CSE386L MATHEMATICAL METHODS IN SCIENCE AND ENGINEERING
Spring 22, # 61775 T Th 11:00 - 12:30

Textbooks:

1. J. T. Oden and L. Demkowicz, *Applied Functional Analysis*, CRC Press, 2018 (third edition).
2. J. W. Cain and A. M. Reynolds, *Ordinary and Partial Differential Equations*, Creative Commons, Virginia Commonwealth University, Richmond, 2010.

Learning Objectives:

1. Students will develop practical skills in the use of mathematics to solve problems. Topics covered should include advanced calculus (grad, curl, and div in curvilinear coordinates, and Gauss and Stokes Theorems), ODE's and dynamical systems, calculus of variations, and PDE's (Sturm-Liouville theory, separation of variables, Fourier transform, and Lax-Milgram theory).
2. Students will develop an appreciation of higher level mathematics (e.g., vector, metric, and Hilbert spaces) as a framework for understanding and solving practical problems.
3. Students will continue to learn graduate level mathematics by learning Hilbert space theory.

Tentative Schedule:

Week	**Topic**
Jan. 18 -Jan.21	Directional and partial derivatives. Multilinear functionals and differentials. Taylor's Theorem. Curvilinear systems of coordinates; grad, curl, div operators.
Jan. 14 -Jan.28	Gauss and Stokes Theorems.
Jan. 31 -Feb. 4	ODEs and Dynamical Systems. Existence and uniqueness. Systems of linear ODEs and relation with eigenvalues.
Feb. 7 -Feb. 11	Constrained optimization and Lagrange multipliers in $\mathbb{R}^n$. Elementary calculus of variations.
Feb. 14 -Feb. 18	Lyapunov stability.
Feb. 21 -Feb. 25	Elementary PDEs. Characteristics for first order hyperbolic PDEs.
Feb. 28 -Mar. 4	Sturm-Liouville theory and separation of variables.
Mar. 7 -Mar. 11	Fourier series and Fourier transform.
Mar. 14 -Mar. 28	Spring Break
Mar. 21 -Mar. 25	Laplace transform.
Mar. 28 -Apr. 1	Hilbert spaces. Self-adjoint operators.
Apr. 4 -Apr. 8	Spectral Theorem and separation of variables (extended).
Apr. 11 -Apr. 15	Green's functions.
Apr. 18 -Apr. 22	Closed Range Theorem.
Apr. 25 -Apr. 29	Variational formulations.
May. 2 -May. 6	Lax-Milgram and Babuška - Nečas Theorems.

Meetings:

In person. We will meet in PMA 7.112. The classroom is designed to accommodate all enrolled students with appropriate social distancing. We will meet on the class days throughout the semester and work online otherwise, if necessary.

Homework: Homework assignments will be posted in Canvas after the lectures. The homework will be collected in class on Tuesdays.

Exams: There will be two (closed book) exams held during evening hours (5:00-8:00 p.m.) according to the following schedule:

- Exam1 (through Section 1.20) Wed., Mar.9, POB 6.304.
- Exam2 (through Section 3.3) Wed., May 4,POB 6.304.

Final Exam: Comprehensive, mandatory and closed book, Thu, May 12, 9:00-12:00 am, POB 6.304.

Discussion session (obligatory): Fri, 3:30-5:00, POB 6.304.

Instructor: Dr. Leszek Demkowicz, POB 6.326, Office hours: *in person:* Tue, Thu, 1:30-3:00 (after the class), Fri, after the discussion session.

TA: Youguang Chen. Office hours TBA.

Final Grade: Is based upon the final score.

Final score range	grade
85 - 100	A with recommendation letter
75 - 85	A
72 - 74	A-
68 - 71	B+
65 - 67	B
62 - 64	B-
58 - 61	C+
55 - 57	C
52 - 54	C-
48 - 51	D+
45 - 47	D
42 - 44	D-
00 - 41	F

The final score is a weighted average of the test score, three mid-term exams and the final exam, with the following weights:

Homework	- 20 %
Exams	- 20 % each
Final	- 40 %