

# TRANSFORM TECHNIQUES AND COMPLEX VARIABLES

(Common to the branches Civil, ECE, EEE, Mechanical, Mechanical (Robotics))

Course Code: **22BM1106**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:** At the end of the course, the student will be able to

**CO1:** evaluate Fourier series and Fourier transform of a function (**L3**)

**CO2:** solve partial differential equations, heat flow and wave propagation problems (**L3**)

**CO3:** discuss the Z- transform technique and use it to solve difference equations (**L2**)

**CO4:** examine continuity, differentiability and analyticity of a complex valued function (**L3**) **CO5:** evaluate the integral of a complex function over a simple closed contour (**L5**)

## UNIT-I

**10 Lectures**

### Fourier series and Fourier Transforms:

Dirichlet's conditions, Fourier series, conditions for a Fourier expansion, functions of any period, odd and even functions - half range series. Fourier integrals, Fourier cosine and sine integrals, Fourier transform, Fourier sine and Fourier cosine transforms and properties. (Sections 10.1 – 10.8, 22.1 – 22.4 of the textbook)

#### Learning Outcomes:

At the end of this unit, the student will be able to

- evaluate the Fourier series expansion for different periodic functions (**L5**)
- analyze the properties of a Fourier transform (**L4**)
- determine the Fourier transform of a function (**L3**)

## UNIT-II

**10 Lectures**

### Partial Differential Equations:

First order partial differential equations, solutions of first order linear and nonlinear PDEs. Method of separation of variables, solution of wave, heat and Laplace's equation in Cartesian coordinates (Sections 17.1 – 17.3, 17.5, 17.6, 18.1-18.7 of the textbook)

#### Learning Outcomes:

At the end of this unit, the student will be able to

- discuss first order linear partial differential equations (**L2**)
- solve a boundary value problem and initial value problem by method of separation of variables (**L3**)
- determine a solution for wave, heat and Laplace's equations (**L3**)

## UNIT-III

**10 Lectures**

### Z-Transforms:

Definition of Z-transform, elementary properties, linearity property, damping rule, shifting to the right and left, multiplication by n, initial value theorem, final value theorem, inverse Z-transform, convolution theorem (without proof) (Sections 23.1-23.12 of the textbook)

#### Learning Outcomes:

At the end of this unit, the student will be able to

- explain the properties of Z-transforms (**L2**)
- apply convolution theorem to find inverse Z-transform (**L3**)
- determine the solution of a difference equation using Z-transformations (**L3**)

## UNIT-IV

10 Lectures

### Complex Variables-Differentiation:

Continuity, differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate function (Sections 20.1-20.5 of the textbook) **Learning Outcomes:**

At the end of this unit, the student will be able to

- test the continuity and differentiability of a function of complex variable (L5)
- discuss the analyticity of a complex variable function (L2)
- determine the harmonic conjugate of a harmonic function (L3)

## UNIT-V

10 Lectures

**Complex variables-Integration:** Contour integrals, Cauchy theorem (without proof), Cauchy integral formula (without proof), Taylor's series, zeros of analytic functions, singularities, Laurent's series, residues, Cauchy residue theorem (without proof) (Sections 20.12-20.14, 20.16-20.18 of the textbook) **Learning Outcomes:**

At the end of this unit, the student will be able to

- calculate Taylor and Laurent series the Taylor and Laurent series (L3)
- determine the nature of the singularities and calculate residues (L3)
- evaluate certain integrals using the Cauchy residue theorem (L5)

### Textbook:

B.S. Grewal, "*Higher Engineering Mathematics*", 44th edition, Khanna publishers, 2017.

### Reference Books:

1. Erwin Kreyszig, "*Advanced Engineering Mathematics*", 9th edition, John Wiley & Sons, 2006.
2. J. W. Brown and R. V. Churchill, "*Complex Variables and Applications*", 7th edition, Mc-Graw Hill, 2004.
3. Web References: <https://nptel.ac.in/courses/111/106/111106111/>  
<https://nptel.ac.in/courses/111/107/111107056/>