Course Specification
(Bachelor)

Course Title:	Engineering Numerical Methods
Course Code:	CE 3001
Program:	Bachelor of Science in Civil Engineering
Department:	Civil Engineering Department
College:	College of Engineering and Architecture
Institution:	Umm Al Qura University
Version:	1
Last Revision Date:	31 January 2025

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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: Level 3 / 2nd Year, First term					
4. Course General Description:					
The intent of this course is to introduce students to concepts of numerical methods relevant to different types of engineering fields by writing programs or using software tools. Topics include: Approximation techniques and reliability and accuracy of the approximations. Numerical methods for the solution of nonlinear equations, Numerical Interpolation, Numerical Differentiation and Integration, and for the initial value ordinary differential equations, Numerical methods for the solution of systems of linear equations. Error analysis. Engineering case studies. Use one of the available numerical software package such as Matlab, as a scripting platform.					
5. Pre-requirements for this course (if any)**:**					
Calculus for Engineering (2)					
6. Co-requisites for this course (if any)**:**					
NA					
7. Course Main Objective(s):					
To provide the numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. To improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.					

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

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	Outline the important basic definitions and the tools of engineering numerical methods and its concepts and learn how to apply them in actual engineering problems.	K1	Traditional classroom	Homework, Quizzes, and Exams
1.2	Gain a high level of Knowledge in how to formulate engineering applactions based on numerical basics and how to solve them.	K1	Traditional classroom	Homework, Quizzes, and Exams
...				
2.0	**Skills**			
2.1	Students will be able to apply their Skills of engineering numerical methods and the techniques used to solve engineering applications based on mathematical formulation	S1	Traditional classroom	Homework, Quizzes, and Exams
2.2	Creativity to solve new mathematical models by numerical methods	S3	Traditional classroom	Homework, Quizzes, and Exams

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.0	Values, autonomy, and responsibility			
3.1	Students will be able to use and apply their numerical methods knowledge, skills and personal, social, and/or methodological abilities, in work or study situation	V1	Traditional classroom	Homework, Quizzes, and Exams
3.2	Students will be able to use new techniques to solve different difficult mathematical problems in their life and work	V1	Traditional classroom	Homework, Quizzes, and Exams
...				

C. Course Content

No	List of Topics	Contact Hours
1.	**Programming and Software** - Packages and Programming - Excel - MATLAB - Mathcad	3
2.	**Truncation Errors and the Taylor Series** - The Taylor Series - Error Propagation - Total Numerical Error	3
3.	**Roots of Equations (Bracketing Methods)** - Graphical Methods - The Bisection Method - The False-Position Method	3
4.	**Roots of Equations (Open Methods)** - Simple Fixed-Point Iteration - The Newton-Raphson Method - The Secant Method - Multiple Roots - Systems of Nonlinear Equations	3
5.	**Interpolation** - Newtons Divided-Difference Interpolating Polynomials - Lagrange Interpolating Polynomials - Coefficients of an Interpolating Polynomial	3

6.	- Inverse Interpolation - Spline Interpolation - Multidimensional Interpolation	3
7.	**Curve Fitting and Least-Squares Regression** - Linear Regression - Polynomial Regression - Multiple Linear Regression	3
8.	- Nonlinear Regression • Linear Regression and Population Models (Chemical/Bio Engineering) • Use Multiple Linear Regression to Estimate Heat Transfer (Civil/Environmental Engineering)	3
9.	**Revision** **Mid Term Exam**	3
10.	**Numerical Integration and Differentiation** - The Trapezoidal Rule - Simpsons Rules	3
11.	- Multiple Integrals - Engineering applications: • Integration to Determine the Total Quantity of Heat (Chemical/Bio Engineering) • Effective Force on the Mast of a Racing Sailboat (Civil/Environmental Engineering)	3
12.	**First Order Ordinary Differential Equations** - Eulers Method - Improvements of Eulers Method - Runge-Kutta Methods	3
13.	**Second Order Ordinary Differential Equations** - Eulers Method - Improvements of Eulers Method - Runge-Kutta Methods - Systems of Equations - Engineering applications: • Using ODEs to Analyze the Transient Response of a Reactor (Chemical/Bio Engineering) • Predator-Prey Models and Chaos (Civil/Environmental Engineering)	3
14.	**Special Matrices and Gauss-Seidel** - Special Matrices	3

	- Gauss-Jacobi method - Gauss-Seidel method - Linear Algebraic Equations with Software Packages - Boundary-Value and Eigenvalue Problems	
15.	**Constrained Optimization** - Linear Programming - Nonlinear Constrained Optimization - Optimization with Software Packages - Engineering applications: • Least-Cost Design of a Tank (Chemical/Bio Engineering) • Least-Cost Treatment of Wastewater (Civil/Environmental Engineering)	3
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Homework	All the weeks	10%
2.	Quizzes	Selective weeks	10%
3.	Midterm Exam	Week 7 or 8	30%
4.	Final Exam	Week16 or17	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	1. S.C. Chapra and R.P. Canale, "Numerical Methods for Engineers", 6th Edition, McGraw Hill, 2010.
Supportive References	1. MATLAB Primer, 2. http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf, © COPYRIGHT 1984–2012 by The MathWorks, Inc. 3. MATLAB software, http://www.mathworks.com. Purchase a student version or use PCs in the labs..
Electronic Materials	Software such as: Basic, Fortran, C. Maple, Mathematica and MATLAB. Web sites involving computational mathematics.
Other Learning Materials	- A white board & Computer with internet and data show. - In order to do the computer assignments one of the following computer software must be available for the student: Maple,

	Mathematica, MATLAB.

2. Required Facilities and equipment

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

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Program Leaders, and Department	Direct
Effectiveness of Students assessment	Students, Program Leaders, and Department	Direct
Quality of learning resources	Students, Program Leaders, and Department	Direct
The extent to which CLOs have been achieved	Students, Program Leaders, and Department	Direct
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**CIVIL ENGINEERING COUNCIL**
REFERENCE NO.	**THE FIFTEENTH SESSION OF THE ACADEMIC YEAR 1446**
DATE	**30 APRIL 2025**

