GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Electrical Engineering

Course / Subject Code: ME01000171

Course / Subject Name: Optimization Techniques

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Basic Mathematics, Linear Algebra
Rationale:	In order to lower production cost and to withstand global competition, engineers have to resort to various optimization methods to design and produce products and systems both economically and efficiently. The purpose of this course is to introduce the concepts of unconstrained and constrained optimization that are commonly used in solving engineering problems. Students will also gain an understanding of the modern evolutionary and swarm optimization methods for solving various engineering problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Contents:

Sr. No.	Content	Total Hrs
1	**Introduction to Optimization:** Introduction, Historical development, Engineering Applications of Optimization, Statement of an Optimization Problem, A brief overview on classification of optimization problems [1]	04
2	**Single Variable Optimization Algorithms:** Optimality criteria, Bracketing methods – Exhaustive Search Method, Bounding Phase Method, Region Elimination methods – Interval Halving Method, Fibonacci Search Method, Golden Section Search Method, Point Estimation method – Successive Quadratic Estimation Method, Gradient based methods -Newton Raphson Method, Bisection Method, Secant Method, Cubic Search Method [2]	10
3	**Multivariable Optimization Algorithms:** Optimality criteria, Unidirectional search, Direct Search methods – Box's Evolutionary Optimization Method, Simplex Search Method, Hooke Jeeves Pattern Search Method, Gradient based methods - Cauchy's Method, Newton's Method, Marquardt's Method, Conjugate Gradient Method [2]	09

4	**Constrained Optimization Algorithms:** Kuhn Tucker Conditions, Lagrangian Duality Theory, Transformation Methods - Penalty function Method, Method of Multipliers, Direct Search for Constrained Minimization – Variable Elimination Method, Complex Search Method, Random Search Methods, Linearized Search Methods – Frank Wolfe Method, Cutting Plane Method [2]	**11**
5	**Modern Methods of Optimization**- Introduction, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization,Optimization of Fuzzy Systems, Neural Network based optimization, TeachingLearning Based Optimization, [1],[3]	**11**
	TOTAL	**45**

References:

[1] Engineering Optimization – Theory and Practice by Singiresu S. Rao, John Wiley & Sons

[2] Optimization for Engineering Design – Algorithms & Examples by Kalyanmoy Deb, PHILearning Private Limited

[3] Teaching Learning Based Optimization by R. Venkata Rao, Springer, https://doi.org/10.1007/978-3-319-22732-0

Course Outcomes:

After completing the course, students will be able to;

Sr. No.	CO statement	Marks % weightage
CO-1	Comprehend the basics of optimization and learn techniques related to single variable optimization methods	30
CO-2	Understand and analyze various multivariable optimization algorithms	20
CO-3	Analyze algorithms employed for solving constrained optimization problems	25
CO-4	Comprehend and analyze optimization methods based on biological and swarmintelligence techniques	25

Suggested list of practicals

1. Develop programs using MATLAB/Octave/Python for solving single variable optimizationproblems
2. Implement programs that use MATLAB/Octave/Python for solving multi-variableoptimization problems
3. Write programs in MATLAB/Octave/Python to solve different constrained optimizationproblems using various algorithms
4. Implement modern methods of optimization using MATLAB/Octave/Python

Suggested MOOC courses for further study

1. Optimization Theory & Algorithms by Uday K Khankhoje https://nptel.ac.in/courses/108106478

2. Optimization methods by Dr. D. Nageshkumarhttps://nptel.ac.in/courses/105108127

3. Computer Aided Single Objective Optimization by Prakash Kotechahttps://nptel.ac.in/courses/103103164

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