ME 2016 Computing Techniques (Required)

Catalog Description: ME 2016 Computing Techniques (3-0-3)

Prerequisites: CS 1371 Introduction to Computing and MATH 1502 Calculus II (C or better)

Corequisites: MATH 2403 Differential Equations

An introduction to numerical methods for the solution of mechanical engineering problems. Topics include: sources of errors in computing, mathematical bases of numerical methods, and implementation of numerical techniques using MATLAB.

Textbook: Steven C. Chapra and Raymond P. Canale, *Numerical Methods for Engineers*, 6th Edition, McGraw-Hill, 2010.

Topics Covered:

1. Introduction to mathematical modeling and the numerical solution of engineering problems.
2. Numerical errors: Computer representation of real numbers. Accuracy, precision, and round-off error. Taylor series and truncation error.
3. Root finding: Bisection and Newton-Raphson methods. Convergence.
4. Curve fitting: Least-squares regression, polynomial interpolation, piecewise cubic splines.
5. Numerical integration: Trapezoidal rule and Simpson's 1/3 rule. Order of convergence.
6. Ordinary differential equations: Euler's method, Runge-Kutta methods (second and fourth order). Order of convergence. Initial value problems. Boundary value problems.
7. Applications of numerical methods to engineering problems using MATLAB.
8. Additional topics at the discretion of the instructor, such as: advanced topics in root finding, curve fitting, or numerical integration, systems of linear equations, optimization, eigenvalue problems, etc.

Course Outcomes:

Outcome 1: The student will develop a working knowledge of several numerical methods and their analytical basis.

1.1 The student will demonstrate a basic understanding of several numerical methods.

1.2 The student will demonstrate an ability to use a Taylor series to approximate functions, derivatives, and integrals, and to determine the order of the truncation error.

1.3 The student will demonstrate an understanding of finite-precision arithmetic, round-off error, and relative and absolute errors.

Outcome 2: The student will gain experience in applying numerical methods to practical engineering problems.

2.1 The student will demonstrate the ability to translate a numerical algorithm into an efficient MATLAB program.

2.2 The student will demonstrate the ability to work with simple mathematical models of engineering problems.

2.3 The student will demonstrate an ability to communicate computational results in printed and graphical form using MATLAB and to incorporate those results into written reports.

Correlation between Course Outcomes and Student Outcomes:

ME 2016											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X										
Course Outcome 1.2	X										X
Course Outcome 1.3	X										X
Course Outcome 2.1	X				X				X		X
Course Outcome 2.2	X				X				X		X
Course Outcome 2.3	X				X		X				X

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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