Devi Ahilya University, Indore, India Institute of Engineering & Technology				MSc – II Year (Applied Mathematics) with Specialization in Computing & Informatics Semester- II			
Subject Code & Name	**Instructions Hours per Week**			**Credits**			
AM2EM3: Optimization Techniques	**L**	**T**	**P**	**L**	**T**	**P**	**Total**
	3	**-**	**-**	**3**	**-**	**-**	**3**
Duration of Theory Paper: 3 Hours							

Learning Objectives:

- To introduce students to the fundamental principles, mathematical formulations, and computational techniques used in optimization.
- They will learn to model real-world problems mathematically, apply suitable optimization methods, and analyse their efficiency and applicability.

Prerequisite(s): Basic knowledge of linear algebra, calculus, differential equations, basic iterative methods and error analysis.

COURSE OF CONTENTS

Unit-I:

Introduction to Optimization: Overview of optimization, classification of optimization problems, mathematical concepts-functions of a single and multiple variables, convex and concave functions, Gradient, Hessian, and Lagrange multipliers; formulation of optimization problems.

Unit-II:

Classical Optimization Techniques: Single-variable optimization- conditions for optimality, Graphical methods; Multivariable optimization-Gradient-based methods-Steepest descent, Newton's method; Constrained optimization-Lagrange multiplier method, Kuhn–Tucker conditions.

Unit-III:

Linear Programming: Formulation, Graphical method, Simplex method, Duality in Linear Programming, Sensitivity Analysis, applications of LPP in engineering and management.

Unit-IV:

Nonlinear and Dynamic Optimization: Nonlinear Programming (NLP)- Characteristics and types, Unconstrained minimization techniques- Gradient and conjugate gradient methods, Constrained minimization- Penalty and barrier methods; Dynamic Programming (DP): Principle of optimality, Multistage decision processes, Applications to shortest path and resource allocation problems.

Unit-V:

Modern Optimization Techniques: Evolutionary and Heuristic Methods- Genetic Algorithms (GA); Simulated Annealing (SA); Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Introduction to Machine Learning-based Optimization; Applications to engineering design, scheduling, and data science problems.

Learning Outcomes:

After completing this course, students will be able to:

- Formulate optimization problems from real-world situations mathematically.
- Analyse and solve both unconstrained and constrained optimization problems.
- Apply classical and modern optimization techniques.
- Use computational algorithms for nonlinear and combinatorial optimization.
- Interpret optimization results and apply them to various fields of applied mathematics and science.

BOOKS RECOMMENDED:

1. S.S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons Inc., 2009.
2. Kanti Swarup, P. K. Gupta & Man Mohan, Operations Research, Sultan Chand & Sons, 2010.
3. K. Deb, Optimization for Engineering Design: Algorithms and Examples, PHI, 2nd edition, 2012.
4. H. A. Taha, Operations Research: An Introduction, Pearson Education, 10th edition, 2019.
5. R. Fletcher, Practical Methods of Optimization, John Wiley & Sons Inc., 2nd edition, 2000.
6. David G. Luenberger & Yinyu Ye, Linear and Nonlinear Programming, Springer Nature; 3rd edition, 2008.