

CHAPMAN UNIVERSITY  
University Honors Program  
One University Drive  
Orange, CA 92866

HON 382  
Spring 2018  
The Fabric of the Universe: Space, Time, and Reality

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Catalog Description:

**Prerequisite:** acceptance to the University Honors Program, or consent of instructor.

Did you ever wonder what is the arena of our physical Reality, what is the Shape of the Universe, or what is the Arrow of Time? Through concrete examples and engaging exercises that teach mind-expanding ideas in an intuitive and informal way, we will learn connections between Geometry and recent developments in Cosmology.

Required Texts:

1. *The Shape of Space*, by Jeffrey Weeks, Chapman & Hall/CRC Pure and Applied Mathematics Book 249, Second Edition, 2001; ISBN-13: 978-0824707095.
2. *Fabric of the Cosmos: Space, Time, and the Texture of Reality*, by Brian Greene, Publisher: Vintage, 2005; ISBN-13: 978-0375727207.

Course Learning Outcomes:

- Students will understand the information presented in quantitative form (e.g. equations, logical formulas, graphs, diagrams, algorithms) and have the ability to convert relevant information into this form.
- Students will understand mathematics and physics concepts in the context of the material presented in class and they will be able to analyze and apply the notions and techniques learned by making relevant assumptions and supporting intermediate steps and solutions in written form.

Honors Program Learning Outcomes:

Upon completing a course in the University Honors Program students will have:

- a. Obtained a starting point for integrative exploration of the development of cultures and intellectual achievements through a variety of disciplinary and interdisciplinary perspectives;
- b. Sharpened their ability to critically analyze and synthesize a broad range of knowledge through the study of primary texts and through engagement in active learning with fellow students, faculty, and texts (broadly understood);
- c. Understood how to apply more integrative and interdisciplinary forms of understanding in the advancement of knowledge and in addressing complex challenges shaping the world;
- d. Developed effective communication skills, specifically in the areas of written and oral exposition and analysis.

Content:

The course introduces students to rigorous concepts and notions of Geometry, Topology, Cosmology, and Physics in the context of understanding Reality. Our own existence takes place in a region of Space and during an interval of Time, yet Science is still struggling to understand what Space and Time actually are.

We start by investigating the Space: notions of surfaces and three-dimensional manifolds are introduced, along with a study of their Topology and Geometry. We construct and study concrete examples of surfaces, and then study several Geometries that these carry, e.g. Euclidean and Hyperbolic. In this context we study notions such as orientability, flatness, the Gauss-Bonnet formula, the Euler number, properties of spheres, and rudiments of knot theory. We continue by an investigation the four-dimensional space and a study of the Geometry of three- and four-manifolds. We conclude this first part with a detailed inquiry about the Geometry of the Universe.

The second part of the course deals with the notion of Time, setting and answering several questions such as: does Time has a beginning, is there an arrow of Time, can we manipulate Space and Time? In this part students learn notions of Relativity, Cosmology, and Quantum Physics, which are the main players in the search for definition and study of Time and Time measurements.

The Mathematics and Physics of Space and Time are crucial in understanding the Reality and the structure of the Universe. There is a general misconception that this study is meant only for specialists in these fields. This course is designed to break down this barrier and make these “cosmic” questions accessible to undergraduate students.

Instructional strategies:

The lectures are based on the material in the required textbooks, complemented by several articles and book chapters which will be provided by the teacher. In class participation is mandatory, as many lectures will be organized in a self-discovery fashion. Students are required to read the material assigned each class time, as there will be follow-up discussions during the next lecture. In addition, students are required to write weekly assignments, which are based on the material taught in class, and on the textbooks. One midterm take-home written project and one take-home written final project will be assigned.

Methods of Evaluation: Total of 600 points

1. Student performance will be evaluated weekly in the form of in-class participation, written assignments, which will assess knowledge acquisition, critical analysis, integration, and creative synthesis of the material. (100 points)
2. There will be one written midterm exam (200 points) and one written final exam (200 points) assigned, consisting in theoretical material and problem solving exercises.
3. In addition, students will be required to complete and present projects related to the material of study. Presentations will occur during class time followed by whole class discussions and peer evaluations (100 points).

**Tentative scale:**

Score of at least (%)	93	90	87	83	80	77	73	70	67	63	60
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-

Chapman University Academic Integrity Policy:

Chapman University is a community of scholars which emphasizes the mutual responsibility of all members to seek knowledge honestly and in good faith. Students are responsible for doing their own work, and academic dishonesty of any kind will not be tolerated anywhere in the university. Collaboration on homework is encouraged. Group discussions and study sessions can be useful tools for learning.

Course Accommodations Policy:

In compliance with ADA guidelines, students who have any condition, either permanent or temporary, that might affect their ability to perform in this class are encouraged to inform the instructor at the beginning of the term. The University, through the Center for Academic Success, will work with the appropriate faculty member who is asked to provide the accommodations for a student in determining what accommodations are suitable based on the documentation and the individual student needs. The granting of any accommodation will not be retroactive and cannot jeopardize the academic standards or integrity of the course.

Equity and Diversity:

Chapman University is committed to ensuring equality and valuing diversity. Students and professors are reminded to show respect at all times as outlined in Chapman's Harassment and Discrimination Policy: <http://tinyurl.com/CUHarassment-Discrimination>. Any violations of this policy should be discussed with the professor, the Dean of Students and/or otherwise reported in accordance with this policy.

Expectations: I expect that everyone will maintain a classroom conducive to learning. I like an informal atmosphere, but it must be orderly. Thus, everyone is expected to behave with basic politeness, civility, and respect for others. In particular, talking in class is OK if it's part of a class discussion or with me. Neither are reading extraneous materials, using electronic equipment, or sleeping. Suggestions for improvement are welcome at any time. Any concern about the course should be brought first to my attention.

Prepared by: Adrian Vajiac  
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