Teaching Plan (Jan 2022-April 2022)

DSE-4 (ii): Linear Programming and Applications

Course Objective: To familiarize the students with an important branch of Operations Research, Linear Programming Problem. Emphasis will be on its application as transportation, assignment and game problem. These problems appear in manufacturing resource planning and financial sectors.

Learning Outcomes:

After the completion of this course the students should be able to:

i) Learn about the graphical solution of linear programming problem with two variables.

ii) Learn about the relation between basic feasible solutions and extreme points.

iii) Understand the theory of the simplex method used to solve linear programming problems.

iv) Learn about two-phase and big-M methods to deal with problems involving artificial variables.

v) Learn about the relationships between the primal and dual problems.

vi) Solve transportation and assignment problems.

vii) Apply linear programming method to solve two-person zero-sum game problems.

Course Content: Month	**Topic**
Jan	**Unit I (3 Weeks)** Linear programming problem: Standard, Canonical and matrix forms, Graphical solution. Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic feasible solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points. **Unit II (1 Week)** Simplex Method: Optimal solution, Termination criteria for optimal solution of the linear programming problem, Unique and alternate optimal solutions, Unboundedness.
Feb	**Unit II (3 Weeks)** Simplex algorithm and its tableau format. Artificial variables, Two-phase method, Big-M method. **Unit III (1 Week)** Motivation and formulation of dual problem; Primal-dual relationships.
March	**Unit III (1 week)** Statements of the fundamental theorem of duality and complimentary slackness theorem with examples. **Unit IV (2 weeks)** Transportation problem, Assignment problem.
April	**Unit IV (2 weeks)** Game Theory: Basic concept, Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method of solving a game. ✓ **(1 week)** ▪ Revision of Syllabus ▪ Taking up doubts ▪ Additional practice of questions of higher difficulty order

❖ To make the lectures interesting, each topic is explained with examples. Students are involved in discussions and encouraged to ask questions.

- ❖ Students are encouraged to give short presentations.

References:

1. Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). Linear Programming and network Flows (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). Linear Programming. Narosa Publishing House. New Delhi.
3. Taha, Hamdy A. (2010). Operations Research: An Introduction (9th ed.). Pearson.

Additional Readings:

1. Hillier, Frederick S. & Lieberman, Gerald J. (2015). Introduction to Operations Research (10th ed.). McGraw-Hill Education (India) Pvt. Ltd.
2. Thie, Paul R., & Keough, G. E. (2014). An Introduction to Linear Programming and Game Theory. (3rd ed.). Wiley India Pvt. Ltd.

Teaching Plan (Jan 2022-April 2022)

Paper IV: Real Analysis

Course Objective: To inculcate a deeper and more rigorous understanding of defining terms and proving results about convergence of sequences and series of real numbers. These problems have extensive applications in real-world problems.

Learning Outcomes:

After the completion of this course the students should be able to:

i) Be familiar with the concept of sequences, series and recognize convergent, divergent, bounded, Cauchy and monotone sequences.

ii) Test the convergence and divergence of series using ratio test, root test and Leibnitz test.

iii) Understand the concepts of pointwise and uniform convergence.

iv) Understand Riemann integrability of continuous and monotone functions.

Course Content: Month	**Topic**
Jan	**Unit I (2 Weeks)** Finite and infinite sets, Examples of countable and uncountable sets; Absolute value of the real line; Bounded sets, Suprema and infima, Statement of order completeness property of $\mathbb{R}$, Archimedean property of $\mathbb{R}$. **Unit I (2 Weeks)** Real sequences, Convergence, sum and product of convergent sequences, Order preservation and squeeze theorem. Monotone sequences and their convergence; Proof of convergence of some simple sequences.
Feb	**Unit I (2 Weeks)** Subsequences and the Bolzano–Weierstrass theorem (statement and examples); Limit superior and limit inferior of a bounded sequence (definition and examples); Statement and illustrations of Cauchy convergence criterion for sequences. **Unit II (2 Weeks)** Definition and a necessary condition for convergence of an infinite series, Geometric series, Cauchy convergence criterion for series; Positive term series, State the integral test and prove the convergence of p-series, Comparison test, Limit comparison test and examples.

March	**Unit III (1 week)** D'Alemberts ratio test, Cauchy's root test; Alternating series, Leibnitz's test; Absolute and conditional convergence. **Unit IV (2 weeks)** Sequences and series of functions, Pointwise and uniform convergence, Uniform norm, Cauchy general principle for uniform convergence of series of functions, Weierstrass M-test.
April	**Unit IV (2 weeks)** Definition of power series, Radius and interval of convergence, Power series expansions for e^x, sinx and cosx and their properties. Riemann Integration and examples, Integrability of continuous and monotone functions. ✓ **(1 week)** ▪ Revision of Syllabus ▪ Taking up doubts ▪ Additional practice of questions of higher difficulty order

- To make the lectures interesting, each topic is explained with examples. Students are involved in discussions and encouraged to ask questions.
- Students are encouraged to give short presentations.

References:

4. Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.). Wiley India Edition.
5. Denlinger, Charles G. (2015). Elements of Analysis. Jones & Bartlett India Pvt. Ltd.
6. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint.

Additional Readings:

1. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.