

**THE UNIVERSITY OF TEXAS AT EL PASO**  
COLLEGE OF SCIENCE  
**Department Of Mathematical Sciences**

Course #: MATH 5343  
Course Title: Numerical Solution of Partial Differential Equations  
Credit Hrs: 3  
Term: Spring 2011  
Course Meetings & Location: MW 15:00 – 16:20, Bell Hall 130 A  
Prerequisite Courses: MATH 2326, 3323, 4329 or equivalent, and programming experience  
Course Fee (if applicable) None  
Instructor: Dr. Son-Young Yi  
Office Location: Bell Hall 218  
Contact Info: E-mail syi@utep.edu  
Phone (915) 747-6864

Office Hours: MW 13:00 – 14:00  
Textbook(s), Materials: Computational Partial Differential Equations Using MATLAB by Jichun Li and Yi-Tung Chen

Course Website <http://www.math.utep.edu/faculty/yi/math5343s11.html>

Course Objectives The objectives of the class are to understand

- (Learning Outcomes):
1. the mathematical and qualitative properties of three basic types of PDE (elliptic, parabolic and hyperbolic equations).
  2. the basic principles of Finite Element Method and Finite Difference Method
  3. how to implement and test the numerical schemes in a computer language (MATLAB)
  4. how to apply these methods to application problems

Course Activities/Assignments: **Homework:** Homework/Lab assignments will be collected throughout the semester. **No late homework /lab report** will be accepted. Computer programming must be done in MATLAB.

**Course project:** In addition to the homework/lab assignments, students will work on a final project on a topic of their own choice, preferably related to their research. A project proposal and a final report should be turned in and each student will present his/her final project on the final exam day. Detailed instructions will follow.

Assessment of Course Objectives: Final project presentation is scheduled for Monday, May 9.

Tentative Course Schedule:

**Week 1 (1/19):** Course introduction, Overview of PDEs

**Week 2 (1/24 – 1/26):**

- Overview of Numerical methods for PDEs
- Finite Difference Method for two-point boundary value problem:
  - Introduction and finite difference formulas
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**Week 3 (1/31 – 2/2):**

- Finite Difference Method for two-point boundary value problems:
  - Error and stability analysis, variable spacing in the grid, discontinuous coefficients, and mildly nonlinear problem

**Week 4 (2/7 – 2/9):**

- Finite Difference Method for 2-D Elliptic Equations
- Computer lab

**Week 5 (2/14 – 2/16):**

- Numerical solution of linear systems
  - Classical iterative methods
  - Conjugate Gradient(CG)

**Week 6 (2/21 – 2/23):**

- Conjugate Gradient and Preconditioned CG continued
- Finite Difference Method for Parabolic Equations:
  - Forward, Backward and Crank- Nicolson methods, ADI methods
  - Stability analysis

**Week 7 (2/28 - 3/2):**

- Finite Difference Method for Parabolic Equation continued
- Finite Difference Methods for the 1<sup>st</sup> order Hyperbolic Equations:
  - The upwind scheme, the Friedrichs scheme, and the Lax-Wendroff scheme

**Week 8 (3/7 - 3/9):**

- Finite Difference Methods for the 2<sup>nd</sup> order Hyperbolic Equations
- Finite Element Methods for Two-Point boundary-value problems:
  - The piecewise-linear and higher-order Galerkin methods

**Week 9 (3/14 - 3/16):** Spring break, No classes

**Week 10 (3/21 - 3/23):**

- Computer lab
- Individual meeting

## Tentative Course Schedule

-Continued

### **Week 11 (3/28 – 3/30):**

- Finite Element Methods for 2-D Elliptic Equations:
  - Abstract finite element theory
- Conforming Finite Element Method

### **Week 12 (4/4 – 4/6):**

- Nonconforming Finite Element Method
- Galerkin methods for the Neumann and the Dirichlet problem

### **Week 13 (4/11 – 4/13):**

- Curved boundaries
- Quadrature rules

### **Week 14 (4/18 – 4/20):**

- Programming Issues –Computer lab
- Finite Element Methods for Parabolic Equations

### **Week 15 (4/25 – 4/27):**

- Finite Element Methods for Wave Equations
- Mixed Finite Element Methods:
  - Abstract formulation
  - The 2<sup>nd</sup> order elliptic equations

### **Week 16 (5/2 – 5/4):**

- Mixed Finite Element Methods continued
- Wrap-up the final project

### **Final week (5/9): Final Project Presentations**

Grading Policy:

Attendance Policy:

Homework: 50%, Final project: 50%

It is student's responsibility to attend every class. Students are expected to arrive for class on time and to remain for the class entire period.

Academic Integrity Policy:

The University policy is that all suspected cases or acts of alleged scholastic dishonesty must be referred to the Dean of Students for investigation and appropriate disposition. Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes, but is not limited to cheating, plagiarism, collusion, submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. For further information, please refer to:

<http://academics.utep.edu/Default.aspx?tabid=23785> or

<http://www.lib.iastate.edu/commons/resources/facultyguides/plagiarism/dishonest.html>.

Civility Statement:

Please do not use cell phones, pagers, iPods, MP3 players, blue tooth devices, etc. during class. Cell phones and pagers should be set to silent or vibrate, and any calls should be taken outside of class. Please do not wear headsets or blue tooth devices during class.

Disability Statement:

If a student has or suspects she/he has a disability and needs an accommodation, he/she should contact the Disabled Student Services Office (DSSO) at 747-5148 or at <dss@utep.edu> or go to Room 106 Union East Building. The student is responsible for presenting to the instructor any DSS accommodation letters and instructions.

Military Statement:

If you are a military student with the potential of being called to military service and/or training during the semester, please contact me by the end of the first week of class.