GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (COMMUNICATION SYSTEMS ENGG) (05)
INTRODUCTION TO OPTIMIZATION TECHNIQUES
SUBJECT CODE: 2730504
M.E. SEM-III

Type of course: Major Elective IV

Prerequisite: Basic knowledge of linear algebra, Calculus and exposure to probability.

Rationale: This kind of course is required to provide strong foundation for students interested in the manipulation of data, broadly defined. In particular, this course is highly recommended for students who are interested in machine learning, algorithms, data-mining, telecommunication, signal processing etc.

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	
4	0	2#	5	70	30	20	10	10	10	150

Contents:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to Optimization** Mathematical formulation, Classification of optimization problems, Engineering applications of optimization	**6**	10
2	**Classical Optimization Techniques:** Single variable optimization, Constrained and unconstrained optimization, Direct substitution method, Lagrange's method of multip Kuhn-Tucker (KKT) conditions	**12**	20
3	**Linear Programming:** Linear programming problem- simplex method,Two Phases of the Simplex Method , duality, Mixed-integer programming. Goal programming, Quadratic Programming, Transportation models and its variants, Sequencing problem, Replacement theory.	**12**	20
4	**Non-linear Programming:** Elimination Method: Unrestricted Search, Exhaustive search, Dichotomous search, Interval-halving method, Fibonacci method, Golden section method.Interpolation Methods:Quadratic Interpolation, Cubic Interpolation,	**12**	20
5	**Modern methods of Optimization:** Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Taguchi's Method of Optimization.	**7**	15
6	**Practical Aspects of Optimization:** Genetic Algorithms, Optimization of Fuzzy Systems, Multi-objective Optimization	**6**	15

Reference Books:

1. S.S.Rao, *Engineering Optimization Theory and Practice*, New Age International (P) Ltd Publishers, Third enlarged edition.
2. E. K. P. Chong and S. H. Zak, *An Introduction to Optimization*, 2nd Edn., Wiley India Pvt. Ltd., 2010.
3. Jasbir S. Arora, Introduction to Optimum Design, , McGraw Hill Publication, International edition 1989
4. Optimization for Engineering Design Algorithms and Examples, Kalyanmoy Deb, Prentice Hall, Third reprint 1998
5. R. Fletcher Practical Optimization (2nd Edition) John Wiley & Sons, New York, 1987.
6. Hamdy A. Taha, "Operations Research: An Introduction10th edition, Pearson education,New Delhi, 2010.

Course Outcome:

Upon completion of the subject, students will be able to:

1. Analyse real-life problems, especially, logistics problems, through the use of mathematical modelling techniques.
2. Gain familiarity with various modelling techniques to build mathematical models for real problems.
3. Perform a critical evaluation and interpretation of analysis and optimization results.
4. Evaluate the basic concepts of multi-objective optimization, including the conditions for optimality and understand with ways to quantitatively assess the expected lifecycle cost of a new system or product

List of Experiments:

1. Find the maximum and minimum values of the function using the first and second derivatives. Use Symbolic Mathematics Toolbox. Study the functions available in the Optimization Toolbox of MATLAB.

2. Find approximately the optimum point of the given linear programming problem graphically. Find the optimum point and optimum function value of a linear programming problem using the standard functions available in the Optimization Toolbox.

3. Write a program to minimize a non-linear one-dimensional function with no constraints using Unrestricted Search Method. First take the step size fixed and then take accelerated step size. Also, write a program to minimize a non-linear one-dimensional function with no constraints using Exhaustive Search Method.

4. Write a program to minimize a non-linear one-dimensional function with no constraints using Dichotomous Search Method.

5. Write a program to minimize a non-linear one-dimensional function with no constraints using Interval Halving Method.

6. Write a program to minimize a non-linear one-dimensional function with no constraints using Fibonacci Method.

7. Write a program to minimize a non-linear one-dimensional function with no constraints using Golden Section Method.

8. Write a program to minimize a non-linear one-dimensional function with no constraints using Quadratic Interpolation Method. Also, write a program to minimize a non-linear one-dimensional function with no constraints using Cubic interpolation Method.

9. Write a program to minimize a non-linear one-dimensional function with no constraints using Newton's method, Quasi-Newton Method and Secant Method.
10. Write a program to minimize a non-linear multi-dimensional function with no constraints using Univariate Method.

Design based Problems (DP)/Open Ended Problem:

- Train scheduling problem
- Crude-Oil transportation problem
- Application of Shortest Path Algorithm in routing /bandwidth problem
- Application of GA/ PSO/ABC in communication engineering-3G/ 4G solutions

Major Equipment: For normal laboratory purpose, major equipment is not required.Computers/Laptops may serve the purpose.

List of Open Source Software/learning website:

NPTEL website: http://nptel.ac.in/courses/111105039/

Scilab or C/C^{++} ,**Other Software(s)**MATLAB® (if license available)

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.