MORIGAON COLLEGE (AUTONOMOUS)
DEPARTMENT OF MATHEMATICS
SYLLABUS

FYUGP SEMESTER – 3

Course Title: **Ordinary Differential Equations**
Course Code: **MAT-CORE-(MJ/MN)-MC-0300104**
Course Type: CORE (MJ, MN, MN-1)
Credit: 4
Total Marks: 100 (External 60, Internal 40)
No. of classes: 60

Prerequisites: Mathematics in 10+2 or equivalent standard.

Course Description: This course introduces ordinary differential equations, their solution techniques, and applications in mathematical modelling. Topics include first and second order differential equations, Wronskian, methods for solving non-homogeneous equations, and models arising in population dynamics, radioactivity, and environmental studies.

Course Objectives: The course aims to enable students to:

1. Understand the basic concepts and classification of ordinary differential equations.
2. Solve first order differential equations using standard methods.
3. Study the theory and solution techniques of second order linear differential equations.
4. Apply methods such as undetermined coefficients and variation of parameters.
5. Develop mathematical models for selected real-life problems.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Identify first order ordinary differential equations such as exact and Bernoulli equations, and determine integrating factors.
2. Recognize second order differential equations, including homogeneous, non-homogeneous, and Cauchy–Euler equations.
3. Solve first and second order ordinary differential equations using appropriate methods.
4. Compute the Wronskian and examine its properties.
5. Apply the methods of undetermined coefficients and variation of parameters to solve differential equations.
6. Formulate and analyse simple mathematical models involving growth, decay, pollution, and harvesting.

Course Contents:

UNIT 1: First Order Ordinary Differential Equations

Classification of differential equations; their origin and application. Solutions, Initial-Value Problems, Boundary-Value Problems and Existence of Solutions, First order exact differential equation. Integrating factors, Rules to find an integrating factor.

[1] Chapter 1 (Sections 1.1, 1.2 and 1.3), Chapter 2 (Sections 2.1, 2.2 and 2.4)

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Linear equations and Bernoulli equations, Orthogonal trajectories, Basic theory of higher order linear differential equations. Solving differential equation by reducing its order. Wronskian and its properties.

[1] Chapter 2 (Section 2.3), Chapter 3 (Section 3.1), Chapter 4 (Sections 4.1 and 4.6)

(No. of classes: 30, Marks: 30)

UNIT 2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients. Linear non- homogenous equations; the method of undetermined coefficients, the method of Variation of Parameters. The Cauchy-Euler equations.

[1] Chapter 4 (Sections 4.2, 4.3, 4.4 and 4.5)

(No. of classes: 20, Marks: 20)

UNIT 3: Mathematical Modelling

Compartmental models: Exponential decay and radioactivity, Lake pollution models; Population models: Exponential growth, Limited growth with harvesting.

[2] Chapter 2 (Sections 2.1, 2.2, 2.5), Chapter 3 (Sections 3.1, 3.2, 3.3)

(No. of classes: 10, Marks: 10)

Text Books:

1. Ross, Shepley L. (2013). Differential Equations (3rd Ed.). John Wiley & Sons, Inc.
2. Barnes, B. & Fulford, G. R. (2011). Mathematical Modelling with Case Studies: A Differential Equations Approach (2nd Ed.). CRC Press.

Reference Books:

1. Kreyszig, E. (2011). Advanced Engineering Mathematics (10th Ed.). John Wiley & Sons, Inc. Wiley India Edition 2015.
2. Raisinghania, M. D. (2020). Ordinary and Partial Differential Equations (19th Ed.). S. Chand and Company.

FYUGP SEMESTER – 3

Course Title:	**Real Analysis-I**
Course Code:	**MAT-CORE-(MJ)-MC-0300204**
Course Type:	CORE (MJ, MN – 1)
Credit:	4
Total Marks:	100 (External 60, Internal 40)
No. of classes:	60

Prerequisites: Mathematics in 10+2 or equivalent standard.

Course Description: This course introduces the foundations of real analysis, emphasizing the structure of the real number system, convergence of sequences, and convergence tests for infinite series.

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Course Objectives: The course aims to enable students to:

1. Understand the properties and completeness of the real number system.
2. Analyze the convergence behaviour of real sequences.
3. Study the convergence of infinite series using standard tests.
4. Distinguish between absolute and conditional convergence.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Explain the order and completeness properties of the real numbers.
2. Determine the convergence of sequences using relevant theorems.
3. Apply convergence tests to investigate infinite series.
4. Differentiate between absolute, conditional, and alternating convergence.
5. Use fundamental concepts of real analysis in solving mathematical problems.

Course Contents:

UNIT 1: Finite and infinite sets, Algebraic and order properties of $\mathbb{R}$, absolute value and real line, bounded sets, supremum and infimum, completeness property of $\mathbb{R}$, the Archimedean property, the density theorem, intervals, Nested interval theorem, uncountability of $\mathbb{R}$.

[1] Chapter – 1 (Section 1.3), Chapter 2

(No of classes: 15, Marks: 15)

UNIT 2: Real sequences: Definition, bounds of a sequence, convergence of sequences and related theorems, limit points of a sequence, Bolzano Weierstrass theorem, Definitions of limit inferior and superior with simple examples, Convergent sequences and statements of related theorems, non-convergent sequences, Cauchy's General Principle of convergence and Cauchy sequence, Sandwich Theorem, monotonic sequences.

[1] Chapter 3

(No of classes: 20, Marks: 20)

UNIT 3: Infinite Series and its convergence: Introduction, Necessary condition for convergence, Cauchy's general principle of convergence for series, Statements of preliminary theorems, positive series and its necessary condition of convergence, Geometric series, Comparison series, Statements of comparison test (first and second types), Cauchy's Root Test, D'Alembert's Ratio Test, and Raabe's Test.

[1] Chapter 9.

(No of classes: 15, Marks: 15)

UNIT 4: Absolute convergence, rearrangement theorem, alternating series, Leibniz test, conditional convergence.

[1] Chapter 9: (Sections 9.1-9.3)

(No of classes: 10, Marks: 10)

Text Book:

1. Bartle, Robert G., and Donald R. Sherbert (2010). Introduction to Real Analysis (4th Ed.). New York Weinheim: Wiley.

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Reference Books:

1. Bilodeau, G., Thie, P., & Keough, G. E. (2010). An introduction to analysis. Jones & Bartlett Learning.
2. Malik, S. C., & Savita Arora (2022). Mathematical Analysis. New Delhi: New Age International Publications.
3. Kumar, A., & Kumaresan, S. (2014). A basic course in real analysis. CRC press.
4. Ross, Kenneth A. R. (2013). Elementary Analysis: The Theory of Calculus. Undergraduate Texts in Mathematics. New York, NY: Springer New York.

FYUGP SEMESTER – 3

Course Title: **Combinatorics and Graph Theory**
Course Code: **SEC-MAT-MC-0300103**
Course Type: Skill Enhancement Course
Credit: 3
Total Marks: 75 (External 45, Internal 30)
No. of classes: 45

Course Description: This course introduces the fundamental concepts of discrete mathematics. It develops analytical and problem-solving skills through the study of graphs, graph representations, and their applications in mathematics and computer science.

Course Objectives: This course aims to provide the basic tools of counting principles, pigeonhole principle. Also introduce the basic concepts of graphs, graphs isomorphism, Eulerian and Hamiltonian graphs, and Konigsberg's Bridge problem and matrix representation of graphs.

Course Learning Outcomes: After completion of this paper, student will be able to:

1. Learn about the counting principles, permutations and combinations, Pigeon hole principle.
2. Understand the basics of graph theory and learn about Eulerian and Hamiltonian graphs.

Course Contents:

UNIT 1: Basic counting principles, Permutations and combinations, the inclusion-exclusion principle, Pigeon hole principle, binomial coefficients.

[1] Chapter 1 (Sections 5.1-5.4)

(No. of classes: 12, Marks: 12)

UNIT 2: Graph Theory: Definition, Directed and undirected graphs, basic terminologies, degree of a vertex, isolated and pendent vertices, The handshaking theorem, types of graphs, sub graphs, graphs isomorphism, operations of graphs, connected and disconnected graphs.

[2] Chapter – 1 (Section: 1.1 – 1.10, 1.12).

(No. of classes: 15, Marks: 15)

UNIT 3: Walk, path and circuits, Eulerian graphs, Hamiltonian graphs, Dirac's theorem, Ore's, theorem, Konigsberg's Bridge problem, Representation of graphs, matrix representation of graph, adjacency matrix, Incidence matrix, Linked representation of graphs.

[2] Chapter – 1 (Section: 1.13, 1.14, 1.16 – 1.18, 1.21, 1.22).

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(No. of classes: 18, Marks: 18)

Text Books:

1. Rosen, K. H. (2007). Discrete Mathematics and Its Applications. McGraw Hill.
2. Vasudev, C. (2006). Graph theory with applications. New Age International.

Reference Books:

1. Towusend, M. (1987). Discrete Mathematics; Applied Combinatorics and Graph Theory. Benjamin-Cummings Pub Co.
2. Deo, N. (2006). Graph theory with applications to engineering and computer science. Prentice Hall of India, New Delhi.