TRANSFORM TECHNIQUES AND COMPLEX VARIABLES

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

Course Code: 22BM1106

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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
1. evaluate the Fourier series expansion for different periodic functions (L5)
2. analyze the properties of a Fourier transform (L4)
3. 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
1. discuss first order linear partial differential equations (L2)
2. solve a boundary value problem and initial value problem by method of separation of variables (L3)
3. 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

1. explain the properties of Z-transforms (L2)
2. apply convolution theorem to find inverse Z-transform (L3)
3. 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

1. test the continuity and differentiability of a function of complex variable (L5)
2. discuss the analyticity of a complex variable function (L2)
3. 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

1. calculate Taylor and Laurent series the Taylor and Laurent series (L3)
2. determine the nature of the singularities and calculate residues (L3)
3. 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/