

HON 254: Symmetry

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Hashinger Science Center 214

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Syllabus

Dates: 08/28/2017 – 12/16/2017

Lectures: Monday and Wednesday, 01:00pm – 02:15pm, Argyros Forum 205

Office hours: Monday and Wednesday, 12:00pm – 01:00pm, Hashinger Science Center 214

Description

Symmetry is everywhere. The human fascination with it originates from our observations of the natural world where symmetric forms appear abundantly. Nature's symmetries range from very simple to extremely complex, from very concrete to very abstract, and they extend over scales ranging from subatomic to cosmological distances. For millennia symmetric forms have inspired artists, architects, musicians and scientists. Artists have explored symmetries of the natural world and the human body to create masterpieces that look harmonious and appeal to our senses of beauty, harmony and perfection. Observing symmetries in nature and developing their own symmetric standards, architects have learned to design beautiful buildings and ornamental art. Ancient Greeks associated rhythm, harmony and patterns in music with periodicity and variations of forms in mathematics. In more recent developments symmetry emerged as one of the deepest ideas of modern mathematics and science responsible for our significant advancement in understanding the world. In this course we will explore historical origins of symmetry and its wide applications by examining how the quest to understand symmetry leads to beautiful science describing the beautiful natural world. We will also briefly mention entertaining aspects of symmetry and demonstrate its use in games and puzzles, mostly in Rubik's Cube and mathematical tricks with playing cards.

Topics

1. Introduction: symmetry around us and at the heart of everything.
2. The mathematical language of symmetry: elements, transformations, one-to-one correspondence, compositions, identity transformations, inverses, invariance, degree of symmetry, asymmetry, symmetry groups, commuting and noncommuting transformations, abstract groups, group tables, isomorphisms, subgroups, Cayley tables and graphs, group generators, permutation groups, transpositions, cycles, even and odd permutations, symmetric and alternating groups.
3. Geometric symmetry: geometric transformations, linear, planar and spatial symmetry, translations, rotations, reflections, glide reflections, lattices, continuous and discrete groups, cyclic and dihedral groups, chirality, border patterns, wallpapers, regular polygons and polyhedra, Platonic solids, aperiodic tiling.

4. Classification of symmetries: bounded objects, border patterns, wallpaper patterns.
5. Symmetry in nature: the known and unknown symmetry, bilateral symmetry and chirality in biology, anatomical asymmetries, order in the world of atoms and molecules, symmetries in organic and inorganic chemistry.
6. Artistic symmetry: mathematics in art, architecture and music.
7. Uses of symmetry in science: analogy, the symmetry principle, the symmetry approach, symmetry in research.
8. Symmetry in physics: atomic and molecular symmetry, crystals, spacial and temporal symmetries, symmetry and the relativity of motion, symmetry of physical laws, conservation laws, the world of elementary particles, fermions and bosons, matter and antimatter, symmetry of particle interactions.
9. Asymmetry: visible, hidden, approximate, lost and spontaneously broken symmetries.
10. Entertaining symmetry: mathematical games, puzzles and paradoxes, Rubik's Cube, mathematical tricks with playing cards.

Grade weights

Quizzes: 30%

Homework: 50%

Exam: 20%

Grade scale

0%...45% (F), 45%...50% (D-), 50%...55% (D), 55%...60% (D+), 60%...65% (C-), 65%...70% (C), 70%...75% (C+), 75%...80% (B-), 80%...85% (B), 85%...90% (B+), 90%...95% (A-), 95%...100% (A)

Program Learning Outcomes

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

1. obtained a starting point for integrative exploration of the development of cultures and intellectual achievements through a variety of disciplinary and interdisciplinary perspectives;
2. 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);
3. understood how to apply more integrative and interdisciplinary forms of understanding in the advancement of knowledge and in addressing complex challenges shaping the world;
4. developed effective communication skills, specifically in the areas of written and oral exposition and analysis.

Course Learning Outcomes

By the end of the course students are expected to be able

1. to effectively communicate scientific information;
2. to write clear, organized, illustrated and referenced technical reports.
3. to formulate fundamental principles of symmetry;
4. to illustrate these principles by multiple examples of phenomena in nature;
5. to identify symmetry types in various situations;
6. to design patterns with given symmetry types;
7. to effectively communicate scientific information;
8. to write clear, organized, illustrated and referenced technical reports.

The student's progress in the learning process will be measured by the average score for the above criteria.

Chapman University's Academic Integrity Policy

Chapman University is a community of scholars that 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 be subject to sanction by the instructor/administrator and referral to the University Academic Integrity Committee, which may impose additional sanctions including expulsion. Please see the full description of Chapman University's policy on Academic Integrity at www.chapman.edu/academics/academic-integrity/index.aspx.

Chapman University's Students with Disabilities 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 contact the Disability Services Office. If you will need to utilize your approved accommodations in this class, please follow the proper notification procedure for informing your professor(s). This notification process must occur more than a week before any accommodation can be utilized. Please contact Disability Services at (714) 516-4520 or visit <https://www.chapman.edu/students/health-and-safety/disability-services/> if you have questions regarding this procedure or for information or to make an appointment to discuss and/or request potential accommodations based on documentation of your disability. Once formal approval of your need for an accommodation has been granted, you are encouraged to talk with your professor(s) about your accommodation options. The granting of any accommodation will not be retroactive and cannot jeopardize the academic standards or integrity of the course.

Chapman University's Equity and Diversity Policy

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. Please see the full description of this policy at <http://www.chapman.edu/faculty-staff/human-resources/eoo.aspx>. Any violations of this policy should be discussed with the professor, the dean of students and/or otherwise reported in accordance with this policy.