King Fahd University of Petroleum & Minerals

College of Computing and Mathematics

Department of Mathematics

MATH-578: Applied numerical methods II

Instructor: Kassem Mustapha

Course Description:

This course introduces finite element, finite difference and finite volume methods, applications to steady-state, diffusion and wave models. Stability and convergence. Homogenization, upscale and multiscale methods. Implementations and computer lab sessions.

Credit hours: 3 hours
Pre-requisite: Graduate standing

References:

1. Grossmann, Roos, and Stynes, Numerical treatment of partial differential equations (Vol. 154), 2007.
2. Larsson and Thomee, Partial Differential Equations with Numerical Methods, Springer, 2003.
3. Efendiev and Hou, Multiscale finite element methods: theory and applications (Vol. 4), 2009.
4. Knabner and Angermann, Numerical Methods for Elliptic and Parabolic PDEs, 2003.

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

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

Course Grade

The final grade will be based on the following distribution:

Assignments and tests	40%
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: Monday and Wednesday from 4 pm till 5 pm, or by appointments, Email: kassem@kfupm.edu.sa, Office: Building 5, 203-5

Topics

1

- Introduction and motivations

Elliptic and Mixed Type Problems in 1D and 2D

2

- Finite Difference Method
- Matrix Structure
- Stability
- Convergence

3

- Finite Element Method
- Quadrature
- Stability
- Interpolations
- Convergence

Time Dependent Models

4

- Time-Stepping Finite Differences
- Semi-Discrete Finite Elements
- Finite Element/Differences
- Implementations
- Stability Analysis
- Simulations

5

- Finite Volume Method