COURSE OUTLINE

ENES-241

Numerical Techniques in Engineering

3 Credits

HOWARD COMMUNITY COLLEGE

Description

This course is an introduction to computational and mathematical techniques used for solving problems in a variety of engineering applications. Students will develop an understanding of error analysis, problem conditioning and stability of algorithms. Topics include numerical solution of nonlinear equations, matrix algebra, Gaussian elimination, matrix inversion, iterative computation of eigenvalues, splines, and numerical integration. Vector spaces and linear transformations, LU factorization, similarity transformation and diagonalization, interpolation and data fitting are also studied. Using current real-world industry problems, students will gain hands-on experience and problem solving skills critical to their success as engineers in the computer age. Prerequisites: ENES-159 and MATH-150 or MATH-182. (2 hours lecture, 2 hours lab).

Overall Course Objectives

Upon completion of this course, the student will be able to:

1. Describe different aspects of numerical computation and identify some of its limitations.
2. Apply basic tools from linear algebra that are useful in modeling real-world signals and systems.
3. Apply key concepts in the frequency analysis of signals in discrete time.
4. Construct a digital filter, discuss how digital filters are implemented, and describe how digital filters can be used in signal processing applications.
5. Use MATLAB, a powerful computational package, to solve engineering problems.

Major Topics

I. Numbers, Vectors and Signals
   A. Introduction to numerical Computation and its limitations
   B. Review of Complex Numbers
   C. Real-valued and Complex-valued sinusoids in continuous time
   D. Discrete-time Sinusoids
   E. Sampling of sinusoids; aliasing

II. Matrices and Systems
   A. Linear transformation and linear systems
   B. Matrix of a linear transformation; systems view of matrix multiplication
   C. Matrix operations
   D. Linear independence and its significance
   E. Nonsingular matrices and their inverse
   F. The signal representation problem and is solution via Gaussian elimination

G. Numerical issues in Gaussian elimination; *LU* factorization, matrix inversion
H. Inner products, distances, projections
I. The least-squares signal approximation problem and its solution
J. Orthogonality and signal approximation
K. Complex-valued signals and their approximation

III. Signals in the Frequency Domain
A. Orthogonality of Fourier sinusoids
B. The discrete Fourier transformation (DFT) and its inverse; significance in signal representation and approximation
C. Basic properties of the DFT
D. Matrix-based approach to the DFT and its inverse
E. Signal transformations and the DFT
F. Combinations and extensions of signals; the duality between convolution and multiplication
G. Detection of sinusoids using the DFT theory

IV. Linear Filters
A. Frequency analysis of sequences; transition from the DFT to the DTFT (discrete-time Fourier transform)
B. Computation of the DTFT
C. A basic frequency-selective filter
D. Finite impulse response (FIR) filters; exponential-type inputs, frequency response and system function
E. Classification of frequency-selective filters; phase response of FIR filters
F. Practical implementation of FIR filters

Course Requirements

Grading/exams: Grading procedures will be determined by the individual faculty. Grades will be based on homework , tests and class participation.

Other Course Information

This course is required in the Engineering AA Degree Program.