# LPS 106/206 and Math 189: Category Theory (Spring 2013)

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Seminar: Tu/Th 3:30–4:50 in SSL 155
Office Hours: Th 11:00–12:00 and by appointment

**Description:** This course is an introduction to category theory. Special attention will be paid to the ways in which category theory can be used to treat many different mathematical topics within a unified framework. Indeed, one of the principle virtues of category theory for the working mathematician—and the mathematically-oriented philosopher—is that it provides a language that can often be used to learn new mathematics quickly and easily, by studying how standard category-theoretic tools (such as epis and monos, initial and terminal objects, or limits) are manifest in some particular category (such as the category of groups, or the category of topological spaces). For this reason, I am going to focus as much as possible on examples of categories from throughout mathematics. Specific topics to be covered are the Mac Lane-Eilenberg axioms; epimorphisms and monomorphisms; initial and terminal objects; duality; products, equalizers, pullbacks, (co)limits; exponentials; Cartesian closed categories; functors and natural transformations; equivalence of categories; the Yoneda lemma; adjunctions.

**Audience:** The course is intended for students a strong undergraduate mathematics background, such as graduate students in LPS or undergraduate mathematics majors. Undergraduate philosophy students are welcome, though they should meet with me early in the quarter to discuss their mathematics backgrounds.

**Course Website:** https://eee.uci.edu/13s/66460

**Required Text:**
*Category Theory*, 2nd edition, by Steve Awodey. (Oxford University Press, 2010; ISBN: 9780199237180)

**Supplemental Texts (Not Required):**
*Conceptual Mathematics: A First Introduction to Categories*, by F. William Lawvere and Stephen Hoel Schanuel. (Cambridge University Press, 1997; ISBN: 0521478170) [More elementary]
*Elementary Categories, Elementary Toposes*, by Colin McClarty. (Oxford University Press, 1992; ISBN: 9780198514732) [More logic and topos theory oriented]
*Basic Category Theory*, by Jaap van Oosten. (http://www.staff.science.uu.nl/ ooste110/syllabi/catsmoeder.pdf, 2002) [Very different presentation; more logic oriented]
*Category Theory for the Working Mathematician* (2nd Ed.), by Saunders Mac Lane. (Springer, 1998; 978-1-4419-3123-8) [The classic text; more advanced]
*Handbook of Categorical Algebra, vol 1*, by Francis Borceux. (Cambridge University Press, 1994; ISBN: 9780521161199) [More advanced]

**Note on texts:** Awodey (2010) is the only book you are required to buy. The supplementary texts will be on reserve in the Science Library, and will also be available in my office.

**Grading:** Grades will be based on four problem sets and a cumulative take-home final.

**Makeup Exams and Late Problem Sets:** If you have a valid reason for a makeup exam or for a late problem set, such as a medical emergency or death in the family, inform me as you can. If you are a student athlete or have similar extracurricular commitments that will force you to miss a deadline, let me know as soon as you become aware of it. Under no circumstances will I give an extension or a makeup exam for a foreseeable conflict that I was not informed of long in advance.

**Collaboration:** You are welcome to collaborate on the problem sets, though every student needs to produce his or her own write-ups. If you do collaborate, you should indicate as much on top of the problem set before turning it in. **Please do not collaborate on the final exam.**

**Students with Disabilities:** Inform me first week if you will need to take exams through the Disability Service Center. The sooner you notify me, the better that I will be able to accommodate you.

**Preferred names/pronouns:** This course is intended as a safe space for all students at UCI. If you have a preferred name that is not listed on the official roster, or if you have a preference regarding gender pronouns, please contact me and I will do my best to follow your preferences.

**Academic Integrity:** UCI has a strict policy on academic dishonesty. Cheating on exams will be reported to the appropriate authorities, with no exceptions. Although you are welcome to collaborate on homework problems, all submitted work must be in your own words. Dishonesty in any capacity in this course will not be tolerated.

**Course Schedule:** Below is the course schedule.

| Meeting | Topic | Reading assignment |
|---|---|---|
| 2 April 2013 (Tuesday) | Course Introduction; **Set** | |
| 4 April 2013 (Thursday) | **Class Canceled** | |
| 9 April 2013 (Tuesday) | Mac Lane-Eilenberg axioms; Examples of categories | Awodey 1.1–1.4 |
| 11 April 2013 (Thursday) | Isos; Constructions on categories; Free categories | Awodey 1.5–1.8 |
| 16 April 2013 (Tuesday) | Epis and monos; Initial and terminal objects | Awodey 2.1–2.4 |
| 18 April 2013 (Thursday) | Products | Awodey 2.5–2.8 |
| 23 April 2013 (Tuesday) | Duality; Coproducts | Awodey 3.1–3.2 |
| 25 April 2013 (Thursday) | Equalizers and Coequalizers | Awodey 3.3–3.4 |
| 30 April 2013 (Tuesday) | **Group** | Awodey 4.1–4.4 |
| 2 May 2013 (Thursday) | Subobjects; Pullbacks | Awodey 5.1–5.3 |
| 7 May 2013 (Tuesday) | Limits and colimits | Awodey 5.4–5.6 |
| 9 May 2013 (Thursday) | Exponentials; Cartesian closed categories | Awodey 6.1–6.2 |
| 14 May 2013 (Tuesday) | Category of categories; Natural transformations | Awodey 7.1–7.5 |
| 16 May 2013 (Thursday) | **Class Canceled** | |
| 21 May 2013 (Tuesday) | Exponentials of categories; Functor categories | Awodey 7.5–7.7 |
| 23 May 2013 (Thursday) | Equivalence of categories | Awodey 7.8–7.9 |
| 28 May 2013 (Tuesday) | Yoneda lemma | Awodey 8.1–8.3 |
| 30 May 2013 (Thursday) | Yoneda lemma (cont.) | Awodey 8.4–8.7 |
| 4 June 2013 (Tuesday) | Adjoint functors | Awodey 9.1–9.3 |
| 6 June 2013 (Thursday) | Adjoint functor theorem | Awodey 9.4-9.8 |