



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Subject Code: ME02072041

Subject Name: Chemical Process Optimization

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

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.

Course Outcome:

After completion of the course, student will able to:

No	Course Outcomes
01	Understand optimization techniques to solve linear programming and nonlinear programming problems.
02	Apply optimization as a tool in process design and operation.
03	Examine the applications of optimization in chemical plants.
04	Decide non-traditional optimization techniques application in other areas.

Teaching and Examination Scheme:

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



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
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.	5	10
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	15
3.	Optimization of Unconstrained Functions: Multivariable Search – Analytical Methods: Classification, Without derivatives - Random search, grid search, Univariate search, With derivatives – Newtons method.	6	10
4.	Optimization of Unconstrained Functions: Multivariable Search – Numerical Methods: general principles of numerical search, direction of search, final stage in search, direct search, pattern search, acceleration in direct search, gradient methods, Simplex search, Powells method, Box complex method, Quasi-Newton methods.	6	15
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.	5	15
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.	5	10
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.	6	15
8.	Non-traditional Optimization Techniques: Genetic Algorithm, Simulated Annealing, Ant Colony Optimization, Particle swarm optimization, TABU search, Multi Objective Optimization, Selection of techniques.	6	10
	Total	45	100



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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	-

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. 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.

(b) Open source software and website:

Students can refer to video lectures available on NPTEL

1. NPTEL open course on Chemical Process Intensification
(<https://archive.nptel.ac.in/courses/103/105/103105139/>)

Suggested Activities for Students:

Students may be allotted one Open-ended Project / Mini Project on any of the above topic. Detailed literature review based on the research papers published in reputed journals to be incorporated.
