MENG 511 - Applied Computational Methods for Engineers

Department:
Mechanical Engineering

Program Name: Mechanical Engineering		**Program Code:** 23	
Course Number: MENG511	**Credits:** 3 (3,0)		**Year/Semester:** 2021-2022 Fall

☒ Required Course ☐ Elective Course ☐ Service Course

Prerequisite(s):
N/A

Catalog Description:
The course is an applied approach to solve different types of equations that arise in engineering analysis. The course contains: solution of systems of linear algebraic equations, eigen-value problems; nonlinear equations; polynomial approximation, numerical differentiation and integration; ordinary differential equations and partial differential equations, Finite Element Analysis and introduction to Machine Learning. This course will expand your knowledge of numerical methods, computational science, and how to solve practical problems by applying novel science and engineering approaches.

Course Web Page:
https://staff.emu.edu.tr/qasimzeeshan/en/teaching/meng-511

Textbook(s):
- Applied Numerical Methods with MATLAB® for Engineers and Scientists, Steven C. Chapra, Third Edition, McGraw Hill, 2012
- Course notes/presentations are available on the website

Indicative Basic Reading List :
- Applied Numerical Methods for Engineers and Scientists by S.S. Rao, Prentice Hall, 2002.
- Numerical Methods for Engineers and Scientists by Joe D. Hoffman, Second Edition, Marcel Dekker, 2001
- Introduction to MATLAB for Engineers by William J Palm III, 3rd Edition, McGraw Hill, 2011
- Essential MATLAB for Engineers and Scientists by Brian H. Hahn and Daniel T. Valentine, Fourth Edition, Elsevier, 2010
- Engineering Optimization Theory and Practice by Singiresu S. Rao, JOHN WILEY & SONS, INC., 2009

Topics Covered and Class Schedule:
(3 hours of lectures per week)

Week 1	Introduction to Numerical Methods
Weeks 2-3	Solution of Nonlinear Equations
Weeks 4-5	Solution of Simultaneous Linear Algebraic Equations
Week 6	Solution of Matrix Eigenvalue Problem
Week 7	Curve Fitting and Interpolation
Weeks 8-9	**Mid-Term Examination**
Week 10	Numerical Differentiation and Integration
Week 11	Ordinary Differential Equations: Initial-Value Problems and Boundary-Value Problems
Week 12	Partial Differential Equations
Week 13	Optimization
Week 14	Finite-Element Method
Week 15:	**Final Examination & Project**

Term Assignment:
Each student is expected to choose a term project on their research area and submit the project at the end of the semester. Completion of the term assignment is a requirement to pass the course.

Reading Assignment:
Besides the textbook material, there will be some reading assignments, which will support the lectures. For any type of examination, students are also responsible from studying all assigned readings, even if they might not be discussed in class.

Software: MATLAB Student Version (any recent version should be fine)
MATLAB will be used as the programming tool in this course. Students are expected to learn how to use it by their own early in the semester.

Course Learning Outcomes: Upon successful completion of the course, the student will demonstrate competency by being able to:

1. Understand how engineering problems can be solved using basic mathematical models and numerical methods.

2. Apply standard techniques to analyze key properties of numerical algorithms, such as stability and convergence.

3. Select appropriate numerical methods to apply to various types of problems in engineering and science inconsideration of the mathematical operations involved, accuracy requirements, and available computational resources.

4. Perform data analysis efficiently and accurately using data fitting methods.

5. Develop techniques for accurate and efficient solution of models based on linear and nonlinear equations, ordinary equations and partial differential equations.

6. Perform optimization using well-established algorithms.

7. Use MATLAB for the implementation and application of numerical methods and the visualization of results.

8. Use the techniques and tools learned to solve practical engineering problems.

	Method	No	Percentage
Assessment	Midterm Exam(s)	1	20 %
	Assignment	1	20 %
	Project	1	20 %
	Final Examination	1	40 %
Prepared by: Associate Prof. Dr. Qasim Zeeshan		**Date Prepared:** October 2021	

Important Notes:
- Submission of the project report on the designated topic in the format of a paper.
- Late Submissions of the Assignments and Project will be graded as zero.
- There is no **make-up or resit** for the **Mid term or Final.**
- **NG Policy:** Students who do not attend any of the above assessment activities (such as mid-term exam, project report, presentation etc.) will be given **NG (Nil Grade).**
- University rules and regulations are applied to this course. **For details, please see** http://mevzuat.emu.edu.tr
- **REGULATIONS FOR SCIENTIFIC RESEARCH AND PUBLICATION ETHICS** apply and the guidelines are available on
  - ME department website: Graduate Program Information Booklet https://me.emu.edu.tr/en/programs/graduate/phd-mechanical-engineering
  - Research and Publication Ethics Board: https://bayek.emu.edu.tr/en/regulations