COURSE: COMS7300 (4 credits): Numerical Methods for PDEs in Computational Science
Pre-req. : COMS6500 (4 credits): Fundamentals of Scientific Computing or consent of instructor

Meeting Times:  T TR 6:00 p.m. - 7:50 p.m.
Location: KOM 202

TEXT BOOK:

- Notes will be provided for Finite Element Methods and Finite Volume Methods, and other topics not covered in the recommended text books.
- Research papers for case studies and presentations.
- Some topics from the books given in the list below.

Useful books and journals related to the course:


- Finite Difference Methods for Ordinary and Partial Differential Equations
  Steady State and Time Dependent Problems

- Numerical Solution of Time-Dependent Advection-Diffusion-Equations


- Numerical Solution of Advection-Diffusion-Reaction Equations Lecture notes, 2000, Willem Hundsdorfer CWI, Amsterdam

- Spectral algorithms for reaction-diffusion equations


- SIAM Journal Multi-scale Modeling and Simulation
Extra resources:

Scientific Computing video lectures (University of Washington):
- https://class.coursera.org/scientificcomp-007/lecture

Finite Elements video lectures:
- https://class.coursera.org/finiteelementmethods-001/lecture - The Finite Element Method for Problems in Physics (University of Michigan)

Finite Elements software:
- https://www.dealii.org/
- http://fenicsproject.org/
- http://www.feelpp.org/

Mesh generators:
- http://gmsh.info/
- http://salome-platform.org/
- http://www.hpfem.jku.at/netgen/

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OFFICE HOURS: 1:00-2:30 p.m. P.M. TTR, and any other time by appointment.

OBJECTIVES:

Students will be introduced to the numerical solutions of partial differential equations with applications to computational science. Case studies with applications to computational science will be discussed. Computer programming will be done in MATLAB and/or FORTRAN. Students will be exposed to software packages through computer assignments, case studies and final research project.

OUTLINE OF COURSE TOPICS:

Parabolic PDEs:
Finite difference methods, stability and consistency, Matrix method for stability analyses, Neumann method of stability

Computer assignments, and case studies- Study of research papers

Reaction-Diffusion PDEs:
Linearly implicit methods, Exponential Time Differencing schemes, Multi-dimensional systems, system of PDEs

Computer assignments, and case studies- Study of research papers

Hyperbolic PDEs:
First and second order hyperbolic PDEs, stability and convergence analyses, convection- diffusion problems

Elliptic PDEs:

Laplace equation and Poisson equation, convergence analysis
Iterative methods: Jacobi method, Gauss Seidel method SOR method, convergence analyses, Finite Element Methods

Computer assignments and case studies

Final Research Project: Final research project will be working on a research paper, which includes presentation and write up.

GRADING SCALE: 90-100% A; 80-89% B; 70 - 79% C; 60 - 69% D; 00 - 59% F

Grades will be based on the following instruments:

2 Tests 45%
Computational Assignments 30%
& Case Studies
Final Project 25%

2 Take-home Tests
(March, April)

You will be given 2 take home tests during the semester. Each test will carry equal weight, and will cover all of the material learned up to and including one day before the exam. Please turn all cell-phones off during the test. There will be no final exam.

Computational Assignments and Case Studies:

You will be given several assignments during the semester. These will include Mathematical and Computational Assignments, and reproducing results of some research papers. Case studies will involve challenging computational problems and study of research papers. You should strive to start the computational assignment the day it is assigned. Be detailed in your explanations when
documenting computational results. Cheating is not to be tolerated, and will be dealt according to MTSU policy.

**Final Research Project (Last days of the class.):**

You will be required to work on a research paper related to the course with application to an area in Computational Science. The project will be presented in class during final exam week, and a short write up will also be required for the grade. This project takes the place of final exam.

**Homework:**

You will be assigned textbook problems on each day class is held (except for exam days). You should strive to solve the problems the day they are assigned. It is very important to keep up with the homework and do the problems regularly. Some home-work problems will be graded, it is very important to do the all the assigned problems for the mastery of the subject.

I encourage you to work with others on homework problems. However, be sure that you understand everything and do not become dependent on others. While I will solve homework problems in class, you may feel free to stop by my office to discuss the problems. Feel free to e-mail me questions you are not able to solve, and I’ll address solutions to such problems in the next lecture.

**Attendance and Late Work Policy:**

Perfect attendance is expected to succeed in the course. To obtain an excused absence due to illness for a day that class meets, you must submit written verification obtained from a physician, or the Office of Student affairs. If you have an excused absence for the day an exam is scheduled, you must contact me to make arrangements for taking a make-up test (which will be different from and perhaps slightly more difficult than the original exam). The make-up Test should be taken as soon as possible, and definitely no later than five days after the original test was administered. Missing a test may mean that you will lose the privilege of obtaining written solutions from me.

If you have an excused absence for the day Assignment is due, you must submit the assignment to me within 48 hours of the time it was due. If you are still on excused absence, you must send someone to bring the assignment to my office before the 48 hours has expired. This deadline is strict so that I may give solutions soon after the assignment is due.

Tests and assignments missed without an excused absence will be recorded as zero points. There will be no other chances to complete missing work, so please keep on top of things.

**IMPORTANT INFORMATION:**

- A grade of “I” will be given only in accordance with university policy.

**DISABILITY STATEMENT:**

If you have a disability that may require assistance or accommodation, or you have questions related to any accommodations for testing, note takers, readers, etc., please speak with me as soon as possible. Students may also contact the Office of Disabled Students Services (898-2783) with questions about such services.
NOTE: Syllabus subject to change with notice