MATH 810-010 Asymptotics and Perturbation Methods
MWF 12:20-1:10, PRN 325 Spring 2002
Web Page: `http://www.math.udel.edu/~edwards/download/m810/s02home.html`

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Introduction

Welcome to MATH 810! In this course you will be learning not only the mathematical techniques of perturbation and asymptotic analysis, but also how they can be used to simplify the analysis of physical systems. The text for this course is *Advanced Mathematical Methods for Scientists and Engineers*, by Bender and Orszag. **The text is required**, since you will be assigned both reading and homework problems from the book. However, I will not be following the book closely.

The following book should be on reserve in Morris Library shortly:

Multiple Scale and Singular Perturbation Methods, by Kevorkian and Cole.

In addition, upon request I will put other books on reserve in the Morris Library that may prove helpful for certain sections.

If you have a problem, question about the material, or interesting application you would like me to address in class, please feel free to contact me during my office hours or make an appointment. **Extra copies of handouts are available at the Web page listed above.**

Please turn off portable phones, pagers, etc. before entering the classroom. You may bring a tape recorder with you to class, if you wish; however, unattended tape recorders will not be permitted. There will be no makeup classes for snow days.

Electronic Communication

The Web page for this course is listed above. There you will find copies of handouts available for downloading, as well as any important announcements (corrections to typographical errors, etc.). Also at the URL

`http://www.math.udel.edu/~edwards/download/suggest.html`

you will find an anonymous suggestion box.

Particularly important messages regarding the course may also be e-mailed to you directly. In addition, you may send me e-mail with questions regarding the course, homework assignments, etc. For more information on how to use electronic resources, contact the Help Center (x6000).

Exams

There will be a midterm and final exam for the course; the dates are listed on the attached schedule. You may take the exams home and you will have approximately a day to do them. Attached to the midterm will be a course evaluation form so that I may receive your suggestions for how the course could be improved. These forms will be seen only by me, so if you have comments that you wish the department to hear, please contact them directly.

When the exams are returned, they will have a numerical score and a letter grade on them. The numerical score is your score for the exam; *the letter grade is your grade for the course* to that point, including all homework scores.

Writing Assignment

As each of you proceeds in your career, you will encounter situations where you will have to communicate your ideas to others. Those in academia have to submit theses and research articles; those in industry must make presentations and write reports. In order to prepare you for this sometimes daunting task, I am assigning a **MANDATORY** writing assignment. In it, you will choose a phenomenon which interests you, create a simple model to describe it, and then solve the equations governing the model using the techniques you have learned in this class. The focus of the assignment will be the clarity of the expression contained therein, rather than the mathematical sophistication of the arguments. Further details will follow.

Homework

The most effective way to succeed in this course is to do all the homework assignments. I select the problems carefully to illustrate the most important topics in the course. Even if you are registered as a listener, I recommend doing the homework, and I will review it.

In most cases, homework will be distributed every Friday during lecture and it will be due the following Friday. (The first homework assignment is attached to this sheet.) The homework will ideally cover material up through the day it is distributed. **ABSOLUTELY NO LATE HOMEWORK WILL BE ACCEPTED!** If you must miss a due date because of University business, it is your responsibility to make sure the homework gets to me ***before*** the due date. Since mathematics is a subject where the material for one section builds on the section before, it is critical that you keep up to date on the homework: hence the stringent policy. However, to calculate your semester-long homework average, I will drop your two lowest homework scores. Therefore, low scores for assignments where you were pressed for time can be erased as long as you don't have too many of them.

Though you may not copy directly from another's paper or use someone else's ideas as your own, I encourage you to discuss the homework problems with your classmates. Any scientific endeavor is rarely done in a vacuum; therefore it is to your advantage to learn the benefits of collaborating. Model homework solutions will be posted on the Web after the assignment is due. Hopefully these will assist you in learning the material.

Homework assignments should be folded like a book with the following information on the "front cover:"

Name
MATH 810—Edwards
Assignment Number
Date

You will turn in your assignments this way so that I can put your grade on the inside, thus ensuring your privacy. I will make every effort to ensure that your graded homework is returned in a timely manner. The number of points assigned to each problem will be listed.

Assessment

Your grade for the course will be determined in two stages. First your *raw score* will be calculated using the *higher* of the two algorithms:

1) Each exam will count for 1/3 of your grade; the other 1/3 will be split between the homework and the writing assignment.
2) The writing assignment will count for 1/6 of your grade; the other 5/6 will be split evenly between the homework and exams.

Then each of the raw scores will be scaled to determine final grades, if necessary.

Tentative Schedule

Note: This is only a tentative schedule; there may be deviations from it. (In particular, topics near the end of the schedule may be dropped if the other topics take more than the allotted time.)

February 6–8: order estimates, asymptotic series, integration by parts
February 6: Homework 1 distributed
week of February 11: perturbed algebraic equations and linear ODEs
February 15: Homework 1 due; Homework 2 distributed
week of February 18: singularly perturbed nonlinear ODEs
February 22: Homework 2 due; Homework 3 distributed
week of February 25: singular boundary-value problems, higher-order equations
March 1: Homework 3 due; Homework 4 distributed
week of March 4: two-timing, Mathieu's equation
March 4: Topic for writing assignment due
March 8: Homework 4 due; Homework 5 distributed
week of March 11: Mathieu's equation, the WKB method
March 15: Homework 5 due; Homework 6 distributed
week of March 18: connection formulas, Laplace transforms
March 20: Midterm distributed
week of March 25: Watson's Lemma, Laplace's method
March 29: Outline of writing assignment due
March 29: Homework 6 due; Homework 7 distributed
week of April 1: Spring break
week of April 8: moving maxima, stationary phase
April 12: Homework 7 due; Homework 8 distributed
week of April 15: the method of steepest descent
April 19: Homework 8 due; Homework 9 distributed
week of April 22: steepest descent, Euler-MacLaurin summation formula
April 26: Homework 9 due; Homework 10 distributed
week of April 29: singularly perturbed linear PDEs
May 3: Homework 10 due; supplemental study material distributed
week of May 6: singularly perturbed linear PDEs, bifurcation theory
May 8: Writing assignments due
May 13: bifurcation theory, paper discussion
May 15: course review