MTH540: Higher Geometry

Credit Hours: 3

Contact Hours: This is a 3-credit course, offered in accelerated format. This means that 16 weeks of material is covered in 8 weeks. The exact number of hours per week that you can expect to spend on each course will vary based upon the weekly coursework, as well as your study style and preferences. You should plan to spend 14-20 hours per week in each course reading material, interacting on the discussion boards, writing papers, completing projects, and doing research.

Faculty Information

Faculty contact information and office hours can be found on the faculty profile page.

Course Description and Outcomes

Course Description:
This graduate-level course covers the foundations of Euclidean and non-Euclidean geometries (geometry of Lobachevski/ Hyperbolic geometry, Spherical geometry). The course also includes a historical study of parallel postulate and discussion of the study of Axiomatic systems. This course will also offer best practices for Dual Credit course instruction and discussions of standard pedagogy. (3 credits total).

Course Overview:
In the area of Euclidean geometry, the following concepts are presented: triangle congruence, similarity, parallel and triangle properties, and transformations. In addition, logic, area, surface area and volume, and circles are discussed. Non-Euclidean Geometry, along with its history, development, and challenges is covered as well.

Course Learning Outcomes:

1. Explain Euclidean geometry and its basic components.
2. Prove statements using reasoning.
3. Prove statements involving parallelism.
4. Prove statements involving triangles, quadrilaterals, similarity.
5. Explain non-Euclidean geometry.
6. Understand transformations.
7. Prove results for right triangles, area, surface area and volume.
8. Prove results for circles.

Participation & Attendance

Prompt and consistent attendance in your online courses is essential for your success at CSU-Global Campus. Failure to verify your attendance within the first 7 days of this course may result in your withdrawal. If for some reason you would like to drop a course, please contact your advisor.

Online classes have deadlines, assignments, and participation requirements just like on-campus classes. Budget your time carefully and keep an open line of communication with your instructor. If you are having technical problems, problems with your assignments, or other problems that are impeding your progress, let your instructor know as soon as possible.

Course Materials

Required:

Martin-Gay, E. (2016). *Geometry* (1st ed.). New York, NY: Pearson Education Inc. ISBN-13: 9780134173658

Other required readings as indicated in the weekly assignment table below.

Suggested:

NOTE: *All non-textbook required readings and materials necessary to complete assignments, discussions, and/or supplemental or required exercises are provided within the course itself. Please read through each course module carefully.*

Course Schedule

Due Dates

The Academic Week at CSU-Global begins on Monday and ends the following Sunday.

- Discussion Boards: The original post must be completed by Thursday at 11:59 p.m. MT and Peer Responses posted by Sunday 11:59 p.m. MT. Late posts may not be awarded points.
- Opening Exercises: Take the opening exercise before reading each week's content to see which areas you will need to focus on. You may take these exercises as many times as you need. The opening exercises will not affect your final grade.
- Students have one attempt on the midterm and final exams. The time limit is 400 minutes for each exam, and the exam must be completed in one sitting.
- Critical Thinking: Assignments are due Sunday at 11:59 p.m. MT.
- Live Classroom: Although participation is not required, Live Classroom sessions are held during Weeks 3 and 6. There are two total sessions.

Week #	Readings	Assignments
1	• Chapter 1.1-1.8 in *Geometry*	• Discussion (25 points) • Critical Thinking (65 points)

	• Greenberg, M.G. (1994). Chapter 2, Logic and incidence geometry. *Euclidian and non-Euclidian geometries: Development and History* (pp. 50-58). • Greenberg, M.G. (1994). Chapter 1, Euclid's geometry. *Euclidean and non-Euclidean geometries: Development and history* (pp. 1-16). • Hilbert, D. (1910). Chapter 1, The five groups of axioms, and Chapter 2, The compatibility and mutual independence of the axioms. *Foundations of Geometry* (2nd ed.) (E.J. Townsend, Trans.). The Open Court Publishing Company, London: England (pp. 1-36). • Kay, D. C. (2011). Chapter 1, Lines, distances, segments, and rays. *College geometry: A unified development* (pp. 1-6).	
2	• Chapter 2.1-2.7, 3.1-3.7 in *Geometry* • Calkins, K.G. (2005-2006). *A review of basic geometry*. • Geometrypreapteacher. (n.d.). *Protractor Postulate*. • Kay, D. C. (2011). Chapter 1, Lines, distances, segments, and rays. *College geometry: A unified development* (pp. 1-6). • Math Warehouse (n.d.). *Same as the angle side side postulate (ASS).* (n.d.).	• Discussion (25 points) • Critical Thinking (65 points)
3	• Chapters 4.1-4.6 and 5.1-5.6 in *Geometry* • Kay, D. C. (2011). Section 1.1 Intended goals, and Section 1.2 Axioms of alignment. *College Geometry: A Unified Development* (pp. 1-6). • Kay, D. C. (2011). Section 1.8 Coordinates for rays. *College Geometry: A Unified Development* (pp. 35-43). • Kay, D. C. (2011). Section 1.10 Segment construction theorems. *College Geometry: A Unified Development* (pp. 47-49).	• Discussion (25 points) • Critical Thinking (65 points) • Live Classroom (0 points)
4	• Chapters 6.1-6.5 and 7.1-7.6 in *Geometry* • Greenberg, M.G. (1994). Chapter 3, Hilbert's axioms. *Euclidean and non-Euclidean geometries: Development and history* (pp. 71-82). • Martin, G. E. (1998). Chapter 12, Pasch's postulate and plane separation postulate. In *The foundations of geometry and the non-Euclidean plane* [E-reader version] (pp. 131-134).	• Discussion (25 points) • Critical Thinking (65 points) • Midterm Exam (200 points)
5	• Chapter 8.1-8.6 in *Geometry*	• Discussion (25 points) • Critical Thinking (65 points)

	• Greenberg, M.G. (1994). Chapter 3, Hilbert's axioms. *Euclidean and non-Euclidean geometries: Development and history* (pp. 82-102). • Math Proofs. (2013, July 21). *Reflection and the ABCD theorem*.	
6	• Chapter 9.1-9.5 and 10.1-10.7 in *Geometry* • Greenberg, M.G. (1994). Chapter 4, Neutral geometry. *Euclidian and non-Euclidian geometries: Development and history* (pp. 115-121).	• Discussion (25 points) • Live Classroom (0 points)
7	• Chapter 11.1-11.7 in *Geometry* • Grandi, G. (2005). Thomas Reid's geometry of visibles and the parallel postulate. Studies in History and Philosophy of Science, 36(1), 79-103. • Greenberg, M.G. (1994). Chapter 4, Neutral Geometry. *Euclidian and non-Euclidian geometries: Development and history* (pp. 122-134). • Lamb, E. (2014, February 28). Roots of Unity: Chasing the parallel postulate. *Scientific American*.	• Discussion (25 points) • Critical Thinking (75 points)
8	• Chapter 12.1-12.6 in *Geometry* • *Discovery of non-Euclidean geometry* (2013, April 24). • Greenberg, M.G. (1994). Discovery of non-Euclidean geometry. *Euclidean and non-Euclidean geometries: Development and history* (pp. 82-102). • Roberts, D. (1988-2012). *Euclidean and non-Euclidean geometry*. **Elliptic Geometry** • Peli, T. (2005-2006). *Elliptical parallel postulate*. **Hyperbolic Geometry** • Bennett, A.G. (2005). *Hyperbolic geometry—triangles, angles, and area*. • Non-Euclid Interactive Constructions in Hyperbolic Geometry. (n.d.) *10: Disk and Upper Half-Plane Models of Hyperbolic Geometry*. • ThatsMaths. (n.d.). *Poincaré half-plane model*. • Weisstein, E.W. (n.d.). *Poincaré hyperbolic disk*.	• Discussion (25 points) • Final Exam (200 points)

Assignment Details

This course includes the following assignments/projects:

Module 1

CRITICAL THINKING ASSIGNMENT (65 points)

Hilbert's Incidence Axioms, Congruence
Answer the following questions on Hilbert's incidence axioms:

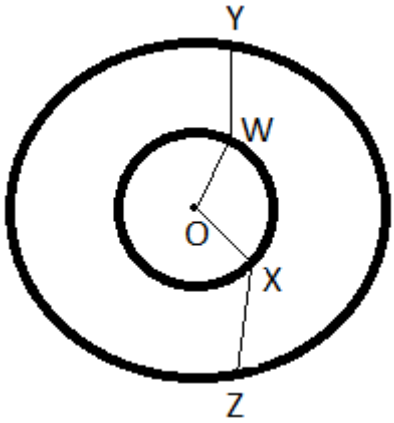
1. Given the following system:
   Points: S={1,2,3,4,5}
   Lines: {1,2,3}, {1,4}, {1,5}, {2,4}, {2,5}, {3,4}, {3,5}, {4,5}
   Planes: {1,2,3,4}, {1,2,3,5}, {2,3,4,5}, {1,4,5},

   which of Hilbert's incidence axiom(s) does not hold? Explain why not.

2. Prove from Hilbert's incidence axioms that a plane cannot be a line.

3. Prove from Hilbert's incidence axioms that each line is contained by at least two planes, whose intersection is that line.

4. Research congruence of triangles. Given two concentric circles with common center O.
   Suppose angle <OWY is congruent to angle <OXZ. Prove that YW=ZX.



Review the Module 1 Critical Thinking Rubric for full details on how you will be graded on this assignment.

Module 2

CRITICAL THINKING ASSIGNMENT (65 points)

Axioms, Quadrilaterals
There are four parts to complete for this assignment.

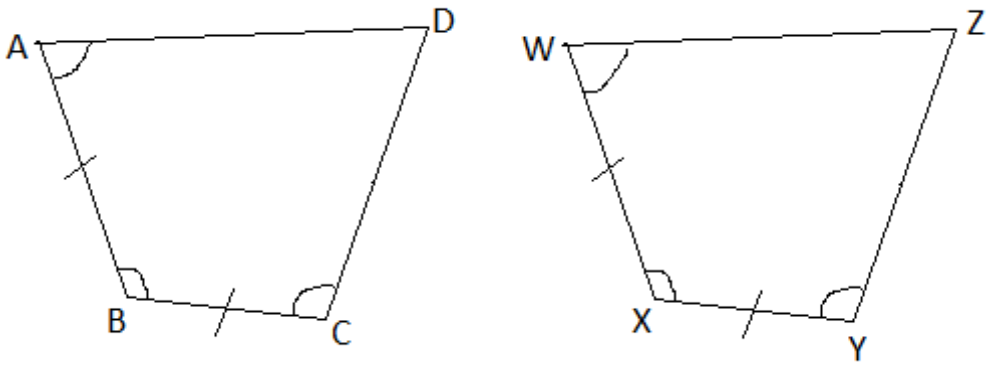
Part 1: Find two different models satisfying the following three axioms:
- Every line is a set of at least two points.
- Each two lines intersect in a unique point.
- There are precisely three lines.

Describe what your points and lines are for each model.

Part 2: Suppose that the betweenness relation (ABC) holds. Prove that (ACB) does not hold. Do not use the ruler postulate or any theorem derived from it.

Part 3: Complete Exercise 4 in Section 1.7 of the textbook *College Geometry: A Unified Development*. See link to textbook page below.

Part 4: Research convex quadrilaterals. Prove the ASASA congruence theorem. In other words, suppose convex quadrilaterals ◊ABCD and ◊WXYZ satisfy ASASA. Prove that ◊ABCD and ◊WXYZ are congruent.



Use this property of convex quadrilaterals:
If A, B, C, and D are consecutive vertices of a convex quadrilateral, then
m(<DAB)=m(<DAC)+m(<BAC).

Review the Module 2 Critical Thinking Rubric for full details on how you will be graded on this assignment.

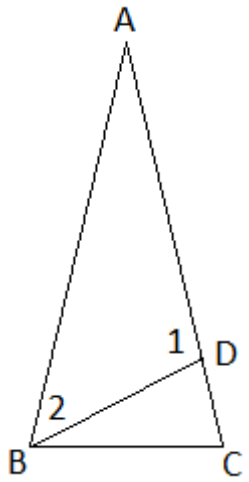
Module 3

CRITICAL THINKING ASSIGNMENT (65 points)

Betweenness, Quadrilaterals, Exterior Angle Theorem

Complete the following for this assignment:

- Use the ruler postulate to prove that for any two distinct collinear points *A* and *B*, there exists a *C* so that (*ACB*).
- Prove that a segment cannot be a ray.
- In Euclidean geometry, draw a picture of two non-congruent convex quadrilaterals satisfying ASAAA.
- Research the exterior angle theorem. Given isosceles triangle ABC with AB=AC, suppose D is between A and C. Using the exterior angle theorem, explain why *m*(<1)>*m*(<2). Do not use the assumption that the angle sum of a triangle is 180° (or any result equivalent to it).



Review the Module 3 Critical Thinking Rubric for full details on how you will be graded on this assignment.

Module 4

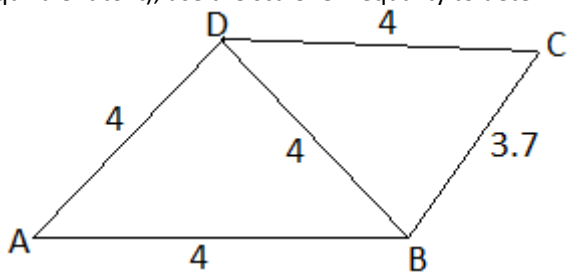
CRITICAL THINKING ASSIGNMENT (65 points)

Triangles and Scalene Inequality
This assignment has two parts:

Part 1: Complete the following exercises from Chapter 4, page 136, in the textbook *Euclidean and Non-Euclidean Geometries: Development and History* (link below):

- Questions 9 and 13

Part 2: Research the scalene inequality. Without using that the angle sum of a triangle is 180° (or any result equivalent to it), use the scalene inequality to determine the smallest angle. Explain why.



Review the Module 4 Critical Thinking Rubric for full details on how you will be graded on this assignment.

MIDTERM EXAM (200 points)
See the associated Exam in Canvas.

Module 5

CRITICAL THINKING ASSIGNMENT (65 points)

Congruence
Your assignment this week is from Chapter 3, page 109, in the textbook *Euclidean and Non-Euclidean Geometries: Development and History* (link below):

- Questions 27, 28, 29, 30, 33, and 34

Review the Module 5 Critical Thinking Rubric for full details on how you will be graded on this assignment.

Module 7

CRITICAL THINKING ASSIGNMENT (75 points)

Option 1: Exploring Cross Sections

For this assignment, you will explore cross sections through a manipulative that you have around your home. Then you will look at a real-world application of cross sections. Finally, you will develop your own classroom activity that you feel would be effective in teaching this concept.

Complete the following steps:

1. Select a household item that can be cut in different ways so that you can obtain at least three different cross section shapes. Describe the shape of the solid formed by the item you chose and include a sketch of the solid with your submission. Then, discuss the following in your paper:
    a. Describe each cross section obtained by the cuts in as much detail as possible.
    b. How did you determine the shape of each cross section?
    c. Was the household item you selected a polyhedra? Why or why not?
    d. How does your answer to part (c) affect your answer to part (a)?
2. Cross sections are used in medical training and research. Research and write about how magnetic resonance imaging (MRI) is used to study cross sections of the brain.
3. Develop your own classroom activity that you feel would help students understand cross sections. Be sure to include the following in your discussion of the activity you created:
    a. What is the student population you have designed this activity for?
    b. What aspects of the activity do you think would motivate students?
    c. How does your activity take into account diverse learning styles?
    d. What challenges do you foresee your students facing with this activity?
4. In the conclusion of your paper, discuss what you have discovered about how to teach this concept through your experience with this assignment. What key points should be included? What types of activities are effective in teaching cross sections?

Module 8

FINAL EXAM (200 points)

See the associated Exam in Canvas.

Course Policies

Course Grading

20% Discussion Participation
0% Opening Exercises
40% Critical Thinking Assignments
40% Midterm and Final Exams

Grading Scale and Policies

A	95.0 – 100
A-	90.0 – 94.9
B+	86.7 – 89.9
B	83.3 – 86.6
B-	80.0 – 83.2
C+	75.0 – 79.9
C	70.0 – 74.9
D	60.0 – 69.9

F	59.9 or below

In-Classroom Policies
For information on late work and incomplete grade policies, please refer to our **In-Classroom Student Policies and Guidelines** or the Academic Catalog for comprehensive documentation of CSU-Global institutional policies.

Academic Integrity
Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /re-purposing your own work (see *CSU-Global Guide to Writing and APA Requirements* for percentage of repurposed work that can be used in an assignment), unauthorized possession of academic materials, and unauthorized collaboration. The CSU-Global Library provides information on how students can avoid plagiarism by understanding what it is and how to use the Library and Internet resources.

Citing Sources with APA Style
All students are expected to follow the *CSU-Global Guide to Writing and APA Requirements* when citing in APA (based on the APA Style Manual, 6th edition) for all assignments. For details on CSU-Global APA style, please review the APA resources within the CSU-Global Library under the "APA Guide & Resources" link. A link to this document should also be provided within most assignment descriptions on your course's Assignments page.

Disability Services Statement
CSU–Global is committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Disability Resource Coordinator at 720-279-0650 and/or email ada@CSUGlobal.edu for additional information to coordinate reasonable accommodations for students with documented disabilities.

Netiquette
Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards and other postings within or connected to the online classroom.

If you have concerns about something that has been said, please let your instructor know.