Course Specification
(Bachelor)

Course Title:	Engineering Analysis (1)
Course Code:	ME2011
Program:	Bachelor of Mechanical Engineering
Department:	Mechanical Engineering
College:	Engineering and Architecture
Institution:	Umm Al-Qura University
Version:	1.0
Last Revision Date:	30 January 2025

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A. General information about the course:

1. Course Identification

1. Credit hours: (4 Hours)

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, from their physical phenomena to their real engineering applications. 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. Emphasis is placed on solving problems using complex numbers, ordinary differential equations, Laplace transform, and partial derivatives of functions of multi-variables, on direct applications within the engineering disciplines (Mechanics, Electric, Civil). Mechanical applications (mass spring, small oscillations, stability). Electrical applications (AC electrical circuits, AC power, RC/RL/RLC circuits, time response, resonance frequency, motion of a charged particle, traveling waves). Civil applications (deformation of a beam, moment-curvature relationship, newton's law of cooling/warming, time responses).

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).

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%

No	Mode of Instruction	Contact Hours	Percentage
2	E-learning	NA	NA
3	Hybrid	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.	KLO1, KLO4	Traditional classroom	Homework, Quizzes, and Exams
1.2	Gain a high level of skills in how to formulate engineering problems based on mathematical basics and how to solve them.	KLO1, KLO4	Traditional classroom	Homework, Quizzes, and Exams
2.0	**Skills**			
2.1	Apply their knowledge of engineering mathematics area and the techniques used to solve engineering applications based on mathematical formulation.	KLO1, KLO4	Traditional classroom	Homework, Quizzes, and Exams
2.2	Take the responsibility to solve examples	KLO1, KLO4, KLO9	Traditional classroom	Homework, Quizzes, and Exams
2.3	Creativity to solve new mathematical models	KLO1, KLO4, KLO9	Traditional classroom	Homework, Quizzes, and Exams
3.0	**Values, autonomy, and responsibility**			
3.1	Assess their mathematical	KLO1, KLO4, KLO9	Traditional	Homework, Quizzes,

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	knowledge, skills and/or methodological abilities, and adapt techniques to solve engineering problems.		classroom	and Exams

C. Course Content

No	List of Topics	Contact Hours
1.	**Chapter (1): Complex Numbers** Real and imaginary parts, modulus and argument, complex conjugate, sum, difference, product, quotient, vector interpretation, the complex plane (Argand plane), graphical representation of complex numbers, polar form, De Moivre's theorem and its applications, the roots of unity, the fractional roots of any complex number. Engineering applications such as: • 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 space, Modelling the Schrödinger equation, in quantum mechanics mechanical vibration, and electromagnetism.)	**12**
2.	**Chapter (2): First Order Ordinary Differential Equations** Basic concepts and definitions of 1st order differential equations; Formation of differential equations; solution of differential equations: variable separable, homogeneous, equations reducible to homogeneous form, exact differential equation, equations reducible to the exact form, linear differential equation, equations reducible to linear form (Bernoulli's equation); orthogonal trajectories. Engineering applications such as: • Electrical Engineering Applications (Engineering modelling of RL and RC electric circuits. Engineering modelling of Growth and Decay, Logistic Growth) • Mechanical Engineering Applications (Deformation of a Beam, Newton's law of cooling, estimating the time of death, velocity, acceleration, Engineering modelling of Bacterial Growth, Engineering modelling of Half-Life of Plutonium and Carbon Dating, Age of a Fossil, Mixture of Two Salt Solutions, Cooling of a Cake) • Civil Engineering Applications (Deformation of a Beam, Moment-curvature relationship, Deflection of a simple beam under uniform load, Deflection of a cantilever beam, Relative deflection of a point with another point)	**12**
3.	**Chapter (3): Second-order Ordinary Differential Equations** Second-order linear homogeneous equations with constant coefficients; differential operators; solution of homogeneous equations; 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. Engineering applications such as: • Electrical Engineering Applications (Engineering modelling RLC- electric circuits.) • Mechanical Engineering Applications (Modeling of small oscillations of mass-	**12**

	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.	**Chapter (4): Laplace Transform** Introduction, linearity, first shift theorem, Second shift theorem, multiplication by t and division by t, inverse LT, Heaviside Expansion theorem, convolution theorem, unit step and Dirac-Delta function, applications on initial value problems. Engineering applications such as: • 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.)	**12**
5.	**Chapter (5): Functions of Multi-Variables** Definition of functions of multi-variables, partial derivatives, The chain rule, Critical points, Engineering applications (Tangent vector and plane to a surface, critical points, figuring surfaces).	**12**
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. 2. Advanced Engineering Mathematics, Dennis G. Zill and Warren S. Wright, 4th. Edition, Jones and Bartlett Publishers, 2011. 3. The first course in differential equations with applications, D. G. Zill, 1989. 4. Fundamentals of differential equations and boundary value problems, R. Nagle, E. Saff and A. Sinder, 4th. Edition, Pearson, 2004.
Supportive References	NA

Electronic Materials	PowerPoint Slides provided by instructor.
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	Indirect Assessment via End of Term Student Feedback Survey
Effectiveness of Students assessment	Faculty	Direct Assessment via HW, Major Exam, and Final Exam
Quality of learning resources	Student	Indirect Assessment via End of Term Student Feedback Survey
The extent to which CLOs have been achieved	Student & Faculty	Indirect Assessment via End of Term Student Feedback Survey for CLOS attainment. Direct Assessment via HW, Major Exam, and Final Exam, mapped for CLOS attainment.
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**ACADEMIC CURRICULUM AND PLANS COMMITTEE IN COLLEGE OF ENGINEERING AND ARCHITECTURE**
REFERENCE NO.	
DATE	**30/01/2025**