Syllabus template

Semester: 2	
Programme : Mathematics	
Course : Linear Programming & Calculus-1	
Paper code: B1MT230221T	Credits: 4
Hours/week : 4 HOURS	
Category: Core/MDC/SEC/VAC : Minor	
Theory / Practical / Composite : Theory	
No of Modules : 2	

Course Overview: **Linear Programming & Calculus-1**

This course introduces the foundational concepts and methods of Linear Programming and Calculus, emphasizing analytical reasoning, problem-solving, and practical applications.

Module–1: Linear Programming

The Linear Programming unit focuses on the formulation, analysis, and solution of optimization problems involving linear objective functions subject to linear constraints. Students will learn to model real-world problems in mathematical form, develop problem-solving strategies, and interpret results meaningfully. The course begins with the formulation of Linear Programming Problems (LPPs) in standard and canonical forms, followed by graphical solutions and insights into various solution types such as finite, alternative, and unbounded solutions. Students will explore basic feasible solutions, convex sets, and the Simplex Method—both algebraically and geometrically—to determine optimal solutions efficiently. The module also introduces duality theory, exploring the relationship between primal and dual problems, and their theoretical implications in optimization. An additional section on Game Theory connects optimization with strategic decision-making, covering two-person zero-sum games, mixed strategies, and the reduction of game problems to LPPs, thereby linking linear programming with economic and competitive applications.

Module–2: Calculus–I

The Calculus unit deepens students' understanding of the behavior of real-valued functions and their applications in science and engineering. Starting with Mean Value Theorems—including Rolle's, Lagrange's, and Cauchy's forms—students explore their geometrical interpretations and practical applications in problem solving. The module advances to indeterminate forms and the L'Hospital's Rule for resolving limiting behaviors of functions.
Further, the Taylor's and Maclaurin's Theorems are introduced along with their remainder forms, leading to series expansions for standard functions such as exponential, trigonometric, and logarithmic functions.
Finally, students apply differentiation techniques to solve problems involving maxima and minima, emphasizing real-world applications in geometry, physics, and economics.

Course Outcome: **Linear Programming & Calculus-1**

1. Identify and formulate real-life optimization problems into Linear Programming Problems in standard and canonical forms.
2. Analyze and solve Linear Programming Problems graphically to obtain finite, alternative, or unbounded solutions.
3. Examine feasible, basic feasible, and degenerate solutions of a system of linear equations and understand the concept of convex sets, extreme points, and boundary points and

analyze them.				
4. Apply the Simplex Method (algebraic and geometric aspects) and Big-M Method to find optimal solutions to LPPs.				
5. Analyze duality theory to establish relationships between primal and dual problems and interpret the Fundamental Theorem of Duality in solving LPPs.				
6. Evaluate and apply game theory concepts — saddle point, maximin–minimax principle, dominance, and reduction of games to LPP — to model and solve two-person zero-sum games.				
7. Remember and interpret the statements and geometrical significance of Rolle's, Lagrange's, and Cauchy's Mean Value Theorems.				
8. Apply Mean Value Theorems and L'Hospital's Rule to solve problems involving derivatives and indeterminate forms.				
9. Construct Taylor's and Maclaurin's series expansions for standard functions and analyze their convergence and application.				
10. Apply the concepts of maxima and minima to solve optimization problems in geometry, physics, and engineering contexts and analyze them.				
Prerequisites: *Basic knowledge about any prior course*				
SYLLABUS: Linear Programming & Calculus-1				
UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I.	1. Linear Programming [37]: Formulation of Linear Programming Problems: standard and canonical forms. (3). Graphical Solution of L.P.P and moving hyperplane method: Examples of Finite Optimal Solution; Alternative Optimal Solution; Unbounded Solution. (3).	6 classes	CO1, CO2	K1, K2, K3, K4
II.	Basic Solution of a system of linear equations: examples. Feasible solution. Degenerate solution. Reduction of a feasible solution to a basic feasible solution. (4). Convex sets and their properties (statement only) Examples; [2]. Extreme points and Boundary points of a convex set and examples [1]	7 classes	CO3	K2, K4
III.	Simplex Method: Its Algebraic and Geometric Aspect (2). Criteria for improvement and optimality of objective function; Criterion for unbounded solution. Computational Aspect of Simplex method: Simplex table. Examples (5) Obtaining initial b.f.s. Artificial variable. Charne's Big M Method (4)	11 classes	CO4	K3
IV.	Duality Theory: Canonical and Standard form of primal and dual l.p.p. , Dual of the dual LPP is the primal LPP[2]. Weak duality Theorem, Fundamental Theorem on Duality (no proof) and their applications. [2]	4 classes	CO5	K4, K5

V.	Game theory: Two Person zero sum game. The Saddle point and the maximin-minimax principle. Relation between maximin and minimax values (2). Games without saddle point: Mixed strategy(2). Graphical Method of solving nx2 and 2xn games (2). Dominance property: generalised dominance (1). Reduction of a game problem to a LPP: Fundamental Theorem of Rectangular Games (statement only) (2).	9 classes	CO6	K3, K5
VI.	Module -2 [Calculus-1] Mean Value Theorems [15]: Statement of Rolle's Theorem - its geometrical interpretation and direct applications. Mean Value Theorems of Lagrange and Cauchy (no proof) and applications (5). Indeterminate Forms: L' Hospital's Rule: statement and problems only (2). Statement of Taylor's and Maclaurin's Theorem with Lagrange's & Cauchy's form of remainders. Taylor's and Maclaurin's infinite series for functions like exp(x), sin(x), cos(x),ln(1+ x) (with restrictions wherever necessary)(5). Application of the principle of maximum and minimum for a function of a single variable in geometrical, physical and other problems (3).	15 classes	CO7, CO8, CO9, CO10	K1, K2, K3, K4, K5

Text Books
1. Real Analysis—S.K.Mapa.
2. Linear Programming: P.M.Karak
3.
Suggested readings
1. Introduction to Real Analysis—Bartle, Sherbert
2. Linear Programming and Network Flows: Bajara & Jarvis
3.
Web Resources
1. https://youtu.be/tffrrtzUhmw
2. https://youtu.be/9EazAcwS3S0
3.
4.
Evaluation: Theory CIA: 20+5+5=30 Semester Exam: 70
Paper Structure for Theory Semester Exam: Module-1 [50 marks]: 5 questions each carrying 10 marks out of 9 questions. Module-2 [20 marks]: 2 questions each carrying 10 marks out of 4 questions.

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Identify and formulate real-life optimization problems into Linear Programming Problems in standard and canonical forms.	K1, K2
CO2	Analyze and solve Linear Programming Problems graphically to obtain finite, alternative, or unbounded solutions.	K3, K4
CO3	Examine feasible, basic feasible, and degenerate solutions of a system of linear equations and understand the concept of convex sets, extreme points, and boundary points and analyze them.	K2, K4
CO4	Apply the Simplex Method (algebraic and geometric aspects) and Big-M Method to find optimal solutions to LPPs.	K3
CO5	Analyze duality theory to establish relationships between primal and dual problems and interpret the Fundamental Theorem of Duality in solving LPPs.	K4, K5
CO6	Evaluate and apply game theory concepts — saddle point, maximin–minimax principle, dominance, and reduction of games to LPP — to model and solve two-person zero-sum games.	K3, K5
CO7	Remember and interpret the statements and geometrical significance of Rolle’s, Lagrange’s, and Cauchy’s Mean Value Theorems.	K1, K2
CO8	Apply Mean Value Theorems and L’Hospital’s Rule to solve problems involving derivatives and indeterminate forms.	K3
CO9	Construct Taylor’s and Maclaurin’s series expansions for standard functions and analyze their convergence and application.	K3, K4
CO10	Apply the concepts of maxima and minima to solve optimization problems in geometry, physics, and engineering contexts and analyze them.	K3, K5