PHYSICS 498 SPRING 2009

SENIOR REVIEW (for Major Field Achievement Test in Physics)

- **Instructor: Dr. Igor Ostrovskii**
- **Lecture: M,W 10:00 – 10:50, Room 109 Lewis Hall**
- **Office: Room 207 Lewis Hall; Email: iostrov@phy.olemiss.edu**
- **Office Hours: M,W,Th 3:00 – 4:00 p.m. (207 Lewis Hall)**

- **Required text**: There is no required text.

- **Recommended texts**:

1) Fundamentals of Physics, 8th (or 7th) edition, 2008 (2005), by David Halliday, Robert Resnik, Jearl Walker. John Willey & Sons.

2) Modern Physics, by R.A. Serway, C.J. Moses and C.A. Moyer, 3rd edition.

3) David Griffiths. Introduction to Quantum Mechanics.

- **Additional reading**:

4) P. A. Tipler, R.A. Llewellyn, Modern Physics, 5th edn, W.H. Freeman Company, New York, 2008.

5) David Griffiths. Introduction to Elementary Particles (Chapter 1).

- **Course learning objectives:**

In the learning objectives, we answer a question: "What will the students know and be able to do as a result of taking this class?"

1. Develop an understanding of a broad knowledge in current undergraduate Physics with emphasis to the diagrams, graphs, experimental data, and descriptions of physical situations.
2. Review of the fundamental principles of undergraduate Physics.
3. To develop in learners an ability to apply the fundamental physical principles for solving the specific problems with multiple-choice answer.
4. Enhance the critical thinking, analytical reasoning, and problem solving skills for general problems, which require application of different principles across all undergraduate Physics.
5. The Senior Review will stress usage of The International System (SI) of units for problem solving and main conversion factors among SI units.
6. To develop in learners the specific skills to present their scientific knowledge, and to enhance their oral communication skills via the student presentations on a number of topics in undergraduate physics.

- **The learning outcomes for students**:

1. In depth understanding of fundamental physics principles at undergraduate level *including* Mechanics, Relativity, Electromagnetism, Optics and Waves, Thermodynamics and Statistical Mechanics, Quantum Mechanics, Atomic Physics, Crystal structure, Semiconductors, Superconductors, Nuclear properties, Particle physics.
2. Understanding of some miscellaneous topics including Astrophysics, Computer applications, Mathematical methods.
3. Ability to solve multiple-choice problems in undergraduate Physics.
4. Students will develop a comprehension of the current basis of broad knowledge in undergraduate Physics.
5. Learners will build on a problem solving skills based on critical thinking and analytical reasoning.
6. Students will know how to use the Internet for their independent learning on undergraduate Physics.

GRADING:

- Grading Scale: A's ---------- 90 – 100
  B's ---------- 80 – 89
  C's ---------- 70 – 79, Etc.
- Grades will be based on:

1. Attendance: 0.8 points a day. ------ max 20 points
2. Presentations: main equations, principles and figures – 8 points; solutions to examples and test problems – 7 points; handout page(s) – 3 points; numbers worth learning – 1 point; math tricks and methods – 1 point. ------ max 20 points
3. Study Notebook: ------ max 20 points
4. Test: 25 problems/43 min, 0.8 points per problem solved ------ max 20 points
5. Final exam: Major Field Test (min 10 points) ------ max 20 points

TOTAL 100 points

- **Tests and Final examination schedule:**

- **Test:** part A (25 multiple-choice problems, 43 minutes) Class #15, March 11.
- **FINAL EXAMINATION → Wednesday, May 6 , 8:00 a.m.**

COURSE CONTENTS:

- **Part A. INTRODUCTORY PHYSICS**

Topic I. CLASSICAL MECHANICS AND RELATIVITY (4 classes)

Newton's laws of motion. Projectile motion. Uniform circular motion. Energy and work. Conservation laws, energy, momentum. Collisions. Angular momentum, rotation of rigid bodies about a fixed axis. Newton's law of universal gravitation, Kepler's laws, satellites. Fluid mechanics. Periodic/oscillatory motion. Special relativity.

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Topic II. ELECTROMAGNETISM (4 classes)

Electrostatics (Coulomb's law, electric field, electric potential, electric potential energy). DC circuits (Ohm's law, Kirchhoff's laws). AC circuits, current, resistance, capacitance. Electric flux. Electromagnetic waves. Gauss's law. Faraday's law of induction and motional emf. Lenz's law. Lorentz force law. Magnetic fields in free space (Ampere's law, Biot-Savart law, magnetic flux, Gauss's law of magnetism). Magnetic and electric fields in matter. Maxwell's equations.

Topic III. OPTICS, WAVES, THERMODYNAMICS, STATISTICAL MECHANICS (5 clas.)

- Geometrical optics. Wave properties, superposition; Diffraction; Interference; Polarization. Doppler effect.
- Ideal gases. Kinetic theory of gases. Calorimetry. Ensembles. Entropy. Equations of state. Laws of thermodynamics. Statistical concepts. Thermodynamic processes. Transfer of heat.

- **Test:** part A **(25 multiple-choice problems, 43 minutes)** Class#15, March 11.

- **Part B. ADVANCED PHYSICS**

Topic IV. QUANTUM MECHANICS AND ATOMIC PHYSICS (6 classes)

- Angular momentum; Bohr model; commutation relations, eigenfunctions, eigenvalues, expectation values. Operators, orthonormality. Wave function. Heisenberg uncertainty principle. Pauli exclusion principle. Perturbation theory. Schrödinger equation solutions. Spin. Wave function symmetry. de Broglie wavelength.

- Atomic structure; atomic spectra; atoms in electric and magnetic fields; blackbody radiation; energy quantization. Molecules. Properties of electrons. Properties of photons; selection rules. X rays.

Topic V. SPECIAL TOPICS (4 classes)

- Condensed matter physics (basic concepts, crystal structure, diffraction, free electron theory, semiconductors, superconductors, thermal properties).
- Nuclear and particle physics (fission and fusion, nuclear reactions, nuclear properties, radioactive decay, particles and interactions).
- Lagrangian and Hamiltonian formalism (Lagrangian, Lagrange's equations of motion, Hamiltonian, Hamilton's equations of motion).
- Laboratory methods (counting statistics, data and error analysis, dimensional analysis, electronics, instrumentation, lasers, probability and statistics, radiation detection).

Topic VI. MISCELLANEOUS TOPICS (1 class)

Astrophysics. Computer applications. Mathematical methods.

REVIEW, and Research Ethics (1 class)

FINAL EXAMINATION: All Topics → Wednesday, May 6 , 8:00 a.m.

- The dates are tentative, and may be changed, **BUT NOT FINAL EXAMINATION**.