GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION AND CONTROL (APPLIED INSTRUMENTATION) (03)
OPTIMIZATION TECHNIQUES FOR ENGINEERS
SUBJECT CODE: 2710310
SEMESTER: I

Type of course: Branch specific Mathematical course

Prerequisite: Engineering Mathematics and control engineering

Rationale: A 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.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to optimization:** Optimal problem formulation, Design variables, Constraints, Objective function, Variable bounds, Optimization algorithms.	02	2%
2	**Nonlinear Programming I:** Single-Variable optimization algorithms, Optimality criteria, 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.	10	25%
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.	06	15%
6	**Optimal Control:** Introduction, Objective function, Performance	04	10%

	index, Calculus of variations, Variational approach to optimal control problem, Define Hamiltonian.		
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.	03	5%

Reference 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

Course Outcome:

After learning the course the students should be able to

1. Learn the unified and exact mathematical basis as well as the general principles of various optimization and soft computing techniques
2. Provide detailed theoretical and practical aspects of intelligent optimization and control engineering systems.
3. Formulate deterministic mathematical programs and solutions for various engineering systems.
4. Develop optimization algorithms and computer programs to solve real engineering problems.

List of Open Source Software/learning website:

- Scilab, C, C++, Java
- NTPEL