King Abdullah University of Science and Technology KAUST

Applied Numerical Methods - Course Syllabus

Course Number: AMCS 206/AMCS 152

Course Title: Applied Numerical Methods

Academic Semester:	Summer	**Academic Year:**	2015/ 2016
Semester Start Date:	Jun 05, 2016	**Semester End Date:**	Aug 04,2016

Class Schedule: Mondays and Thursdays, 2-5pm

Instructor(s) Name(s):	Maria Alexandra Gomes
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Office Location:	Building 1, Room 3126
Office Hours:	Every time I am available in my office or by appointment.

COURSE DESCRIPTION FROM PROGRAM GUIDE

A fast-paced one-semester survey of numerical methods for engineers and scientists, with an emphasis on technique and software. Computer representation of numbers and floating point errors. Numerical solution of systems of linear and nonlinear algebraic equations, interpolation, least squares, quadrature, optimization, nonlinear equations, approximation of solutions of ordinary and partial differential equations. Truncation error, numerical stability, stiffness, and operation and storage complexity of numerical algorithms.

COMPREHENSIVE COURSE DESCRIPTION

Preliminaries:

Taylor series. Nested multiplication and Horner's algorithm. Floating-point representation. Roundoff error. Loss of significance.

Nonlinear Equations:

Bisection method. Newton's method. Secant method. Fixed-point iteration.

Interpolation and Numerical Differentiation:

Polynomial interpolation. Cubic splines. B-splines. Estimating derivatives.

Numerical Integration:

Trapezoid, Simpson's and Newton-Cotes rules. Gaussian quadratures.

Linear Systems:

Gaussian elimination. Gaussian elimination with scaled partial pivoting. Condition Numbers. Tridiagonal and banded systems. LU decomposition. Eigenvalues and eigenvectors. Singular value decomposition. Power method. Aitken acceleration. Inverse and shifted inverse power method. Linear least squares.

Initial Values Problems:

Vector fields. Taylor series methods. Euler's method. Types of errors. Runge-Kutta methods.

Partial Differential Equations:

Parabolic problems: heat equation model. Finite-differences and Crank-Nicolson methods.

Hyperbolic problems: wave equation model. Lax and upwind models.

Elliptic problems: Helmholtz equation. Finite-element methods.

GOALS AND OBJECTIVES

The goal of the course is to provide the students with a strong background on numerical approximation strategies and a basic knowledge on the theory that supports numerical algorithms.

REQUIRED KNOWLEDGE

Undergraduate Calculus and Linear Algebra. Previous programming experience in any language is preferred.

REFERENCE TEXTS

1) Numerical Mathematics and Computing, 7th international edition, 2013, Authors: Ward Cheney, David Kincaid, Cengage Learning

Location: main library, Call no.: QA297.C426 2013

2) Scientific Computing: An Introductory Survey, 2nd international edition, 2001, Author: Michael T. Heath, McGraw-Hill Europe

Location: main library, Call no.: Q183.9.H4 2002

METHOD OF EVALUATION

Percentages %	Graded content
 30 % 30% 40%	There are three components to the final grade: problem sets, 2 tests and a final exam. The contribution of each component to the course grade is as follows**:** • **Problem Sets,** • **2 Tests** • **Final Exam.**

COURSE REQUIREMENTS

Assignments

The tests and the final exam are both written individual papers with emphasis on the interpretation of the results. The problem sets are also individual assessments. These involve numerical implementation of algorithms and guided development of methodologies. As such, some problems require simple programming in Matlab.

Course Policies

The students are required to attend all lectures and take notes. Late homework submissions have a 10% penalty per day and are no longer accepted once the solutions are made available. Students that do not show up for a test or for the exam should expect a zero in that assessment.

Additional Information

NOTE

The instructor reserves the right to make changes to this syllabus as necessary.