Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Third Year Bachelor of Engineering (CE/IT)

(In Effect From Academic Year 2019-20)

Subject Code: CT506D-N	**Subject Title:** Optimization Techniques
Pre-requisite	Numerical Methods, Linear Algebra, Differential Calculus

Teaching Scheme (Credits and Hours)

Teaching scheme				Total Credit	Evaluation Scheme					
L	T	P	Total		Theory		Mid Sem Exam	CIA	Pract.	Total
Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	Marks
03	00	02	05	04	03	70	30	20	30	150

Course Objective:

- Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.
- Cast engineering minima/maxima problems into optimization framework.
- Learn efficient computational procedures to solve optimization problems.
- Use Matlab/Scilab to implement important optimization methods.

Outline of the Course:

Sr. No	Title of the Unit	Minimum Hours
1	Mathematical preliminaries	10
2	Linear programming	12
3	Non-linear programming	4
4	Unconstrained optimization	12
5	Constrained optimization	10

Total hours (Theory): 48
Total hours (Lab): 32
Total hours: 80

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Detailed Syllabus

Sr. No	Topic	Lecture Hours	Weightage (%)
1	**Mathematical preliminaries:** Vector space and matrices, Transformations, Concept of Geometry, Elements of calculus.	10	21
2	**Linear programming:** Introduction to Linear Programming, Simplex Method (The Simplex Algorithm, Two Phase Method, Revised Simplex Method), Duality, Karmarkar's Method.	12	25
3	**Non-linear programming:** Basics of Set Constrained and Unconstrained Optimization, FONC, SONC and SOSC Conditions for Local Minimizers.	4	8
4	**Unconstrained optimization:** One dimensional Search Methods, Gradient Methods, Conjugate Direction Methods, Quasi-Newton Methods.	12	25
5	**Constrained optimization:** Problems with Equality Constraints, Problems with Inequality constraints, Algorithms for Constrained Optimization.	10	21
	Total	48	100

Instructional Method and Pedagogy:

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lecture and laboratory which carries 10 marks in overall evaluation.
- One internal exam will be conducted as a part of internal theory evaluation.
- Assignments based on the course content will be given to the students for each unit and will be evaluated at regular interval evaluation.
- Surprise tests/Quizzes/Seminar/tutorial will be conducted having a share of five marks in the overall internal evaluation.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- The course needs more focus on numerical examples based on exercises at the end of each chapter to aware of methods more precisely.
- Experiments shall be performed in the laboratory related to course contents.

Learning Outcome:

On successful completion of this course, the student should be able to:

- Be able to model engineering minima/maxima problems as optimization problems.
- Be able to use Matlab/Scilab to implement optimization algorithms.

e-Resources:

- https://nptel.ac.in/courses/105108127/
- https://nptel.ac.in/courses/111105039/
- https://nptel.ac.in/courses/111104071/
- https://nptel.ac.in/courses/106108056/
- https://nptel.ac.in/courses/112106064/

Reference Books:

1. An introduction to Optimization by Edwin P K Chong, Stainslaw Zak
2. Nonlinear Programming by Dimitri Bertsekas
3. David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 3rd Edition, Springer, 2008.
4. Fletcher R., Practical Methods of Optimization, John Wiley, 2000.
5. Optimization: Theory and applications By S. S. Rao
6. Nonlinear Multiobjective Optimization By Kaisa Miettinen
7. Optimization For Engineering Design: Algorithms and Examples By Kalyanmoy Deb

List of experiments:

Sr. No	Name of Experiment
1	Write a C and SCILAB program to find Rank of a Matrix.
2	Perform various SCILAB Basic Commands.
3	Write a program in SCILAB to plot functions in 2D and 3D. (With Output)
4	Write a function in SCILAB to find weather given matrix is singular or not.
5	Write a SCILAB program to demonstrate Level Sets with Rosenbrock's (Banana) function. (With Output)
6	Implement a SCILAB program to find out various norms of vector and Matrix.
7	Write a function to find solution of Linear function AX=b in SCILAB.
8	Solve LPP problems using Karmarkar Method in SCILAB.
9	Plot LPP problems using Contour and Plot2d function in Scilab.
10	Formulate LPP problem from given problem statement.
11	Solve and Plot Primal and Dual problem using Karmarkar Method in SCILAB.
12	Plot and Prove FONC, SONC and SOSC condition of a function in SCILAB.
13	Implement Secant Method in SCILAB.
14	Implement Newton Raphson Method in SCILAB.
15	Implement Golden Section Method in SCILAB.
16	Implement Fibonacci Series Method in SCILAB.
17	Solve Quadratic Programming Problem using qp_solve function in Scilab.
18	Solve Non Linear Programming Problem using optim in SCILAB.
19	Implement function for Steepest Descent Method in SCILAB.
20	Implement function for BFGS method in SCILAB.