

Course URL:

<http://widener.parameterid.com/>

Textbook:

Probability Concepts in Engineering, Emphasis on Applications to Civil and Environmental Engineering, A. H-S. Ang, and W.H. Tang, 2nd Edition, 7th edition, John Wiley and Sons, Inc.
Numerical Computing with Matlab, Cleve Moler, Society for Industrial and Applied Mathematics (SIAM), 2004. (Online Book)

Reference book for Laboratory:

Applied Statistics and Probability for Engineers, Montgomery & Runge
Introduction to Probability and Statistics, Milton & Arnold
Mathematical Statistics with Applications, Mendenhall, Snee, Wackerly
Applied Numerical Methods with matlab, Chapra
Numerical Methods, Algorithms and Applications, Fausett
Applied Numerical Methods using Matlab, Fausett
Applied Numerical Methods using Matlab, Yang, Cao, Chung, Morris

Tentative Grading:
(± will be used)

Five Mid-term test average	50%
Homework/Quizzes/Programming	25%
Final Examination	25%
Total:	100%

Class Schedule:

Lecture: KH#233 T-TH 8:00 – 9:15PM, Lab: KH#123 M 2:00 - 4:00PM

GENERAL CONDUCT OF COURSE

1. During the semester, 5 one-hour tests will be given. The student **MUST** take all five tests. Basically **NO** make-ups are granted unless absence from a test is justified with proper documentation. All tests will be based on the material covered up to the date of test. Unless otherwise instructed, closed-book tests should be expected. Any grade review you see justified should be brought to my attention within the first week of receiving the grade.
2. Homework will be assigned and *collected* at that time. There will be computer assignments and programming assignments using Matlab.
3. It has been my experience in the past that when students study in groups, and communicate and share resources, they seem to perform better. Obviously, this is a generalization and I am sure there are many exceptions. However, please keep this in mind and take advantage of study groups whenever you can. **One exception to this rule is the computer and programming assignments. These assignments will be individuals work with NO collaboration. Plagiarism in programming assignments will have EXTREME consequences.**

COURSE OBJECTIVES

Solution techniques with Civil Engineering applications. Concepts from probability and statistics, linear algebra, and numerical methods. Programming in the Matlab environment. Three one-hour lectures and one two-hour laboratory per week. 4 semester hours.

Upon successful completion of this course, students will be able to:

1. Apply basic concepts of statistics in description of data
2. Apply commonly used probabilistic models
3. Conduct data analysis, interpolation, curve fitting, and quantify the degree of fit using definition of error,
4. optimization and linear regression
5. Perform basic matrix operations
6. Formulate and Solve systems of linear equations by Gaussian elimination, LU decomposition, matrix inversion,
7. Cramer's rule, and Gauss Seidel iteration
8. Find eigenvalues and eigenvectors and use them in matrix diagonalization
9. Utilize various finite difference discretization approaches for solution of 1 and 2 dimensional ODE's and PDE's.

COURSE OUTCOMES

1. Ability to apply the fundamental knowledge of mathematics, science & engineering, as well as the ability to use the techniques, skills, and modern engineering tools to solve civil engineering problems in practice.
2. An ability to identify, formulate, and solve civil engineering problems in various civil engineering disciplines.
3. An ability to conduct laboratory experiments, and to analyze and interpret data in various civil engineering disciplines.

COURSE OUTLINE

I. Programming with Matlab

1. Introduction to Matlab
 - a. Variables and Operators, Relational and Logical Operators
 - b. Selection and Repetition Structures
 - c. Data and File Input/Output
 - d. Scalar and Matrix Operations
 - e. m-files, Script and Functions
 - f. Plotting (2-D, Function Plot, Multiple Graphs, Formatting)
 - g. Matlab "Stat" toolbox
2. Programming
 - a. Program Design (Structure, Documentation, Organization, Implementation and Testing)
 - b. Error Types (Precision, Round-off and Truncation)
 - c. Convergence and Iteration

II. Probability and Statistics with Matlab Applications

1. Introduction to Probability in Engineering
 - a. Uncertainty and Types
 - b. Observation of Measurements (range, max, min, average, frequency, histogram, scattergram)
2. Introductory Statistics-Overview
 - a. Descriptive Statistics (population, sample, central tendency, dispersion)
 - b. Sets and Operations (sets, events, De Morgan's rule)
3. Fundamentals of Probability
 - a. Principle of Counting (permutation, combination, other)
 - b. Axioms of Probability
 - c. Conditional Probability, Statistical Independence
 - d. Total Probability, Bayes' Theorem
4. Analytical Models of Random Phenomena
 - a. Random Variable (discrete and continuous)
 - b. Probability Mass and Density Functions
 - c. Cumulative Distribution Function
5. Moments of Functions of Random Variables
 - a. Mathematical Expectation, Dispersion,
 - b. Skewness, Kurtosis
 - c. General Definition of Moments
6. Probability Distributions
 - a. Discrete
 - i. Bernoulli Sequence and Distribution
 - ii. Geometric Distribution
 - iii. Negative Binomial Distribution
 - iv. Hypergeometric Distribution
 - b. Continuous
 - i. Poisson Process and Distribution
 - ii. Normal Distribution
 - iii. Lognormal Distribution
 - iv. Exponential Distribution
 - v. Gamma Distribution
7. Multiple Random Variables
 - a. Joint Probability Mass - Density Functions and Cumulative Distribution Functions
 - b. Conditional and Marginal Probability Distributions
 - c. Covariance and Correlation
8. Functions of Random Variables
 - a. Functions of RVs (Examples on combined variability)
 - b. Central Limit Theorem
 - c. Taylor Series Approximation to Mean and Variance
 - d. Examples on Reliability
9. Statistical Inferences from Observational Data
 - a. Estimation: Point and Interval (Method of maximum likelihood, Method of moments)
 - b. Sampling Distributions for Mean and Variance
 - c. Hypothesis Testing
 - d. Confidence Interval of the Mean and of the Variance

III. Numerical Methods with Matlab Applications

1. Single Variable Problems and Root Finding
 - a. Bisection Method
 - b. Linear Interpolation and Secant Method
 - c. Newton's Method
 - d. Matlab fzero, and Polynomial Roots
2. System of Linear Equations
 - a. Linear Algebra Review (Transpose, Determinant, Co-factor, Adjoint, Inverse, Rank, Cramer's Rule)
 - b. Gauss Elimination (Naïve and with Pivoting)
 - c. Gauss-Jordan Method
 - d. Band and Tri-diagonal Solvers
 - e. Iterative Techniques (Jacobi Method, Gauss-Seidel Method, Successive Over Relaxation)
3. Nonlinear System of Equations
 - a. Newton's Method (1-D, 2-D Taylor Series and Jacobian Matrix)
 - b. Fixed Point Iteration
 - c. Iterative Methods (Successive Substitution, ~~Minimization and Gradient Method~~)
4. LU Decomposition
 - a. Crout's and Doolittle's Technique
 - b. Cholesky Method
 - c. Decomposition with Pivoting
5. Matrix Inversability
 - a. Ill Conditioned
 - b. Norm
 - c. Condition Number
6. Eigen Analysis
 - a. Eigenvalues and eigen vectors
 - b. Polynomial Method
 - c. Power Method
 - d. Shift Method
 - e. Inverse Power Method
7. Interpolation and Approximation
 - a. Newton's Interpolation
 - ~~b. Hermite's Interpolation~~
 - ~~c. Rational Function Interpolation~~
 - d. Cubic Splines
 - e. Discrete Least Square Approximation (linear, quadratic, nonlinear)
8. Numerical Differentiation
 - a. Taylor Series
 - b. Forward, Backward and Central Finite Difference Formulas
 - c. Higher Order Finite Difference Formulas
9. Solution of Ordinary Differential Equations (ODEs)
 - a. Finite Difference Solution to Boundary Value Problems (BVP)
 - i. Beam Deflection Problem
 - ii. Beam on Elastic Foundation
 - iii. Euler Buckling
 - iv. Eigenvalue Problem for Beam Buckling
10. Partial Differential Equations (PDEs)
 - a. Solution of Laplace Equation
 - i. 2-D Steady State Flow Problem
 - ii. 2-D Temperature in a Plate
 - iii. Direct and Indirect Iteration Methods
 - iv. Neumann and Dirichlet Boundary Conditions
 - b. Solution of Bi-harmonic Equation
 - i. Plate Bending Problem
 - ii. Fixed and Simply Supported Boundary Conditions
 - iii. Plate Bending under Uniform Distributed Load Example
11. Numerical Integration
 - a. Rectangle, Trapezoidal, and Simpson's Method (1/3)
 - b. Gauss Quadrature
12. Solution of ODE Initial Value Problems (IVPs), (Given additional time)