BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2021-22
COURSE HANDOUT

Date: 17.01.2022

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course Number : MATH F241
Course Title : Mathematical Methods
Instructor-In-charge : RAJESH KUMAR
Instructor(s) :
Tutorial/Practical Instructors:

1. Course Description:

Integral equations: Classification of integral equations, Voltera equations, Fredholm equations, Greens functions. Integral Transforms: Fourier, Fourier sine/cosine and their inverse transforms (properties, convolution theorem and application to solve differential equation), Discrete Fourier series, Fast Fourier transform, Calculus of Variation: Introduction, Variational problem with functionals containing first order derivatives and Euler equations, Variational problem with moving boundaries.

2. Scope and Objective of the Course:
Course introduces the concept of different mathematical methods and their applications to engineering or real life problems. Students will be able to apply basic mathematical methods to modeling and solving real-world problems.

3. Text Books:
T1: Francis B. Hildebrand, Methods of Applied Mathematics, Dover Publications; 2nd edition, 1992.
T2: Sudhakar Nair**,** Advanced Topics in Applied Mathematics: For Engineering and the Physical Sciences, Cambridge University Press; 2011.

4. Reference Books:
R1. G. B. Arfken and H. J. Weber, Mathematical Methods for Physicist, Academic Press; 2002.
R2. Anadi S. Gupta, Calculus of Variations with Applications, Prentice-Hall of India Pvt. Limited; 2004.
R3. Lokenath Debnath and D. Bhatta, Integral Transforms and their Applications, Taylor & Francis Group; 2002.
R4. Ivar Stakgold, Michael Holst, Green's Functions and Boundary Value Problems, Wiley; 3rd Edition, 2011.
R5. Ram P. Kanwal, Linear Integral Equations, Birkhauser Boston; 1996.
R6. A. Jerri, Introduction to Integral Equations with Applications, Wiley-Interscience; 2nd Edition, 1999.

5. Course Plan:

Module Number.	**Learning Outcome**	Lecture Session/ Tutorial Session	**Reference**
1.Introduction	How the differential equations converted to	L1: Introduction	**T1 (3.1-3.2)**

	integral equations and vice versa	L2:Relation between integral and differential equations T1.1 Related Exercise Problems.	
2. Solution of BVP	To find the solution of boundary value problems with the help of Green's function	L3: Dirac delta function, Green's operator L4: Green's function, Adjoint operator L5: Sturm-Liouville operator T2.1 Related Exercise Problems.	**T2 (1.1-1.10), T1 (3.3)**
3. Solutions of the integral equations	To find the solutions of the integral equations with separable kernels	L6-L7:Fredholm integral equations T3.1 Related Exercise Problems.	**T1 (3.6-3.7)**
4. **C**haracteristic numbers and characteristic functions	Properties of characteristic numbers and characteristic functions	L8-L9: Hilbert-Schmidt theory T4.1 Related Exercise Problems.	**T1 (3.8)**
5. Integral equations	To find the solution techniques for integral equations	L10: Iterative methods for solving equations of the second kind, L11: The Neumann series L12: Fredholmtheory T5.1 Related Exercise Problems.	**T1 (3.9-3.11)**
6. Approximate Methods for Integral equations		L13: Approximation of Fredholm equations by sets of algebraic equations, L14: Approximate methods ofundetermined coefficients, L15: The method of collocation, L16: The method of weighting functions, The method of least squares T6.1 Related Exercise Problems.	**T1 (3.15-3.19)**
7.Integral transform	To find the solution of differential equations with the help of integral transform	L17: Fourier series, Riemann-Lebesgue lemma, Localization lemma, L18: Fourier integral theorem, Fourier cosine and sine transforms T7.1 Related Exercise Problems.	**T2 (3.1-3.4)**
8. Fourier Transform		L19: Properties of Fourier transforms, L20: Properties of trigonometric transforms, L21: Transforms of elementary functions T8.1: Related Exercise Problems.	**T2** (**3.5-3.7)**
9. Applications of Fourier Transform		L22: Convolution integral,	**T2 (3.8-3.9, 3.11, 3.19)**

		L23: Mixed trigonometric transform, L24-25: Applications of Fourier transform, L26: Discrete Fourier transforms, T9.1: Related Exercise Problems.	
10. Maxima/ Minima	What is calculus of variation? How it is used to maximizing or minimizing definite integrals involving functions and their derivatives of one and two independent variables?	L27-28: Maxima and minima, the simplest case, illustrative examples T10.1 Related Exercise Problems.	**T1 (2.1-2.3)**
11. Introduction to Calculus of Variation		L29: Natural boundary conditions, transition conditions, L30:The variational notation T11.1 Related Exercise Problems.	**T1 (2.4-2.5)**
12. Functions and their derivatives of one and two independent variables		L31:General case of two independent variables	**T1 (2.6)**
13. Lagrange multipliers		L32-33: Constraints and Lagrange multipliers T13.1 Related Exercise Problems.	**T1 (2.7)**
14. Strum-Liouville problems		L34: Variable end points, L35: Strum-Liouvilleproblems T14.1 Related Exercise Problems.	**T1 (2.8-2.9)**
15. Applications of Calculus of Variations		L36: Hamilton's principle L37-38: Lagrange's equations T15.1 Related Exercise Problems.	**T1 (2.10-2.11)**
16. Approximate solutions of BVP	Approximate solutions of the differential equations with the help of Rayleigh-Ritz method	L39-40: The Rayleigh-Ritz method	**T1 (2.19)**

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	.	-		CB/OB (details will be announced later)
Comprehensive Examination		-		CB/OB (details will be announced later)
Surprise Quizzes /Assignments		-		Details will be announced later

7. Chamber Consultation Hour: To be announced in the class.

8. Notices: All notices regarding the course MATH F241 will be put on Mathematics department notice board/NALANDA.

9. Make-up Policy: Make up will be given only for genuine cases and for that prior permission has to be obtained

Instructor-in-charge
Course No. MATH F241