This course explores concepts, methods and applications of the classical theory of fields. On the physics side, we will learn about cosmological inflation, superconductivity, electroweak theory, solitons and magnetic monopoles. On the mathematical side, we will learn the basics of differential geometry and Lie algebras. Throughout the course, we will emphasize the unity of physical principles and techniques - across a wide range of systems and disciplines.

I. Schedule

Lectures: MW, 11:00-12:15, PA 1285

Office Hours: By appointment (email me at sahakian@hmc.edu)

II. Prerequisites

Physics 111 & Physics 51

III. Assignments and Exams

There will be 13 homeworks, roughly one every week. The homeworks will always be due on a Wednesday.

We will have a midterm exam halfway through the semester on Wednesday March 8, at 6PM; And a final exam at the end of the term. The two exams will be memorable experiences; the midterm will have no time limit; the final exam will be take-home.

All solutions will be posted on the sakai website: http://sakai.claremont.edu:8080/portal/login

The course grade will be computed from the homeworks and two exams, each weighed roughly equally.

IV. Textbook

There is no textbook for the course. You will need to take good notes.

There are several books that may be useful in complementing or extending the notes at various stages. Here’s a tentative list (that will be updated periodically). Do not buy any of these books for this course unless you are rolling in money. This list is for your personal reference. These are generally good books that may be useful for you to know about in the future.

Classical Mechanics, Goldstein

Classical Theory of Gauge Fields, Rubakov

Introduction to the Physics of Fluids and Solids, Trefil

Solitons and Instantons, Rajaraman

Introduction to Superconductivity, Tinkham
V. Outline

Week 1. Classical fields & Lagrangian formalism
Homework 1: Lateral waves & charged chain

Week 2. Some examples & Noether’s theorem
Homework 2: Couplings & complex fields

Week 3. Energy-momentum
Homework 3: Pendulum chain & higher dimensions

Week 4. A little differential geometry
Homework 4: Massive Klein-Gordon system

Week 5. Vacua & solitons
Homework 5: The Lorentz group

Week 6. Fluids & review
Homework 6: Sine-Gordon dispersion & more solitons

Midterm Exam (March 8)

Week 7. A little cosmology
Homework 7: Equations of state & damped systems

Week 8. Electromagnetism & critical phenomena
Homework 8: Tensor notation & Landau-Ginzburg system

Week 9. Superconductivity
Homework 9: Correlation lengths & Backlund transformations

Week 10. Vortices & a little group theory
Homework 10: Gauge conditions & physics units

Week 11. More group theory & Yang-Mills
Homework 11: Symplectic group & homotopy

Week 12. Magnetic monopoles & Higgs mechanism
Homework 12: Yang-Mills examples

Week 13. Tying loose ends & review
Final Exam