MATH 360: Modern Geometry (Fall 2008) Class: MW from 2:00 – 3:15 in Ambrose 002

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Overview:

This course will introduce students to concepts and methods of modern geometry. Beginning with a brief history of geometry, the course will give students the opportunity to develop definitions, proofs, constructions, and deep conceptual understanding of Euclidean (plane) and non-Euclidean (spherical, hyperbolic, cylindrical, conic) geometries. Students in the course will be required to demonstrate their understanding of geometric concepts by completing in-class exam, a project, and a presentation.

Because this course is required for math education majors, students will be given opportunities to learn effective methods for teaching geometric concepts to middle and high school students.

Required Materials:

Life of Fred: Geometry by Stanley F. Schmidt (ISBN: 0-9709995-4-2)
Flatland by Edwin A. Abbott (ISBN: 048627263X) *Note: This book is available for free online*
Binder for course notes and written assignments
Additional materials will be announced in class (or will be provided to students)

Prerequisites:

Students enrolled in this course have successfully completed MATH 191 (Calculus I) and MATH 192 (Calculus II). This prerequisite is to ensure students have the mathematical maturity to successfully complete the course. It is assumed students completed a geometry course in high school. No previous knowledge of non-Euclidean geometry is assumed.

Outline of Major Topics:

Required Topics:

1) What is geometry?
   a. History, strands, types, relationship to trigonometry
   b. Geometry curriculum (Iowa Model Core Curriculum – Essential characteristics, skills, and content)
   c. Euclid's postulates
2) Intensive review of basic geometry (definitions, figures, constructions, formulas, proofs to prepare for teaching)
3) Euclidean vs. Non-Euclidean geometries
   a. What is straight? -- Definition and construction on planes, spheres, cylinders, cones, hyperbolic planes
   b. What is an angle? – Proof of the vertical angle theorem
   c. Triangles, congruencies, similarities
4) Dimensionality
5) Transformational geometry
6) Geometry Education

Optional Topics:

Parallel Transport / Parallel Postulates	Isometries, patterns, fractal geometry
Area and holonomy	Dissection Theory
Projections, Perspective Geometry	Manifolds

Course Procedures:

This course has two important goals: (1) to ensure you have a complete and solid understanding of geometry needed to become an effective math teacher, and (2) to introduce you to concepts and methods of modern geometry.

Goal 1: Students will master the geometric concepts and methods needed to become an effective math teacher (K-12)

Procedures: Students will read all chapters from the textbook and complete exercises
Each student will present content from one chapter of the textbook (teach lesson)
Each student will discuss the Iowa Model Core Curriculum requirements
Each student will present a project

Assesment: Class exams, quizzes, activities
Project evaluation
Chapter summaries
Student discussion/participation

I've carefully selected a textbook to help us meet the first goal. The *Life of Fred: Geometry* textbook covers every geometric concept and formula you will be expected to teach in an elementary, middle, or high school setting. Because the book is an easy and enjoyable read, I will expect every student in this class to read the entire book before the end of the semester.

Each week, you will read one chapter from the book and look-over the first two sets of exercises on your own. Since the book provides solutions to these exercises, I expect that you will check your understanding of the content of each chapter. During class, we will discuss the concepts from the chapter, check your understanding (discussions, quizzes, activities, etc), and discuss ways in which we could teach these concepts to students.

Each student will be required to write a short summary and teach a lesson dealing with the content from one chapter of the textbook. The chapter summary should include: 1) definitions, (2) postulates, (3) theorems, (4) an important example, and (5) a plot summary of the chapter. We will discuss these requirements in class.

Your lesson should address some of the content from the chapter. I do NOT want you to simply review the content from the chapter. I want you to design (or find) a unique activity/lesson for students. The lessons should be approximately 20-40 minutes long. We will discuss these requirements in class.

Another way in which I will work to ensure you can teach geometry is by having you write a paper and present (the lesson, project, or geometric concept) to the class. I will provide you with an incomplete list of possible presentation topics, but you are free to choose a topic that interests you (share the topic with me before you put too much work into it). These presentations will take place towards the end of the semester.

Goal 2: Students will gain an understanding of modern geometry
Procedures: Students will complete in-class activities
Students will complete a project
Assesment: Class exams, quizzes, activities
Project evaluation
Student discussion/participation

The other goal of this course is to introduce you to modern geometry (the geometric concepts that traditionally aren't taught in high school). Since I am holding you responsible for reading the textbook and reviewing basic geometry concepts outside of class, I will do my best to minimize the amount of outside work needed to learn these concepts. I will prepare lessons and activities that will introduce you to more advanced geometric concepts, such as non-Euclidean geometries, transformational geometry, and dimensionality. During these activities, you can expect to work in small groups and to think deeply about these new concepts. It is my hope that if you eventually teach a geometry course, you will be able to incorporate some modern geometry into your teaching.

We will occasionally have problem-solving days, quizzes, and exams in class. These days will serve to check your level of understanding of geometric concepts and methods. You may be asked to answer simple paper-and-pencil questions or you may be asked to construct models, proofs, or reasoning to support a theorem. You will always be told in advance of any class exams.

Student Expectations:

1) Students are expected to attend class. Because of how this course is structured (with discussions and activities), attendance is extremely important. Each student will be allowed one free unexcused absence. If a student has another unexcused absence, the student will be required to complete extra work outside of class. Excessive absences will hurt your grade in the course.

2) Students are expected to read the assigned chapter before class and work through the first two problem "cities." I will not collect your answers to these questions, so feel free to just work through the solutions in your head. If I feel as though you are not keeping up with the readings, I will give quizzes over the textbook material. I might also ask you to complete the other "cities" from the chapters

3) Each student is expected to provide a written summary of one chapter from the book. Each student is also expected to teach a lesson related to the content from one chapter of the textbook.

4) Students are expected to participate in class. Ask and answer questions! If you think of any activities we could do to reinforce concepts, share your ideas. Think creatively and think deeply about the concepts presented in class. Your level of participation in class discussions and problem-solving sessions will impact your course grade.

5) Students are expected to successfully complete any quizzes or course exams. If you have an unexcused absence on the day of a scheduled exam, you will be allowed to retake the exam with a maximum grade of C. I would appreciate it if you would tell me in advance if you must miss class.

6) Students are expected to complete a paper and presentation. I expect the paper to be approximately 5-8 pages long and the presentation to last approximately 30 minutes. Students will be allowed to choose their topic (but please get permission from me before working on the project). I will give you time in class to work on these projects.

7) Take responsibility for their learning. Students are encouraged to work collaboratively on assigned problems and seek assistance if needed. The best way to contact me outside of my posted office hours is via e-mail. Feel free to stop by my office for assistance.

Student Evaluation:

Each unit will have the following grading components:

	Traditional
Quizzes / Exams	15%
Chapter summary	10%
Lesson (related to chapter content)	20%
Discussions/Participation	20%
Project paper	15%
Project presentation	20%

Plagiarism:

Don't cheat. You can work with other students on the homework, but the exams should only represent your level of understanding. Review the Policy on Academic Dishonesty in the University Catalog.

Accommodations:

Students with disabilities who believe they may need accommodations in this class are encouraged to contact the Office of Services for Students with Disabilities at 333-6275 as soon as possible to better ensure that such accommodations are implemented in a timely fashion.

Monday		Wednesday	
8/25 Pretest Outline	Introductions, course overview, syllabus review Discuss course requirements, materials, evaluation Outline: What is Geometry? Why is it important? High School Geometry Pre-test • Purchase course materials • Read pages 7-11 (notes to students/teachers) • Find Euclid's 5 postulates	8/27 What is G? Euclid Definitions MCC	Historical perspective – Strands of geometry Euclidean geometry – Postulates (axiomatic approach) What is non-Euclidean geometry? Analytic geometry? Model Core Curriculum – Characteristics, Skills, Content Rate your mastery of Geometric Topics • Begin definition sheet
9/1	**Labor Day – No Class** **Choose chapters & projects**	9/3 Contour NASA Core 1	Coordinates, Points, Lines (Vertices, Edges) Distance, Midpoint formulas; Slope (parallel, perpendicular) Vectors, Matrices 3+ dimensions – Plotting, Distance, Contour maps • NASA contour map activity • Read chapter 1 (17-45) and write summary • Complete Danbury exercises
9/9 Straight	Discuss C1: Points & Lines What is a straight line? (isometries) Do two points define a line? (induction) Definitions, postulates, theorems; Logic (converse) Discuss definition on page 33 (line through 2 points) • Read chapter 2 (50-87) and write summary • Complete Santa Barbara exercises	9/11 Angle Euclid Foolproof Lament	Discuss C2: Angles What is an angle? What is a degree? A radian? Definitions, postulates, theorems; Types of angles Euclid's *The Elements* • Read *Foolproof* • Read *A Mathematician's Lament*
9/15 Proofs	The role of proof in mathematics Triangle proofs Complete proofs in class • Read chapter 3 (91-109) and write summary • Complete Quincy exercises	9/17	Discuss C3: Triangles Definitions, postulates, theorems; Isosceles Triangles SSS, SAS, ASA • Read chapter 4 (116-151) and 5 (158-175); summarize • Complete Zeigler (C4) & Vancouver (C5) exercises
9/22 Poly's Core 2 Divide Tri	Polyominoes Activity Dividing Triangles in half Exam #1	9/24	Discuss C4-5: Parallel & Perpendicular Lines Definitions, postulates, theorems; Transversals Interior & exterior angles Bisectors, medians, distance • Read chapter 6 (188-221) write summary • Complete Tasco exercises
9/29	Discuss C6: Quadrilaterals Definitions, postulates, theorems • Read chapter 7 (231-270) & 8 (288-309); summarize • Complete Dania (C7) & Vanderbilt (C8) exercises	10/1	Discuss C7-8: Area & Similar Triangles Definitions, postulates, theorems • Read chapter 9 (324-341) and write summary • Complete Walnut Grove exercises
10/6 Core 3 Transform	Vectors, Matrices, Transformations, Isometries Determinants, Eigenvalues, Eigenvectors Core Curriculum transformation activity	10/8	Lesser-known area formulas for triangles Heron's Formula Junior Geometry: 3-point & 4-point Geometry Exam #2
10/13	Discuss C9: Right Triangles Definitions, postulates, theorems • Read chapter 10 (347-381) and write summary • Complete Walpole exercises	10/15 Core 4 Trig	Trigonometry
10/20	Pythagorean Theorem Proofs Catch-up day Work on projects	10/22 Pi is wrong	Discuss C10: Circles Definitions, postulates, theorems • Read chapter 11 (388-402). No exercises! • Read *Pi is Wrong!*
10/27	Discuss C11: Constructions Definitions, postulates, theorems • Read chapter 11.5 (415-421) • No exercises!	10/29	Discuss C11.5: Non-Euclidean Geometry Definitions, postulates, theorems • Read chapter 12 (422-447) and write summary • Complete Walsh exercises
11/3	Straightness on spheres – geodesics, great circles Straightness on cylinders and cones Discussion of hyperbolic geometry	11/5	Discuss C12: Solid Geometry Definitions, postulates, theorems • Read chapter 13 (470-482) • Complete Jeffersonville exercises
11/10 Core 5 V-E Video Numbers	Discuss C13: Coordinate Geometry Vertex-edge graphs – Euler paths & circuits Salesman Problem; Scheduling optimizations Numbers – Catch a thief Matrix representation	11/12	Catch-up Day • Read *Flatland* (Chapters 1-12) • Summarize/sketch selected chapter
11/17	Dimensionality: Explain 3rd dimension to *The Simpsons* • Formally write out your answers to the exercises • Read *Flatland* Part 2 (chapters 13-22) • Summarize/sketch selected chapter	11/19	Flatland Discussion Present chapter summaries and sketches
11/24	Project Presentations Fractals	11/26	**Thanksgiving Break – No Class**
12/1	Project Presentations	12/3	Project Presentations Exam #3

Final Exam: Watch Flatland: The Movie on _____

8/5/2008

MATH 360: Modern Geometry Course Projects

Books: Summarize/review a book or two and explain what you learned
Flatterland by Ian Stewart (2001)
An Episode on Flatland: How Plain Folk Discovered the 3rd Dimension by Charles Hinton (1907)
Sphereland by Dionys Burger (1965)
The Planiverse by A. K. Dewdney (1984)
Spaceland (2002) and *Message Found in a Copy of Flatland* (1983) by Rudy Rucker
Other geometry-related book

Constructions: Demonstrate a series of constructions using a compass and straightedge.
Explain why these two tools (but no others) are allowed in constructions. Create exercises for the class.

Geometric Proofs: What is a geometric proof? What is the role of proof in mathematics?
Demonstrate a series of geometric proofs. Create exercises for the class.
Explain the criteria used to determine if a proof is "good." Explain the format of geometric proofs
Present and evaluate a series of proofs of the Pythagorean Theorem.

Geometry Education: What are the best practices in teaching geometry to middle/high school students?
What materials, methods, strategies should be used? What is the role of technology?
What is the relationship among geometry and other branches of mathematics?
Summarize current research in teaching geometry. How can you teach axiomatic systems?
How can you teach induction and deduction to students?

Applications: Demonstrate some real-world applications of geometry
Explain some modern geometric problems What are the current uses of geometry?

Computer Programs: Demonstrate how to use Sketchpad, Cinderella, Cabri or other geometry software
Create exercises for the class. Demonstrate both Euclidean and non-Euclidean exercises
Summarize advantages and limitations of geometry software

Book Chapter: Summarize a chapter from our textbook that we will not cover in class
Solve the problems in the chapter and create exercises for the class
Go beyond the textbook to find additional information related to the topic

Biographical sketch: Present information about historical figures in geometry
Explain why the chosen figure is important and their contributions to geometry
Explain how that figure has influenced modern mathematics

Historical Geometry: Investigate one of the four historical strands of geometry

Dimensionality and the Shape of the Universe: Explain current theories about the shape of the universe

Model-Building: Construct physical models of plane, spherical, hyperbolic, conical, cylindrical surfaces
Use your model to explain key concepts in geometry

Other ideas: Geometry Junkyard: http://www.ics.uci.edu/~eppstein/junkyard/
Interactive geometry puzzles: http://www.cut-the-knot.org/geometry.shtml
Geometry of minesweeper
Dr. Sarah's Geometry of our Earth: http://www.cs.appstate.edu/~sjg/class/3610/earth.html
Dr. Sarah's Geometry of the Universe:
http://www.mathsci.appstate.edu/~sjg/class/1010/wc/geom/earthanduniverse.html

Topics from *The Geometry Junkyard*:

Circles and Spheres
Compass and Straightedge
Covering and Packing
Fractals
Geometric Topology
Knot Theory
Nearest Neighbors and Voronoi Diagrams
Pentagonal Geometry and the Golden Ratio
Randomness and Geometric Probability
Spirals
Tiling
Width, Diameter, and Geometric Inequalities
Three-dimensional Geometry
Open Problems
Software and Animations
Coloring
Combinatorial Geometry
Dissection
Geometric Models
Hyperbolic Geometry
Lattice Theory/Geometry of Numbers
Origami
Polyhedra and Polytopes
Rectilinear Geometry
Symmetry and Group Theory
Triangles and Simplices
Planar Geometry
Many-dimensional Geometry
Lesson Plans and Teaching Materials
Miscellanous

Paper Project Criteria & Scoring Rubric:
Paper Projects will be graded on a 100-point scale using the "5-C" rubric

Clarity (15 pts)
The paper clearly expresses geometric ideas.
15 points = All ideas are clearly expressed; the paper has 0-2 errors in grammar or punctuation
10 points = All ideas are clearly expressed; the paper has noticeable errors in grammar/punctuation
5 points = Most ideas are clearly expressed, but the paper is difficult to understand
0 points = Ideas are not clearly expressed; the paper is illegible

Correctness (25 pts)
The mathematical ideas, formulas, explanations, and results contained in the paper are accurate
25 points = All mathematical formulas, explanations, and results are accurate. All work is shown.
20 points = All mathematical formulas, explanations, and results are accurate, but some work is missing.
15 points = The formulas and results are accurate, but explanations are missing. Some work is missing.
10 points = The paper contains errors in formulas and/or results. Explanations are inadequate.
5 points = The paper contains serious mathematical errors and/or very few explanations are provided.

Content (40 pts)
The paper contains sophisticated ideas and/or mathematics. The project was worthwhile.
40 points = It presents significant mathematics/concepts; readers will learn by reading this paper.
30 points = The paper presents mathematics/concepts at a level appropriate for this course.
20 points = The mathematics and/or ideas are at a level lower than what is appropriate for this course.
10 points = The paper contains few mathematical concepts or ideas.
0 points = The paper does not contain any worthwhile content.

Coring (10 pts)
Coring = Not boring
10 points = The paper maintained reader interest.
5 points = The main ideas of the paper were interesting, but the writing style was boring.
0 points = I was too bored by the paper to finish reading it.

Complete (10 pts)
A wholistic score from 0-10
10 points = Regardless of the other rubric scores, this paper was worthwhile to read.
5 points = Overall, this was an average paper.
0 points = Overall, this paper has no redeeming qualities.

Presentation Project Criteria & Scoring Rubric:
Paper Projects will be graded on a 100-point scale using the "5-C" rubric

Clarity (20 pts)
The presentation was clear.
20 points = All ideas are clearly expressed; the presenter made eye contact & checked for understanding
15 points = All ideas clearly expressed; the presenter made eye contact; did not check for understanding
10 points = The presentation was difficult to understand; speaker spoke too quickly or quietly
5 points = The audience did not understand the presentation

Correctness (20 pts)
The mathematical ideas, formulas, explanations, and results contained in the paper are accurate
25 points = All mathematical formulas, explanations, and results are accurate. All work is shown.
20 points = All mathematical formulas, explanations, and results are accurate, but some work is missing.
15 points = The formulas and results are accurate, but explanations are missing. Some work is missing.
10 points = The paper contains errors in formulas and/or results. Explanations are inadequate.
5 points = The paper contains serious mathematical errors and/or very few explanations are provided.

Content (40 pts)
The paper contains sophisticated ideas and/or mathematics. The project was worthwhile.
40 points = Significant mathematics/concepts were presented; the audience learned something of value.
30 points = Mathematics/concepts at a level appropriate for this course were presented
20 points = The mathematics and/or ideas were at a level lower than what is appropriate for this course.
10 points = The presentation contained few mathematical concepts or ideas.
0 points = The presentation did not contain any worthwhile content.

Coring (20 pts)
Coring = Not boring
20 points = The presentation maintained audience interest (visual aids/models were probably used).
10 points = The ideas were interesting, but they were presented in a boring manner.
0 points = It was painful to sit through this presentation