Course Description Form

1. Course Name: Topics in Applied Mathematics/ MATH

2. Course Code:

MATH507

3. Semester / Year: Second / 2023-2024

4. Description Preparation Date:

5. Available Attendance Forms: Class Attendance

6. Number of Credit Hours (Total) / Number of Units (Total): 45

7. Course administrator's name (mention all, if more than one name)

Name: Prof.Dr. Ali Hassan Nasser Al-Fayadh
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8. Course Objectives

Course Objectives	• To develop the knowledge of different transforms and its application • To provide an introduction to the integral transforms and their applications in mathematics and signal processing. • To make the students acquire sound knowledge of techniques in solving differential and integral equations. • To equip the students with various possible applications of integral transforms.

9. Teaching and Learning Strategies

Strategy	• Lectures. • Tutorials. • Discussion. • Problem solving. • Home work. • Exam.

10. Course Structure

Week	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method

1	3	•Have understanding regarding different mathematical concepts. • Derive Fourier series representation of periodic functions	•Introduction: Basic definitions. Vector space, Inner products and orthonormal sets, piecewise Continuous functions, Periodic function, Fourier series formula for periodic functions.	Attendance interactive lectures	• Ask questions and give assign-ments.
2	3	• Derive Fourier series representation of odd and even functions. • Derive Fourier series representation on other intervals, and for discontinuous functions.	• Fourier Series (part I). Fourier series for odd and even functions, adaptation to other intervals, Fourier series for discontinuous functions, half range Fourier series , half range Cosine series, half range Sine series	Attendance interactive lectu	• Ask questions and give assign-ments.
3	3	• Prove some theorems regarding Fourier coefficients. • Prove some theorems regarding Differentiation and integration of Fourier series.	• Fourier Series (part II). One-Sided derivatives, A property of Fourier coefficients, Absolute and uniform convergence of Fourier series, Differentiation of Fourier series, Integration of Fourier series.	Attendance interactive lectu	• Ask questions and give assign-ments.
4	3	• Apply Fourier series of a function to obtain best approximation. • Prove and apply Bessel's inequality and Parseval's equation.	• Fourier Series (part III). Best approximation in the mean, Bessel's inequality and Parseval's equation, Applications to Fourier series.	Attendance interactive lectu	• Ask questions and give assign-ments.
5	3	• Studying various types of Fourier Integrals.	• Fourier Integral. Fourier integral of a function, Fourier	Attendance interactive lectu	• Ask questions and give assign-ments.

			Cosine integral, Fourier Sine integral, Complex Fourier integral, Properties of Fourier integral, Computation of integration using Fourier integral.		
6	3	• Studying various types of Fourier Integrals.	• Fourier Transform (part I). Fourier sine and cosine transformation Properties of Fourier Sine and Cosine transform, Applications of Fourier Sine and Cosine transform on Partial differential Equations.	Attendance interactive lectu	• Ask questions and give assign-ments.
7	3	• Apply Fourier transform for solving PDEQs.	• Fourier Transform (part II). Convolution theorem, Parseval's identity for Fourier transforms, Fourier transform of the derivative of a function, Applications to solve integral equations, Finite Fourier transforms.	Attendance interactive lectu	• Ask questions and give assign-ments.
8	3	• Apply Fourier transform for solving IEQs. •Applications of Fourier transforms i initial and boundary value problems: applications of infinite Fourier transforms.	• Fourier Transform (part III). Finite Fourier Sine transforms, Inversion formula. Finite Fourier Cosine transforms, Inversion formula, Applications of Fourier transforms in initial and boundary value problems: applications of	• Attendance interactive lectu	• Ask questions and give assign-ments.

			infinite Fourier transforms, Applications of finite Fourier transforms, finite Fourier transforms of partial derivation. **Midterm exam (1)**		
9	3	•Applications of DFT, DCT, and DST in signal processing.	• Discrete Fourier Transform (DFT): General formula, Discrete Cosine Transform (DCT), Discrete Sine Transform (DST), Applications to signal processing.	Attendance interactive lectur	• Ask questions and give assign-ments.
10	3	• Applications of Laplace transforms for solving PDEQs and IEQs.	• Laplace Transform. Definition, Standard forms, Shifting theorems, Properties, Inverse transform of derivatives, Heaviside expansion theorem, Inverse Laplace transform, Convolution theorem, Differentiation and integration properties of Laplace transform, Applications of Laplace transforms to solutions of partial differential equations and integral equations.	Attendance interactive lectur	• Ask questions and give assign-ments.
11	3	• Understanding and Applications of Hankel and Mellin transforms in various scientific fields.	• Hankel Transform: Introduction, properties and applications to PDEQs, • Mellin transforms: Introduction, properties,	Attendance interactive lectur	• Ask questions and give assign-ments.

			applications; Generalized Mellin transforms.		
12	3	• Understanding and Applications of Z Transform in Engineering and Physics problems.	• Z Transform: Introduction, Definition, Properties; Dynamic linear system and impulse response, Inverse Z transforms, Summation of infinite series, Applications to finite differential equations. • **Midterm exam (2)**	Attendance interactive lectu	• Ask questions and give assign-ments.
13	3	• Applications of fractional Laplace transforms for solving fractional DEQs.	• Fractional Calculus and its applications. Introduction, fractional derivatives, integrals, Laplace transform of fractional integrals and derivatives.	Attendance interactive lectu	• Ask questions and give assign-ments.
14	3	• Understanding the derivation of wavelets transform.	• Wavelet Transform. (part I) Definition, Discussion on continuous and discrete, Properties, Multi-resolution property, Haar, Shannon and Daubechie Wavelets.	Attendance interactive lectu	• Ask questions and give assign-ments.
15	3	• How to apply wavelets transform in various scientific fields.	• Wavelet Transform. (part II) Applications: Solving PDEQs, Signal processing.	Attendance interactive lectures.	• Ask questions and give assign-ments.

11. Course Evaluation	
15% Exam1, 15% Exam2, 70% Final Exam.	
12. Learning and Teaching Resources	
Required textbooks (curricular books, if any)	• R.V. Churchill and J. Brown.: "Fourier Series and Boundary Value Problems" (7th edition)(Publisher: McGraw-Hill Book Company). • Advanced Topics in Applied Mathematics for Engg physical Science: Sudhakar Nair.
Main references (sources)	• Introduction to Applied Mathematics, Gilbert Strang. • Fractional Calculus Theory and Applications of Differentiation and Integration to Arbitrary Order: J. Spanier and K. B. Oldham. • Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010.
Recommended books and references (scientific journals, reports…)	• Handbook of Mathematical Functions: M. Abramowitz & I. Stegun. • W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", John Wiley and Sons.(7th Edition) • L Debnath , D Bhatta, Integral Transforms & their Applications – Chapman & Hall/CRC. • Ravish R. Singh and Mukul Bhatt, Advanced Engineering Mathematics(4th Edition),McGrawHill publication,2018. • Ingrid Daubechies. 1992. Ten lectures on wavelets. SIAM. • G. Kaiser, A Friendly Guide to Wavelets, Birkhauser, Boston, 1994, pp. 44-45.
Electronic References, Websites	•http://www.efunda.com/math/math_home/math.cfm •http://www.sosmath.com •http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks