ME 201/400 MTH 281 CHE 400 Applied Boundary Value Problems Fall 2019

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Office Hours: MWF 4:45pm-5:30, or by appointment

Lectures: MWF 11:50 – 12:40 pm Dewey 2162

Recitation: F 3:25 – 4:40 pm Dewey 2162

During the three "lectures," the instructor will typically present new material and work through examples. During the "recitation," the teaching assistants will typically discuss homework problems and review some material the students might be having difficulties with.

Blackboard:

Any student registered for the class should have access to Blackboard. I will use it to communicate important information about the course, including homework and exams.

Course Webpage:

http://www.complexflowgroup.com/courses/Fall%202019/ME201

The course webpage has office hours for TAs and instructor, HW due dates, Exam dates, syllabus, etc. ....

Prerequisites: MTH 164, MTH 165

Text: *Applied Partial Differential Equations,* 5th edition,
by Richard Haberman, Pearson 2013.

Credit Hour Policy:

This course follows the College credit hour policy for 4-credit courses. This course meets three times weekly for 3 academic hours per week. The course also includes a recitation session for 1.5 academic hours per week.

Course Outline:
Physical phenomena in a wide range of areas such as fluid and solid mechanics, electromagnetism, quantum mechanics, chemical diffusion, and acoustics are governed by PDEs. In this course, you will learn how to solve a variety of BVPs, each of which is defined by a PDE, BCs, and possibly ICs. We will cover the classical PDEs of mathematical physics: 1) diffusion equation, 2) Laplace equations, 3) wave equation.

You will learn different techniques to solve these equations. Topics include separation of variables, Fourier analysis, Sturm-Liouville theory, spherical coordinates and Legendre's equation, cylindrical coordinates and Bessel's equation. Emphasis will be on a physical understanding of the governing equations and the resulting solutions. We will use the software package, *Mathematica*, extensively to visualize solutions. Homework assignments require plotting the final solutions.

You are responsible for all material in the textbook sections listed below, as well as all material covered in the lectures and in the problem sets, and material provided in handouts. The lectures will cover most, but not all, of the assigned material in the text and will include examples and applications. However, it is still imperative to attend all lectures which will sometimes cover additional material not in the textbook. You should read ahead in the text to prepare yourself for the lecture and benefit the most out of it. Topics to be covered are:

Chapter 1 (all) Heat Equation:
1-D Heat (Diffusion) Equation Derivation, Boundary Conditions and Initial Conditions, Solve by direct integration, 1-D BVPs governed by ODEs, Derivation of the 3-D Diffusion Equation.

Chapter 2 (all) Separation of Variables:
Classification of PDEs, Principle of superposition, Dirichlet BCs, Laplace's Equation.

Chapter 3 (all) Fourier Series:
Orthogonality, Convergence, Representation of functions, integration, differentiation, complex Fourier series.

Chapter 4 (4.1-4.5) Wave Equation:
Derivation, BCs, vibrating string and membrane examples.

Chapter 5 (5.1-5.8) Sturm-Liouville Eigenvalue Problem:
General problem statement, theorems, examples, Self-adjoint property, orthogonality, Uniqueness of Eigenfunctions, Rayleigh Quotient, Periodic BCs, D'Alembert's Solution, Propagating versus Standing Waves, BCs of the 3rd kind.

Chapter 7 (7.1-7.8) Higher Dimensional PDEs:
Separation of variables, Helmholtz equation and theorems, Cylindrical Coordinates, Bessel equation and Bessel functions.

Chapter 8 (8.1-8.3) Nonhomogeneous Problems:
Eigenfunction Expansion

Chapter 9 (9.3.4) Green's Functions:
Convolutions

Chapter 10 (10.1-10.6) Infinite Domains:
Complex Fourier Series, Fourier transform + properties, reduce PDE to ODEs, Dirac delta, Heaviside (unit step), and Top hat functions, Spherical Coordinates.

Homework: There will be approximately 10 homework assignments and 10 challenge problems. A weekly problem set will be posted on Blackboard. Tentative due dates can be found on the course webpage (subject to change). Although you may discuss homework problems with me, teaching assistants, or your classmates, you are expected to work out the problems independently (see Academic Honesty).

Students enrolled at the **graduate level** are required to solve both the regular homework assignments + challenge problems. The challenge problem has a 25% weight and the regular assignment has a 75% weight, for a total of 100 on each assignment.

Students enrolled at the **undergraduate level** are not required to do the challenge problems. However, solving them correctly would allow the students to get up to 10 bonus points on an assignment (max score of 110/100). This would be included in the final course grade calculation.

Format of HW assignments:
There is no specific format for the HW assignments, however

- Indicate if you are a **graduate or undergraduate** next to your name
- Please write legibly
- Organize your solutions**, indicate problem part number**
- Include printed plots.
- Staple everything together as a single HW assignment.

You may lose credit if the TA is unable to find your answer easily.

When to turn in HW:
You are expected to put your homework assignment in the Head TA's mailbox on the due date, **by 11:40am** of that day unless the instructor informs you otherwise. Late HW submissions will receive a zero grade unless permission is obtained from the instructor *before* the due date.

Where to turn in HW:
DO NOT slide your HW under my office door!!! Any HW slid under my door will be considered late and not be graded. Please put your finished HW assignment in the

Head TA's mailbox. Graduate student mailboxes, including the Head TA's, are located just outside the ME department's office (Hopeman 235) on the 2nd floor of Hopeman.

Mathematica: UofR has a site license for *Mathematica*, so students can download a copy on their personal computer for free. Go to
http://tech.rochester.edu/software/mathematica/
And follow the instructions for students. Download *Mathematica* as soon as possible and start training on using it. You are encouraged to use the many tutorials and exercises available online.

Exams: There are three regular exams during the semester. In case you miss an exam, your score on that test will be zero without an option for a make-up. There is no final exam for the course.

Final Term Project:
There will be one final term project. **Undergraduates** are encouraged to work in teams of two. **Graduate students** must do the project independently. The project should be handed in **before the last day of classes**.

Academic Honesty: http://www.rochester.edu/college/honesty/
You may discuss homework problems with others, but you must **not retain** written notes from your conversations with other students, or share data electronically (e.g. files, emails, etc ...) to be used in completing your homework. Your written work must be completed without reference to such notes, with the exception of class and recitation notes.

Classroom etiquette: Please try to arrive on time for each class. Late arrivals are distracting. If you arrive late please enter quietly and take a seat near the back of the room. Please do not converse with your classmates during class. All electronic devices (cell phones, iPods, iPads, laptops, ...) must be turned off and stowed unless you are told otherwise.

Grading: Each of the three regular exams will count as 100, the homework will count collectively as 100 points, and the final term project will count as 25 points, for a total of 425 points. Your final grade for the course will be based primarily on your total point score, but other appropriate factors, such as participation and personal initiative, will also be considered.

Conversion to letter grades:
I will average (with appropriate weights as described above) all numerical grades and convert your final numerical grade to a letter grade per the following table. For example, in the table below, a grade of 95 is an A but a grade of 94.5 is an A-, and so on.

Undergraduates		**Graduate Students**	
0	E	0	E
0.59	D		
0.69	C-	0.69	C
0.73	C		
0.77	C+		
0.8	B-	0.8	B-
0.83	B	0.83	B
0.87	B+	0.87	B+
0.92	A-	0.92	A-
0.95	A	0.95	A