GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (CAD/CAM) (08) /MECHANICAL (MACHINE DESIGN) (09)

ENGINEERING OPTIMIZATION
SUBJECT CODE: 2720821
SEMESTER: II

Type of course: Post Graduate

Prerequisite: Zeal to learn the Subject

Rationale: The objective of the course to introduce conventional and modern optimization techniques and their application to mechanical engineering problems. The course also introduces advanced topic on topology optimization.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	0	2#	4	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to Optimization:** Engineering applications of Optimization, Design vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems.	02	5%
2	**Classical Optimization Techniques:** Single variable optimization, Constrained and unconstrained multi-variable optimization, Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions	05	10%
3	**Linear Programming:** Statement of an LP problem, Simplex method, Dual simplex method.	03	10%
4	**Non-linear Programming: One-dimensional minimization:** Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods: Newton-Raphson and Quasi Newton methods.	05	15%
5	**Non-linear Programming: Unconstrained Optimization Techniques:** Direct Search Methods: Random search methods, Grid search method, Univariate method, Hookes and Jeeves' method, Powell's method Indirect Search Methods: Steepest descent method, Fletcher-Reeves method, Newton's method.	07	15%
6	**Non-linear Programming: Constrained Optimization Techniques** Direct Methods: Random search method, Sequential linear programming Indirect methods: Transformation techniques, Exterior penalty function method, Interior penalty function method.	07	15%
7	**Modern Methods of Optimization:** Genetic algorithms, simulated annealing, fuzzy optimization, neural-network-	07	15%

	based methods, Particle Swarm Optimization.		
8	**Topology Optimization:** Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, combining topology and shape design, buckling problems, stress constraints.	**06**	**15%**

Reference Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, New Age International.
2. Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
3. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund
4. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley, 2010
5. Multi-objective optimization using evolutionary algorithms, K Deb John Wiley Publications.
6. Introduction to Optimum Design, J S Arora, Mc-Graw Hill.

Course Outcome:

After learning the course the students should be able to:

1. Modelling of constrained decision making for an optimization problem.
2. Solve practical problems using suitable optimization technique.
3. Optimize topology of a given structure.

List of Experiments:

Practical exercises should be developed for topics covered in theories. Emphasis should be on developing own programmes using platforms like Matlab / Scilab and practice of using readily available toolbox should be avoided.

1. Programming exercise for Classical optimization techniques.
2. Programming exercise for Linear Programming.
3. Programming exercise Non-linear Programming: One-dimensional minimization**.**
4. Programming exercise Non-linear Programming: Unconstrained Optimization Techniques
5. Programming exercise Non-linear Programming: Constrained Optimization Techniques
6. Programming exercise Modern Methods of Optimization
7. Programming exercise Topology Optimization

Design based Problems (DP)/Open Ended Problem:

1. Optimize design of a mechanical equipment using techniques learned. Compare results of various method and comment about the best suited one.

Major Equipment:

1. Computational Facility.
2. Programming software.

List of Open Source Software/learning website:

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be

generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website