Course Specification
(Bachelor)

Course Title:	Engineering Numerical Methods
Course Code:	ME3001
Program:	Mechanical Engineering
Department:	Mechanical Engineering
College:	Engineering and Architecture
Institution:	Umm AL-Qura University
Version:	1
Last Revision Date:	14 January 2025

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☒ Required		☐ Elective		
3. Level/year at which this course is offered: (5/3)					
4. Course General Description:					
The course includes an introduction to Scientific Computing, differentiation, nonlinear equations, simultaneous linear equations, interpolation, regression, integration, ordinary differential equations, optimization and partial differential equations.					
5. Pre-requirements for this course (if any)**:**					
ME2002: Engineering Analysis (2)					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					
Then main objectiveas are as follows: • Students will be able to develop mathematical models of lower level engineering problems. • Students will learn how to calculate, quantify, and minimize errors, concept of significant digits and how errors are related to correct number of significant digits. • Students will learn how to solve nonlinear equations numerically • Students will be introduced to fundamental matrix algebra concepts and shown how to solve simultaneous linear equations numerically • Students will learn how to curve fit (interpolation and regression) discrete date • Students will learn how to numerically integrate continuous and discrete functions. • Students will learn how to numerically solve ordinary differential					

equations that are initial value or boundary value problems.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	75	100
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	45
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)**	
Total		75

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Able to develop mathematical models of lower level engineering problems.	**K1**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
1.2	Able to calculate, quantify, and minimize errors, concept of significant digits and how errors are related to correct number of significant digits.	**K1**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
1.3	Able to solve nonlinear	**K2**	Lectures, tutorials	Homework,

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	equations numerically		and independent study assignments	Quizzes, Medterm and Exam
1.4	Able to introduce to fundamental matrix algebra concepts and shown how to solve simultaneous linear equations numerically	**K1**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
1.5	Able to learn how to curve fit discrete date and to numerically integrate continuous and discrete functions.	**K2**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
1.6	Able to learn how to numerically solve ordinary differential equations that are initial value or boundary value problems	**K2**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
2.0	**Skills**			
2.1	Ability to design and conduct experiments, as well as to analyze and interpret data;	**S2**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
2.2	Ability to design a system, component, or process to meet desired needs;	**S1**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
2.3	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;	**S3**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
2.4	Ability to identify, formulate, and solve engineering problems;	**S3**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
				Exam
2.5	Ability to apply advanced mathematics through multivariate calculus and differential equations.	**S4**	Lectures, tutorials and independent study assignments	Homework, Quizzes, Medterm and Exam
3.0	**Values, autonomy, and responsibility**			
3.1	Ability to self-learning about computational method for engineering method.	**V3**	Study presentation and report preparation	Oral presentation and minor projects.

C. Course Content

No	List of Topics	Contact Hours
1.	**INTRODUCTION TO SCIENTIFIC COMPUTING** Introduction to Numerical Methods, Measuring Errors, Sources of Error, Binary Representation of Numbers, Floating Point Representation of Numbers, Propagation of Errors, Taylor Series Revisited.	5
2.	**DIFFERENTIATION** Background, Continuous Functions, Discrete Functions.	10
3.	**NONLINEAR EQUATIONS** Background, Bisection Method, Newton-Raphson Method, Secant Method.	10
4.	**SIMULTANEOUS LINEAR EQUATIONS** Background, Gaussian Elimination, LU Decomposition, Gauss Seidel Method.	10
5.	**INTERPOLATION** Background, Direct Method, Newton's Divided Difference Method, Lagrange Method, Spline Method.	5
6.	**REGRESSION** Background, Linear Regression, Nonlinear Regression.	5
7.	**INTEGRATION** Background, Trapezoidal method, Simpson's 1/3rd Rule method, Romberg method, Gauss-Quadrature method,	5
8.	**ORDINARY DIFFERENTIAL EQUATIONS**	15

	Background, Euler's method, Runge-Kutta 2nd order method, Runge-Kutta 4th order method, Shooting Method, Finite Difference Method.	
9.	**OPTIMIZATION** Golden Section search method, Newton's method, Multidimensional Direct search method, Multidimensional Gradient search method.	10
Total		**75**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quiz	3,6,10	10%
2.	Midterm exams	8	20%
3.	Lab work	Bi-weekly	20%
4.	Final exam	16-18	50%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Numerical Methods with Applications: Customized for Mechanical Engineering, Autar Kaw, Egwu Kalu, S.T., (2011).
Supportive References	- An Introduction to Computational Fluid Mechanics by Example, By Sedat Biringen & Chuen-Yen Chow (2011). - Numerical Methods for Engineers and Scientists, BY Joe D. Hoffman (2000). - Numerical Methods for Engineering Applications, By Joel H. Ferziger (Apr 17, 1998) . - Introduction to Programming Concepts with MATLAB, By By Autar.1 Kaw, Daniel Miller, (July 9, 2012). - Numerical Methods for Fluid Dynamics, By Dale R. Durran (2010).
Electronic Materials	All the lecture notes
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities	Classroom and lab

Items	Resources
(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	
Technology equipment (projector, smart board, software)	Data show
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Faculty	Direct (project, HW, Quiz, midterm and final exam)
Effectiveness of Students assessment	Students	Indirect (Student Survey)
Quality of learning resources	Program Coordinator	Direct (CLOSO folder analysis)
The extent to which CLOs have been achieved	Faculty	Direct (project, HW, Quiz, midterm and final exam)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**ME DEPARTMENT**
REFERENCE NO.	
DATE	**JAN. 14, 2025**