

Heavenly Mathematics

Syllabus

Deep Springs College
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Academic Year 2021-2022, Terms 4 & 5
Credits: 4 (regular full-semester course)
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Overview

Thanks to GPS, and before that LORAN, nobody in the United States has had much need to determine their location by traditional methods for several decades, except in unusual emergencies where electronics were temporarily unavailable. However, pilots, sailors, and astronauts continued to know how to determine their positions using spherical trigonometry and the position of the stars up until the 1980s.

The study of trigonometry — the relationship between the measurement of angles and lines — finds a natural home on the sphere. Describing both the celestial motion of the stars and the terrestrial relationship of points on the earth, spherical trigonometry is as timeless a mathematical subject as they come, laying out a self-contained world of unique and surprising results and applications. Equipped with a small Lénárt sphere — a spherical whiteboard of sorts — it is possible to account for the mathematics of the heavens.

This course will be an exploration of the results of spherical trigonometry from some of the first, very crafty results known to the ancients all the way to the methods of celestial navigation that remained in wide use up through the 1950s. In the final unit, we will learn how a ship's navigator turned an estimate of a position and the measured altitudes of two astronomical objects into a refined estimate of the ship's position.

Course Content and Equivalence

This course is a rigorous, self-contained, college-level mathematics course on spherical trigonometry. Student learn fundamentals of spherical geometry and trigonometry, celestial navigation, and how to construct and evaluate mathematical proofs.

Materials

Course text: [Heavenly Mathematics: The Forgotten Art of Spherical Trigonometry](#) by Glen Van Brummelen, Princeton Press, 2013.

Supplementary text: Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time by Dava Sobel, Bloomsbury, 2007.

Lab Materials (provided): Lénárt Sphere. Sextant.

Other texts may be provided on the reserve shelf from time to time.

Unit Outline

- I. A Selection of Results from Ordinary (Two-dimensional) Trigonometry
- II. An Introduction to Trigonometry on the Sphere
- III. Ancient Approaches to Spherical Trigonometry
- IV. Analyses using Right-Angled Triangles on the Sphere
- V. Analyses using Oblique Triangles on the Sphere
- VI. Celestial Navigation

The unit outline is in close correspondence with Chapters 1, 2, 3, 5, 6, and 9 of Heavenly Mathematics. Each of the six units will occupy 2 to 3 weeks of the 14-week course. Time permitting, additional material from the course text and other sources may be added.

Assignments, Exams, Grading

The course will be graded 45% on submitted problem sets (of which there will be roughly 12 in total — about one due every week except exam weeks), 10% on active participation, and 20%, and 25% on Term 4 and Term 5 exams, respectively. To avoid concurrent end-of-term crunches with other classes, our exams will be on the Thursday *of the penultimate week* of each term (e.g., Thursday, Feb. 17, and Thursday, April 21).

Problem sets must be on 8 1/2 x 11 paper, stapled, with name, problem set #, and due date. Do not work in pen unless you think you are perfect or like to recopy things until they aren't littered with scratch-outs. Instead, work in pencil, rub out mistakes completely, and recopy work that gets convoluted due to wrong turns. Complete solutions to problem sets will be supplied.

Additional Course Policies

Each student is permitted one late assignment, to be turned in the following class, without penalty. All other late assignments are dropped one letter grade per 24 hours late. No more than two course absences are permitted and having zero absences is strongly recommended.