ECEXXXX: OPTIMIZATION TECHNIQUES FOR COMMUNICATION AND SIGNAL PROCESSING

Department of Electronics and Communication Engineering — The LNMIIT, Jaipur

Programme: B.Tech./ M.Tech | **Year:** 4th | **Semester:** Even
Course: Open Elective | **Credits:** 3 | **Hours:** 40

Course Context and Overview (100 words):

The focus of the course is to provide a deep study of optimization tools in the context of important problems related to point-to-point and Networked Communications, as well as Signal Processing. On the one hand, these are very useful tools in order to understand, model and analyze correctly real problems and these are also the key tools to design solutions for real life problems. The course will cover both classic results and also more recent results.

Prerequisites Courses: Mathematics M1, M2 and M3.

Course outcomes (COs):

On completion of this course, the students will have the ability to:
CO1: understand basics of convex optimization language.
CO2: know how to model and formulate real communication and signal processing problems as optimization problems.
CO3: understand well the underlying theory, concepts and properties related to each of the optimization tools.
CO4: design, implement and simulate practical (centralized and distributed) algorithms to solve the various optimization problems.
CO5: analyze the structures/ decompositions of problems and solutions as well as the relationship between different problems.

Course Topics:

Topics	Lecture Hours	
UNIT – 1 Introduction: Convex Optimization	2	2
Mathematical optimization, Least square and linear programming.	1	
Convex optimization and nonlinear optimization, outline and notation.	1	
UNIT – 2 Convex Sets and Convex Functions	8	8
Affine and convex sets, Some important examples, Operations that preserve convexity, Generalized inequalities.	2	
Separating and supporting hyperplanes, Dual cones and generalized inequalities.	2	
Basic properties of convex functions, the conjugate function.	2	
Log concave and log convex functions, convexity with respect to generalized inequilities.	2	
UNIT – 3 Convex Optimization problems and Duality	8	8
Optimization problems, convex optimization, linear optimization problems, quadratic optimization problems, geometric programming, Generalized inequality constraints, vector optimization	4	

The Lagrange dual function, the Lagrange dual problem, geometric interpretation, saddle-point interpretation, optimality conditions, perturbation and sensitivity, theorems of alternatives, generalized inequalities	4	
UNIT – 4 Applications	9	9
Approximation and fittings: norm approximation, least-norm problems, regularized problems, robust approximation, function fitting and interpolation.	3	
Statistical estimation: parametric and non-parametric distribution estimation, optimal detection design Hypothesis testing,	3	
Geometric problems: projection on a set, distance between sets, Euclidean distance and angle problem, external volume ellipsoids, centering.	3	
UNIT – 5 Algorithms	10	10
Unconstrained minimization: unconstrained minimization problems, descent methods, gradient and steepest descent method, Newton's method, self-concordance.	3	
Equality constrained minimization: Equality constrained minimization problems, Newton's method with equality constraints, infeasible start Newton method.	3	
Interior-point methods: Inequality constrained minimization problems, Logarithmic barrier function and central path, the barrier method, feasibility and phase I methods, complexity analysis via self-concordance, problems with generalized inequalities, primal-dual interior-point methods.	4	
UNIT – 6 Project Work (one week duration)	3	3

Text Books:

S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press 2004.

Reference books:

D. P. Bertsekas, Nonlinear Programming, Athena Scientific, 2nd Edition, 1999.

Ranjan Ganguli, Engineering Optimization: A modern approach, University Press (I) Ltd.

Evaluation Method:

Item	Units	Weightage (%)
Quiz 1	1, 2 and 3	5
Midterm	1,2 and 3	30
Quiz 2	4 and 5	5
Project Work	6	10
End Term	Complete	50

Please note, as per the notice circulated in the ECE department on 5th March 2018 students having attendance less than 60% will not be allowed to sit in the final examination. Students having attendance <75% will be penalized by 1 grade demotion (A to AB or B to BC etc.)

Updated By: Santosh Shah (16/12/2019)