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| | with the concepts.). This course also envisages to enable the students to understand the major theorems: the Green's, Stokes' and the Gauss' theorems of the course and some physical applications of these theorems. |
| Course Outcome(s) | Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables; Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids; Solve problems involving maxima and minima, line integral and surface integral and understand the major theorems: the Green's, Stokes' and the Gauss' theorems of the course and some physical applications of these theorems. Develop mathematical maturity to undertake higher level studies in mathematics and related fields. |

**Syllabus:**

Functions of several variables, Directional derivative, Partial derivative, Total derivative, Jacobian, Chain rule and Mean value theorems, Interchange of order of differentiation, Higher derivatives, Taylor's theorem, Inverse mapping theorem, Implicit function theorem, Extremum problems, Extremum problems with constraints, Lagrange's multiplier method.

Multiple integrals, Properties of integrals, Existence of integrals, iterated integrals, change of variables.

Curl, gradient, divergence, Laplacian. Cylindrical and spherical coordinates. Line integrals, surface integrals, Theorems of Green, Gauss and Stokes.

**Text books:**

1. C.H. Edwards Jr., Advanced Calculus of Several Variables, Academic Press,
1973. 2. Apostol T.M., Calculus-II - Part-2, Non-Linear Analysis

**References:**

1. Apostol T.M., Mathematical Analysis, Original Edition .
2. Apostol T.M., Calculus-II - Part-2,Non-Linear Analysis.

| **Code:MAT5205: Ordinary Differential Equations**<br>Prerequisites: Knowledge of ordinary differential equations of first order and second order | L | T | P | Credit |
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| Course Category | Core |
| Course Type | Theory |
| Course Objective | Introduce the concepts of existence and uniqueness of solution of differential equations Develop analytical techniques to solve differential equations Understand the properties of solution of differential equations |
| Course Outcome(s) | Understand the genesis of ordinary differential equations. Classify the differential equations with respect to their order and linearity; explain the meaning of solution of a differential equation; express the existence uniqueness theorem of differential equations; find solution of higher-order linear differential equations; solve systems of linear differential equations. Analyze real-world scenarios to recognize when ordinary differential equations (ODEs) or systems of ODEs are appropriate, formulate problems about the scenarios, creatively model these scenarios in order to solve the problems using multiple approaches, judge if the results are reasonable, and then interpret and clearly communicate the results. |

**Syllabus:**

Ordinary Differential Equations: Linear Equations with constant coefficients – Second order Homogeneous equations - Initial value problems - Linear dependence and independence, Wronskian and a formula for Wronskian - Non-Homogeneous equation of order two.

Homogeneous and Non-Homogeneous Equations of order 'n' - Initial value problems - annihilator Method to solve a non-homogeneous equation. Algebra of constant coefficients operators.

Linear Equations with variable coefficients - Initial value problems - Existence and Uniqueness Theorems - Solutions to a non-homogeneous equation -Wronskian and Linear dependence - reduction of the order of a homogeneous equation - Homogeneous equation with analytic coefficients - the Legendre equation. Linear Equation with regular singular points – Euler Equation - Second order equations with regular singular points - Exceptional cases - Bessel equation. Existence and Uniqueness of solutions to first order equations - Equation with variables separated - Exact Equations - Method of successive approximations - the Lipschitz condition - convergence of the successive approximations and the existence theorem.

First order systems in two variables and linearization: The general phase plane – some population models - Linear approximation at equilibrium points - Linear systems in matrix form. Examples of nonlinear systems, Stability analysis, Liapunov stability, phase portrait of 2D systems, Poincare Bendixon theory, Leinard's theorem.

**Text books:**

1. Coddington, E. and Levinson, N., Theory of Ordinary Differential Equations. McGraw-Hill, New York, 1955.

**References:**

1. Eral. A. Coddington, An Introduction to Ordinary Differential Equations, PHL Learning Pvt Ltd, 2009.
2. Lawrence Perko, Differential equations and dynamical systems, Springer, 3rd Edition, 2001. 3. G.F. Simmons: Differential Equations with Applications and Historical notes. Tata McGraw Hill, 2nd Edition, 2003.
4. A. K. Nandakumaran, P. S. Datti and Raju K. George, Ordinary Differential Equations: Principles and Applications (Cambridge IISc Series), IISc Press, 2017.
5. Hartman, Ordinary Differential Equations, Birkhaeuser, 1982.