Optimization Methods and Applications

1.1 Course Number: MA 422

1.2 Contact Hours: 41 (L) Credits: 9 [LTP: 3-0-0]

1.3 Semester-offered: Even

1.4 Prerequisite: Linear Algebra; Analysis; Calculus and Matlab

1.5 Syllabus Committee Member: Dr. C. Kundu, Dr. M.K. Rajpoot (convener), Dr. A. Kumar, Dr. G. Rakshit.

2. **Objective:**

This course emphasizes the prevailing abilities of mathematical programming to problems like costs minimization, resource allocation, efficiency optimization and offering better solution in many other key areas in economics, science, engineering, and industry by solving their respective decision-making problems.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	**Convex sets and Unconstrained optimization**	Convex sets and convex functions; Unconstrained optimization: Basic properties of solutions and algorithms, global convergence.	7
2	**Basic descent methods and Constrained optimization**	Basic descent methods: Line search methods, steepest descent, and Newton methods; Constrained optimization: first order necessary conditions, second order necessary conditions, Karush-Kuhn-Tucker (KKT) conditions, constraint qualification.	10
3	**Convex and Dynamic Programming**	Convex programming problem; Dynamic programming; Quadratic programming: Active set methods, gradient projection methods and sequential quadratic programming.	12
4	**Goal Programming**	Goal Programming: Concept of goal programming, model formulation, graphical solution method; multi-objective programming; Interior point methods; Karmarkar's algorithm.	12
		Total	41

4. Readings

4.1 Textbook:

I. D. Bertsimas and J. N. Tzatzikis, *Introduction to Linear Optimization*, Athena Scientific (1997).
II. Robert J. Vanderbei, *Linear Programming: Foundations and Extensions*, Springer, 4th ed. (2014).
III. G. V. Reklaitis, A. Ravindran, K. M. Ragsdell, *Engineering Optimization: Methods and Applications*, Wiley (2006).
IV. Mokhtar S. Bazaaraa, Hanif D. Shirali and M. C. Shetty, *Nonlinear Programming, Theory and Algorithms*, John Wiley & Sons, New York (2004).

4.2 Reference books:

I. Don T. Phillips, A. Ravindran and James J. Solberg, *Operations Research: Principles and Practice*, John Wiley & Sons (1987).
II. S. S. Rao, *Engineering Optimization: Theory and Practice*, 4th Edition, John Wiley & Sons (2009).

5 Outcome of the Course:

After completion of the course students

- Should be able to understand and make mathematical model the decision-making problems.
- Have adequate understanding of theoretical concepts of linear and quadratic programming.
- Would be able to solve different types of linear and quadratic programming problems arising in various domains in industry.