C 10 Differential Equations & Mechanics

**6 Credits (5L+1 T)**

Duration 3hrs Marks: 100( 75+25 ) 75 Lectures + 15 Tutorials

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| **Programme: Diploma**  **Class: B.Sc.** | | | | **Year: Second** | | **Semester: Fourth** | | | | |
| **Subject: Mathematics** | | | | | | | | | | |
| **Course Code: B030401T** | | | | **Course Title: Differential Equations & Mechanics** | | | | | | |
| **Course outcomes:**  **CO1:** The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of first order and second order and to have qualitative applications.  **CO2:** A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem.  **CO3:** The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces.  **CO4:** The student, after completing the course can go for higher problems in mechanic such as hydrodynamics, this will be helpful in getting employment in industry. | | | | | | | | | | |
| **Credits: 6** | | | | | **Core Compulsory / Elective** | | | | | |
| **Max. Marks: 25+75** | | | | | **Min. Passing Marks:** | | | | | |
| **Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 6-0-0** | | | | | | | | | | |
| **Part- A**  **Differential Equations** | | | | | | | | | | |
| **Unit** | | **Topics** | | | | | | | **No. of**  **Lectures** | |
| **I** | | Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method. | | | | | | | **12** | |
| **II** | | Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations. | | | | | | | **11** | |
| **III** | | Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces. | | | | | | | **11** | |
| **IV** | | Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution. | | | | | | | **11** | |
| **Part- B**  **Mechanics** | | | | | | | | | | |
| **Unit** | | | **Topics** | | | | | **No. of**  **Lectures** | | |
| **V** | | | Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes. | | | | | **12** | | |
| **VI** | | | Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength. | | | | | **11** | | |
| **VII** | | | Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic  motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves. | | | | | **11** | | |
| **VIII** | | | Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion, Motion of particle in three dimensions,  Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems. | | | | | **11** | | |
| **Suggested Readings(Part-A Differential Equations):**   1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill 2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa 3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication 4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific. 5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs 6. Course Books published in Hindi may be prescribed by the Universities.   **Suggested Readings(Part-B Mechanics):**   * 1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers   2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers   3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill   4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill   5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs   6. Course Books published in Hindi may be prescribed by the Universities. | | | | | | | | | | |
| This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics(UG/PG), B.Sc.(C.S.) | | | | | | | | | | |
| **Suggested Continuous Evaluation Methods: Max. Marks: 25** | | | | | | | | | | |
| SN | **Assessment Type** | | | | | |  | | | **Marks** |
| **1** | **Class Tests** | | | | | | | | | | **10** |
| **2** | **Online Quizzes/ Objective Tests** | | | | | | | | | | **5** |
| **3** | **Presentation** | | | | | | | | | | **5** |
| **4** | **Assignment** | | | | | | | | | | **5** |
| **Course prerequisites:** To study this course, a student must have Certificate Course in Applied Mathematics | | | | | | | | | | | |
| **Suggested equivalent online courses:** | | | | | | | | | | | |
| **Further Suggestions:** | | | | | | | | | | | |

**C11 Riemann Integration and Series of Functions 6 Credits (5L+1T)**

**Duration 3hrs Marks : 100( 75+25 ) 75 Lectures + 15 Tutorials**

**Course Learning Outcomes:** This course will enable the students to Learn about Riemann integrability of bounded functions and algebra of R-integrable functions.

**UNIT-1**

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral;

**UNIT-2**

Definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Improper integrals; Convergence of Beta and Gamma functions.

**UNIT-3**

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions;

**UNIT-4**

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

**UNIT-5**

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel’s Theorem; Weierstrass Approximation Theorem.

**Books Recommended**

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

**C12 Linear Programming 6 Credits (5L+1T)**

**Duration 3hrs Marks : 100( 75+25 ) 75 Lectures + 15 Tutorials**

**Course Learning Outcomes**: This course will enable the students to:

i)Analyze and solve linear programming models of real life situations.

ii)Provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.

iii)Understand the theory of the simplex method.

iv)Know about the relationships between the primal and dual problems, and to understand sensitivity analysis.

v)Learn about the applications to transportation, assignment and two-person zero-sum game problems.

**Unit-I**: Linear Programming Problem, Convexity and Basic Feasible Solutions Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

**Unit-II**: Simplex Method Optimality criterion, Improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

**Unit-III**: Duality Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

**Unit-IV**: Sensitivity Analysis Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

**Unit-V**: Applications Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution.

**Assignment Problem**: Mathematical formulation and Hungarian method.

**Books Recommmended:**

1.Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition). John Wiley & Sons.

2.G. Hadley (2002). Linear Programming. Narosa Publishing House.

3.Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). McGraw-Hill Education.

4.Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.

5.Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory (3rd edition). Wiley India Pvt.Ltd.

**SEC 4 Graph Theory 3 Credits (2L)**

**Duration 2hrs Marks : 50( 35+15 ) 30Lectures**

**Course Learning Outcomes:** This course will enable the students to:

1. Appreciate the definition and basics of graphs along with types and their examples.
2. Understand the definition of a tree and learn its applications to fundamental circuits.
3. Know the applications of graph theory to network flows.
4. Understand the notion of planarity and coloring of a graph.
5. Relate the graph theory to the real-world problems.

**UNIT-1**

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi‐partite graphs, isomorphism of graphs,

**UNIT-2**

Paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix,

**UNIT-3**

Weighted graph, travelling salesman’s problem, shortest path,

**UNIT-4**

Dijkstra’s algorithm, Floyd‐Warshall algorithm.

**Books Recommended**

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.