Course Specification
(Bachelor)

Course Title:	2)Engineering Analysis (
Course Code:	ME2012
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

Table of Contents

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 in order 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. This course is a continuation to Engineering Analysis (1) course. Emphasis is placed on solving problems using linear algebra such as the matrices, vectors analysis, special function, partial differential equations, and Foureier series on direct applications within the engineering disciplines (Mechanics, Electric, Civil). Mechanical application (free vibration of a two-mass system, work done, momentum, circulation, tangent vector to a surface, motion of a damped harmonic oscillator, driven mass on a spring, string vibrated at some frequency, the natural frequencies, vibrations in building, heat transfer, sound waves transfer). Electrical applications (calculation the current in electrical circuits, the two-loop circuit, RC/RL/RLC circuit analysis, signal analysis, resonance frequency, estimation of electric field, magnetic flux, calculate the magnitude and direction of impedances, voltages, currents). Civil applications (calculation the reactions and forces of some concrete structures and trusses, determination of beam reactions, elastic stresses and strain, and forces factorization, slope measurement of edge of pavement of a parking area, potential function, area-surface, deflections of beams and plats, estimating the strength of buildings).

5. Pre-requirements for this course (if any):

Calculus for Engineering (2)

6. Co-requisites for this course (if any):

Engineering Analysis (1)

7. Course Main Objective(s):

The objectives of this course are to provide students with a thorough understanding of the fundamental ideas of linear algebra such as the matrices, vectors analysis, special function, partial differential equations, and Foureier series as well as their applications in engineering (Mechanics, Electric, Civil). To solve several engineering applications (Mechanical, Electric, and Civil).

1. Mechanical Applications (free vibration of a two-mass system, work done, momentum, circulation, tangent vector to a surface, motion of a damped harmonic oscillator, driven mass on a spring, string vibrated at some frequency, the natural frequencies, vibrations in building, heat transfer, sound waves transfer)
2. Electrical Applications (calculation the current in electrical circuits, the two-loop circuit, RC/RL/RLC circuit analysis, signal analysis, resonance frequency, estimation of electric field, magnetic flux, calculate the magnitude and direction of impedances, voltages, currents)
3. Civil Applications (calculation the reactions and forces of some concrete structures and trusses, determination of beam reactions, elastic stresses and strain, and forces factorization, slope measurement of edge of pavement of a parking area, potential function, area-surface, deflections of beams and plats, estimating the strength of buildings).

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	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	KLO1, KLO4	Traditional classroom	Homework, Quizzes, and Exams

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	formulation.			
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 knowledge, skills and/or methodological abilities, and adapt techniques to solve engineering problems.	KLO1, KLO4, KLO9	Traditional classroom	Homework, Quizzes, and Exams

C. Course Content

No	List of Topics	Contact Hours
1.	**Chapter (1): Linear Algebra** Linear Equations, Quadratic Equations, Matrices (Algebra of matrices; types of matrices, linear system of algebraic equations, consistency of linear systems, the rank of a matrix, Gauss elimination, the inverse of a matrix, Gauss Jordon- Gauss Jacobi and Gauss-Seidel methods, Determinants and their properties, Cramer's rule). Engineering applications such as: • Civil Engineering Applications (Calculation of the reactions and forces of some concrete structures and trusses, Determination of Beam Reactions, elastic stresses and strain, and forces factorization Using Matrix analysis, Calculation of Slope Measurement of Edge of Pavement of a Parking Area). • Electrical Engineering Applications (Calculation of the current in electrical circuits, The two-loop circuit) • Mechanical Engineering Applications (Free vibration of a two-mass system)	**12**
2.	**Chapter (2): Vectors Analysis** Definition of vectors, vectors multiplications, Scalar Product – the angle between two vectors, properties of scalar product, and applications of the dot product. Vector product, right-handed and left-handed systems, properties of vector product, applications of the cross product. Product of three vectors – Scalar triple product, properties of the scalar triple product, vector triple product, vector product of four vectors, scalar product of four vectors, gradient vectors and directional derivatives, divergence, curl, Laplace operators, Vector integral theorems: Greens, Stokes, and Gauss divergence theorems. Engineering applications such as: • Mechanical Engineering applications (work done, Stress, strain and tensors, momentum, circulation, tangent vector to a surface, potential function, area-surface, conservative fields, Maxwell equations) • Civil Engineering Applications (Angle between two vectors; Static forces, frameworks; Applications in geotechnical and structural analysis) • Electrical Engineering Applications (Estimation of Electric Filed, Electric Flux, Calculate the magnitude and direction of impedances, voltages, currents)	**12**
3.	**Chapter (3): Fourier Series** Piecewise Continuous Functions, Inner Products and Orthonormal Sets, Periodic Functions, Even and Odd Functions, Fourier Series, Half-Range Expansion,	**12**

	Generalized Fourier Series, Fourier Cosine Series, Fourier Sine Series, Fourier Series, Fourier Series On Other Intervals, Engineering applications such as: • The Motion of a Damped Harmonic Oscillator, Driven Mass on a Spring, • Circuit Analysis Signal Analysis, Resistor, Inductor, • String Vibrated at Some Frequency, The Natural Frequencies, • Vibrations in Building, Estimating the Strength of Buildings.	
4.	**Chapter (2): Special Functions** Gamma Function, Beta function, Properties – Relation Between Beta and Gamma Functions- Evaluation of Improper Integrals, Legendre Functions, Bessel Functions, Hermite Functions, Laguerre Functions, Hypergeometric Functions, Engineering Applications (Integration due to several engineering problems).	**12**
5.	**Chapter (5): Partial Differential Equations; PDEs** Important of linear PDEs, Typical boundary and initial conditions, Classification of second-order PDEs (elliptic, parabolic, hyperbolic), Wave equation (Derivation of one-dimensional wave equation - Understanding of the role of constants, parameters used in derivation - Familiarity with working with prescribed boundary conditions and initial conditions - Solution using separation of variables), Heat equation (Use of separation of variables/Fourier series for the Heat equation in one-dimensional problem - Understanding of the role of constants, parameters used in derivation - Familiarity with working with prescribed boundary conditions and initial conditions), Steady-state two dimensional heat flow (Laplace Equation), Expression of PDEs in cartesian, spherical, cylindrical, polar coordinates, Use of separation of variables in different coordinate systems. Engineering Applications (Heat Transfer, Sound Waves Transfer, Deflections of Beams and Plats)	**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**