GUJARAT TECHNOLOGICAL UNIVERSITY
Master of Engineering, Chemical (Computer Aided Process Design)
Subject Code - 3721602
Semester II
Subject Name: Chemical Process Optimization

Type of course: Program Elective –IV

Prerequisite: Fundamentals of optimization and chemical engineering.

Rationale:
Optimization is an important engineering tools for addressing the issues which modern industry faces like increasing cost of energy, stringent environmental regulations and global competition in product pricing and quality. Modifications in plant design and operating procedures have been implemented to reduce costs and meet constraints, with an emphasis on improving efficiency and increasing profitability. Optimization helps to formulate the problem which includes the concept; i.e., how one develops mathematical statements for the objective function (usually economic model) to be minimized or maximized and the equality and inequality constraints (the process model). Optimization helps to solve the formulated problem by applying various techniques, identifying and selection of optimization technique which is best suited to the problem characteristics.

Teaching and Examination Scheme:

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

Syllabus Content:

Sr. No.	Content	Total Hrs
1	**Optimization:** Basic concept of optimization, Mathematical formulation of optimization problems; Classification of Optimization Problems - single variable problems, Multivariable problems without constraints, Multivariable problems with constraints, Maximization and minimization problems, Convex and concave functions & determination, Necessary and sufficient conditions for stationary points.	4
2	**Optimization of Unconstrained Functions: Single variable Search:** Analytical methods, Numerical methods, scanning and bracketing techniques, region elimination techniques, exhaustive search, interpolation methods – with & without derivatives, comparison of various methods, examples.	6
3	**Optimization of Unconstrained Functions: Multivariable Search – Analytical Methods: C**lassification, Without derivatives - Random search, grid search, Univariate search, With derivatives – Newtons method.	6
4	**Optimization of Unconstrained Functions: Multivariable Search – Numerical Methods:** general principles of numerical search, direction of search, final stage in search,	7

	direct search, pattern search, acceleration in direct search, gradient methods, Simplex search, Powells method, Box complex method, Quasi-Newton methods.	
5	**Optimization of Constrained Functions: Linear Programming (LP) and its applications:** Basic linear programming, definitions, formulation of LP problem, Solution of LPP by graphical technique, Simplex algorithm, Primal-Dual relation.	**6**
6	**Optimization of Constrained Functions: Non- Linear Programming (NLP) and its applications:** Lagrangian Multiplier method, Kuhn-Tucker theorem, penalty function, Quadratic programming, Geometric Programming, Dynamic programming, Integer and mixed integer programming.	**6**
7	**Application of Optimization In Chemical Engineering:** Optimum vessel sizing, optimum insulation, Optimal pipe diameter, Optimum work of compression, Optimal shell-tube heat exchanger design, optimal design of distillation column, Optimal design of an Ammonia reactor and other applications.	**7**
8	**Non-traditional Optimization Techniques:** Genetic Algorithm, Simulated Annealing, Ant Colony Optimization, Particl swarm optimization, TABU search, Multi Objective Optimization, Selection of techniques.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**25**	**10**	**10**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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. Gordon S. G. Beveridge and Rober S. Schechter, Optimization: Theory and Practice, McGraw-Hill Book Company.
2. Edger, Himmelblau, Lasdon, Optimization of Chemical Processes, McGraw-Hill International Edition.
3. S. S. Rao, Engineering Optimization: Theory and Practice, Third Edition, Wiley Eastern Ltd.
4. B. V. Babu, Process Plant Simulation, Gulf Publications.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand optimization techniques to solve linear programming and nonlinear programming problems.	20 %
CO-2	Use optimization as a tool in process design and operation.	30 %

CO-3	Proficiency in the applications of optimization in chemical plants.	30 %
CO-4	Non traditional optimization techniques application in other areas.	20 %

List of Open Source Software/learning website:

- Students can refer to video lectures available on NPTEL.