruler** – at least 12 inches (18 inches is even better), marked with both inches and centimeters

5. **Paper** – you should have 8.5×11 inch loose-leaf paper (lined, blank, or graph paper is fine). Do not submit work that has been ripped out of a spiral notebook.

You may need to purchase materials for completion of your projects during the semester.

Additional materials

If you have a computer of your own, I recommend, but do not require, purchasing the student's version of *Geometer's Sketchpad*. Information can be found at http://www.keypress.com/x26810.xml

You will be asked to complete several art projects during the semester. For these projects, you will want colored pencils, markers, or other media. You are responsible for acquiring the needed supplies to complete your project.

COURSE SCORING AND ASSESSMENT

NO GRADES!

Rather than assigning "grades" for assignments, you will accrue points as you complete activities connected to the course. Class participation, completion of homework, strong performance on exams, compelling art projects: these will all contribute toward your total course score.

The key sources of points for the course will come from:

- **In-class work** (quizzes, worksheets, reflective writing, etc): typically 6 points per day

- **Homework**: 6 points per assignment

- **Art projects**: 30 points for each of three projects

- *Sketchpad* **Activities**: 25 points per project

- **Class-wide project**: 50 points

- **In-class exams**: 75 points for each of two exams

- **Final exam**: 150 points

> ### How does my score translate to a letter grade?
>
> By the end of the semester, there are approximately 1000 total possible points for you to earn. Your grade will be determined by the total number of points you've accumulated by the end of the semester:
>
> | | |
> |---|---|
> | *950 points* | *A* |
> | *900 points* | *A–* |
> | *875 points* | *B+* |
> | *800 points* | *B* |
> | *770 points* | *B–* |
> | *730 points* | *C+* |
> | *700 points* | *C* |
> | *650 points* | *C–* |
> | *600 points* | *D+* |
> | *550 points* | *D* |
> | *500 points* | *D–* |

PREPARATION AND PARTICIPATION

To help foster a deeper discussion in class, you will be asked to read and reflect on new material before most class meetings. At the beginning of most classes, I will either collect a short writing response from the reading or give a short quiz about the reading — your work on these assignments will contribute to your in-class points per day.

If there is no reading preparation for the day, you will earn points based on your participation in the day's discussion/activities.

You cannot receive points for any reading response or quiz for a class that you miss. If you miss a class for any reason, you will not be able to earn in-class points for that day.

HOMEWORK

Homework assignments are meant to add to the learning experience. Ideas that we only touch on in class will be fleshed out more fully in the homework sets. Note that often we will not have time to discuss

many of the homework problems in class – if you have questions about the homework, *please stop by my office to talk!*

Unless otherwise specified, all assignments are due by the beginning of the class period on the date due and will earn you up to 10 points, depending on accuracy and presentation.

SKETCHPAD AND EXCEL PROJECTS

Geometer's Sketchpad and *Excel* are available on all campus computers – both Mac and Windows machines. In addition, you can purchase a student version of *Sketchpad* if you wish to install it on your own computer (http://www.keypress.com/x26810.xml — a student license is about $10).

Computer assignments will be completed and submitted electronically. Details will be provided with the first assignment.

ART PROJECTS

There will be four projects through the semester that will have you create a piece of artwork based on given parameters and write a short description of the artwork, including the role that mathematics played in your creation.

The projects for this semester will be:

1. *Perspective drawing:* This will be pencil on paper – I recommend paper larger than the standard 8.5×11", but that is not required. You will use techniques from the class to make a perspective drawing of nearby location.
2. *Planar geometry project:* You may use your choice of material/method to create a 2-dimensional design exploring or illuminating an idea from planar geometry.
3. *Polyhedron project:* Make a three-dimensional representation of a polyhedral object, using the material/method of your choice.

A rubric and complete description for these activities will be provided during the semester.

MIDTERMS & FINAL EXAM

There will be two midterms: **Friday, February 20** and **Wednesday, April 1**. Be sure to mark these dates on your calendar, as make-up exams are generally not given. The final exam will be on **Tuesday, May 5 at 1:30pm**.

The exams will be based on your reading of the text, our classroom discussion, problems given for homework, and the *Sketchpad/Excel* projects. Details will be provided preceding each exam.

ACTIVITY BONUSES

Throughout the semester, you will have opportunities to earn bonus points. Some bonus points will be individually rewarded (e.g.: bonus points to the most creative art project). Other bonus points will be awarded to the entire class (e.g.: a class-wide bonus when the total points acquired by the class passes 1000).

An evolving list of options for earning bonus points will be provided on the class web page.

ADDITIONAL INFORMATION

ATTENDANCE AND CLASSROOM NORMS

There are no "excused" or "unexcused" absences. If you miss a class, you will not be eligible for any in-class points awarded that day.

If you know that you will be missing a class, be sure to inform me as soon as possible so you may get any missed worksheets or assignments. **You are responsible for getting any homework to me even if you miss class.**

In addition, you may be deducted daily points if your conduct detracts from the learning environment in the classroom. Detractions include arriving late, texting during class, interrupting/disrespecting others, or refusing to participate.

Missing in-class activities

Your attendance in class is particularly important for certain activities. *Inform me in advance if you know you will miss a class*. Special arrangements may need to be made for you to get credit for these activities if you are not in class. Activities that your attendance may directly impact include

- *Sketchpad/Excel projects*: The points earned for these computer projects depend in part on your in-class work.
- *Class Activities*: There will be a "barn-raising" activity on DATE. Your active work, including in-class work is necessary to earn maximum points for that activity.
- *Art projects:* On the dates the art projects are due, you will be asked to say a few words about your project. Discussion and critique of the projects will contribute to your point total for these assignments.
- *Midterms*: Missing a midterm will merit a zero points toward your course score.

Homework submission

If you cannot attend class, it is your responsibility to get any work due submitted. Work submitted after 4:00pm on the date due may incur a penalty. Late will only be accepted until scored homework is returned.

Chronic absences

If you find that you will be missing several class periods (due to a serious illness/injury or a similar reason), please inform both me as soon as possible. Special arrangements or considerations might be possible if you will have a long-term attendance issue.

New York trip

Class will not be held on the day of the art trip to New York City (Friday, March 27).

ACADEMIC HONESTY

Everyone is expected to adhere to Moravian College's Academic Honesty policy, as described in the Student Handbook (http://www.moravian.edu/studentLife/handbook/academic/academic2.html).

Please ask if you have questions about the policy in this class.

LEARNING SERVICES

This course asks for communication in class – both written and oral. You will be asked to do a significant amount of reading, take timed exams, and complete homework based on work done in class.

Students who wish to request accommodations in this class for a disability should contact Ms. Elaine Mara, Assistant Director of Academic & Disability Support, located on the first floor of Monocacy Hall (extension 1401). Accommodations cannot be provided until authorization is received from the Academic & Disability Support office.

FINAL REMARKS AND DISCLAIMERS

- If you have any questions, concerns, or comments about the course, please feel free to contact me in my office or by e-mail (hartshornk@moravian.edu).

- This syllabus* is subject to change. The latest version of this syllabus can be found on the class website (https://sites.google.com/a/moravian.edu/math-109-spring-2015).
- Final determination of your grade will be based on my judgement as professor.

SCHEDULE FOR THE SEMESTER

Keep in mind that the topics are subject to change, and date may need to be adjusted. Experience point listings below assume optimal performance. Partial credit is possible.

Monday, January 19

Bring book to class ....6 points

In-class: Introductions, mathematics attitude survey, discuss class expectations ....6 points

Wednesday, January 21

Gather class materials, first reading (Chapter 1: Pages 3-19) ....6 points

In-class: work with ratios and proportions...6 points

Friday, January 23

Photo scavenger hunt submission, finish reading Chapter 1 ....6 points

In-class: Quiz on chapter 1, discuss results of scavenger hunt ....6 points

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Monday, January 26

Exercises from chapter 1, reading (Chapter 2: Pages 39-57) ....6 points

In-class: Quiz on reading, introduction to golden ratio and fibonacci numbers ....6 points

Wednesday, January 28

Homework exercises, reading (Chapter 3: Pages 63-84) ....6 points

In-class: Quiz on reading, activity on angles and triangles..6 points

Friday, January 30

Sketchpad activity: Introduction to *Geometer's Sketchpad* ....25 points

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Monday, February 2

Exercises from chapter 3 ....6 points

In-class: Quiz on reading (Chapter 4: Pages 93-102), discussion on geometry ....6 points

Wednesday, February 4

Exercises and reading (Chapter 4: Pages 103-124)..6 points

Quiz on reading and discussion of quadrilaterals..6 points

Friday, February 6

1st *Sketchpad* activity due (Introduction to *Geometer's Sketchpad*)

Sketchpad activity: Rectangles and polygons..25 points

Monday, February 9

Pre-assessment: Perspective drawing ....3 points

In-class: Introduction to mathematical perspective, including reflection on activity ....8 points

Wednesday, February 11

Reading (Chapter 12: Pages 363-371)..6 points

In-class: Introduction to perspective ....6 points

Friday, February 13

2nd *Sketchpad* activity due (Rectangles and polygons)

Excel activity: Perspective by the numbers ....25 points

Monday, February 16

Exercises in perspective ....6 points

In-class: TJC and further explorations in perspective..6 points

First art project assigned (mathematical perspective) ....30 points

Wednesday, February 18

Your initials in perspective ....6 points

In-class: Introduction to 2-point perspective ....6 points

Friday, February 20

Excel project due (Perspective by the numbers)

Reading (Chapter 5: Pages 131-152)...6 points

In-class: work on polygons and polygrams...6 points

Monday, February 23

Exercises, Reading (Chapter 5: Pages 153-160) ....6 points

In-class: tilings of the plane ....6 points

Wednesday, February 25

Art project due (mathematical perspective)

Exercises in polygons and tilings ....6 points

In-class: discussion of art projects and further work with tilings ....6 points

Friday, February 27

First exam ....75 points

Monday, March 2

In-class: Classifying tilings ....6 points

Wednesday, March 4

Exercises classifying tilings ....6 points

In-class: work on tilings by regular polygons ....6 points

Friday, March 6

Sketchpad activity: Tilings of the plane..25 points

Monday, March 9 — Friday March 13

Spring break!

Monday, March 16

Reading (Chapter 6: Pages 167-177)...6 points

In-class: quiz on reading, work on geometry of the circle..6 points

Wednesday, March 18

Sketchpad activity due (Tilings of the plane)

Work on properties of the circle, reading (Chapter 7: Pages 195-199) ....6 points

In-class: quiz on the reading, more work on circular geometry..6 points

Friday, March 20

Sketchpad activity: Circular geometry ....25 points

Monday, March 23

Reading (Chapter 7: Pages 201-219)...6 points

In-class: quiz on reading, circular design...6 points

Wednesday, March 25

In-class: Synthesizing work in planar geometry ....10 points

Friday, March 27

New York City art trip: No class

Monday, March 30

Sketchpad activity due (Circular geometry)

Homework on circular design and reading (Chapter 9: Pages 260-270)...................................6 points

In-class: Quiz on reading, work on sprirals and rosettes ....6 points

Second art project assigned (planar geometry) ....30 points

Wednesday, April 1

Second exam...75 points

Friday, April 3

Easter break!

Monday, April 6

Homework problems on spirals and rosettes..6 points

In-class: closing work and reflections on spirals ....6 points

Wednesday, April 8

Exercises on rosettes, reading (Chapter 10: Pages 281-294) ....6 points

In-class: Introduction to solid geometry ....6 points

Friday, April 10

Second art project due (planar geometry)

Homework problems form solid geometry...6 points

Discussion of art projects and further work on solid geometry...6 points

Monday, April 13

Reading (Chapter 10: Pages 295-312)...6 points

In-class: Polyhedral nets and Building polyhedra...6 points

Third art project assigned (polyhedra) ....30 points

Wednesday, April 15

Prepare materials for in-class work ....6 points

In-class: 3D symmetry ....6 points

Friday, April 17

    In-class: Constraints on building polyhedra...6 points

Monday, April 20

    Write-up on platonic and archimedean solids, reading (Chapter 13: Pages 393-401) ....6 points

    In-class: quiz on reading, introduction to fractal dimension, sketching fractals......................................6 points

Wednesday, April 22

    Art project due (polyhedra)

    Exercises in sketching fractals and computing dimensions ....6 points

    In-class: Discuss art projects and practice fractal drawing ....6 points

Friday, April 24

    Sketchpad activity: Generating fractals ....25 points

Monday, April 27

    Exercises on fractals ....6 points

    In-class: Introduction to barn-raising activity, further work with fractals ....6 points

Wednesday, April 29

    Barn-raising: Collaborative work building large sculpture ....50 points

Friday, May 1

    Sketchpad activity due (Generating fractals)

    Reflection and final work on class project..6 points

    In-class: reflection on semester ....6 points

Tuesday, May 5 at 1:30pm in PPHAC 235

    Final exam ....150 points