The University of Jordan
School of Engineering
Mechanical Engineering Department

COURSE TITLE	Advanced Mathematical Methods in Mechanical Engineering	COURSE CODE	0904901
LECTURER	Prof. Ibrahim Abu-Alshaikh	EMAIL: i.abualshaikh@ju.edu.jo	
CREDIT HOURS	3	PRE-REQUISITE(S)	-

2025 COURSE CATALOG DESCRIPTION

Calculus of Variation, vector calculus; multivariable calculus and analytic geometry; Introduction to perturbation theory, Hankel, Mellin transforms, Green function method, fractional differential equations; Introduction to modern methods of applied mathematics, including non-depersonalization and scaling analysis, regular and singular asymptotic; Ordinary, partial and stochastic differential equations, introduction to engineering statistics, probability, and Markov chains.

REFERENCES:

1. Vector Calculus (6-Edition), Jerrold E. Marsden & Anthony Tromba, W. H. Freeman Company Publishers, New York, 2012.
2. Vector Calculus, David Tong, University of Cambridge
3. Special Functions (A Graduate Text), Richard Beals & Roderick Wong, 2010, Cambridge University press.
4. Special Functions in Fractional Calculus and Engineering, Harendra Singh, H. M. Srivastava, R. K. Pandey - 2023, CRC Press.
5. Ordinary and Partial Differential Equations_ With Special Functions, Fourier Series, and Boundary Value Problems, Ravi P. Agarwal, Donal O'Regan (auth.) -Springer-Verlag New York (2009).
6. Theory and Applications of Special Functions for Scientists and Engineers, Xiao-Jun Yang - (2022, Springer).
7. Fractional Differential Equations, Igor Podlubny, Academic Press, 1999.
8. Introduction to perturbation methods, Mark H Holmes -Springer (2013).
9. Fractional Integral Transforms-Theory and Applications- Ahmed I. Zayed, CRC Press (2024).
10. The calculus of variations and functional analysis with applications in mechanics, Leonid P. Lebedev, Michail J. Cloud & Victor A. Ermeyev , World Scientific 2012.
11. Dean G. Duffy - Green's Functions with Applications-Chapman and Hall_CRC (2015).
12. Erwin Kreyszig," Advanced Engineering Mathematics", 10th Edition, John Wiley & Son, Inc.

COURSE OBJECTIVES:

1. A thorough understanding of mathematical concepts and their application in engineering.
2. Ability to apply Maple software in solving advanced mathematical problems.
3. Ability to Model Engineering problems Mathematically.

COURSE LEARNING OUTCOMES:

At the end of the course students will be able to:

1. Deal with advanced topics in mathematics like Vector Calculus, special functions, fractional differential equations, variations with functional analysis, integral Transforms and Green's functions.
2. Deal with scientific papers related to mechanical Engineering topics associated with the aforementioned mathematical topics.
3. Deal with symbolic programming Maple software to solve problems associated with the aforementioned mathematical topics.

LEARNING/TEACHING METHODS:

1. Lectures
2. Web-Based Scholarly Content
3. Seminars by students

ASSIGNMENTS:

1. Problem Solving and Coding using Maple.
2. Scholarly Research and Digital Source Exploration in Focused Areas.
3. Presentations.

ASSESSMENT:

Mid-Term Exam 1	20%
Mid-Term Exam 2	20%
Assignments and activities	20%
Final Exam	40%

SYLLABUS PLAN:

Week	Topic	Hrs.
1	Introduction of ODEs, PDEs and Complex Analysis	3
2	Vector Calculus, Geometry of Euclidean space, vector valued functions, differentiation of multivariable functions, curvature, gradient, curl.	2
3-4	Vector Calculus, integral transformation and integral transformation theorems.	6
5	Special functions, Gamma, Beta, Zeta, Confluent hypergeometric functions, Cylinder function	3
6-7	Hypergeometric functions, Spherical functions, Elliptic functions and other functions	6
	Mid-Term Exam 1	
8	Fractional DEs, Fractional Derivatives and Integrals, The Laplace Transform Method in solving FDEs	3
9-10	Other methods of solving FDEs and Engineering Models (problems) of FDEs	6
11-13	Basic Calculus of Variations and Applications of the Calculus of Variations in Mechanics	9
	Mid-Term Exam 2	
14-15	Green's Functions, Green's Functions for ODEs , wave, heat and Helmholtz differential Equations	9
16	Final Exam	