MEC 320: Numerical Methods in Engineering Design and Analysis

Spring 2020 (SBU)

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Class Time and Location: TuTh: 11:30 AM – 12:50 PM, Earth and Space Sciences 001

Instructor: Professor Foluso Ladeinde **Office Location:** Heavy 224

Preferred E-mail Address: foluso.ladeinde@stonybrook.edu

Instructor Office Hours (Tentative): TuTh: 1:00 – 2:30 PM

TAs: HyeJin Oh & Deep Nilesh Vira **TA Office Hours**: TBD

Credits: 3

Pre-requisites: MEC 102 or CSE 114 or CSE 130 or ESG 111 or ESE 124; AMS 261 or MAT 203; AMS 361 or MAT 303.

Textbook: 1. Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canale, McGraw-Hill, Seventh Edition
2. Lecture notes on Optimum Design

Course Description:

This course emphasizes the implementation of numerical methods for computer-aided solutions to problems that arise in engineering design and analysis. Methods include interpolation, extrapolation, curve fitting, and integration and techniques for solving non-linear equations, systems of linear equations, and differential equations. Optimization in engineering design is covered from the formulation of design specifications and criteria, to analyzable models, through to numerical implementation.

Schedule (Subject to Change):

Week	Description	Date	Chapters	Programming Assignments
1.	Introduction: Modeling, Computers, Programming/Software, and Error Analysis	1/27-1/31	1,3,4	
2.	Roots of Non-Linear Equations	2/3-2/7	5	
3.	Roots of Non-Linear Equations	2/10-2/14	6	
4.	System of Linear Algebraic Equations	2/17-2/21	9	1: Root Finding
5.	System of Linear Algebraic Equations	2/47-2/28	10	
6.	(Midterm I: March 3, 2020)			
6.	Optimization	3/5	13	2: Algebraic Eqns.
7.	Optimization	3/9-3/13	13…14	
8.	No Classes – Spring Breaks	3/16-3/20		

9.	Optimization, Linear Programming	3/23-3/27	14…15	
10.	Curve Fitting, Interpolation, & Fourier	3/30 – 4/3	17…18	3: Optimization
11.	Curve Fitting, Interpolation, & Fourier	4/6 - 4/10	18…19	
12.	Midterm II: 4/13			4: Curve Fitting
12.	Numerical Integration and Differentiation	4/17	21	
13.	Numerical Integration and Differentiation	4/20 – 4/24	21…22	5: Integration & Differentiation
14.	ODEs and Introduction FEM	4/27 – 5/1	25…26	
15.	ODEs and Introduction FEM	5/4 – 5/8	26…27	6: ODEs
16/17.	End of Classes May 9 Finals Begin May 12 – 20			
	Commencement	5/22		

Homework: Approximately one homework assignment per week or fewer
Homework will be due one week after it is assigned.
Late homework will receive half credit before the solutions are posted and will not be accepted after that.

Exams: All exams will be scheduled in class, unless otherwise stated
No makeup exam unless arranged prior to the exam.

Grading Scale: Will grade on a curve

Grading Scheme (Subject to Change):

Midterm I: 15%
Midterm II: 15%
Final: 25% (Comprehensive)
Homework: 10%
Programming Assignments: 30% (MATLAB)
Attendance: 5%

Homework is to be done individually. Homework must be neat and orderly so that your work can be followed clearly. Solutions which are not clearly written and easy to follow (based on the judgment of the instructor) will not be graded.

MEC 320: Numerical Methods in Engineering Design and Analysis	
Credits: 3	Contact Hours: 3 hour lectures per week
LEAD COORDINATOR: TBD	**TEXTBOOK:** Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canale, McGraw-Hill, Seventh Edition or Latest Edition **SUPPLEMENTAL MATERIAL:** Lecture notes on optimum design
BULLETIN DESCRIPTION: This course emphasizes the implementation of numerical methods for computer-aided solutions to problems that arise in engineering design and analysis. Methods include interpolation, extrapolation, curve fitting, and integration and techniques solving non-linear equations, systems of linear equations, and differential equations. Optimization in engineering design is covered from the formulation of design specifications and criteria, to analyzable models, through to numerical implementation.	
PREREQUISITES: MEC 102, MAT 203, MAT 303	**THIS COURSE IS** Required

COURSE LEARNING OBJECTIVES	**PIs**	**ASSESSMENT TOOLS**
1. Be able to numerically find roots of nonlinear scalar equations	1a	Exams and Programming Assignments
2. Be able to numerically solve systems of linear algebraic eqns.	1a	Exams and Programming Assignments
3. Be able to interpolate and extrapolate a data set	1a	Exams and Programming Assignments
4. Be able to differentiate and integrate numerically	1a	Exams and Programming Assignments
5. Be able to pose and understand the nature of an optimal design problem	1c	Exams and Programming Assignments
6. Be able to solve unconstrained and constrained optimization problems numerically.	1d	Exams and Programming Assignments
7. Be able to find numerical solutions of two-point BVP's	2e	Exams and Programming Assignments
8. Be able to find numerical integrations of ODE IVP's	2e	Exams and Programming Assignments.
9. Be able to use methods of curve fitting	2e	Exams and Programming Assignments

STUDENT OUTCOMES SUPPORTED	1	2	3	4	5	6	7
	3	2					
	3 – Strongly supported 2 – Supported 1 – Minimally supported						

COURSE TOPICS

1. Introduction: Modeling, Computers, Programming/Software, and Error Analysis
2. Roots of Non-Linear Scalar Equations
3. Systems of Linear Algebraic Equations using direct and iterative methods
4. Interpolation (Lagrange and Newton Polynomials); Richardson extrapolation
5. Numerical Differentiation and Integration Methods
6. Introduction to Optimum Design
7. Numerical Methods for Optimization, Constrained Optimization, Linear Programming

8. Numerical Solutions of two-point BVP's by finite difference & shooting
9. Numerical Solutions of IVP's (ODE's), R-K & predictor corrector
10. Curve-Fitting (Least Squares & Fourier Approximations)
11. Applications to Engineering Systems

Student Accessibility Support Center Statement
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Student Accessibility Support Center, ECC (Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.
Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Student Accessibility Support Center. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities

Academic Integrity Statement
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management
Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.

Allowed Calculators
Following the Mechanical Engineering Department's mandatory calculator policy, **only** the following calculators will be allowed to be used on the midterm and final exams. There will be no exceptions. This list of calculators is identical to that allowed for the *National Council for Examiners for Engineering and Surveying* (NCEES) Fundamentals of Engineering (FE) exam that many of you will take in your senior year, as well as the Professional Engineering (PE) exam that you may take several years from now. The sooner you become comfortable on one of these calculators, the better. If you have any questions on this policy please feel free to contact me. The NCEES policy on calculators can be found here: http://www.ncees.org/exams/calculators/ .

Casio:	All **fx-115** models. Any Casio calculator must contain **fx-115** in its model name.
Hewlett Packard:	The **HP 33s** and **HP 35s** models, but no others.
Texas Instruments:	All **TI-30X** and **TI-36X** models. Any Texas Instruments calculator must contain either **TI-30X** or **TI-36X** in its model name.