

Core VI

Differential Equations-I

Course Objective:

Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students to various methods of solving differential equations, partial differential equations and to have a qualitative application through models. The students have to solve problems to understand the methods.

Learning Outcomes:

After completing the course the student will be able to

- Get the idea to solve first order linear ordinary differential equations of different types those are arising in physical problems.
- Get the idea to solve second order linear ordinary differential equations of different types those are arising in physical problems.
- Get basic ideas of first order partial differential equations, its formulation in two, three variables and variable separable method for identify the solutions.
- Get idea to solve various mathematical models of ODEs and PDEs which may be helpful for simulation process.

Unit I

Differential equations and mathematical models, general, particular, explicit, implicit and singular solutions of a differential equation, exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli's equation, compartmental model, population model for single species.

Unit II

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, method of

variation of parameters, linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equations.

Unit III

Partial Differential Equations - Basic concepts and definitions, origin of first order PDEs, Classification of first order PDEs, Pfaffian differential forms and equations, solution of Pfaffian differential equations in three variables, Cauchy's problem for first order PDEs, linear equations of first order, integral surfaces passing through a given curve, Cauchy's method of characteristics, compatible systems, method of separation of variables for solving first order and second order partial differential equations.

Unit IV (Practical)

The students will implement the following problems in the computer Lab using *Matlab / Mathematica / Maple* etc.

1. Plotting of second order solution family of differential equations.
2. Plotting of third order solution family of differential equations.
3. Population growth model (exponential case only).
4. Population decay model (exponential case only).
5. Solution of Cauchy problem for first order PDEs.
6. Finding the characteristics for the first order PDEs.
7. Plot the integral surfaces of a given first order PDE with initial data.

Books Recommended:

- ✓ *J. Sinha Roy and S. Padhy: A course of Ordinary and Partial differential equations, Kalyani Publishers, New Delhi, 2018.*
- ✓ *Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approaching Maple and Matlab, 2nd Edn. Taylor and Francis group, London and New York, 2009.*
- ✓ *Sneddon; Elements of Partial Differential Equations, McGraw-Hill, International Students Edition, 1957.*

Books for Reference:

- ✓ *G. F. Simmons, Differential equation, Tata McGraw Hill, 1991.*
 - ✓ *J. N. Sharma and Kehar Singh, PDE for Engineers and Scientists, Narosa, New Delhi, 2009.*
 - ✓ *Martin Braun, Differential Equations and their Applications, Springer International Student Ed. 1978.*
 - ✓ *S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India, 2014.*
 - ✓ *C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.*
 - ✓ *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*
1. e-Learning Source <http://ndl.iitkgp.ac.in> ; <http://ocw.mit.edu> ; <http://mathforum.org>