COURSE DESCRIPTION

Approval: 24th Senate Meeting

Course Number: EE 530
Course Name : Applied Optimization
Credits : 3-0-0-3 (L-T-P-C)
Prerequisites : Linear algebra (MA512 or IC 111) or Matrix Theory (EE522).
Intended for : UG /MS/MTech (CSP)/PhD/M.Sc. (Applied Mathematics)
Distribution : Core for MTech (CSP), Elective for B.Tech. III/IV year, MS, Ph.D, M.Sc (Applied Mathematics).
Semester : Even
Comments: The syllabus for EE 530 has been revised. The revised syllabus as recommended by 33rd BOA, held on 31st January 2020 and approved by 24th Senate meeting held on 13th February is as mentioned below.

Preamble

This course is intended to be a core course for M.Tech Communication and Signal Processing students and elective for MS/Phd and senior B.Tech students. Many of the problems in communication as well as signal processing are solved using optimization. Many of these are nonconvex in nature. This course is focused on enabling students to solve convex optimization problems and also to handle nonconvexity.

After finishing this course the students should be in a position to (i) convert a given problem to an appropriate optimization problem (ii) analyze the problem and (iii) choose an appropriate algorithm to solve the problem.

Specific applications from communication and signal processing which uses the theory developed in the intial modules is included in the last module. For these, in addition to the theory the students are expected to implement these algorithms and analyze the solvability in some of the cases.

Course modules with Quantitative lecture hours:

Convex analysis: convex sets, convex cones, polyhedral sets, extreme points and directions. Convex functions, properties and tests for convexity, operations that preserve convexity, conjugate function. (6 hours)

Convex optimization problems: standard form, equality and inequality constraints, slack variables, eliminating equality and inequality constraints. Local and global optima. Optimality criterion for unconstrained, equality constrained and inequality constrained problems. (7 hours)

Linear optimization problems with examples, linear and generalized linear-fractional programming. Quadratic problems with examples. Second order cone programming – robust linear programming, linear programming with random constraints. Geometric programming with examples. Generalized inequality constraints – conics form problems, semidefinite programming, examples. (14 hours)

Handling non-convexity: Lagrangian duality theory – Lagrangian dual function, strong and weak duality, duality gap. Certificate of suboptimality and stopping criteria, complementary slackness. KKT optimality conditions. Solving the primal via dual. (9 hours)

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Applications of convex programming in communication and signal processing: ***The choice of applications is left to the faculty member handling the course.*** Examples that could be used are: Optimal decentralized estimation (single and multisensor case). Pulse shaping filter design. Quasi-ML detection via SDP relaxation (or any other problems in CSP). (6 hours)

Textbook:

1. S. Boyd and L. Vandenberghe, Convex optimization, Cambridge University Press, 2008.

Reference books:

1. M.S. Bazaraa, H.D. Sherali and C.M. Shetty, Nonlinear Programming, 3/e, Wiley, 2006.
2. D. P. Bertsekas, Nonlinear programming, Athena Scientific, 1999.
3. D. G. Luenberger and Y. Ye, Linear and nonlinear programming, 3/e, Springer, 2008.
4. Relevant literature.

Similarity Content Declaration with Existing Courses:

Sr No	Course code and title	Similarity content	Approx % of content	Remarks
1.	MA 515, Applied Mathematical Programming	Linear programming, non linear programming	10%	Minor overlap.
2.	MA 651 Optimization Techniques	Convexity, duality, unconstrained optimization algorithms	15%	Overlap of concepts.

Justification for new course proposal if cumulative similarity content is > 30%: NA