Semester	**EIGHT**
Course	**Major**
Paper Code	**C4ST230831T**
Paper Title	**Optimization Techniques**
No. of Credits	**3**
Theory / Practical /Composite	**Theory**
Classes per week	**2 periods/week**
Module	**1**

Course Outcomes

1. **Remember** the fundamental concepts, terminology, classifications, and formulations of optimization problems.
2. **Understand** the principles and procedures of linear programming, nonlinear optimization, duality, and integer programming.
3. **Apply** appropriate optimization techniques to formulate and solve linear, nonlinear, and integer programming problems.
4. **Analyze** optimization problems to identify suitable solution methods, feasibility conditions, and optimality criteria.
5. **Evaluate** alternative optimization solutions using appropriate optimality and duality principles.
6. **Create** suitable optimization models and solution strategies for practical problems.

Syllabus

Unit/Module	Content	No. of lectures	CO mapping	Cognitive levels
Unit 1	*Introduction:* Definition and classification of optimization problems with examples. *Linear Programming*: Formulation; standard and canonical forms; feasible region; graphical method of solution of an LPP; simplex method of solution of an LPP. *Special Linear Programming Problems:* Transportation problem and its initial feasible solutions (Vogel's approximation method), test for optimality; Assignment problem and its solution (Hungarian method).	1 4 3	CO1 CO2 CO3 CO4	K1 K2 K3 K4

Unit 2	*Non-linear Optimization*: Introduction; characteristics; basic optimality conditions; formulation of an NLPP. *Unconstrained Optimization Methods:* One-dimensional methods – Golden Section method, Fibonacci method; Multi-dimensional methods – Steepest Descent method, Conjugate Gradient method, Newton's method, Quasi-Newton method (L-BFGS); applications *Constrained Optimization Methods:* Equality constraints and Lagrange's multiplier, Inequality constraints and Karush-Kuhn-Tucker condition (statement only); concept of convexity; applications.	2 6 6	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
Unit 3	*Duality Theory:* Concept and formulation; weak and strong duality; applications. *Integer Programming:* Introduction and classification; formulation; feasible region, graphical solution; concept of Branch and bound method; applications.	2 2	CO2 CO3 CO4 CO5 CO6	K2 K3 K4 K5 K6

Reading/Reference list

1. Nocedal, J. and Wright, S. J. (2006) *Numerical Optimization*. 2nd edn. New York: Springer.
2. Antoniou, A. and Lu, W. (2021) *Practical Optimization: Algorithms and Engineering Applications*. 2nd edn. New York: Springer.
3. Gill, P. E., Murray, W. and Wright, M. H. (1981) *Practical Optimization (Classics in Applied Mathematics)*. Philadelphia: Society for Industrial and Applied Mathematics.
4. Fletcher, R. (2000) *Practical Methods of Optimization*. 2nd edn. John Wiley & Sons.
5. Luenberge, D. G. and Ye, Y. (2008) *Linear and Nonlinear Programming*. 3rd edn. New York: Springer.
6. Taha, H. A. (2019) *Operations Research: An Introduction*. 10th edn. Pearson Education.
7. Rao, S. S. (2019) *Engineering Optimization: Theory and Practice*. 5th edn. John Wiley & Sons.
8. Sharma, S. D. (2009) *Operations Research*. 15th edn. Kedar Nath Ram Nath.

9. Conforti, M., Cornuejols, G. and Zambelli, G. (2014) *Integer Programming*. Switzerland: Springer.
10. Wolsey, L. (2020) *Integer Programming*. 2nd edn. John Wiley & Sons.
11. Schrijver, A. (1998) *Theory of Linear and Integer Programming*. John Wiley & Sons.
12. Boyd, S. and Vandenberghe, L. (2004) *Convex Optimization*. Cambridge University Press.

Evaluation

Paper Structure for Semester Exam	**(35 marks)**
	Short questions (5 marks each): 4 out of 6 Long questions (15 marks each): 1 out of 2

CO	CO Description	Cognitive levels
CO1	**Remember** the fundamental concepts, terminology, classifications, and formulations of optimization problems.	K1
CO2	**Understand** the principles and procedures of linear programming, nonlinear optimization, duality, and integer programming.	K2
CO3	**Apply** appropriate optimization techniques to formulate and solve linear, nonlinear, and integer programming problems.	K3
CO4	**Analyze** optimization problems to identify suitable solution methods, feasibility conditions, and optimality criteria.	K4
CO5	**Evaluate** alternative optimization solutions using appropriate optimality and duality principles.	K5
CO6	**Create** suitable optimization models and solution strategies for practical problems.	K6