Title of the Course: MATHEMATICAL METHODS
Semester   : III

Course Code	22MA3T2	Course Delivery Method	Blended Mode
Credits	4	CIA Marks	30
No. of Lecture Hours / Week	4	Semester End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Year of Introduction : 2020-21	Year of offering : 2023-24	Year of Revision: 2023-24	Percentage of Revision : 5%

Course Objectives : The objective of this course is provide the students with the basic knowledge of various mathematical methods like Fourier series, calculus of variations, difference equations and the Laplace Transformations which play an important role in solving various problems of Engineering and science.

Course Outcomes: After successful completion of this course, students will be able to

CO-NO	COURSE OUTCOME	BTL	PO	PSO
CO1	understand the concepts of Fourier Series and their properties.	K3	1	1
CO2	solve Euler's equation and related problems.	K3	7	2
CO3	solve the difference equations.	K3	7	2
CO4	understand the concepts of Laplace Transforms and its properties.	K3	3	1
CO5	solve Initial value problems using Laplace Transforms.	K3	1	2

Mapping of Course Outcomes:

CO-PO-PSO MATRIX									
22MA3T2	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
	CO1	2							2	
	CO2							3		3
	CO3							3		3
	CO4			2					2	
	CO5	3								3

UNIT – I
Fourier Series: Introduction, Euler's Formulae, Conditions for a Fourier Expansion, Functions having points of discontinuity, Change of Interval, Even and Odd functions, Half-range series.
(Sections 10.1 to 10.7 of Chapter 10 of [1])

UNIT-II
Calculus of variations: Introduction, Functionals, Euler's Equation, Solutions of Euler's Equation, Geodesics, Isometric Problems, Several Dependent Variables, Functionals involving higher order derivatives, Hamilton's Principle, Lagrange's Equation.
(Sections 35.1 to 35.8, 35.11 and 35.12 of Chapter 35 of [1])

UNIT III
Difference Equations: Introduction, Definition, Formation of Difference equations, Linear Difference equations, Rules for finding the Complementary Function, Rules for finding the Particular Integral.
(Sections 31.1 to 31.6 of Chapter 31 of [1])

UNIT IV
The Laplace Transform: Existence of Laplace Transform, Functions of exponential order, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Laplace Transform of the derivative of F(t), Initial value theorem, Final value theorem, Laplace Transform of integrals, Multiplication by t, Multiplication by t^n, division by t, Periodic functions, Some special functions.
(Sections 1.5 to 1.22 of Chapter I of [2]).

UNIT V
The Inverse Laplace Transform: Inverse Laplace transforms, Null Function, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Use of partial fractions-Inverse Laplace transforms of derivatives, Inverse Laplace transforms of integrals-multiplication by powers of p, Division by powers of p, Convolution theorem-Heaviside's expansion theorem or formula, The Complex inversion formula.
(Sections 2.1, 2.2, 2.6 to 2.16 and 2.18 of Chapter II of [2])

PRESCRIBED TEXT BOOKS:
[1] Grewal B.S, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2018.
[2] Vasihatha A.R. and Gupta R.K, Integral Transforms, 36th edition, KRISHNA Prakashan Media (P) Ltd.2017.

REFERENCE BOOKS:
1. Differential Equations Theory, Technique and Practice by George F. Simmons and Steven G.Krantz, Tata McGraw-Hill Edition.
Course has focus on : Skill Development

Websites of Interest: 1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

M. Sc. Mathematics
Third Semester
MATHEMATICAL METHODS-22MA3T2

Time: 3 hours   Max. Marks: 70

SECTION A

Answer all questions.   (5x4=20)

1 a) Obtain Fourier series of e^x in the interval $[-\pi, \pi]$ (CO1, K3)
(OR)
 b) Write the Fourier series expansion of $f(x) = x/2$ in the interval $[-\pi, \pi]$ (CO1, K3)

2 a) Prove that the shortest distance between two points in a plane is a straight line. (CO2, K3)
(OR)
 b) Find the extremal of the functional $\dfrac{\sqrt{1+(y^1)^2}}{y}$.   (CO2, K3)

3 a) Solve the difference equation Solve $y_{n+2} - 5y_{n+1} - 6y_n = 0$.   (CO3, K4)
(OR)
 b) Find the complete solution of $y_{n+2} - 4y_{n+1} + 3y_n = 5^n$.   (CO3, K4)

4 a) State and prove the first shifting theorem of Laplace transformations.   (CO4, K2)
(OR)
 b) Find the Laplace transformation of sin at.   (CO4, K2)

5 a) Find Inverse Laplace transformation of $\dfrac{p}{p^2 - a^2}$

(CO5, K4)

(OR)
 b) Find Inverse Laplace transformation of $\log\left(\dfrac{p+3}{p+4}\right)$.   (CO5, K4)

SECTION B

Answer all questions. All questions carry equal marks.   (5X10=50)

6 a) Obtain the Fourier series for the function $f(x) = e^{-x}$ in the interval $0 < x < 2\pi$. (CO1, K3)
(OR)
 b) Find the Fourier series of the function $f(x) = x \sin x$ as a cosine series in $(0, \pi)$.

Deduce that $\dfrac{1}{1.3} - \dfrac{1}{3.5} + \dfrac{1}{5.7} - \ldots\ldots\infty = \dfrac{\pi-2}{4}$

(CO1, K3)

7 a) Prove that the necessary condition for the functional $I = \int_{x_1}^{x_2} f(x, y, y^1)dx$ to be an

extremum is $\dfrac{\partial f}{\partial y} - \dfrac{\partial}{\partial x}\left(\dfrac{\partial f}{\partial y}\right) = 0$. (CO2, K4)

(OR)

b) Show that the curve which extremizes the functional $I = \int_{0}^{\pi/4}(y^{11^2} - y^2 + x^2)dx$ under

the conditions y(0)= 0, $y^1(0) = 1$, $y(\pi/4)= y^1(\pi/4) = \dfrac{1}{\sqrt{2}}$ is y = sin x.

(CO2, K4)

8 a) Form the difference equation corresponding to the family of curves $y = ax+bx^2$

(CO3, K4)

(OR)

b) (i) Solve $y_{n+2} - 4y_n = n^2+n-1$ (ii) Solve $y_{n+2} - 2y_{n+1} + y_n = n^2\, 2^n$. (CO3, K4)

9 a) Prove the following Hypothesis: If F(t) is continuous for all $t \geq 0$ and be of
exponential order a as $t \to \infty$ and if $F^1(t)$ is of class A, then the Laplace
transformation of the derivative $F^1(t)$ exists when $p > a$ and
$L\{F^1(t)\} = p\, L\{F(t)\} - F(0)$. (CO4, K3)

(OR)

b) Find the Laplace transformations of $\dfrac{e^{-at} - e^{-bt}}{t}$ and $J_0(t)$. (CO4, K3)

10 a) Find the inverse Laplace Transformation of the following functions

(i) $\dfrac{2p+1}{(p+2)^2(p-1)^2}$ (ii) $\dfrac{e^{-4p}}{(p-3)^4}$

(CO5, K3)

(OR)

b) State and prove convolution theorem. (CO5, K3)

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