Physics

**PHYS 598  Special Topics in Physics  credit: 1 TO 4 hours.**

(PHYCS 498) Lecture course in topics of current interest. Several subjects are announced in each Class Schedule. Among them are semiconductor physics, magnetic resonance, surface physics, lattice dynamics, band theory of solids, crystal imperfections, nuclear structure, field theory, elementary particle physics, advanced statistical mechanics, plasma theory, astrophysics, atmospheric physics, group theory and applications. Prerequisite: Determined for each offering; see Class Schedule.

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<tr>
<th>CRN</th>
<th>Type</th>
<th>Section</th>
<th>Time</th>
<th>Days</th>
<th>Location</th>
<th>Instructor</th>
</tr>
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<tbody>
<tr>
<td>34935</td>
<td>Lecture</td>
<td>AST</td>
<td>03:30 PM - 04:50 PM</td>
<td>MW</td>
<td>158 - Loomis Laboratory</td>
<td>Lamb, F</td>
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</tbody>
</table>

Credit Hours: 4 hours
Restricted to Graduate - Urbana-Champaign.

**ASTROPHYSICS.** Satisfies the physics graduate program "cafeteria" requirement. PHYS 598AST will survey astrophysical phenomena and processes relevant to the evolution of the Universe and structures in it, from the formation of stars and galaxies at the earliest times to the final end states of matter as compact objects. The emphasis will be on developing an understanding based on the underlying physics. Exciting recent developments will be described. Specific topics will include big bang cosmology and the cosmic microwave background radiation; formation, interaction, and evolution of galaxies; formation, structure, and evolution of stars; dynamics of stellar systems; white dwarfs, supernovae, neutron stars, and black holes; physics of accretion disks; the fate of the universe. Topics of special current interest will include cosmological inflation, dark matter in the universe, powerful gamma-ray bursts, feeding of quasars, generation of radio and X-ray emission by supermassive black holes, gravitational lensing, sources of gravitational radiation, and the solar neutrino problem. Course work will consist of weekly homework problems, a mid-term exam, and a final exam. The course will be based on lecture notes and readings, and will be taught at the level of the Astrophysics I and II texts by Bowers and Deeming.

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<th>Instructor</th>
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<tbody>
<tr>
<td>34933</td>
<td>Lecture</td>
<td>B</td>
<td>10:30 AM - 11:50 AM</td>
<td>F</td>
<td>144 - Loomis Laboratory</td>
<td>Stack, J</td>
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Credit Hours: 1 hours
Meets 24-Aug-05 - 14-Oct-05.

**GRADUATE PHYSICS ORIENTATION: RESEARCH AND TEACHING IN THE PHYSICS DEPARTMENT.** PHYS 598B is required for all new physics graduate students. It includes advice on choosing a field of research and finding a research advisor. Current graduate students will relate their experiences and advice; faculty will present overviews on the major areas of research in the Department. Physics staff will explain our computing facilities, the physics and astronomy library, and other facilities. There will be general discussions on research and instructional topics as well as ethics in teaching and research.

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<tr>
<td>34934</td>
<td>Lecture</td>
<td>MMA</td>
<td>10:30 AM - 11:50 AM</td>
<td>MW</td>
<td>144 - Loomis Laboratory</td>
<td>Stone, M</td>
</tr>
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</table>

Credit Hours: 4 hours
Restricted to Graduate - Urbana-Champaign.

**MATHEMATICAL METHODS IN PHYSICS.** Replaces PHYS 506/507 (PHYCS 411/412). PHYS 598MMA focuses on core techniques widely used in the physical sciences. Emphasis is on applications, and a broad range of illustrative examples will be explored. Primary topics include: calculus of variations and its applications; partial differential equations of mathematical physics (including classification and boundary conditions); separation of variables, series solutions of ordinary differential equations and Sturm-Liouville eigenproblems; Legendre polynomials, spherical harmonics, Bessel functions and their applications; normal mode eigenproblems (including the wave and diffusion equations); inhomogeneous ordinary differential equations (including variation of parameters and Green functions); inhomogeneous partial differential equations and Green functions; potential theory; and integral equations (including Fredholm theory). Will continue in spring semester PHYS 598MMB with complex variables, group theory, and other topics.

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<tr>
<td>34946</td>
<td>Laboratory-Discussion</td>
<td>OS</td>
<td>10:30 AM - 11:50 AM</td>
<td>TR</td>
<td>144 - Loomis Laboratory</td>
<td>Clegg, R</td>
</tr>
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Credit Hours: 4 hours
OPTICAL SPECTROSCOPY. PHYS 598OS is a course for students who want to acquire a more detailed molecular description of the interaction of radiation with molecular matter and molecular fluorescence. Both quantitative theory and experiments will be covered. The description of the experimental situations and data analysis for obtaining molecular information will be based on a solid theoretical setting that forms the framework for the course. The emphasis will be on biophysical experimental situations, using fluorescence and absorption measurements, stressing optical spectroscopic transitions involving molecular electronic and vibrational transitions. The basic interaction of the E&M field with the molecules will be covered mainly from a semi-classical point of view. The course will contain a laboratory section. Practical spectroscopy examples will demonstrate how to measure and interpret molecular properties from optical spectroscopy experiments. The course should be of interest to students with a broad range of backgrounds.
Prerequisites: undergraduate courses in quantum mechanics and statistical mechanics, or consent of instructor. Register for this section OS (34946) or for section OS2 (42387) or for section OS3 (42571).

42387
Laboratory-
Discussion
OS2
10:30 AM
- 11:50 AM
TR
144 - Loomis
Laboratory
Clegg, R

Laboratory-
Discussion
OS2
01:00 PM
- 03:50 PM
R
6106 - Engineering
Sciences Building
Clegg, R

Credit Hours: 4 hours
OPTICAL SPECTROSCOPY. See (PHYS 598) section OS for description. Register for section OS (34946) or for this section OS2 (42387) or for section OS3 (42571).

42571
Laboratory-
Discussion
OS3
10:30 AM
- 11:50 AM
TR
144 - Loomis
Laboratory
Clegg, R

Laboratory-
Discussion
OS3
05:00 PM
- 07:50 PM
R
6106 - Engineering
Sciences Building
Clegg, R

Credit Hours: 4 hours
OPTICAL SPECTROSCOPY. See (PHYS 598) section OS for description. Register for section OS (34946) or for section OS2 (42387) or for this section OS3 (42571).

38745
Lecture
QL
10:30 AM
- 11:50 AM
MW
158 - Loomis
Laboratory
Leggett, A

Credit Hours: 4 hours
QUANTUM LIQUIDS: BOSE CONDENSATION AND COOPER PAIRING IN CONDENSED MATTER SYSTEMS. The phenomena of Bose-Einstein condensation and Cooper pairing, which are believed to be closely related, occur in a variety of condensed matter systems at low temperatures and give rise to a number of spectacular effects including superfluidity (or its analog in a charged system, superconductivity). This course is a general survey of these phenomena as they occur in liquid 4-He, the BEC atomic gases, the “classic” superconductors, liquid 3-He and the “exotic” (cuprate and other) superconductors. The last part of the course will discuss the “crossover” between Bose condensation and Cooper pairing recently realized in the dilute Fermi atomic gases. The emphasis will be on those phenomena (such as macroscopic interference and superfluidity) which are direct consequences of the BEC/Cooper pairing as such and are relatively independent of the details of the excitation spectrum, etc. Prerequisites: Quantum Mechanics I and II, Statistical Mechanics.

34936
Lecture
SPA
02:30 PM
- 03:50 PM
TR
136 - Loomis
Laboratory
Wandelt, B

Credit Hours: 4 hours
STATISTICS IN PHYSICS AND ASTRONOMY: METHODS, INference AND COMPUTATION. This course will provide an introduction to statistics and discuss examples where the power of statistical methods, inference and computation can be brought to
bear. Statistics can have a decisive impact when: 1) New and exciting science is created at the interface of theory and experiment/observation. 2) Hints at new results are obtained by pushing instruments to their limits and may need to be tested by combining data from a range of lines of inquiry. 3) An exciting discovery may be hidden in a massive dataset like a piece of hay in a huge stack of needles. 4) We are trying to either model analytically or simulate numerically a stochastic (classical or quantum) system. 5) We are faced with a seemingly impossible numerical task in an otherwise deterministic problem. This course aims at developing a unified understanding of statistics which can be used to tackle situations 1-5 listed above: 1) Statistics is a quantitative way of linking theory with experiment. 2) Statistical inference techniques can help to combine all the available information to infer optimal constraints in theory space. 3) Machine learning and computer assisted discovery can help sift the through large amount of data. 4) and 5) Stochastic/Monte Carlo techniques can sometimes produce seemingly miraculous solutions to otherwise unmanageable analytical or numerical problems. Prerequisites: a solid foundation in linear algebra; some familiarity with mathematical and computational methods. If in doubt, contact bwandelt@uiuc.edu.