King Fahd University of Petroleum & Minerals
College of Computing and Mathematics
Department of Mathematics

MATH-578: Applied Numerical Methods II.

Instructor: Dr. Abdullah Shah

Course Description:

This course introduces finite element, finite difference, and finite volume methods. Applications of these methods to steady-state, diffusion and wave models. Stability and convergence. Homogenization, upscale and multiscale methods. Implementations and computer labs.

Course Objective: The objective of the course is to:

1. Provide the students with a strong background in Numerical Methods for PDEs.
2. Use computing software for hands-on knowledge and practical implementation.

Learning Outcomes: By the end of this course, students will be able to:

1. Describe finite difference, finite element and finite volume methods.
2. Apply these methods for solving steady-state and time-dependent models.
3. Evaluate the accuracy and stability of the numerical solutions.

Credit hours: 3
Pre-requisite: Graduate standing

Textbook:

Larsson and Thomee, *Partial Differential Equations with Numerical Methods*, Springer, 2003.

Reference Books:

1. Mat G. Larson, F.Bengzon, The Finite Element Method: Theory, Implementation, c and Applications, Springer 2013.
2. Grossmann, Roos, and Stynes, Numerical treatment of partial differential equations Springer, 2007.
3. Richard L. Burden, J. Douglas Faires, Numerical Analysis, 10th Edition, Cengage Learning, 2016.
4. Randall J. LeVeque, Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2002.

Course Grade

The final grade will be based on the following distribution:

Assignments (Theory)		20%
Assignments (programming)		20%
Midterm Exam		25%
Final Exam		35%
Total		**100%**

Note: Any student will get less than 50 % will be given an F grade.

Attendance: Students are expected to attend all classes. Six unexcused absences lead to a DN grade.

Office hours: Sunday and Tuesday from 1500-1630 or by appointments,

Email: abdullah.shah.1@kfupm.edu.sa Office: Building 5, 201-7.

Midterm Exam: TBA
Final Exam: TBA

Topics

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1 Introduction and Motivations

Elliptic and Mixed Type Problems in 1D and 2D

2 Finite Difference Method
Matrix Structure
Numerical Stability and Convergence
Implementation

3 Finite Element Method
Quadrature and Mesh generation
Stability Convergence
Implementation/Matlab PDE Toolbox

Time Dependent Models

4 Time-Stepping Finite Differences
Semi-Discrete Finite Elements
Implementations

5 Finite Volume Method for Hyperbolic Problem.