PHYSICS 2326: ELECTROMAGNETISM AND WAVES

Fall 2005 (Aug 18 - Nov 24)

Classes: **TR 12:30-1:45 PM** in **FN 2.102**

INSTRUCTOR: Dr. Yuri Gartstein

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Office hours: T 2:00-3:30 pm			Problem solving sessions: TBA		
Web communication and access to course materials: https://webct.utdallas.edu					
Homework website: http://bca.brookscole.com				PIN: Provided in WebCT version	

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Office hrs: M 12:00-2:00 pm; F 9:00-11:00 am					

COURSE OBJECTIVES

This is an introductory course on electricity, magnetism and electromagnetic waves. The goal is for students to develop an understanding and gain a practical knowledge of basic notions of electric charges, currents, electromagnetic fields and forces. Our focus will be not on "training" and "dry" learning of the lecture materials but on conceptual understanding (broad concepts like "physical fields vs action-at-a-distance", "superposition principle", etc.) and developing skills to apply basic principles to actual problem solving. Lectures and problem solving sessions will include examples of how to approach problems; students are expected to spend as much as possible of their own time on problems, quizzes, etc. Some part of the lectures will be devoted to topics beyond the textbook content and intended to make students aware of more advanced stuff, to put things in a more general picture and to be, in a sense, inspirational. Lectures and other materials will be made available online. The content of the lectures however can be broader and deeper than posted materials.

The instructor believes that students can find "internal incentives" for learning of various flavors, such as in: (i) subject matter itself; (ii) relationship between math and physical reality; (iii) generic aspects of creative approaches to problem solving.

EVALUATION AND GRADING POLICY

In accordance with the course objectives, practical understanding and problem solving skills are the key to high grades. The major ingredient of a regular grading procedure are the results of four exams (including the final), about a month apart from each other, and approximately contributing 20/20/20/25 % to the final grade. The exams will consist of 3-5 creative problems; no multiple choice questions will be given. The final exam takes place in the classroom, intermediate exams may or may not be take-home exams. When in the classroom, exams are open book. In all cases, a student should be able to explain his/her solution. For take-home exams, some auditing will be in place. Extra material given at lectures will not be used for testing.

Every attempt will be made to give students an opportunity to improve their standing. That will include the possibility of individual make-up tests at the end of the semester. A proactive student's position is encouraged and your feedback is always welcome.

Students are **required** to register on publisher's website http://bca.brookscole.com (using the PIN (course access code) provided above), where homework assignments will be given. Homework is expected to be completed in a timely fashion and will contribute approximately 15% to the final grade.

The integrity of students' behavior matters - working in groups and using various materials is encouraged but it is the individual understanding of the subject and results that will be tested. All special student needs should be reported within first two weeks of the course. All questions about exam grades should be addressed the same week the grades become known. Communication of all grades and announcements will be through WebCT.

Last but not least, I strongly feel that satisfaction one gets from the learning accomplishments

makes "grades" a much less sensitive issue. My general position is that "I am not here to make your life harder but to help you learn". I would like to invite all students to have more fun from learning and worry less about grading.

MAIN TEXTBOOKS

The basic material is covered in many textbooks and students may use any of them. This particularly refers to:

- R.A. Serway and R.J. Beichner, **"Physics for Scientists and Engineers"**, Volume 2.
- D. Halliday, R. Resnick, J. Walker, **"Fundamentals of Physics"**, Volume 2.
- H.D. Young and R.A. Freedman, **"University Physics"**, Volume 2.

ADDITIONAL BOOKS

For some topics, students may want to consult other texts. In addition, depending on student's personal demands and aesthetical preferences, he or she may find attractive alternative treatments, which, of course, is always encouraged. There are many wonderful books that cover numerous aspects of electricity and magnetism and to different depths. I happen to have the following books on my desk that could be quite suitable:

- R.P. Feynman, R.B. Leighton, & M. Sands, **"The Feynman Lectures on Physics"**, Vol. 2 – Read this for the Physics of it!
- A. Shadowitz, **"The Electromagnetic Field".**

Those who would like to better appreciate ideas related to the concept of physical fields will find a very profound exposition in:

- A. Einstein and L. Infeld, **"Evolution of Physics"**.

If you feel that you would also like to work with more advanced texts, I would be happy to show you some other books from my bookshelf.

HIGH-LEVEL DESCRIPTION OF THE COURSE

This brief description is intended just to give you a glimpse of some of the subjects we will be talking about (not necessarily in the same order and to different depths).

INTRODUCTION

Electric charges and fields; Properties of electric charges; Coulomb's law and superposition; Conductors and insulators; Magnetic fields and Lorenz force; How Maxwell equations look like

MATHEMATICS OF VECTOR FIELDS

Vectors, their scalar and vector products; Scalar and vector fields; Flux of vector fields and line integrals; Del operator, gradient, divergence and curl; Gauss', Stokes' and Helmholtz theorems

ELECTROSTATICS IN VACUUM AND DIELECTRICS

Gauss' law and electric filed lines; Electric potential and Poisson's equation; Potential and fields of continuous charge distributions; Earnshaw's theorem (instability of equilibrium in electrostatic fields); Conductors and insulators in electric fields; Method of images; Polarization of dielectrics; Capacitance and capacitors; Electrostatic energy

ELECTRIC CURRENT AND DC CIRCUITS

Current and current density; Ohm's law; Conductivity in metals, insulators and semiconductors; Superconductors; Electrical energy and dissipation; Combinations of resistors; Kirchoff's rules; RC circuits

MAGNETOSTATICS IN VACUUM AND MATTER

Magnetic forces on and between current elements; Biot-Savart and Ampere's laws; Magnetic fluxes and field lines; Vector potential; Solenoids; Magnetostatic energy and inductance; Magnetization and magnetic materials

MOTION OF CHARGES IN ELECTRIC AND MAGNETIC FIELDS

Cathode ray tube (CRT); Motion in self-consistent fields: space charge limited currents; "Levitation" by electrostatic traveling waves; Mass-spectrometers and cyclotrons; Crossed electric and magnetic fields: Hall effect

TIME-DEPENDENT FIELDS AND CURRENTS

Faraday's and Lenz's laws; Induced emf and electric fields; Generators and motors; Self-inductance and mutual inductance; Conservation of charge and displacement current; RL, LC and RLC circuits

MAXWELL EQUATIONS AND ELECTROMAGNETIC WAVES

Maxwell equations and their plane wave solutions; Hertz's experiments; Energy and momentum of electromagnetic waves; Antennas; Spectrum of electromagnetic waves; Polarization, reflection, refraction and interference of electromagnetic waves