Math 478, Introduction to Partial Differential Equations and Numerical Methods, Fall, 2022

Lecturer:
Dr. E. Sander, Exploratory Hall, Rm 4408, 993-1490, *esander at gmu.edu*
(where at is replaced with @)

Lectures: Mondays and Wednesdays 12-1:15pm, Innovation Hall Room 328

Office hours: Announced on Blackboard.

Textbook: Evelyn Sander and Thomas Wanner, *Nonlinear Analysis and Computation for Partial Differential Equations*, Unpublished, In PDF form, Available from the Blackboard Class Site. This book is for your own use. We ask that you do not distribute this book to others.

Prerequisite: C or better in MATH 203 and 214 or 216.

Links:

- Detailed syllabus
- Relevant official GMU policies

Course description: This course introduces basic facts about partial differential equations, including elliptic equations, parabolic equations and hyperbolic equations. Methods of solution, characteristics, initial/boundary-value problems, and numerical approximation techniques. This includes generalized Fourier series, separation of variables, and numerical methods of solving partial differential equations, including finite difference methods and spectral methods in one and two dimensional domains for both linear and nonlinear equations of all three types.

Matlab: Computation is an integral part of the course. You will need to have access to Matlab -- which is available for no extra cost for all students. It is strongly advised that you attend the department Matlab workshops, but at least go through a tutorial such as

- A very good tutorial by Kermit Sigmon, University of Florida.
- The official Getting Started with Matlab guide from Mathworks.
- This tutorial which I wrote may be the world's shortest.

Homework: There will be homework assignments, which will be available from Blackboard. Most of these assignments will be graded and count towards your homework score. While the remaining ones do not have to be handed in, I do advise everyone strongly to study them and write out the solutions properly. I will plan to go through many of the homework problems in the following class and you will not benefit from this if you have not made a serious attempt at solving them.

Test Dates

- Midterm: Wednesday, October 19.
- Final Project Presentations: Monday, December 12, 10:30-1:15 (per official university schedule).

Grading: The grade is distributed approximately according to the following:

Homework	Midterm Exam	Final Project	Attendance

40%	25%	25%	10%

The assignment of your course grade is based on the total course score. The following grading scale may serve as a guideline, although changes are possible:

Score above	90%	80%	70%	60%	otherwise
Letter grade	A-, A, or A+	B-, B, or B+	C or C+	D	F

Introduction to Partial Differential Equations with Numerical Methods

Math 478-001

Fall 2022

The following table contains a preliminary schedule for the course. This page will be updated regularly throughout the semester. The section numbers in the last column refer to the textbook.

Week	Date		Sections	Assignment due
		I. Introduction to Differential Equations		
1	08/22	1. Ordinary and Partial Differential Equations 1.1.3	1.1.1, 1.1.2,	
	08/24	2. Domains and Their Boundaries	1.1.4	
2	08/29	3. The Heat Equation	1.2.1	
	08/31	4. Laplace's Equation	1.2.2	
3	09/05	**Labor Day, No Class**		
	09/07	5. The Transport Equation	1.2.3	
4	09/12	6. The Wave Equation	1.2.4	Homework 1
	09/14	7. Classification of Partial Differential Equations	1.3.1, 1.3.2	
		II. Separation of Variables		
5	09/19	1. Orthogonal Functions	2.1.1	Homework 2
	09/21	2. Generalized Fourier Series Expansions	2.1.2	
6	09/26	3. Extensions to Higher Dimensions	2.1.3	
	09/28	4. Sturm-Liouville Boundary Value Problems 2.2.3	2.2.1, 2.2.2,	Homework 3
7	10/03	5. Separation of Variables I	2.3.1	
	10/05	6. Separation of Variables II	2.3.2, 2.3.3	
8	10/11	7. Eigenvalue Problems I (Fall break Monday)	2.4.1, 2.4.2	
	10/12	8. Eigenvalue Problems II	2.4.3	Homework 4
9	10/17	9. Inhomogeneous Evolution Equations I	2.5.1, 2.5.2	
	10/19	**Midterm Exam**		
		III. Basic Numerical Techniques		
10	10/24	1. Numerical Computation of Derivatives 3.1.3	3.1.1, 3.1.2,	
	10/26	2. Numerical Solution of Nonlinear Equations	3.2.1	
11	10/31	3. Newton's Method and its Extensions	3.2.2	Homework 5
	11/02	4. Trigonometric Transforms and Spectral Differentiation	3.4.1	

12	11/07	5. Chebyshev Differentiation	3.4.2	
		IV. Linear Elliptic Equations		
	11/09	1. Finite Difference Method	4.1, 4.2.1	Homework 6
13	11/14	2. Chebyshev Spectral Methods	4.3.1, 4.3.2	
	11/16	3. Two-Dimensional Problems	3.4.3, 4.2.2	Homework 7
14	11/21	**Individual Work on Projects!**		
	11/23	**Thanksgiving Break, No Class**		
15	11/28	4. The Chebyshev Method in Two Dimensions	4.3.3	
		V. Nonlinear Elliptic Equations		
	11/28	1. Finite Difference Method	5.1.1	
	12/1	2. Spectral Methods	5.1.2	
PS	**12/12**	**Final Projects (10:30am-1:15pm)**		