

Discipline Specific Core (DSC): 04 Credits

DSC 1 (I.1) Calculus and Ordinary Differential Equations Discipline Specific Core

1. Credit Distribution of the course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC 1 (I.1)						
Calculus and Ordinary Differential Equations	4	3	0	1	Undergraduate	Mathematics in Class XII

2. Learning Objectives

The paper builds up on the topics, namely limits and continuity, differentiation and integration, and based on these concepts, they will develop ordinary differential equations models. The methodology involves first analyzing and understanding the real-life problems, solving them, and then analyzing the solution. Students will use MATHEMATICA software for the purpose of simulation.

3. Learning Outcomes

After completing this course, students should be able to:

- explain the fundamental concepts of calculus and ordinary differential equations (ODEs);
- use MATHEMATICA software to solve problems and applications of calculus and ordinary differential equations;
- formulate real-life problems based on concepts of Calculus and ordinary differential equations.

4. Syllabus

Unit I: Understanding of the ideas of limits and continuity graphically, calculating limits at infinity, indeterminate forms, special limits involving exponential and logarithmic functions, and asymptotes; algebraic manipulation, graphing of quadric surfaces; Comparing the graphs of a function, its first derivative and its second derivative, sketching curves, solving optimization problems, differentiation, concavity, how derivatives and its effect on the shape of the graph. [12 hours]

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Unit II: Integration as a limit of a sum, volume of a 3D shape. Finite volume but infinite surface area, parametric equations of curves, arc length, and surface area. Understanding the ideas of sequences and infinite series, including Taylor approximations. [9 hours]

Unit III: First order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors. Application of first-order differential equation to draining a tank, harvesting renewable natural resources, indoor temperature oscillation, etc. [12

hours]

Unit IV: General solutions of second-order differential equation - Homogeneous and non-homogeneous differential equations with constant coefficients - Method of variation of parameters - Method of undetermined coefficients. System of linear differential equations applied to mechanical systems, electrical networks, and solutions of a linear system. [12

hours]

5. Practical Details – The following explorations would be carried out on *Mathematica* software: [30 hours]

- Plotting of slope fields and solution curves of first-order and second-order differential Equations.
- Graphical analysis of the solution of Population model, Pollution Model, Acceleration Velocity Models.
- Graphical illustration of limits of the functions.
- Plotting of the graphs of the functions and their derivatives.
- Create a project using fundamental knowledge and principles that help to provide a hands-on experience.

6. Essential Readings

- Thomas G. B. & Finney, R.L. (1998). *Calculus and Analytic Geometry*, Addison-Wesley.
- Thomas G.B., Weir M.D., Hass J. & Hell C. (2014). *Calculus*, 13th Edition, Pearson.
- Edwards C.H. & Penny D.E. (2005). *Differential equations and boundary value problems: Computing and modeling*, Pearson Education (Singapore).

7. Suggestive Readings

- Cohen, D; Henle, J. M. and Cohen, W. D. (2005) *Calculus: The Language of Change*, Jones and Bartlett Publishers, Inc.
- Callahan, J.; Cox, D and Hoffman, K. (1995) *Calculus in Context: The Five College Calculus Course*, W.H. Freeman & Co. Ltd.
- Krantz, S.G (2015) *How to Teach Mathematics*, American Mathematical Society.