Course code	21AMAA33C	MATHEMATICAL METHODS	L	T	P	C
Core/Elective/Supportive		Core	3	1	-	4
Pre-requisite	Basic concepts of calculus, initial value problems, boundary value problems and linear transformations		Syllabus Version	2021-2022 onwards		

Course Objectives:

The main objectives of this course are to:

1. Introduce the basic concepts and knowledge about different types of integral equations and its applications.
2. Gain the key concept of popular and useful transformations techniques like Fourier transform and Hankel transform.
3. To lay a broad foundation for an understanding of the problems of the calculus of variations and its various methods and techniques.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Familiarize and understand the Volterra and Fredholm integral equations and their solutions using various methods.	K1
2	Solve simple IVP and BVP by using calculus of several variables.	K4
3	Apply techniques of Integral transform to formulate and solve complex problems of differential equations.	K3
4	Solve the equations involving functional and parametric form.	K2
5	Solve applied problems of science and engineering by using learned mathematical methods.	K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Integral Equations	12 hours

Introduction: Integral equations with separable kernels - Reduction to a system of algebraic equations, Fredholm alternative, an approximate method, Fredholm integral equations of the first kind, method of successive approximations - Iterative scheme, Volterra integral equation, some results about the resolvent kernel, classical Fredholm theory - Fredholm's method of solution - Fredholm's first, second, third theorems.

Unit:2	Applications of Integral Equations	12 hours

Application to ordinary differential equation - Initial value problems, boundary value problems - Singular integral equations - Abel integral equation.

Unit:3	Fourier Transforms	12 hours

Fourier Transforms, Fourier sine and cosine transforms – Fourier transforms of derivatives - convolution integral – Parseval's Theorem - Solution of Laplace Equations by Fourier transform.

Unit:4	Hankel Transforms	12 hours

Properties of Hankel Transforms – Hankel transformation of derivatives of functions - The Parseval's relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space - Axisymmetric Dirichlet problem for a thick plate.

Unit:5	Calculus of Variations	12 hours

The method of variations in problems with fixed boundaries: Variation and its properties - Euler's equation - Functionals of the form $\int F(x,y1,y2,..., yn,y1',y2',...yn')dx$, Functionals dependent on higher order derivatives – Functionals dependent on the functions of several

independent variables - Variational problems in parametric form - Some applications.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		
	Total Lecture hours	**62 hours**

Text Books

1	R.P. Kanwal, Linear Integral Equations: Theory and Technique, Second Edition, Birkhauser, Boston, 1997.
2	I.N. Sneddon, The Use of Integral Transforms, Tata Mc Graw Hill, New Delhi, 1974.
3	L. Elsgolts, Differential Equations and the Calculus of Variations, MIR Publishers, Moscow, 1970.

Reference Books

1	M. Rahman, Integral Equations and their Applications, WIT Press, Boston, 2007.
2	L. Debnath and D. Bhatta, Integral Transforms and their Applications, Taylor & Francis Group, London, 2007.
3	B.V. Brunt, The Calculus of Variations, Springer-Verlag, New York, 2004.
4	I.M. Gelfand and S.V. Fomin, Calculus of Variations, Dover Publications, New York, 2000.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/107/111107103/
2	https://nptel.ac.in/courses/111/104/111104025/
3	https://nptel.ac.in/courses/111/102/111102129/

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COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	M	M	S	M	M
CO3	M	L	S	S	S	S	S	M	S	S
CO3	S	S	S	S	M	M	S	M	L	M
CO4	S	S	L	S	M	S	S	M	S	S
CO5	M	M	S	S	S	S	M	S	S	M

*S-Strong; M-Medium; L-Low