



**GOSHEN COLLEGE**  
**MATHEMATICS DEPARTMENT**  
**MATH 305 MODERN GEOMETRY- SPRING 2019**

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**Motivation**

Geometry is the mathematical study of shape. Although arising from techniques used by navigators, land surveyors, artisans, and builders, the genius of Greek mathematicians was the use of deductive arguments and the abstraction and idealization of concepts such as point, line, on, and between. The axiomatic approach to geometry reported by Euclid laid the foundation for the development of all modern mathematics.

Post-Euclid developments in geometry have combined visual, axiomatic, algebraic, and transformational viewpoints to elucidate and expand Euclid's approach. Geometry has been applied to drawing in perspective, designing buildings and integrated circuits, describing the shape of the universe and bubbles, classifying patterns in crystals and decorations, creating graphics with a computer, imaging with x-rays and nuclear magnetic resonance, allowing automated facial recognition and driverless vehicles, and folding paper artistically, proteins biologically, and devices efficiently.

"Geometry combines visual delights and powerful abstractions, concrete intuitions and general theories, historical perspective and contemporary applications, and surprising insights and satisfying certainty." (Thomas Q. Sibley, *Thinking Geometrically: A Survey of Geometries*, page xv).

**Learning Objectives**

The student will

1. Identify, classify, visualize, define, analytically represent, and interrelate geometric objects including points, lines, angles, triangles, quadrilaterals, regular polygons, circles, planes, prisms, pyramids, cones, cylinders, and spheres;
2. Rationalize, derive, and use formulas relating angle measures, lengths, areas, and volumes of two- and three-dimensional objects such as triangles, quadrilaterals, regular polygons, circles, prisms, pyramids, cones, cylinders, and spheres, with attention paid to units, unit comparison, and the iteration, additivity, and invariance related to measurements;
3. Construct geometric figures using straightedge, compass, ruler, computer software, and other devices;
4. Describe and visualize congruence, similarity, and symmetry in terms of transformations including dilation, translation, rotation, reflection, glide reflection, and their compositions;
5. State definitions and prove theorems about geometric objects based on definitions, axioms, and theorems including Euclid parallel, Playfair parallel, SSS, SAS, ASA, AAA, Thales, Pappus, Desargues, Pythagorean, algebraic rules, and non-Euclidean;
6. Describe, use, and interrelate axiomatic, constructive, analytic, projective, and transformational viewpoints of Euclidean and non-Euclidean geometries;
7. Describe the historical development of geometry including the contributions of significant persons and diverse cultures;
8. Learn mathematics by reading, listening, exploring, and conversing in an effective manner;
9. Explain and critique mathematical reasoning through speaking and writing in a precise and articulate manner in both informal and formal settings; and
10. Exhibit curiosity, playfulness, creativity, confidence, perseverance, interest in multiple perspectives, and a collaborative spirit.

**Prerequisites**

A grade of C or higher in Math 211 Calculus I, and a grade of C or higher in Math 205 Discrete Mathematics or Math 212 Calculus II, showing a post high school level of mathematical maturity and an ability to read and write proofs. Knowledge from a high school geometry course is assumed.

**Instructor**

David Housman, SC 117, dhousman@goshen.edu, 535-7405, 612-7185 (cell)  
Office hours posted on office door and [www2.goshen.edu/~dhousman/Schedule19Spring.htm](http://www2.goshen.edu/~dhousman/Schedule19Spring.htm)

<b>Class Time</b>	TR 9:30-10:45AM in AD 20.
<b>Textbook</b>	<i>The Four Pillars of Geometry</i> , by John Stillwell published by Springer in 2005, ISBN-13: 978-0387-25530-9.
<b>On-line</b>	Moodle <a href="https://moodle.goshen.edu">https://moodle.goshen.edu</a>
<b>Software</b>	<i>GeoGebra</i> will be used for geometric constructions. A free copy of <i>GeoGebra</i> can be downloaded from <a href="http://www.geogebra.org">www.geogebra.org</a> .
<b>Other Materials</b>	A three-ring binder with loose-leaf blank, lined, and graph papers is recommended so that you can keep a written record of diagrams, problem solving attempts, questions, math discoveries, and skill assessments. The binder will be useful at the end of the semester when you will be asked to provide a synthesis of what you have learned during the semester. A ruler and compass would be useful and inexpensive tools to purchase.
<b>Activities</b>	<p>The study of mathematics is not a spectator sport! Reading, listening, solving problems, writing explanations, reflecting upon ideas, and receiving feedback are essential to learning mathematics. Read with paper and pencil in hand, and take an anticipatory approach: try to obtain solutions, explanations, and proofs before reading what the author provides. Write down specific questions when you do not understand a portion of the text or a lecture. Try to recreate the key ideas without looking at the book or notes.</p> <p>Moodle will announce the reading to complete <i>before</i> class and the exercises to complete by the start of the <i>next</i> class. Class discussion will be based primarily upon the preparatory reading and somewhat on the completed exercises. The goal of class discussion and subsequent exercises is to review, deepen, complement, and extend student understanding of what you have read in preparation for class. It is important to commit to memory the basic concepts and processes, and quizzes will both assess and help with the needed retention.</p> <p>An average student can obtain an average grade with an average of nine hours each week devoted to this course—adjust if you are not average or desire a grade that is not average.</p>
<b>Collaboration and Academic Integrity</b>	<p>You are encouraged to use all available resources in order to learn the concepts and techniques discussed in this course. In particular, conversations with other students and the instructor can be an effective learning method. Reading other books and web pages can be another effective learning method. However, copying someone else's work subverts the learning process.</p> <p>For homework and the project, you may look at and discuss another student's work, but any written work developed during collaboration with another student should be destroyed before writing your own solutions. You should give written acknowledgement to people with whom you have had discussions and to any written materials (other than the text) that were helpful.</p> <p>For quizzes, you may <i>not</i> use any resources unless a specific exception is stated.</p> <p>Failure to observe the above rules will result in a zero on the assignment or exam. Any violation of academic integrity will be reported to the Academic Dean. Observation of the above rules will help you learn the material well and give you the satisfaction of knowing that you have earned your grade.</p>
<b>Grading</b>	Course grades will be based on performance on class participation (10%), quizzes (10%), homework (60%), and a project (20%). Letter grades will be assigned A if 93-100%, A- if 90-92%, B+ if 87-89%, B if 83-86%, B- if 80-82%, C+ if 77-79%, C if 73-76%, C- if 70-72%, D+ if 67-69%, D if 60-66%, and F if 0-59%.
<b>Class Participation</b>	Come to class, listen carefully, engage in activities, present solutions to exercises, ask questions, suggest answers, and share insights. Your participation will be evaluated on the regularity and quality of your engagement. A student who comes prepared to every class, listens carefully, and engages in directed activities but does not otherwise contribute to class discussion will earn a grade of 75%. Missing class, coming unprepared, or not listening or engaging in activities during a class will result in a lower grade. Respectfully presenting solutions to exercises, asking questions, suggesting answers, and sharing insights will result in a higher grade, but no more than three proactive contributions will be counted during a single class.

**Quizzes**

Check your basic understanding of the material by answering a few questions. These will occur during almost every class, will be based on recently assigned reading and exercises, and will be completed without notes or other resources.

**Homework Exercises**

Achieve and exhibit understanding by completing the assigned exercises. Your solutions will be evaluated on the correctness of your mathematical descriptions and arguments, the clarity of your writing, and the quality of your presentation, including the judicious use of clearly labeled diagrams.

It may be helpful for you to distinguish between the process of figuring out an exercise and the process of writing up your results. Normally, what a person writes down during the process of figuring out an exercise is not sufficiently clear or complete for another person to read and understand, unless they have already done the same exercise. Imagine that your audience is a student taking a similar geometry class at a different college, who does not happen to have a copy of the book in their hands, and write up the results of the exercise in a clear and readable form.

Some basics on writing clearly: Restate the question as a claim that can be understood on its own. Write in complete sentences. Define any variables that you use. Consider computations and drawings as supplemental to your verbal description of the mathematics. If you include a lengthy computation or a drawing, describe it verbally. Check for spelling, grammar, punctuation, and readability.

Some basics on presentation: Write your name and the assignment number on the front page. Staple all the pages of your homework into one neat packet. Trim the frayed edges of paper with scissors. Write neatly, and make sure that there is adequate space between exercises. If your handwriting is illegible, use a word processor (e.g., Word with its equation editor, or LaTeX using TeXView or other software environment). If a mathematical expression is longer than a long word, put it on a line by itself. If you include a drawing or a graph, make sure it is clearly labeled.

Homework is due at the *start* of class. Resubmissions and late submissions of individual exercises are due two class periods after the original due date. Most exercises will be graded on a 10 point scale in accordance with the following rubric (points for on-time submission, resubmission or late submission are given in parentheses):

- (10, 8): correct mathematics, clear writing, and good presentation
- (8, 6): contains only one or two easily correctible small mathematical gaps, lack of clarity in writing, and/or poor presentation style
- (5, 3): contains one clearly identifiable major mathematical gap, lack of clarity in writing, or poor presentation style
- (2, 1): attempted (not just restated), but the approach was inappropriate, the reasoning faulty, or the writing was unclear
- (0, 0, 0): not attempted

You are encouraged to resubmit or late submit individual exercises initially earning less than 8 points. If you resubmit or late submit any exercises, they should be stapled on top of the complete original graded submission.

You are encouraged to collaborate and seek assistance when having difficulties. You will have achieved the expected level of understanding when you are able to obtain your own solutions, independently reproduce solutions developed in collaboration or with assistance, and/or explain a solution to others.

**Other Homework**

Synthesize what you are learning about geometry and relate it to other aspects of life by completing some other assigned tasks. These tasks usually involve the statement of informed opinions, and so students are given full credit if serious effort is displayed.

**Extra Credit**

Receive extra credit toward your homework grade by doing one or more of the following: (1) find errors in the text or posted course materials and describe the error in writing; (2) attend a quantitative presentation (e.g., [Science Speakers](#)) or participate in a quantitatively based activity and describe in writing some interesting mathematical aspect of the presentation or activity; or (3) participate in a [Career Services](#) event and describe your most important discovery. The description should be a substantive paragraph or two and be submitted to the instructor on paper or a pdf document.

**Project**

Delve deeper into one aspect of geometry by investigating a topic not covered by Stillwell or during class. Potential topics include axiomatic systems, finite geometries, geometries over fields, differential geometry, fractal geometry, three-dimensional transformations, sphere-packing, frieze groups, wallpaper groups, mathematical study of origami, geometry in map-making, geometry as applied to cosmology (what is the shape of space), soap bubble geometry, kaleidoscopes (2-D and 3-D), descriptions of fourth dimension (and higher?), Archimedean solids, and inversion (across a circle). Projects can be completed by groups of one to three students. Your grade will be based upon a presentation, a paper, and self and group member evaluations.

Group membership, topic, and sources to be used should be approved by the instructor, preferably by March 25. At this stage, the instructor states sophistication level expectations for the project. Typically, the material to be learned should include definitions, one main theorem or a sequence of smaller theorems, and a variety of applications of the theorem(s) to special cases.

The presentation will be given during the scheduled final exam period, should give the audience a taste of the topic you have learned, can include activities for the audience to engage in, and should last about 25 minutes. The presentation will be worth 30% of your grade.

The final paper should be submitted via Moodle, typed, 6 to 10 pages, formal, expository, and directed towards your classmates. The paper should be a coherent introduction to the topic that could be read by an interested geometry student. The paper does not need to document everything learned. The paper should be deeper and/or more comprehensive than the presentation. The paper will be worth 60% of your grade.

Each individual should submit via Moodle an evaluation of group members including her or his self. There are many ways in which a member can contribute to a group, including asking good questions, explaining concepts, helping organize the group members' thoughts, recording observations, drawing helpful pictures, writing sections of the paper, proofreading sections of the paper, preparing or delivering parts of the class activity, and maintaining everyone's spirits. Keeping this in mind, please describe (typically in a short paragraph) each of your group members' contributions (including your own) and estimate the percentage of your group's total effort each person contributed. The evaluation you write will be worth 10% of your grade.

**Tutoring**

The Academic Success Center provides tutoring and writing support for free to all undergraduate students. Make an appointment at [goshen.edu/asc](http://goshen.edu/asc). Unfortunately, there is only one current student who had previously taken this course. Therefore, your best bet to receive assistance is to make use of David's office hours.

**Disability Services**

Goshen College is committed to providing all students equal access to programs and facilities. Students who need accommodations based on disability should contact the Director of the Academic Success Center (ASC). Students must register with ASC before faculty are required to provide reasonable accommodations. For more information or to register, please contact the Director of the ASC, Judy Weaver, Good Library 112, [jweaver@goshen.edu](mailto:jweaver@goshen.edu) or 574-535-7560. To ensure that learning needs are met, contact the director of the ASC the first week of classes.

**Due Date Policy**

Class participation, assignments, projects, and quizzes can only be excused, rescheduled, or made up if (1) there is a serious medical problem, a death in the immediate family, or an irreconcilable conflict with another official Goshen College activity; (2) there is written documentation signed by proper authorities; and (3) the instructor is notified prior to the due date or as soon as possible afterwards.