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 an additional abstraction 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 113

Instructor: Kevin Hartshorn
Office: PPHAC 215
Hours: Tue 10:15-11:45am,
     Wed 8:30-10:00am
     or by appointment

e-mail: hartshorn@math.moravian.edu
Web: http://math.moravian.edu/hartshorn/109/
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 blade-sharpener.
3. **Eraser** – the little nub on the back of your pencil is not enough. Buy a pink eraser.

4. **Colored pencils, crayons, or colored pens** – some means for creating color images

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

6. **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 take and share photos at several points during the semester, and I strongly recommend that everyone has access to some sort of digital camera. If you do not have access to a digital camera, please let me know before January 18.

GRADING AND ASSESSMENT

Computing Grades

To assess your progress, we will look at your growth in computational ability, your engagement with the course, and your synthesis of mathematics and aesthetics. We will thus compute grades using the following activities:

20%	Preparation and participation – including quizzes (average over all submissions)
20%	Homework and writing (average over all submissions)
15%	*Sketchpad* and *Excel* activities (average over eight activities)
15%	Art projects (average over four art projects, and an assignment based on the NY art trip)
15%	Midterms (average over two midterms)
15%	Final exam

We will cover a lot of material in this class. My philosophy is that if you can master half of the material that we encounter, then you deserve to pass the course. Thus any grade above 50% is considered passing in my class. More generally, for this class you can translate percentage grades to letter grades by this rough guide: 85% or above is an A (+ or –), 70 – 85% is a B (+ or –), 60 – 70% is a C (+ or –) and 50 – 60% is a D (+ or –).

This scale is subject to change based on my judgement as professor of the course. When in doubt, I use the guidelines provided by the student handbook[*], and re-iterated in the sidebar to the right.

A	These grades indicate achievement of the highest caliber. They involve expectations of independent work, original thinking, and the ability to acquire and use knowledge effectively.
B	These grades indicate higher than average achievement. Evidence of independent work and original thinking is expected.
C	These grades are given when the student has devoted a reasonable amount of time, effort, and attention to the work of the course and has satisfied the following criteria: familiarity with the content of the course, familiarity with the methods of study of the course, and active participation in the work of the class.
D	These grades indicate unsatisfactory work, below the standard expected by the College, in which one or more important aspects falls below the average expected of students for graduation. The work is, however, sufficient to be credited for graduation if balanced by superior work in other courses.
F	This indicates failure.

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[*] http://www.moravian.edu/studentLife/handbook/academic/academic.html

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 (this will be made clear during the semester).

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

Note that these assignments indicate your participation in class. Thus you cannot receive credit for any reading response or quiz for a class that you miss. If you miss a class for any reason, you will get a zero on the preparation/participation score for that day.

Homework And Writing

Homework and writing 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 end of the class period of the date due and will be scored on a 10 point scale. Solutions to the homework assignments will be made available after they have been submitted.

Photo Scavenger Hunts

There will be three photo scavenger hunts through the semester. For each, you will be asked to submit a certain number of digital photos illustrating ideas from the class.

If you do not have a digital camera or a means of taking digital photos, please see me as soon as possible to discuss alternative arrangements we might make for this assignment.

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).

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 pencil (colored or not), pen, marker, or other implement for 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.

4. *Open project:* Create a piece of art on any topic connected to the course. The choice of materials is yours.

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

New York trip

In addition to the four art projects, you will need to complete an assignment in connection with the art department's trip to New York City. Class will not be held on the day of the art trip to New York City (March 30), and it is expected that you will join the art department on that trip (or an equivalent experience).

If you will not be attending the art trip, an alternative assignment will be provided. Please inform me as soon as possible if this is the case.

Midterms & Final Exam

There will be two midterms: **Wednesday, February 22** and **Wednesday, April 4**. Be sure to mark these dates on your calendar, as make-up exams are generally not given. The final exam will be on **Wednesday, May 2** at **8:30am**.

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.

ADDITIONAL INFORMATION

Attendance And Classroom Norms

There are no "excused" or "unexcused" absences. Missing a quiz or class preparation submission merits a "0" regardless the reason for missing class (including illness, sporting events, or family emergencies).

In addition, your preparation/participation grade may be penalized 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 will need to be made for you to get credit for these activities if you are not in class.

- *Sketchpad/Excel projects*: Particularly if you are unfamiliar with these two applications, you will need to be in class on the days we work on the computers.
  Relevant dates (all on Fridays): Jan 27, Feb 10, Feb 17, Feb 24, Mar 16, Mar 23, Apr 20

- *Class Activities*: There will be a few class-wide projects, and your homework will depend on your attending the activity.
  Relevant dates: Feb 3, Apr 25

- *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 be part of the grade.
  Relevant dates: Feb 20, Mar 21, Apr 13, Apr 27

- *Midterms*: Missing a midterm will merit a score of zero.
  Relevant dates: Feb 22, Apr 4

Homework and Art projects

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 solutions are posted on-line (typically 24 hours after the assignment is due).

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.

Chronic absences

If you miss more than three classes – for *any reason* – each additional class will result in a 5% penalty in your final course grade. This penalty will apply regardless the reason for the absence.

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 and the Learning Services office (x1510) as soon as possible. Some special arrangements or considerations can be made if you will have a long-term attendance issue.

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.

If you have a documented disability that may impact any of these activities, please see Learning Services as soon as possible so that arrangements can be made.

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 (hartshorn@math.moravian.edu).
- This syllabus[†] is subject to change. The latest version of this syllabus can be found on the class website (http://math.moravian.edu/hartshorn/109).
- Final determination of your grade will be based on my judgement as professor.

[†] *Last updated January 16, 2012*

SCHEDULE FOR THE SEMESTER

Keep in mind that the topics are subject to change, and date may need to be adjusted. Please see the class web page (http://math.moravian.edu/hartshorn/109) for the latest version of the syllabus.

Monday	Wednesday	Friday
Jan 16 **Preparation:** Buy textbook **Class Activity:** Introduction, discuss class expectations	*Jan 18* **Homework:** Get materials, respond to syllabus **Preparation:** Read chapter 1: Pages 3–19 **Class Activity:** Ratios and proportions	*Jan 20* **Homework:** Photo submission **Preparation:** Finish reading chapter 1 **Class Activity:** Quiz, results of scavenger hunt, discussion of chapter 1
Jan 23 **Homework:** — **Preparation:** Read chapter 2: Pages 39–57 **Class Activity:** Quiz, golden ratio and fibonacci	*Jan 25* **Homework:** Exercises on ratios/proportions and the fibonacci sequence **Preparation:** Read chapter 3: Pages 63–84 **Class Activity:** Quiz, angles and triangles	*Jan 27* *GSP* project assigned **Homework:** — **Preparation:** — **GSP:** Introduction to *Sketchpad*
Jan 30 *GSP* project **Homework:** — **Preparation:** Read chapter 4: Pages 93–102 **Class Activity:** Quiz, Basic geometry discussion	*Feb 1* *GSP* project **Homework:** Constructions and measurement, first perspective project **Preparation:** Read chapter 4: Pages 103-124 **Class Activity:** Quiz, analyzing special quadrilaterals	*Feb 3* *GSP* project due **Homework:** — **Preparation:** Perspective drawing **Class Activity:** Taping activity (perspective)
Feb 6 **Homework:** Reflection on perspective **Preparation:** Read chapter 12: Pages 363–371 **Class Activity:** Quiz, introduction to mathematical perspective	*Feb 8* Perspective project assigned **Homework:** — **Preparation:** — **Class Activity:** Further ideas in perspective	*Feb 10* Perspective project *Excel* project assigned **Homework:** Perspective techniques, write your initials in perspective **Preparation:** — **Excel:** Perspective by the numbers
Feb 13 Perspective project *Excel* project **Homework:** — **Preparation:** — **Class Activity:** Two- and Three- point perspective	*Feb 15* Perspective project *Excel* project **Homework:** More on 2-point perspective **Preparation:** Read chapter 5: Pages 131–152 **Class Activity:** Quiz, more general look at polygons	*Feb 17* Perspective project *Excel* project due *GSP* project assigned **Homework:** — **Preparation:** — **GSP:** Polygons and polygrams
Feb 20 Perspective project due *GSP* project **Homework:** Polygons and polygrams **Preparation:** — **Class Activity:** Final perspective discussion	*Feb 22* *GSP* project **Midterm**	*Feb 24* *GSP* project due *GSP* project assigned Photo scavenger hunt assigned **Homework:** — **Preparation:** Read chapter 5: Pages 153–160 **GSP:** Tilings
Feb 27 *GSP* project Photo scavenger hunt **Homework:** — **Preparation:** — **Class Activity:** Classifying tilings	*Feb 29* *GSP* project Photo scavenger hunt **Homework:** Practice classifying patterns **Preparation:** — **Class Activity:** Tilings by regular polygons	*Mar 2* *GSP* project due Photo scavenger hunt due Geometry art project assigned **Homework:** Demi-regular tilings **Preparation:** — **Class Activity:** View hunt results, tiling activity
Mar 5 **Spring break**	*Mar 7* **Spring break**	*Mar 9* **Spring break**

Monday	Wednesday	Friday
Mar 12	*Mar 14*	*Mar 16*
Geometry art project **Homework:** — **Preparation:** Read chapter 6: Pages 167–177 **Class Activity:** Quiz, Geometry of the circle	Geometry art project **Homework:** Properties of the circle **Preparation:** Read chapter 7: Pages 195–199 **Class Activity:** Quiz, more circular geometry	Geometry art project *GSP* project assigned **Homework:** — **Preparation:** — **GSP:** Circular geometry
Mar 19	*Mar 21*	*Mar 23*
Geometry art project *GSP* project **Homework:** — **Preparation:** Read chapter 7: Pages 201-219 **Class Activity:** Quiz, Circular design	Geometry art project due *GSP* project **Homework:** — **Preparation:** — **Class Activity:** Discuss art project	*GSP* project assigned *GSP* project due **Homework:** Exercises in circular design **Preparation:** — **Class Activity:** Gothic architecture and round design
Mar 26	*Mar 28*	*Mar 30*
GSP project **Homework:** — **Preparation:** Read chapter 9: Pages 260–270 **Class Activity:** Quiz, spirals and rosettes	*GSP* project Polyhedron art project assigned **Homework:** Exercises on rosettes **Preparation:** Read chapter 10: Pages 281–294 **Class Activity:** Introduction to solid geometry	*GSP* project due Polyhedron art project **New York Art Trip**
Apr 2	*Apr 4*	*Apr 6*
Polyhedron art project Photo scavenger hunt assigned **Homework:** Practice working with polyhedra, initial ideas for polyhedron project **Preparation:** Read chapter 10: 295–312 **Class project:** Building polyhedra	Polyhedron art project Photo scavenger hunt **Midterm**	**Easter break**
Apr 9	*Apr 11*	*Apr 13*
Easter break	Polyhedron art project Photo scavenger hunt **Homework:** Responses to class project **Preparation:** — **Class Activity:** 3D symmetry	Polyhedron art project due Photo scavenger hunt **Homework:** Exercises in 3D symmetry **Preparation:** — **Class Activity:** Discuss polyhedra projects
Apr 16	*Apr 18*	*Apr 20*
Photo scavenger hunt Final art project assigned **Homework:** — **Preparation:** Read chapter 13: Pages 393–401 **Class Activity:** Quiz, fractals and dimension	Photo scavenger hunt due Final art project **Homework:** Computing dimensions **Preparation:** — **Class Activity:** Discuss scavenger hunt, building fractals	*GSP* project assigned Final art project **Homework:** — **Preparation:** — **GSP:** Generating fractals
Apr 23	*Apr 25*	*Apr 27*
GSP project Final art project **Homework:** Some simple fractals **Preparation:** Handout on golden ratio **Class Activity:** Golden ratio facts and myths	*GSP* project Final art project **Homework:** — **Preparation:** Get ready for class project **Class Activity:** Barn-raising activity	*GSP* project due Final art project due **Homework:** Response to class activity **Preparation:** — **Class Activity:** Final thoughts and comments, discuss final art project
	May 2, 8:30am **Final Exam**	