COURSE TITLE	**OPTIMIZATION TECHNIQUES**
COURSE CODE	**01CA1221**
COURSE CREDITS	**3**

Objective:

1 To analyze and formulate optimization problems and apply suitable techniques to solve mechanical engineering challenges. The course also aims to compare different optimization methods and implement advanced techniques, including evolutionary approaches, in practical mechanical systems.

Course Outcomes: After completion of this course, student will be able to:

1 Analyze optimization problems and their mathematical formulation.

2 Apply optimization techniques to solve problems in mechanical engineering.

3 Compare various optimization techniques based on their performance and applicability.

4 Analyze evolutionary optimization techniques for engineering applications.

Pre-requisite of course: Calculus

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	**Introduction to Optimization** Engineering applications of Optimization,, Design vector and constraints, Constraint surface, , Objective function, Classification of Optimization Problems.	8
2	**Classical Optimization Techniques** Single variable optimization, Constrained and unconstrained multi-variable optimization, Direct substitution method, Lagrange's method of multipliers, , Karush-Kuhn-Tucker conditions, , Case study on mechanical engineering	6
3	**Linear Programming** Statement of an LP problem, Simplex method, , Dual simplex method process., Case study on mechanical engineering	4
4	**Non-linear Programming One-dimensional minimization** Unimodal function, Unrestricted search, Exhaustive search, , Dichotomous search, Interval halving method, , Fibonacci method, Golden section method,, Case study on mechanical engineering	8

Contents : Unit	Topics	Contact Hours
5	**Non-linear Programming Unconstrained Optimization Techniques** Direct Search Methods: Random search methods, Grid search method,, Univariate method, Hooke's and Jeeves' method, Powell's method , Indirect Search Methods: Steepest descent method,, Case study on mechanical engineering	6
6	**Non-linear Programming Constrained Optimization Techniques** Direct Methods: Random search method, , Sequential linear programming Indirect methods: Transformation techniques, , Exterior penalty function method, Interior penalty function method., Case study on mechanical engineering.	6
7	**Evolutionary Algorithm** Genetic algorithms, simulated annealing, fuzzy optimization, neural-network based methods, , Particle Swarm Optimization, TLBO., Case study on mechanical engineering.	4
Total Hours		**42**

Textbook :

1 Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons, Inc., 2019

2 Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer , Academic Publishers , 1992

References:

1 Practical Optimization Methods with Mathematical Applications, Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer , 2000

2 Multi-objective optimization using evolutionary algorithms, Multi-objective optimization using evolutionary algorithms, K Deb John, Wiley Publications, 2001

3 Topology Optimization – Theory, Methods and Applications, Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund, Springer, 2011

4 3. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, 3. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M, Wiley, 2010

5 Introduction to Optimum Design, Introduction to Optimum Design, J S Arora, Mc-Graw Hill., 2016

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	25.00	25.00	15.00	5.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses

Supplementary Resources:

1 https://swayam.gov.in/