NE 548
Engineering Analysis II
TR 11:00-12:15 in Van Vleck B341

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Textbook 1 Required: *Advanced Mathematical Methods for Scientists and Engineers*, Bender and Orszag, Springer.

Textbook 2 Recommended: *Applied Partial Differential Equations*, Haberman, Pearson/Prentice Hall. This text is recommended because some of you may already own it (from Math 322). Almost any intermediate-advanced PDEs text would be suitable alternative as reference.

Pre-requisite: NE 547. If you have not taken NE 547, you should have previously taken courses equivalent to Math 319, 320 or 340, 321, 322.

Assessment: Your grade for the course will be based on two take-home midterm exams (35% each) and selected homework solutions (30%). The homework and midterms exams for undergraduate and graduate students will be different in scope; please see the separate learning outcomes below. Graduate students will be expected to synthesize/analyze material at a deeper level.

Undergraduate Learning Outcomes:

- Students will demonstrate knowledge of asymptotic methods to analyze ordinary differential equations, including (but not limited to) boundary layer theory, WKB analysis and multiple-scale analysis.
- Students will demonstrate knowledge of commonly used methods to analyze partial differential equations, including (but not limited to) Fourier analysis, Green's function solutions, similarity solutions, and method of characteristics.
- Students will apply methods to idealized problems motivated by applications. Such applications include heat conduction (the heat equation), quantum mechanics (Schrodinger's equation) and plasma turbulence (dispersive wave equations).

Graduate Learning Outcomes:

- Students will demonstrate knowledge of asymptotic methods to analyze ordinary differential equations, including (but not limited to) boundary layer theory, WKB analysis and multiple-scale analysis.
- Students will demonstrate knowledge of commonly used methods to analyze partial differential equations, including (but not limited to) Fourier analysis, Green's function solutions, similarity solutions, and method of characteristics.
- Students will apply methods to idealized problems motivated by applications. Such applications include heat conduction (the heat equation), quantum mechanics (Schrodinger's equation) and plasma turbulence (dispersive wave equations).

- Students will apply methods to solve problems in realistic physical settings.
- Students will synthesize multiple techniques to solve equations arising from applications.

Grading Scale for Final Grade: 92-100 A, 89-91 AB, 82-88 B, 79-81 BC, 70-78 C, 60-69 D, 59 and below F

Midterm 1: Given out Thursday March 2, 2015 and due Thursday March 9, 2017.

Midterm 2: Given out Thursday April 27, 2017 and due Thursday May 4, 2015.

Homework: Homework problems will be assigned regularly, either each week or every other week, paced for 6 hours out-of-class work every week. Homework groups are encouraged, but each student should separately submit solutions reflecting individual understanding of the material.

Piazza: There will be a Piazza course page where all course materials will be posted. Piazza is also a forum to facilitate peer-group discussions. Please take advantage of this resource to keep up to date on class notes, homework and discussions.

Piazza Sign-Up Page: piazza.com/wisc/spring2017/neema548
Piazza Course Page: piazza.com/wisc/spring2017/neema548/home

Course Outline

Part I: Intermediate-Advanced Topics in ODEs from Bender and Orszag.

1. Review of local analysis of ODEs near ordinary points, regular singular points and irregular singular points (BO Chapter 3, 1.5 weeks)

2. Global analysis using boundary layer theory (BO Chapter 9, 1.5 weeks).

3. Global analysis using WKB theory (BO Chapter 10, 1.5 weeks).

4. Green's function solutions (1 week)

5. Multiple-scale analysis (BO Chapter 11, 1.5 weeks).

Part II: Intermediate-Advanced Topics in PDEs

1. Review of Sturm-Liouville theory and eigenfunction expansions (1.5 weeks)

2. Non-homogeneous problems and Green's function solutions (1.5 weeks)

3. Infinite domain problems and Fourier transforms (1.5 weeks)

4. Quasilinear PDEs (1.5 weeks)

5. Dispersive wave systems (time remaining)