MATH 045: Numerical Methods

Term: 2020 Winter Session Instructor: Staff Language of Instruction: English Classroom: TBA Office Hours: TBA
Class Sessions Per Week: 5 Total Weeks: 3 Total Class Sessions: 15 Class Session Length (minutes): 240 Credit Hours: 4

Course Description:

This course provides a practical introduction to numerical methods, including: Numerical solution of linear equations and systems; Interpolation and quadrature; Solution of nonlinear systems; Computation of eigenvalues and eigenvectors; Numerical solution of initial and boundary value problems for ODE's; Introduction to numerical solution of partial differential equations; Linear programming; Applications drawn from science, engineering, and finance.

Course Materials:

Numerical Methods, Third Edition: Using MATLAB, 3rd Edition, by George Lindfield (Author), John Penny (Author)

Course Format and Requirements:

This course has 15 class sessions in total. Each class session is 240 minutes in length. Please do not use electronic devices such as phones, iPads, computers, etc. during the lectures.

Attendance

Students are expected to attend and participate in class. Missing class is the most common reason for poor performance in the course. If you miss a class, you are responsible for obtaining notes

for that class from a student who attended. It is also your responsibility to find out about any announcements made in class.

Grading Scale:

A+: 98%-100%
A: 93%-97%
A-: 90%-92%
B+: 88%-89%
B: 83%-87%
B-: 80%-82%
C+: 78%-79%
C: 73%-77%
C-: 70%-72%
D+: 68%-69%
D: 63%-67%
D-: 60%-62%
F: Below 60%

Course Assignments:

Quizzes:

Types of the quizzes will be matching, multiple-choice and short answer questions, which will cover the concepts and methodologies learned in class while student's ability of programming will not be tested. There will be six quizzes in total, of which the lowest score will not be taken into account. No make-up quiz will be given.

Project:

Several homework problems/computational projects will be assigned during the semester. They will be designed for students to have an opportunity to apply the skills acquired on various topics in class. Another student's expected learning outcome will be the ability of coming up with good data structures and good algorithmic strategies, aiming for efficient problem solving.

These projects should not take too long if the material discussed in class is properly understood. MATLAB will fulfill the software need for programming part of all assignments.

Exams:

There will be one midterm exam and one cumulative final exam administrated through this semester. Both the midterm and the final exam will be closed book. Note that the final will not be taken during the normal class times. Exact time and location for final will be announced later.

Course Assessment:

Quizzes	15%
Project	30%
Midterm Exam	25%
Final Exam	30%
Total	**100%**

Course Schedule:

Week	**Topics**	**Activities**
1	• Course overview & Calculus Review • Mathematical Modeling Numerical Analysis • MATLAB Fundamentals and Programming with MATLAB • Computer Arithmetic and Error Analysis: machine calculations, types of numerical error and propagation of errors, backward recurrence, overflow and series convergence • Root finding methods: Bisection; Newton's; Secant; Fixed point • Root finding algorithms and code • Root finding methods, algorithms and programming • Linear Algebraic Equations and Matrices: Elimination and Factorization, Inverse, Eigenvalue and Eigenvectors, Jacobian, special matrix structures, several types of iterative algorithms	Reading Review Quiz 1 and Quiz 2 Projects

2	• Linear Interpolation applied using MATLAB • Polynomial Interpolation: Taylor Series, Lagrange Interpolating Polynomials, Newton Polynomials, Chebyshev Interpolation; Error analysis for polynomial interpolations • Introduction to Least Squares • Other interpolation method and programming with MATLAB • Curve Fitting: Linear Least Squares approximations and optimizations (linear regression, polynomial regression, other linear models), Nonlinear Least Squares models, Splines. • Fourier Series and Fast Fourier Transform	Reading Review Quiz 3 & Quiz 4 Projects Midterm
3	• Numerical Differentiation and Integration: Differentiation and Integration formula and functions, Newton Cotes rules, Composite rules, Gaussian quadrature, Adaptive Algorithms; Error estimation • From Numerical integration to differential equations: Recall theorem of calculus, introduction to ODE, IVP, PDE • Ordinary Differential Equations • Initial Value Problems • Boundary Value Problems • Partial Differential Equations • MATLAB Programming Applications • Different models in physics, economics and finance • Wrap-up	Reading Review Quiz 5 & 6 Projects Final exam

Academic Integrity:

Students are encouraged to study together, and to discuss lecture topics with one another, but all other work should be completed independently.

Students are expected to adhere to the standards of academic honesty and integrity that are described in the Shanghai Normal University's *Academic Conduct Code*. Any work suspected of violating the standards of the *Academic Conduct Code* will be reported to the Dean's Office. Penalties for violating the *Academic Conduct Code* may include dismissal from the program. All students have an individual responsibility to know and understand the provisions of the *Academic Conduct Code*.

Special Needs or Assistance:

Please contact the Administrative Office immediately if you have a learning disability, a medical issue, or any other type of problem that prevents professors from seeing you have learned the course material. Our goal is to help you learn, not to penalize you for issues which mask your learning.