Course Specification
(Bachelor)

Course Title:	Engineering Analysis (1)
Course Code:	CE 2004
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: (4)					
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:					
Modern engineering analysis relies on a wide range of analytical methods and techniques to solve a wide range of engineering problems. The aim of this course is to equip students with the necessary skills to investigate engineering problems and formulate analytical models to obtain their solutions. Complex numbers, ordinary differential equations, Laplace transform, and partial derivatives of functions of multi-variables. Mechanical applications (mass spring). Electrical applications (AC electrical circuits, RC/RL/RLC circuits, time response, resonance frequency). Civil applications (deformation of a beam, moment-curvature relationship, newton's law of cooling/warming).					
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):					
The objectives of this course are to provide students with a thorough understanding of the fundamental ideas of complex numbers and their geometric representation on the Argand diagram, as well as their applications in engineering (Mechanics, Electric, Civil). Ordinary differential equations (ODEs) from engineering applications and some successful methods for solving them will be taught to the learner (Laplace transform). Partial derivatives of functions of multi-variables, on direct applications within the engineering disciplines (Mechanics, Electric, Civil)Engineering problems can be modelled from physical phenomena, and then the methods of solution can be applied to identify real-world engineering applications (Mechanics, Electric, Civil). To solve several engineering applications (Mechanical, Electric, and Civil); MATHEMATICA and/or MAPLE will be used.					

1- Mechanical Applications (Mass spring, Small oscillations, Stability)
2- Electrical Applications (Electrical circuits, Motion of a charged particle, Traveling waves)
3- Civil Applications (Deformation of a Beam, Moment-curvature relationship, Newton's law of cooling/warming, Time responses)

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	4	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**	60
2.	**Laboratory/Studio**	NA
3.	**Field**	NA
4.	**Tutorial**	NA
5.	**Others (specify)**	NA
Total		60

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 mathematics 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 mathematical basics and how to solve them.	K1	Traditional classroom	Homework, Quizzes, and Exams
...				
2.0	**Skills**			
2.1	Students will be able to	S1	Traditional classroom	Homework,

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	apply their Skills of engineering mathematics area and the techniques used to solve engineering applications based on mathematical formulation			Quizzes, and Exams
2.2	Creativity to solve new mathematical models	S3	Traditional classroom	Homework, Quizzes, and Exams
3.0	**Values, autonomy, and responsibility**			
3.1	Students will be able to use and apply their mathematical 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 many mathematical problems in their life and work	V1	Traditional classroom	Homework, Quizzes, and Exams
...				

C. Course Content

No	List of Topics	Contact Hours
	Chapter (1): Complex Numbers	
1.	Real and imaginary parts, modulus and argument, complex conjugate, sum, difference, product, quotient, vector interpretation	**4**
2.	The complex plane (Argand plane), graphical representation of complex numbers, polar form, De Moivre's theorem and its applications	**4**
3.	The roots of unity, the fractional roots of any complex number. Electrical Engineering Applications (Calculations of current, voltage or resistance in AC circuits (AC stands for Alternating Current, which is a current that changes magnitude and direction over time). A common application of complex numbers (more specifically, Euler's formula) is to compute the potential difference across two AC power supplies concerning time.) Mechanical Engineering Applications (Modeling of rotations of a rigid body in	**4**

	space, Modelling the Schrödinger equation, in quantum mechanics mechanical vibration, and electromagnetism.)	
4.	**Chapter (2): First Order Ordinary Differential Equations** Basic concepts and definitions of 1st order differential equations; Formation of differential equations.	4
5.	Solution of differential equations: variable separable, homogeneous, equations reducible to homogeneous form.	4
6.	Exact differential equation, equations reducible to the exact form, linear differential equation, equations reducible to linear form (Bernoulli's equation); orthogonal trajectories.	4
7.	**Revision** **Mid Term Exam**	4
8.	**Chapter (3): Second-order Ordinary Differential Equations** Second-order linear homogeneous equations with constant coefficients; differential operators; solution of homogeneous equations.	4
9.	Euler-Cauchy equation; linear dependence and independence; Wronskian; Solution of nonhomogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients; higher order linear homogeneous equations.	4
10.	Electrical Engineering Applications (Engineering modelling RLC- electric circuits.) Mechanical Engineering Applications (Modeling of small oscillations of mass-spring, Modeling of Spring/Mass Systems, Temperature of a Fluid, Bending of a Circular Plate.) Civil Engineering Applications (Deflection of a Beam, Buckling of a thin vertical Column, Bending moments and stresses, Surveying, and slope measurements.)	4
11.	**Chapter (4): Laplace Transform** Introduction, linearity, first shift theorem, Second shift theorem, multiplication by t and division by t.	4
12.	Inverse LT, Heaviside Expansion theorem, convolution theorem, unit step and	4

	Dirac-Delta function, applications on initial value problems.	
13.	Electrical Engineering Applications (Integrodifferential equation of Series Circuits, Transform of a Periodic Function, A Periodic Impressed Voltage, Systems of differential equations and its engineering applications (double circuits analysis, time responses). Mechanical Engineering Applications (Systems of differential equations and their engineering applications (mass-spring system, Coupled Springs). Civil Engineering Applications (Beam embedded at its left end and free at its right end, Beam embedded at both ends).	4
14.	**Chapter (5): Functions of Multi-Variables** Definition of functions of multi-variables, partial derivatives, The chain rule,	4
15.	Critical points, Engineering applications (Tangent vector and plane to a surface, critical points, figuring surfaces).	4
Total		**60**

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. Advanced Engineering Mathematics, Erwin Kreyszig, 10th. Edition, Wiley, 2011.
Supportive References	1. NA Advanced Engineering Mathematics, Dennis G. Zill and Warren S. Wright, 4th. Edition, Jones and Bartlett Publishers, 2011. 2. The first course in differential equations with applications,

	D. G. Zill, 1989. 3. Fundamentals of differential equations and boundary value problems, R. Nagle, E. Saff and A. Sinder, 4th. Edition, Pearson, 2004.
Electronic Materials	https://www.pdfdrive.com/advance-engineering-mathematics-books.html
Other Learning Materials	NA

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**

