Instructor: Prof. Katharine Long

Contact:
○ My email address is katharine.long@ttu.edu. *It is better to use Piazza.*
○ I have no office phone. Why waste an ethernet port on 19th century technology?

Office hours:
○ Scheduled office hours are MW 2-4 PM (Math 102).
○ Drop-ins at other times are welcome. Outside office hours, you're most likely to find me after 2 PM TuThFr.

Course Objectives: This course covers topics in ordinary and partial differential equations. Topics to be covered include: systems of linear and nonlinear first-order differential equations; Fourier series, the Fourier transform, and orthogonal functions; boundary-value problems and partial differential equations; numerical methods.

Expected Learning Outcomes: Students will learn: solution techniques for systems of ordinary differential equations; analysis of stability of equilibrium points in linear and nonlinear systems; computation of Fourier series and application to the solution of boundary value problems for partial differential equations, specifically, the heat equation, wave equation, and Laplace's equation in rectangular and other coordinate systems; application of Fourier and Laplace transform to solution of boundary-value and initial-boundary-value problems.

Prerequisites: Linear Algebra, Differential Equations I

Text: *Elementary Differential Equations and Boundary Value Problems,* Boyce, DiPrima, and Meade. The most recent edition is 12th, but anything after 8th edition will do.

Software:

- *Mathematica* is required. You can buy a student license for *Mathematica* from wolfram; alternatively, *Mathematica* comes for free with the Raspberry Pi operating system on Raspberry Pi computers.
- You will need to get the TopHat app (for free) from TTU site license

Resources:

- You'll turn in homework assignments in Blackboard
- We'll use Piazza for online questions and posting assignments (it has better math editing and simpler uploading than blackboard)
- I keep various resources (Mathematica files, notes) on my GitHub page.

Assessment:

Type	Weight
Homework (includes written problems, *Mathematica* work, and Webwork)	**50%**
Quizzes	**12%**
2 midterm exams	**10%** each
Final exam (**comprehensive**)	**18%**

Grading scale: 85-100 A; 70-84 B; 55-69 C; 40-54 D; 0-39 F

Exam information:

Exam	*Tentative* date	Weight
Midterm #1	Friday, 27 Sep	10%
Midterm #2	Friday, 25 Oct	10%
Final exam	Tuesday, 5 Dec, 1:30-4:00 PM	18%

Course Content:

Topic area	Subtopics
Systems of first-order linear differential equations	Solving $\mathbf{u}' = A\mathbf{u}$ with eigenvalue methods; the spectral theorem for Hermitian and anti-Hermitian matrices; non-diagonalizable systems; qualitative behavior and phase plane orbits. A quick look at the general theory of system of linear differential equations.
Systems of nonlinear differential equations	Local stability analysis and linearization; Liapunov (energy) functions; numerical methods; periodic solutions and limit cycles; chaos; **first midterm**
Two-point boundary-value problems – first look	Eigenvalue problems and eigenfunctions
Fourier series	Simple examples; orthogonality; real and complex forms; convergence; term-by-term operation; **second midterm**
Partial differential equations	Solving PDEs with Fourier series; numerical methods
The Fourier transform	Extending a Fourier series' period to infinity; simple transform pairs; identities; applications to PDEs.

Use of "AI"

Generally speaking, you are not allowed to use so-called artificial intelligence (AI) engines, software, or artwork generating programs (such as ChatGPT or DALL-E) to produce work for this class. Be warned: predictive text tools are not good at math!

Policies for homework and take-home tests

Homework is emphasized in this course: working problems is how you learn. Homework will be assigned roughly once per week, and it counts for **48%** of your grade. **Blowing off the homework is the most reliable way to fail this course.**

- **General**
  - Assignments should be turned in electronically on the due date, except by *prior* arrangement. If prior arrangement is not possible for some reason (*e.g.* illness, car accident) please contact me ASAP. I prefer to post solutions within a day of the due date, and I cannot accept homework submitted after solutions have been posted.
  - In extraordinary circumstances such as an extended illness or hospitalization, you should contact me ASAP to let me know we need to work out special arrangements for homework. For example: if you only tell me *after* being out for three weeks, you will be unable to make up missed homework; if you tell me early on, we can make arrangements.
  - There will absolutely ***not*** be any *deus ex machina* "extra credit" homework assignments given to rescue anyone's grade. Don't even bother asking for it.
- **Written problems**
  - You will write out your calculations, along with explanations in words of the reasoning behind your steps.
  - Each assignment must be turned in through Blackboard as a single PDF file for your written work and computer calculations. Do not submit multiple files, and do not use any format other than PDF. A bunch of image files is not acceptable.
  - Your PDF file should be readable as multiple pages, not as a single giant page like a CVS receipt.
  - If I tell you to include a cover sheet on an assignment, then include the cover sheet.
  - Homework must be in neat, legible handwriting, written in large enough script to be read easily, and with space between lines to allow space for a grader to write comments.
  - Correct mathematical notation must be used. In particular, you should clearly distinguish between vectors and scalars by writing vectors with markings such as arrows or undertildes, and hats in the case of unit vectors.
  - You must *explain* your steps in English along with math. A jumble of equations is not a solution.
  - Homework is graded by a grader; tests and quizzes are graded by me. I have instructed the grader to deduct points for incorrect notation, lack of organization, and lack of explanation in words.
  - **Failure to follow these instructions (or any additional assignment-specific instructions) can result in points lost, or in extreme cases a zero can be given on an entire assignment.**
- **Computer work**
  - You must turn in your computer work by including images of all code, plots, solutions, etc as part of your PDF file for that assignment. You can do this in a number of ways, including: saving your Mathematica notebook as a PDF and including it in your master PDF, making screensots of your work, taking photos of your screen, and probably several other ways as well.

  - Do **not** submit raw files (notebook, LiveScript, m-file, etc).
  - Do **not** submit your computer-produced figures as extra images
  - **Failure to follow these instructions (or any additional assignment-specific instructions) can result in points lost, or in extreme cases a zero can be given on an entire assignment.**

- **Webwork**
  - Although written homework will be emphasized, Webwork assignments will be given as well. Despite its many limitations, Webwork does have the virtue of giving you instant feedback.

Homework advice

Homework is the meat of this course, so here is some advice:

- Work as part of a study group. As a professional scientist you'll collaborate with others, and now is a good time to start. Work together to develop and criticize solutions, and build on your complementary strengths. While working together is encouraged, you must still write up your own solutions!
- Write up your solutions clearly, showing all nontrivial steps and explaining your reasoning in words.
- Look at all problems early, think them over for a while, and then solve them and write them up. Doing them all cold the night before the due date is unlikely to work.
- Do the Webwork problems before the written problems, so you can get early feedback on misconceptions.
- I write my own problems, so doing an online scavenger hunt for solutions will just waste your time.
- When you get your graded papers back, look them over and make sure you understand your mistakes.
- Read and understand the solutions I give out after each problem set.

Piazza, Blackboard, and email

- Blackboard is certified by TTU for use in posting grades. Therefore we use Blackboard for submitting and returning assignments.
- We use Piazza for online questions and discussions. *Please post your math or logistics questions as **public** messages to Piazza, not by email to me.* Here are a few reasons why:
  - Notices of piazza messages are clearly marked in my inbox, and are less likely than emails to be accidentally sent to the spam folder.
  - Everyone gets to see my reply to your question, so you are doing a service for your classmates. You're not in competition with each other.
  - Another student might be able to answer your question.
  - I don't need to answer the same question multiple times.
  - I can use Piazza's math editor to write equations.
- Piazza has anonymous and private question modes
  - If you want to remain anonymous to your classmates or to me, you can make the question anonymous.
  - *If you need to send a private message (e.g., a question about your grade or some other private concern) that can be done using Piazza's private message feature.* It's OK to send such questions by email, but be warned they're more likely to get lost in the volume of emails I get. Piazza message notices usually stand out.

How to ask effective questions

- When asking about a problem, always tell me what you've already tried and where you're stuck

  - Useless: "I don't know what to do in problem 3"
  - Useful: "I'm stuck in problem 3. I could set up and solve the auxiliary polynomial but don't know what to do with the solutions"
  - Even more useful: a screenshot of what you've tried, or (better yet) a description of your attempt using Piazza's built-in LaTeX math editor.

- When asking for computer help, *always* provide a screenshot of what you've tries.
  - Useless: "In problem 3, my code doesn't work"
  - Useful: "Here's my code for problem 3. [screenshot] Why is it giving me a blank plot?"

TTU Policies

- https://www.depts.ttu.edu/tlpdc/RequiredSyllabusStatements.php
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