

# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHANICAL ENGINEERING (19)

### OPTIMIZATION

SUBJECT CODE: 2181912

B.E. 8<sup>TH</sup> SEMESTER

**Type of course:** Undergraduate

**Prerequisite:** Zeal to learn the Subject

**Rationale:** The system configuration and parameters obtained through conventional processes have a large domain within which variable may change. However, all combinations of variable may not give the optimum performance of the system. It is desirable to obtain values of variables which makes the system to perform at its optimum state. Additional methods and processes as to be learnt in the course are required to determine values of variable for an optimum system.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	2	0	5	70	20	10	30	0	20	150

#### Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Introduction to Optimization:</b> Classification of Optimization, Design vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems.	03	5%
2	<b>Classical Optimization Techniques:</b> Single variable optimization, Multi-variable: Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions	09	20%
3	<b>Linear Programming:</b> Statement of an LP problem, Simplex method, Dual simplex method.	05	10%
4	<b>Non-linear Programming: One-dimensional minimization:</b> Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods: Newton-Raphson and Quasi Newton methods.	09	25%
5	<b>Non-linear Programming: Unconstrained Optimization Techniques:</b> Direct Search Methods: Random search methods, Grid search method, Univariate method, Hookes and Jeeves' method, Powell's method	08	25%
6	<b>Modern Methods of Optimization:</b> Genetic algorithms, simulated annealing, fuzzy optimization, neural-network-based methods.	08	15%

### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	15	10	10	10

**Legends: R: Remembrance; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

### Reference Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
2. Multi-objective optimization using evolutionary algorithms, K Deb John Wiley Publications.
3. Introduction to Optimum Design, J S Arora, Mc-Graw Hill.
4. Optimization Methods for Engineering Design, Fox, R. L., Addison Wesley, 2001.

### Course Outcome:

After learning the course the students should be able to:

1. Formulate a problem for determining optimum state of the Mechanical system.
2. Apply optimization techniques to simple and moderate systems to determine magnitude of variables for optimum performance of system.
3. Use modern methods of optimization.

### List of Experiments:

1. Exercise on mathematical modelling and problem formulation for optimization of various mechanical system.
2. Write a program to implement single variable optimization technique.
3. Write a program to implement multivariable optimization techniques.
4. Write a program to implement LP techniques.
5. Write programs to implement Non-linear programming methods.
6. Write program to implement GA.

### Design based Problems (DP)/Open Ended Problem:

1. Design a mechanical system using conventional method. The system can be a machine component, a thermal system or a product. Develop an objective function. Use leaned methods and compare the results derived from different method and also with the original method.

### Major Equipment:

1. Computational facility
2. Programming tools like Scilab

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.