PHYS 412: Efficient Critical Thinking and Problem Solving Strategies

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Course Meeting: Thursdays, 5:30-6:30 PM in JC Long room 219

COURSE DESCRIPTION

Physicists are problem solvers. Often, a full solution to a system is unnecessary to grasp the central elements of a problem. This course utilizes the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to engage in problem solving exercises where speed is more important than an exact closed-form solution. In particular, we will be focusing on approaches that are helpful for success on the Physics GRE examination.

PREREQUISITES

Instructor Permission

COURSE OBJECTIVES

1. Broadly review basic content from introductory and intermediate-level Physics courses.
2. Discuss the nature of the Physics Subject GRE test including the purpose of the exam, deadlines (including how they relate to graduate school application timetables), test-taking strategies, and the exam format (including topics covered).
3. Discuss and practice applying the basic tools of symmetry, limiting cases, scaling, and dimensional analysis to a variety of standard undergraduate-level Physics problems, including problems in areas where students have had little or no previous formal instruction.
4. Collaboratively work through problems on retired GRE examinations by combining previous Physics knowledge with skills developed elsewhere in the course
5. Solve so-called "Fermi Problems" (collaboratively and individually).

LEARNING OUTCOMES

1. Successful students will demonstrate substantial improvement in sample Physics subject GRE test performance.
2. Successful students will be able to professionally present solutions to both pre-prepared and extemporaneous "Fermi Problems".
3. Successful students will be able to identify their own personal areas of weakness on GRE-type tests to help target their studying patterns for subject GRE and Major Field Test assessments.
4. Successful students will be able to discard incorrect proposed solutions to complex physics problems by using symmetry, limiting cases, scaling, and dimensional analysis.

GRADING

Grades will be based on the following components:

1. Attendance and Participation (25%)

   Attendance in this class is critical to the student experience. The skills to be developed in this class rely on practice which will include carefully designed dialogue between students and the instructor. The instructor uses counter-examples to demonstrate how the central tools used in this course (symmetry, limiting cases, scaling, and dimensional analysis) apply to each problem. Since each problem applies these ideas in slightly different ways, students must be present for these discussions to develop an understanding of the course content.

2. Completion and Self-Evaluation of 5 Sample GRE Exams (50% total)

   Each of the 5 Sample GRE exams is 100 questions, which the student has 2 hours and 50 minutes to answer. The completion of these tests will, thus, take a total of just under 14.5 hours (outside of class). Students will be expected to also write a brief (1-2 paragraph) reflection on each sample testing experience.

3. Preparation and Presentation of Fermi Problem (25%)

   Each student will be tasked with preparing and presenting a professional solution to a so-called "Fermi Problem". The presentations will include the prepared Fermi Problem (70%) and a solution of an extemporaneously posed problem (30%). Presentations will be graded for clarity, accuracy, and appropriate use of skills developed in the class. The prepared presentation will be expected to be at least 20 minutes in duration, and include pre-prepared audio-visual aids.

GRADING SCALE

The grading scale applied to this class will be:

A:	91-100	C+:	79-80	D-:	60-61
A-:	90-91	C:	71-79	F:	<60
B+:	89-90	C-:	70-71		
B:	81-89	D+:	69-70		
B-:	80-81	D:	61-69		

Class Schedule (Tentative)

Week 1: Discuss the Structure and Purpose of the General GRE Exam, Subject GRE Exam, and discuss timelines associated with applying and taking the subject GRE Exam and how they relate to the grad school application process. Discuss general test-taking strategies. Discuss topics typically covered on subject GRE exam. General Q&A about the general and subject GRE exams and graduate school. Review of introductory Physics.

Week 2: First Sample GRE Test DUE! Start addressing problem-questions on the first sample GRE test. Show examples of questions that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis.

Week 3: Second Sample GRE Test DUE! First Sample GRE Test Returned! Work through problems on Sample GRE Test 1 that were of particular trouble to students. Show examples of questions on Sample GRE Test 2 that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis.

Week 4: Third Sample GRE Test DUE! Second Sample GRE Test Returned! Work through problems on Sample GRE Test 2 that were of particular trouble to students. Show examples of questions on Sample GRE Test 3 that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis.

Week 5: Third Sample GRE Test Returned! Work through problems on Sample GRE Tests 2 and 3 that were of particular trouble to students.

Week 6: Fourth Sample GRE Test DUE! Show examples of questions on Sample GRE Test 4 that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis.

Week 7: Fourth Sample GRE Test Returned! Work through problems on Sample GRE Test 4 that were of particular trouble to students.

Week 8: Fifth Sample GRE Test DUE! Show examples of questions on Sample GRE Test 5 that can be productively addressed by appeals to symmetry, limiting cases, scaling, and/or dimensional analysis.

Week 9: Fifth Sample GRE Test Returned! Work through problems on Sample GRE Tests 4 and 5 that were of particular trouble to students.

Week 10: Introduction to Fermi problems. Presentation of the general form, as well as instructor presentations of solved examples.

Weeks 11-15 and Final Exam Time-Slot: Presentation of prepared and extemporaneous Fermi problems by instructor and students.