The Hashemite University
Faculty of Engineering
Department of Mechanical Engineering

Course Title: COMPUTATIONAL METHODS IN ME
Course No.: 110402703
Sections: 1
Classroom: In-Class/Online
Prerequisites: 101203 and 404103.
Semester: 2nd Semester 2025/2026
Instructor: Dr. Mohammad Gharaibeh
Office: E3101
Office Hours: See Posted Hours

Course Description:

Basic principles of numerical analysis and methods for solving different engineering problems: solution of linear and nonlinear algebraic equations, numerical differentiation and integration, numerical solution of ordinary and partial differential equations as well as finite element methods.

Required Background:

Students are expected to be familiar with ordinary **differential equations (101203)** and **(404103)** as required prerequisites prior to registering on this course.

Course Objectives:

This course is designed to give understanding and working knowledge of computational methods. The course involves a fair amount of engineering computation and programming. To really understand the subject and gain a working knowledge of engineering computing; one needs to practice and experience numerical difficulties as well as the power of numerical methods.

Course Outcomes:

By the end of the course students will have the necessary knowledge about the following concepts:

- The meaning of numerical techniques.
- How to evaluate the accuracy of numerical solutions.
- Understanding the fundamentals of numerical analysis: root of equations, least-squares regression, system of linear algebraic equations, direct and iterative methods for solving these systems, interpolation and polynomial approximation, and numerical differentiation and integration.
- Numerical solutions for 1st and 2nd order differential equations.
- Write discretized forms of elliptic and parabolic equations using finite difference methods.

Textbook:

Numerical Methods for Engineers by Chapra, S.C. and Canale, R.P., McGraw-Hill, 6th edition.

References:

- ***Applied Numerical Analysis*** by Curtis F. Gerald and Patrick O. Wheatley, Addison-Wesley. 6th edition.
- ***An Introduction to Numerical Methods and Analysis*** **by** James F. Epperson, Wiley, 2001.

Attendance:

Attendance is subject to university laws and regulations which state a **15% (approximately 2 lectures)** or less, and up to **20%** allowed absence in cases of medical emergencies. Any student who exceeds these limits will not be admitted to the final exam.

Course Evaluation and Grading:

	Date	Time	
Mid Term	**To be Announced (**TBA)		30%
HWs	**4 to 5 HWs**		15%
Project	**To be Announced (**TBA)		15%
Final Exam	**To be Announced (**TBA)		40%

Course Content:

Chapter 4: Error Analysis: Truncation Errors and the Taylor Series (1)
- 4.1 Taylor Series.
- 4.3 Total Numerical Error.

Chapter 5: Roots of Equations: Bracketing Methods (1)
- 5.2 Bisection Method.
- 5.3 False Position Method.

Chapter 6: Roots of Equations: Open Methods (2)
- 6.1 Simple Fixed-Point Iteration.
- 6.2 Newton-Raphson Method.
- 6.3 Secant Method and Modified Secant.
- 6.4 Multiple Roots.
- 6.5 Systems of Nonlinear Equations.

Chapter 9: Linear Algebraic Equations: Gauss Elimination (2)
- 9.1 Solving Small Numbers of Equations.
- 9.2 Naive Gauss Elimination.
- 9.3 Pitfalls of Elimination Methods.
- 9.4 Techniques for Improving Solutions.
- 9.7 Gauss-Jordan.

Chapter 10: Linear Algebraic Equations: LU Decomposition and Matrix Inversion (1.5)
- 10.1 LU Decomposition.
- 10.2 The Matrix Inverse.

Chapter 21: Numerical Differentiation and Integration: Newton-Cotes Integration Formulas (2)
- 21.1 Trapezoidal Rule.
- 21.2 Simpson's Rules.
- 21.3 Integration with Unequal Formulas.

Chapter 23: Numerical Differentiation and Integration: Numerical Differentiation (1.5)
- 23.1 High Accuracy Differentiation Formulas.
- 23.3 Derivatives of Unequally Spaced Data.

MID TERM EXAM

Chapter 25: Ordinary Differential Equations: Runge-Kutta Methods (3)
- 25.1 Euler's Method.
- 25.2 Improvements of Euler's Method.
- 25.3 Runge-Kutta Methods.
- 25.4 System of Equations.

Chapter 27: Ordinary Differential Equations: Boundary-Value and Eigenvalue Problems (2)
- 27.1 General Methods for Boundary-Value Problems and Derivative Boundary Conditions.

Chapter 29: Partial Differential Equations: Finite Difference in Elliptic Equation (2)
- 29.1 The Laplace Equation.
- 29.2 Solution Technique
- 29.3 Boundary Conditions

Chapter 30: Partial Differential Equations: Finite Difference in Parabolic Equation (2)
- 30.1 The Heat-conduction Method.
- 30.2 Explicit Methods
- 30.3 A Simple implicit method
- 30.5 Parabolic Equations in Two Spatial Dimensions

Chapter 31: Partial Differential Equations: Finite Element Method(2)
- 31.1 The General Approach.
- 31.2 Finite Element Application in One Dimension
- 31.3 Two Dimensional Problems

FINAL EXAM