GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Civil and Infrastructure Engineering
Subject Code: 3154013
Semester – V
Subject Name: Optimisation of Engineering Systems

Type of course: Open Elective

Prerequisite: Mathematics-1 and 2, Numerical and Statistical Methods

Rationale:

The objective of this Open Elective is to enable the students with tools for optimization of systems and processes, for obtaining the best result under given circumstances. At each step in an engineering process (design, construction and/or maintenance) engineers are required to make critical decisions. These decisions must be aimed at either maximizing the benefits or to minimize the efforts. This course imparts understanding of optimization methods for solving different optimization problems. In this course, after discussing about the optimization problem formulation, Linear Programming, Non Linear Programming, Dynamic Programming techniques will be explained in detail along with their applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	Introduction and Basic Concepts: Historical Development; Engineering applications of Optimization; Art of Modeling Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical Programming problems Classification of optimization problems Optimization techniques – classical and advanced techniques	**8**
2	Optimization using Calculus: Stationary points; Functions of single and two variables; Global Optimum Convexity and concavity of functions of one and two variables Optimization of function of one variable and multiple variables; Gradient vectors; Examples Optimization of function of multiple variables subject to equality constraints; Lagrangian function Optimization of function of multiple variables subject to Equality constraints; Hessian	**10**

	matrix formulation; Eigen values Kuhn-Tucker Conditions; Examples	
3	Linear Programming and its Applications: Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations Graphical method for two variable optimization problem; Examples Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems Revised simplex method; Duality in LP; Primal-dual relations; Dual Simplex method; Sensitivity or post optimality analysis Other algorithms for solving LP problems – Karmarkar's projective scaling method Use of software for solving linear optimization problems using graphical and simplex methods Examples for transportation, assignment, water resources, structural and other optimization problems	**12**
4	Dynamic Programming and its Applications: Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP) Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP Problem formulation and application in Design of continuous beam and Optimal geometric layout of a truss Water allocation as a sequential process Capacity expansion and Reservoir operation	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**10**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International (P) Ltd., New Delhi, 2000.

2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.
3. H.A. Taha, "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 1992.
4. K. Deb, "Optimization for Engineering Design- Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.
5. K. Srinivasa Raju and D. Nagesh Kumar, "Multicriterion Analysis in Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, India, ISBN 978-81-203-3976-7, pp.288, 2010.

Course Outcomes:

Upon successful completion of the course, the students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the need and philosophy of optimization of systems and create optimization problems for existing and proposed systems	10
CO-2	Understand the various methods for optimization of an engineering system	20
CO-3	Analyse a system for optimum performance using Linear Programming	30
CO-4	Apply optimisation techniques to determine the most efficient system properties	40

Term Work:

The students will have to solve at least five examples and related theory from each topic as an assignment/tutorial. Practical examinations shall consist of oral based on term-work and above course.

Open Source Software/learning website: www.nptel.ac.in

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 presented and 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.