MA 501, SP 2019, Advanced Mathematics for Engineers and Scientists I

TR, 11:45 am - 1:00 pm, SAS 2102. Final exam Tues May 7, 8-11 am. Final exam date cannot be changed.
Professor: S. R. Lubkin, lubkin@ncsu.edu, 515-1904, http://www4.ncsu.edu/~lubkin
Office hours: SAS 4226, hours MW 3pm, with some changes TBA from time to time

Official listing: Survey of mathematical methods for engineers and scientists. Ordinary differential equations and Green's functions; partial differential equations and separation of variables; special functions, Fourier series. Applications to engineering and science. Not for [graduate] credit by mathematics majors.

Goals: Upon successfully completing this course,

- You will be skilled in solving the fundamental linear PDE's that engineers use.
- You will be familiar with the properties of the heat/diffusion equation, the wave equation, and the potential/Laplace equation.
- You will be able to find series and integral solutions to these PDE, in Cartesian and/or polar coordinates.
- You will be able to display and interpret solution curves and surfaces in space and time on the computer.
- You will be able to interpret and implement different kinds of boundary conditions.

Other courses: MA 501 and 401 are almost identical. I teach both of them. However, I expect more from my students at the 500 level, so we cover more topics in the same amount of time. In particular, we cover integral transforms in 501 but not in 401. I do not have time in MA 501 to cover modeling with PDEs; that important topic is covered in MA 450, 451, 573, 574, and 774. Similarly, we do not cover nonlinear PDE in MA 501, but they are covered in various ways in MA 584, 587, 774, and others. A solid understanding of linear PDE from MA 501 or 401 gives a firm foundation for learning to work with nonlinear PDE such as the Navier-Stokes equations.

Required Text: *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, 5th edition* by Richard Haberman, 2013. You should own your own copy, so you can read it any time, mark it up, *use* it.

Possible supplements: Some people like using *Schaum's Outline of Advanced Mathematics for Engineers and Scientists* and/or *Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems* (less than $20 each) as a supplement for extra practice problems and fully worked examples. Other books on the subject may be useful; look in the table of contents for a focus on the wave, heat, and Laplace (or potential) equations, with Fourier series and Fourier transforms. There are online lectures on these subjects out there. Every professor, every textbook, has a somewhat different approach, and sampling a variety of approaches may be helpful to you.

Grades final exam 30%, 2 midterms @ 20%, 15% HW and possibly quizzes (rare), 15% team "projects" (which are like in-depth HW problems).

- The main **purpose of HW** is give you **practice** using the individual methods through solving problems ranging from easy to hard. Through HW graphical implementation, you will also gain familiarity with the behavior of solutions of different equations with different IC and BC.
- The main **purpose of projects** is to give you experience applying the methods to **more complex** and/or **realistic problems** than on the HW. Your grade on the projects is some indication of your ability to understand and solve complex problems.
- The main **purpose of exams** is to determine your **fluency** with the essential techniques and underlying concepts. Note that **exams measure different aspects of your learning from HW and projects.** You will get practice tests to try at home the week before an exam.
- I cannot promise that your HW and quizzes will be graded with great precision, but I can promise that your HW/quiz grade will be representative of your work.
- Maple calculations will be required on most of the assignments. Nobody is expected to purchase Maple; it is available on campus computers and via VCL from your own computer. If you have another package that you prefer, you are free to use it, but I will not teach how to use other packages, nor should you expect my help with them.

Policies

- If you have a disability or conflict that I need to know about, let me know as soon as possible (not the week of the first exam). **Your final exam cannot be moved.** Make your travel plans for **after** the exam.
- You are welcome to work on HW with other students, with some restrictions. Since **the point of HW is learning**, you should work with others only to the extent that it facilitates your learning and your partner's learning. Giving each other ideas: good. Explaining to each other: good. Finding each other's errors: good. Copying answers: bad. Letting your partner do the work: bad.
- You are welcome to use Maple or any other computer package to help on the HW. Please say when you are using technological help. For instance, "Integrating this term by parts (Maple) yields...." In general, show your work, including computer work.
- You may not work with others on the exams. In accordance with the NCSU policy on academic integrity, found in the

Code of Student Conduct, it is assumed that in turning in any assignment to the instructor, the student has thereby implicitly taken the honor pledge: "I have neither given nor received unauthorized aid on this test or assignment."

- I should not even have to say this (why isn't it obvious to everyone?), but **you may not copy any solutions from any source for any assignment**.

Courtesy

- Some of you may need to eat or drink during class. I don't mind this, but your fellow students might, so please keep noises, crumbs, and odors under control.
- If you are in class, I expect you to be paying attention and participating.
- If you are sick, please stay home, rest up, and get the notes from a classmate.

Homework aesthetics

- Staple homeworks. Don't fold in half. Loose sheets get lost.
- If a solution has both hand-written work and Maple work, the pages should be next to each other. Do not cluster Maple outputs separate from handwritten work.
- Every graph must be labeled. Always label all axes. Arrowheads have a very specific meaning indicating the direction of motion or of a vector or time. Arrows do not belong on axes or curves unless they are intended to indicate time or motion or vectors.
- If you are asked to make an argument, or "show that..." then you need to use enough words to make that argument. Mathematical symbols without context make no sense. Look at your textbook: it is mostly words with symbols used within the sentences. That is how your homework should be written.
- If you do calculations in Maple (for instance) and hand in the Maple session, the printout should be edited for clarity and conciseness just as you would edit your handwritten notes (only giving me your best work). Show me all the necessary lines and don't show me unnecessary lines. Do show me the results of calculations, unless they are very long. I can't grade properly unless I see your intermediate results. It is easy to make graphs in Maple, but you should only show those graphs which illustrate your point. Delete graphs which do not contribute to your discussion.
- If, for some reason, you need to turn in your HW or project electronically, the preferred format is pdf. Please do not send me other file types (like Maple worksheets).
- If you are asked to show an animation, the ideal way to show it on paper is to use superimposed curves on the same axes, with some indication of the time sequence. Do not print blank graphs. If I can't see them, I can't grade them.

Tips

- **You are expected to own the book and read it.**
- Don't lose this syllabus.
- Look carefully at your Maple plots and animations. Do they satisfy the IC and BC? If they look wrong, then your solution is wrong.
- A great amount of learning happens when you correct your own HW and find your own errors and misconceptions. That is why you will get printed HW solutions. Your engagement with the homework should not stop when you hand it in.
- You are expected to check email daily. I often send reminders or explanations or assignments by email. You are responsible for making sure that the email NCSU has for you is the one you check.
- If your Maple outputs are getting too big, print them 2-up, or resize before printing.
- Office hours are for me to help you with material you aren't understanding, despite coming to class, participating, reading the book, and working on the exercises. If you can't make the scheduled times, email me to set up a different time to meet.
- I am hard to find by just stopping at my office, and when I am in, I am not always free. I tend to respond pretty promptly to email, although if I am off campus, my prompt emails sometimes don't send, for some mysterious technical reason.
- No one needs to purchase Maple. It is available on all campus computers, such as in the Mathematics Multimedia Center, SAS 2103/2105, where there is also free tutoring available.
- Did I mention that you should actually **read the book**?

Links

- Applets that show various phenomena that we model in this class (heat, waves, etc.): http://www.falstad.com/mathphysics.html
- Waves: http://www.kettering.edu/~drussell/demos.html
- Handbook of Mathematical Functions, Milton Abramowitz and Irene Stegun, courtesy of the US National Bureau of Standards has all the facts you need on special functions and not-so-special functions. This is what your grandparents had on their desk if they were engineers or physicists. Now it's online, and free.
- Khan Academy (www.khanacademy.org/math/differential-equations) is a great resource for review. It does not have material on PDE, but it does cover ODE and Laplace transforms.