GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Applied Instrumentation

Course / Subject Code : ME01067011

Course / Subject Name : OPTIMIZATION TECHNIQUES FOR ENGINEERS

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PCC-01

Prerequisite:	Engineering Mathematics and control engineering
Rationale:	Unified and unique mathematical treatment of various optimization and soft computing techniques for engineers. The course covers the theory and applications of NLP, LPP and evolutionary strategies like genetic algorithms in developing intelligent systems with examples and practical applications.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Learn the unified and exact mathematical basis as well as the general principles of various optimization and soft computing techniques	U
02	Provide detailed theoretical and practical aspects of intelligent optimization and control engineering systems.	A
03	Formulate deterministic mathematical programs and solutions for various engineering systems.	N
04	Develop optimization algorithms and computer programs to solve real engineering problems.	E

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to optimization:** Optimal problem formulation, Design variables, Constraints, Objective function, Variable bounds, Optimization algorithms.	2	2
2.	**Nonlinear Programming I: Single-Variable optimization algorithms,** Optimality criteria, Exhaustive search method, Bounding phase method, Region-Elimination methods, Interval halving method,	10	25

	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.		
3.	**Nonlinear Programming II: Multivariable optimization algorithms,** optimality criteria, Direct search methods, Random search methods, random walk method, Random jumping method, univariate method, Hooke and Jeeve's method, Powell's conjugate direction method, Rosen brock's method, Simplex method, Indirect search (descent) method, Cauchy's (steepest descent) method, Conjugate gradient (Fletcher-Reeves) method, Newton's method, Fletcher-Powell algorithm.	10	25
4.	**Nonlinear Programming III:** Multivariable constrained optimization algorithms; Generalized reduced gradient method, Gradient projection method, Box-Complex algorithm, Kuhn-Tucker conditions, and Penalty function methods.	10	18
5.	**Linear Programming:** Formulation of LPP, Graphical method, Simplex method, The use of artificial variables, Big-M method, Sensitivity analysis and duality theory.	6	15
6.	**Optimal Control:** Introduction, Objective function, Performance index, Calculus of variations, Variational approach to optimal control problem, Define Hamiltonian.	4	10
7.	**Non-traditional Optimization algorithms: Genetic algorithms,** Working Principles, Differences between GAS and traditional methods, Similarities between GAS and traditional methods, GAS for constrained optimization.	3	5
	Total		**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**20**	**20**	**15**	**5**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Optimization for Engineering Design by Kalyanmoy Deb, PHI.
2. Engineering Optimization by S. S. Rao, John Wiley & Sons.
3. An Introduction to Optimization by Edvin K.P.Chong,Stanislaw H.Zak, 2e,Wiley Student Edition.
4. Multi-objective Optimization Using Evolutionary Algorithms by Kalyanmoy Deb, Wiley Student Edition
5. Optimal Control Systems by Desineni Subbaram Naidu, CRC Press, 2003.

6. Linear Programming in single and multiobjective systems by James P Ignizio, Prentice Hall.
7. Principles of Soft Computing by S.N.Sivanandam, S.N.Deepa , 2e, Wiley India Pvt.Ltd

(b) Open source software and website:

1. Scilab,C, C++, Java
2. NTPEL

Suggested Course Practical List: If any

List of Laboratory/Learning Resources Required:

Suggested Project List:

Suggested Activities for Students: If any

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