CSE 5361 (Approved): Numerical Methods

Course Description

Numerical methods for scientific computation: computer arithmetic, rounding errors, machine precision, machine representation, root-finding, interpolation, integration, linear systems, splines, smoothing, curve-fitting, linear programming.

Prior Course Number: 541
Transcript Abbreviation: Numerical Methods
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Senior, Masters, Doctoral
Course Offerings: Autumn, Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: CSE 2231 and (Math 2568 or 568 or 571) and (Math 1151 or Math 151)
Exclusions: Not open to students with credit for CSE 541
Cross-Listings:

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.0901
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
BS CSE	BS Computer Science and Engineering
MS CSE	MS Computer Science and Engineering
PhD CSE	PhD Computer Science and Engineering

Course Goals

Master using the bisection method, Newton's method, and the secant method in single variable root finding.
Master central difference formula and Richardson extrapolation for numerical differentiation.
Master trapezoid rule, recursive trapezoid formula and Romberg algorithm for numerical integration.
Master Gaussian elimination with scaled partial pivoting.
Be competent with using IEEE single precision floating point arithmetic standard.

Be competent with loss of significant digits in numerical calculations.
Be competent with polynomial interpolation and Lagrange and Newton form.
Be competent with numerical computation of second derivative.
Be familiar with Simpson's and adaptive Simpson's algorithm.
Be exposed to calculating errors in polynomial interpolation.
Be exposed to Gaussian quadrature formulas.
Be exposed to solving linear systems using matrix factorization.
Be exposed to iterative solutions of linear systems.
Be exposed to method of least squares.
Be exposed to Monte Carlo simulation.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Taylor series	3.0							
Computer arithmetic, rounding errors, machine precision, machine representation	6.0							
Root finding	4.0							
Polynomial interpolation	2.0							
Numerical differentiation and integration	6.0							
Systems of linear equations; Gaussian elimination and iterative methods	10.0							
Monte Carlo Integration	1.0							
Smoothing of data and least squares method	3.0							
Splines	4.0							
Linear Programming	3.0							

Grades

Aspect	Percent
Homeworks and implementation of simple numerical methods	30%
Midterm Exam	30%
Final Exam	40%

Representative Textbooks and Other Course Materials

Title	Author
Numerical Mathematics and Computing	Cheney and Kincaid

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	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.
*	d	An ability to function on multi-disciplinary teams.

Course Contribution		College Outcome
**	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 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.

BS CSE Program Outcomes

Course Contribution		Program Outcome
***	a	an ability to apply knowledge of computing, mathematics including discrete mathematics as well as probability and statistics, science, and engineering;
**	b	an ability to design and conduct experiments, as well as to analyze and interpret data;
*	c	an ability to design, implement, and evaluate a software or a software/hardware system, component, or process to meet desired needs within realistic constraints such as memory, runtime efficiency, as well as appropriate constraints related to economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability considerations;
*	d	an ability to function on multi-disciplinary teams;
**	e	an ability to identify, formulate, and solve engineering problems;
	f	an understanding of professional, ethical, legal, security and social issues and responsibilities;
	g	an ability to communicate effectively with a range of audiences;
*	h	an ability to analyze the local and global impact of computing on individuals, organizations, and society;
*	i	a recognition of the need for, and an ability to engage in life-long learning and continuing professional development;
*	j	a knowledge of contemporary issues;
**	k	an ability to use the techniques, skills, and modern engineering tools necessary for practice as a CSE professional;
***	l	an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;
***	m	an ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;
*	n	an ability to apply design and development principles in the construction of software systems of varying complexity.

Prepared by: David Lee