COURSE NAME: OPERATIONAL MATHEMATICS L-T-P-C: 3-0-0-4

This course offers advanced topics of mathematics required to analyze the problems in engineering. Topics to be covered in this course include: Laplace transforms, Inverse Laplace Transforms and its applications to ordinary differential equations, Fourier series, Fourier Transforms, Fourier Sine and Cosine Transforms, Z transforms, the application of these Transforms to Partial Differential Equations. The mathematical skills derived from this course provides necessary base to analytical and theoretical concepts occurring in the program.

Unit 1

LAPLACE TRANSFORMS:

- Laplace Transform of standard functions, inverse transform
- Linearity, First Shifting Theorem (*s*-Shifting)
- Transforms of Derivatives and Integrals. ODEs
- Unit Step Function (Heaviside Function).
- Second Shifting Theorem (*t*-Shifting)
- Short Impulses. Dirac's Delta Function. Partial Fractions
- Transforms of the periodic functions
- Convolution. Integral Equations
- Differentiation and Integration of Transforms.
- Applications of Laplace transforms to ordinary differential equations.

-

Unit 2

FOURIER SERIES:

- Determination of Fourier coefficients
- Fourier series, even and odd functions
- Fourier series in an arbitrary interval, even and odd periodic continuation.
- Half-range Fourier sine and cosine expansions.
- Approximation by Trigonometric Polynomials
- Sturm–Liouville Problems. Orthogonal Functions
- Orthogonal Series. Generalized Fourier Series
- Fourier Integral theorem, Fourier sine and cosine integral.

Unit 3

FOURIER TRANSFORMS:

Fourier transform, Fourier Sine and Cosine Transforms

- Properties
- Inverse Transforms
- Fourier Transform. Discrete and Fast Fourier Transforms
- Finite Fourier transforms.

Unit 4

Z - TRANSFORMS:

- Z-transforms
- Inverse Z-transforms, Properties
- Damping rule
- Shifting rule,
- Initial and final value theorems
- Convolution theorem,
- Solution of difference equations by Z-transforms.

Unit 5

Partial Differential Equations (PDEs):

- Basic Concepts of PDEs
- Solution by Separating Variables. Use of Fourier Series
- Modeling: Heat Flow from a Body in Space. Heat Equation
- Heat Equation: Solution by Fourier Series.
- Steady Two-Dimensional Heat Problems. Dirichlet Problem
- Heat Equation: Modeling Very Long Bars.
- Solution by Fourier Integrals and Transforms
- Solution of PDEs by Laplace Transforms

Tentative weekly plan:

Module 1: Laplace transforms	Week 1	• Laplace Transform of standard functions, inverse transform • Linearity, First Shifting Theorem (*s*-Shifting) • Transforms of Derivatives and Integrals. ODEs
	Week 2	• Unit Step Function (Heaviside Function). • Second Shifting Theorem (*t*-Shifting) • Short Impulses. Dirac's Delta Function. Partial Fractions • Transforms of the periodic function
	Week 3	• Convolution. Integral Equations • Differentiation and Integration of Transforms. • Applications of Laplace transforms to ordinary differential equations.
Module 2: Fourier series	Week 4	• Determination of Fourier coefficients • Fourier series, even and odd functions • Fourier series in an arbitrary interval, even and odd periodic continuation.
	Week 5	• Half-range Fourier sine and cosine expansions. • Approximation by Trigonometric Polynomials • Sturm–Liouville Problems. Orthogonal Functions
	Week 6	• Orthogonal Series. Generalized Fourier Series • Fourier Integral theorem, Fourier sine and cosine integral
Module 3: Fourier Transforms	Week 7	• Fourier transform, Fourier Sine and Cosine Transforms: Properties, Inverse Transforms
	Week 8	• Fourier Transform. Discrete and Fast Fourier Transforms • Finite Fourier transforms.
Module 4: Z Transforms	Week 9	• Z-transforms • Inverse Z-transforms, Properties • Damping rule
	Week 10	• Shifting rule, • Initial and final value theorems
	Week 11	• Convolution theorem, • Solution of difference equations by Z-transforms.
Module 5: Applications to PDE's	Week 12	• Basic Concepts of PDEs • Solution by Separating Variables. Use of Fourier Series • Modeling: Heat Flow from a Body in Space. Heat Equation • Heat Equation: Solution by Fourier Series.
	Week 13	• Steady Two-Dimensional Heat Problems. Dirichlet Problem • Heat Equation: Modeling Very Long Bars. • Solution by Fourier Integrals and Transforms • Solution of PDEs by Laplace Transforms

Text Books:

1. Advanced Engineering Mathematics" by Erwin Kreyszig, 10th edition.
2. Grewal B. S (2007), Higher Engineering Mathematics, 40th edition, Khanna Publishers,New Delhi

Evaluation Components:

Midterm=20%

End Sem=30%

Class participation=10%

Assignments=20%

Scheduled Quiz=20%