

MATH 303  
REFLECTIONS IN SPACE AND TIME  
CSULB  
SPRING 2017

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OFFICE: MON/WED 5-5:30, TUE 10:45-11:45

## Overview

Symmetry and patterns are all around us. Or are they? Do we *discover* that something *has* symmetry or *is* a pattern? Or, is this a matter of our imposing a concept on the world? It must be that both processes are involved. Does an abstract rectangle have the “same” symmetry as a picture frame? Why do we want to see objects *as* symmetric even though they aren’t quite? What features do we overlook? What do we perceive in this act of *symmetric-seeing*? What about other senses? Can we hear or feel symmetry?

These questions quickly lead to the heart of philosophical theories of art, perception, mathematics, and . . . what else? This course is designed to promote an inquiry-driven conversation among students whose primary interests vary widely. Bringing their own expertise and insight to an exploration of the rich ideas of symmetry and pattern, students will collect, present, and investigate examples having to do with this pervasive aspect of the world. Whether it stems from visual art, music, literature, or a science the challenge for each will be to make the examples accessible to the whole of the class. Such a collaboration and discussion will produce new means of understanding and appreciating symmetry and patterns.

The driving principle of this course is that mathematics both stems from and helps us make sense of our experience. Perceptual and conceptual experimentation will provide its experiential content.

## Course components

### I. Symmetry observed: “I can’t define it, but I know it when I see it.”

We’ll begin by considering a variety of examples that students bring to the class. These can range from the obvious to the subtle. At this stage some cursory remarks will be made concerning what seems symmetric about them. In so doing, we’ll begin a classification, albeit a crude one.

### II. Symmetry described and considered: “I can define it, but I don’t know it when I see it.”

Here’s where mathematics gets into the game. Using the examples found in Part I we’ll take a more sophisticated approach. Once we have a more-or-less precise definition of symmetry, the task will be to develop a language with which to sharpen the classification of the sample cases. There might be examples that don’t yield easily to this abstract treatment. Such a circumstance can provide material for additional study in a project whose preparation and presentation will constitute a significant part of the course.

From our enhanced point of view, we’ll explore the appearance of symmetry in several disciplines. The focus will be to see how our mathematical understanding of symmetry sheds light on an issue.

### III. Symmetry Project

Working individually or collectively students will independently explore some part of the vast world of symmetry and pattern. (Collaborative work in groups of two or three is strongly encouraged.) This is an opportunity for experimentation, hypothesis, construction, and, above all, creativity. The nature of the project can be artistic, theoretical, philosophical, historical,

technological, etc. A list of sample topics will appear by the fifth week. A key to a rewarding project is to explore in depth a *narrowly focussed* topic. A broad survey or book report is not suitable. I encourage you to chat with me early and often as you develop your project.

By week eight, you should be considering a project topic. Feel free to discuss your ideas with me.

By week twelve, you should have a fairly clear vision of what you plan to undertake. What will be the focus of your investigation? How will you approach the question, problem, or issue? What means of research—physical or thought experiment, abstract reasoning, sources—will you use?

Each project should be accompanied by a paper that develops and explains the ideas you've explored. If you work in some medium (drawing, painting, sculpture, film, etc.), you should submit an interpretive paper. At the end of the semester we'll have a *Symmetry Fair* when you will display and discuss your work.

## Geometry and Symmetry Project

Our course is running as part of the **Long Beach Project in Geometry and Symmetry**, an initiative that promotes thinking that's rooted in perception and experimentation. The project's centerpiece is *The Geometry Studio* which we'll be using as a classroom. Your critical comments—signed or anonymous—on the project or studio experience are welcome at all times.

## Getting involved

A typical class session will consist of experiments and explorations that are part of a developing class discussion. You'll work in groups of 2-4. Following group work we'll discuss matters as an entire class. The key to success in this course is **initiative**—a willingness to try things and contribute.

Much of our work will be *open-ended* in the sense that you won't figure out something *completely*. Chances are that I won't have all the answers either. Deep thinking really works this way—you're able to make sense of some things out, but there's still more to understand. This is like hiking in the mountains—you reach one peak and gain a nice view, but there are more peaks around you.

## Reading, writing, and speaking

A preliminary essay will be assigned and collected in the first two weeks.

There will be weekly assignments of readings and three exploratory essays. The overall emphasis will be on organizing and making sense of our experience—observations, experimental activities. A typical assignment will consist of several questions that require essay responses. For each assignment, you will select two items to explore and write about (500-600 words per essay). The questions will address issues that arise in the readings and class-discussions. Written work will be submitted and returned with comments that should inform future essays. The resulting marks will form a significant part of the course grade. (**Late essays** will be accepted for 90% credit up to **two weeks** after the original deadline.)

I urge you to **work with others** and to consider the questions at some length before asking about them in class. I also encourage you to ask about them. You may submit a write-up for the exercises as a group of two. The work represented in what you submit should be **your own**.

Everything that you submit should be written in concise, clear sentences. Experiment with various styles in developing one that works.

A third piece of the course-grade will be the evaluation of the written work and presentation that result from the course project. Emphasis will be placed on clarity of exposition, insightful perspectives, and creativity.

Teamwork (preferably, two members) is encouraged. Submit one paper (1500-2000 words) for the group. On the day of the final exam, we'll hold a **Symmetry Fair** in which projects will be displayed and explained.

## On writing

Everything that you submit should be written in concise, clear sentences. Experiment with various styles in developing one that works. Guidelines to style and content are available on the class website. For further help with writing, take a look at

S. Pinker. *The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century*. Penguin (2015).

W. Strunk and E. White. *The Elements of Style*. Longman (1999).

W. Zinsser. *On Writing Well*. Harper (2006).

## Planned itinerary

Weeks	Topics	Coursework
1	Introductory exploration: What is symmetry?	Preliminary essay distributed and due
2-5	Continue collection and discussion of examples What is a pattern? What good is a theory of symmetry?	1st assignment distributed 1st essay due
5-9	What's a physical law? Are physical laws symmetrical? What would happen if time ran backwards? Is the universe right or left-handed?	2nd assignment distributed
9-12	Atoms, molecules, and matter Molecular symmetry and chemical properties	2nd essay due
12-14	Growth, form, and life Biological significance of symmetry Phyllotaxis and the golden ratio	3rd assignment distributed
14-15	Use of symmetry/asymmetry in art How do we perceive symmetry? Can something sound or feel symmetrical? Is symmetry a matter of degree?	3rd essay due
16		Symmetry Fair

## WWW

Materials related to the course (course description, assignments, reference materials) will appear on project's website,

`geomsymm.cns.csulb.edu`

Please make recommendations for things that you'd like to see on the site.

## Assessment.

Grades will be determined by the following factors.

Essays	50%
Course project	40%
Contribution to class activities	10%

Here's a *rough* indication of how I'll assign grades. These are **minimum** standards. The actual boundaries between grades might be lower than these, but won't be higher.

85-100%	A
75-85%	B
65-75%	C
50-65%	D

To each individual part of your work I assign a mark 0-10. See below for an *indication* of what these marks mean.

10 . . . .	Clear, elegant, mathematically and scientifically correct, shows depth of understanding, insight, or creativity
9 . . . . .	Clear, shows understanding and some elegance, insight, or creativity; mathematically and scientifically correct
8 . . . . .	Mathematically and scientifically correct, little elegance, insight, or creativity
7 . . . . .	Mostly mathematically and scientifically correct; little elegance, insight, or creativity
6 . . . . .	Some significant misconceptions
5 . . . . .	Quite significant misconceptions
0-4 . . . .	Deep misconceptions—shows little effort.

**Let me know if you're happy or unhappy about something.**

## Key to comments on marked papers

- a This needs a supporting **argument**.
- a? What's the **argument**—the line of reasoning—here?
- d **Describe** what's going on here.
- e **Explain** what you're doing here.
- f↓ Text does not **flow** well.
- h? **How** did you get this?
- i **Illustrate** what you're talking about—give an example, a picture, etc.
- p A **picture** would help here.
- s This is not a **sentence**.
- w **Wording** is awkward, confusing, etc. Meaning is unclear.
- y? **Why** is this so? What's the connection to what you've already said?
- ! Very nice. Something especially clear, insightful
- ? What this means or what you're doing is **unclear**. Where does this come from?
- X Something's wrong here—in concept or calculation.
- √ This is right—you have the idea.

## **Fine Print**

**Withdrawal** A copy of the School of Natural Sciences withdrawal policy is available from the Department Office. Note that it's different from the University withdrawal policy and the deadlines are earlier. Deadlines to which you should pay particular attention to appear below. Withdrawals from this course will be allowed only in accordance with University and College policies. Please be aware of the more specific and restrictive withdrawal policy for the College of Natural Sciences and Mathematics.

**Weeks 1-2.** Withdrawals will not appear on the student's permanent record.

**Weeks 3-8.** Withdrawals are permissible only for serious and compelling reasons. Academic progress unsatisfactory to the student is considered a serious and compelling reason during this period. Instructor and Department Chair signatures on the drop form are required.

**Weeks 9-12.** Withdrawals are permissible for serious and compelling reasons, but during this period, unsatisfactory academic progress is not considered a serious and compelling basis to drop a course. Circumstances must be shown that preclude the student from attending class or from any effective opportunities to study. In addition to the normal withdrawal form, a special form must be completed, and instructor and department chair signatures are required.

**Weeks 13-15.** Withdrawals are permissible only for serious accident or illness and involve a total withdrawal from the University. Detailed written documentation must accompany withdrawal forms. Instructor, chair, and college dean signatures are required.

**Disability** It is the student's responsibility to notify the instructor in advance of their need for accommodation of a disability that has been verified by the University.

**Cheating/Plagiarism** Cheating and plagiarism are in violation of the California Administrative Code, Title 5, Section 41301. CSULB has adopted a specific policy with respect to the violations of this nature (see the Bulletin or Schedule of Classes). Any student in violation of this code and policy in any assignment or examination related to this course shall be subject to the options specified in the policy statement. This may result in the student receiving a failing grade in the course or, in certain circumstances, being expelled from the University.