

*Texas Tech University, Department of Mathematics and Statistics*  
**MATH 5344, TOPICS IN NUMERICAL ANALYSIS I**  
**COURSE SYLLABUS, Fall 2015**

## Instructor

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## Weekly meeting

TR 11:00am-12:20pm, room Math 113

## Course general description

This special topics course provides the students with the necessary ingredients to perform research in the fields of Numerical Analysis of Partial Differential Equations and Scientific Computing.

Prerequisites: MATH 5334-5335, or consent of department.

## Expected Student Learning Outcomes

Students will learn to

- formulate numerical discretizations of PDEs;
- analyze finite element approximations and their theoretical convergence properties;
- implement algorithms using cutting-edge open-source software;
- perform software development in a collaborative way using version control systems.

Emphasis will be given to both theoretical and practical aspects. Students will be guided in a hands-on approach to the solution of challenging numerical problems with advanced algorithms, strongly motivated by theoretical results.

## Tentative course outline

This outline concerns the two-semester series.

### Numerical analysis of PDEs

- Overview of numerical methods for PDE
- Introduction to the finite element method. Variational formulation of elliptic problems
- Construction of a finite element space
- Finite element multigrid methods. Domain decomposition methods
- Variational crimes. Mixed finite element methods
- Optimal control

### Scientific computing

- Computer hardware; operating systems. Linux kernel, Linux distributions
- Programming languages: paradigms, typing disciplines, implementation
- C++ as a descendant of C. Types of variables, operators, functions
- Structures and classes: encapsulation; constructors and destructors
- Polymorphism: inheritance, operator overloading, templates
- Software development: integrated environments, build systems
- Simulation pre- and post- processing: mesh generation, visualization
- Programming practices. Version control systems
- Error detection: debugging, profiling
- Software testing, continuous integration systems
- Parallel computing: shared memory and distributed memory paradigms. HPC facilities
- Nonlinear problems: automatic differentiation

## Assessment of Learning Outcomes

The exam consists in the discussion of an individual project.

Attendance is mandatory.

## **TTU Operating Policies**

### **Americans with Disabilities Act (TTU OP 34.22)**

Any student who, because of a disability, may require some special arrangements in order to meet course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services, during the instructor's office hours. Please note instructors are not allowed to provide classroom accommodations to student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office at 335 West Hall or 806-742-2405.

### **Absence for observance of a religious holy day (TTU OP 34.19)**

1. "Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code 11.20. 2. A student who intends to observe a religious holy day should make that intention known to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence. 3. A student who is excused under Section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

### **Academic Honesty (TTU OP 34.12)**

It is the aim of the faculty of Texas Tech University to foster a spirit of complete honesty and high standard of integrity. The attempt of students to present as their own any work not honestly performed is regarded by the faculty and administration as a most serious offense and renders the offenders liable to serious consequences, possibly suspension. "Scholastic dishonesty" includes, but it not limited to, cheating, plagiarism, collusion, falsifying academic records, misrepresenting facts, and any act designed to give unfair academic advantage to the student (such as, but not limited to, submission of essentially the same written assignment for two courses without the prior permission of the instructor) or the attempt to commit such an act.

### **The grade of "I" (TTU OP 34.12)**

The grade of "I" is given only when a student's work is satisfactory but, due to reasons beyond his or her control, cannot be completed. It is not given in lieu of an "F" or "W". The instructor assigning the grade will stipulate in writing at the time the grade is given the conditions under which the "I" may be removed. The assigned work and a change of grade must be recorded within one calendar year from the date of the "I". Failure to do so results in an "F" for that course.