CHEMICAL ENGINEERING MATHEMATICS

(Professional Elective-V)

Course Code: 15CH1140

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Course Outcomes :

At the end of the Course, the Student will be able to:

CO 1 Write the physicochemical problems in terms of mathematical expressions and solve using boundary conditions.

CO 2 Solve the ordinary differential and second order non linear equations.

CO 3 Evaluate ODE's using series solution methods, recognize the Bessel's functions. Solve the integral functions and ODE's using Laplace Transformations.

CO 4 Solve the Staged Process models.

CO 5 Solve PDE's using Laplace Transformations.

UNIT-I (12 Lectures)

FORMULATION OF PHYSICOCHEMICAL PROBLEMS:

Introduction, Illustration of the Formulation Process (Cooling of Fluids), Combining Rate and Equilibrium Concepts (Packed Bed Adsorber), Boundary Conditions and Sign Conventions, Summary of the Model Building Process, Model Hierarchy and its Importance in Analysis.

UNIT-II (12 Lectures)

Solution Techniques for Models Yielding Ordinary Differential Equations (ODE): Geometric Basis and Functionality, Classification of ODE, First Order Equations, Exact Solutions, Equations Composed of Homogeneous Functions, Bernoulli's Equation, Riccati's Equation, Linear Coefficients, First Order Equations of Second Degree, Solution

Methods for Second Order Nonlinear Equations, Derivative Substitution Method, Homogeneous Function Method, Linear Equations of Higher Order, Second Order Unforced Equations: Complementary Solutions, Particular Solution Methods for Forced Equations, Summary of Particular Solution Methods, Coupled Simultaneous ODE, Summary of Solution Methods of ODE.

UNIT-III (12 Lectures)

SERIES SOLUTION METHODS AND SPECIAL FUNCTIONS:

Introduction to Series Methods, Properties of Infinite Series, Method of Frobenius, Indicial Equation and Recurrence Relation, Summary of the Frobenius Method, Special Functions, Bessel's Equation, Modified Bessel's Equation, Generalized Bessel Equation, Properties of Bessel Functions, Differential, Integral and Recurrence Relations.

INTEGRAL FUNCTIONS:

Introduction, The Error Function, Properties of Error Function, The Gamma and Beta Functions, The Gamma Function, The Beta Function, The Elliptic Integrals, The Exponential and Trigonometric Integrals.

LAPLACE TRANSFORMATIONS:

Building Blocks, Taking the Transform, Transforms of Derivatives and Integrals, The Shifting Theorem, Transform of Distribution Functions, Practical Inversion Methods, Partial Fractions, Convolution Theorem, Applications of Laplace Transforms for Solutions of ODE.

UNIT-IV (7 Lectures)

STAGED-PROCESS MODELS:

The Calculus of Finite Differences: Introduction, Modeling Multiple Stages, Solutions Methods for Linear Finite Difference Equations, Complementary Solutions, Particular Solution Methods, Method of Undetermined Coefficients, Inverse operator Method, Nonlinear Equations (Riccaati Equation).

UNIT-V (7 Lectures)

SOLUTION TECHNIQUES FOR MODELS PRODUCING PDES:

Introduction, Classification and Characteristics of Linear Equations, Particular Solutions for PDEs, Boundary and Initial Conditions

Combination of Variables Method, Coated Wall Reactor, Orthogonal Functions and Sturm-Liouville Conditions, The Sturm-Liouville Equation, Inhomogeneous Equations, Applications of Laplace Transforms for Solutions of PDEs

TEXT BOOK:

Rice R G. and. Do, D. D. "Applied Mathematics and Modeling for Chemical Engineers", John Wiley and Sons, New York, 1995.

REFERENCES:

1. Mickley. H.S., Sherwood, T. K. and Reed, C.E, "Applied Mathematics in Chemical Engineering" , 2nd Edition, Tata McGraw-Hill, New Delhi Publications, 1975.
2. Jenson. V.J. and Jeffereys, G.V, "Mathematical Methods in Chemical Engineering", 2nd Edition, Academic Press New York, 1977.