MATH 810-010 Asymptotics and Perturbation Methods
MWF 11:15-12:05, EWG 210 Spring 2010
Web Page: `http://www.math.udel.edu/~edwards/download/m810/s10home.html`

Instructor: Prof. D. A. Edwards Office Hours: R 9:30–10:30, F 1:30–2:30
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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. Further details will follow about making up 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).

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 Monday during lecture and it will be due the following Monday. (The first homework assignment is attached to this sheet.) The homework will ideally cover material up through the Wednesday after 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.

Exams

The final exam will be oral, administered individually. It will cover one of the homework problems from the course.

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.

Assessment

Your grade for the course will be determined in two stages. First your *raw score* will be calculated. The homework will count for 70% of the grade; the writing assignment and final exam will count for 15% each.

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 12: order estimates
February 12: Homework 1 distributed
week of February 15: asymptotic series, integration by parts, perturbed algebraic equations, and linear ODEs
February 15: Homework 1 due; Homework 2 distributed
week of February 22: singularly perturbed linear ODEs
February 22: Homework 1 due; Homework 2 distributed

The rest of the schedule is listed as it was set up before the snow hit. So it may be shifted as well, depending on how the makeup days are scheduled.

week of March 1: singularly perturbed nonlinear ODEs, singular boundary-value problems, higher-order equations
March 1: Homework 2 due; Homework 3 distributed
week of March 8: higher-order equations, two-timing
March 8: Homework 3 due; Homework 4 distributed
March 10: Topic for writing assignment due
week of March 15: two-timing, Mathieu's equation
March 15: Homework 4 due; Homework 5 distributed
week of March 22: Mathieu's equation, the WKB method connection formulas, Laplace transforms
March 22: Homework 5 due; Homework 6 distributed
week of March 29: Spring break
week of April 5: the WKB method, connection formulas, Laplace transforms
April 5: Outline of writing assignment due
April 5: Homework 6 due; Homework 7 distributed
week of April 12: Laplace transforms, Watson's Lemma, Laplace's method
April 12: Homework 7 due; Homework 8 distributed
week of April 19: stationary phase, steepest descent
April 19: Homework 8 due; Homework 9 distributed
week of April 26: saddle points
April 26: Homework 9 due; Homework 10 distributed
week of May 3: saddle points, Euler-MacLaurin summation formula, singularly perturbed linear PDEs
May 3: Homework 10 due; Homework 11 distributed
week of May 10: singularly perturbed linear PDEs
May 10: Writing assignments due
May 17: singularly perturbed linear PDEs
May 17: Homework 11 due
beginning May 20: final exams