Proposal for a New Course

Course Number : EE 530
Course Name : Optimization theory
Credits : 3-0-0-3 (L-T-P-C)
Prerequisites : Linear algebra (MA512 or IC 111) or Matrix Theory (EE522), instructor consent.
Intended for : UG /MS/MTech (CSP)/PhD/M.Sc(Maths)
Distribution : Core for Mtech (CSP), Elective for B.Tech. (EE. & CSE) III/IV year, MS, Ph.D, M.Sc(Maths).
Semester : Even

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. This course is intended to impart a strong mathematical background to the students so that they are 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.

Though the examples are selected from communication and signal processing, the course can benefit students from other areas of engineering/science since the theory covered is valid for all, irrespective of the application area.

Course modules with Quantitative lecture hours:

Math background: Vector spaces, sequences, limit and continuity. Matrix norms, eigenvalues, eigenvectors, symmetric and positive definite matrices. Coercive functions. Weierstrass theorem.

(5 lectures)

Convex analysis: convex sets, theorem of alternatives, convex cones, polyhedral sets, extreme points and directions. Convex functions, conjugate function, quasiconvex and pseudoconvex functions.

(7 lectures)

Linear programming: fundamental theorem of LP, simplex method, transportation and network flow problems, Interior-Point methods.

(7 lectures)

Unconstrained optimization: Necessary and sufficient conditions. Descent methods, convergence and rate of convergence.

(6 lectures)

Constrained optimization: tangent plane, eigenvalues in tangent space, cone of feasible directions and improving directions. Problems with equality and inequality constraints - Lagrangian function and the Lagrange multipliers, KKT conditions (necessary and sufficient).

(7 lectures)

Duality: Lagrangian dual problem, weak and strong duality theorems, properties of dual functions, getting the primal solution for convex, linear and quadratic programs.

(5 lectures)

Applications of convex programming, geometric programming, quadratic programming, second-order cone programming,and semi-definite relaxation to problems from communication and signal processing and other areas.

(5 lectures)

Textbook:

1. M.S. Bazaraa, H.D. Sherali and C.M. Shetty, Nonlinear Programming, 3/e, Wiley, 2006.

Reference books:

1. S. Boyd and L. Vandenberghe, Convex optimization, Cambridge University Press, 2008.
2. D. P. Bertsekas, Nonlinear programming, Athena Scientific, 1999.
3. D. G. Luenberger and Y. Ye, Linear and nonlinear programming, 3/e, Springer, 2008.

Similarity Content Declaration with Existing Courses:

Sr. No.	Course code and Title	Similarity content	Approx. % of content	Remarks
1	MA 651 Optimization Techniques	Convexity, simplex method, duality, unconstrained optimization algorithms	25%	MA 651 deals mostly with techniques and not the theory. The mentioned topics are covered in much more detail in the proposed course (more hours are spend for these topics).
2	EE 510 Mathematical Methods for Signal Processing	Unconstrained and constrained optimization.	20%	The topics are dealt with only at an introductory level.
3	MA 515 Applied Mathematical Programming	LP, simplex, nonlinear programming.	19%	MA515 is predominantly about solving linear programs, whereas the proposed course has LP as a small part. Hence the overlap.

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

1. Since this is a core requirement for M.Tech (CSP) students, they need a single course which exposes them to the theory. They cannot be expected to take three courses to satisfy the requirement of a single area.
2. After discussing with the faculty members who are offering/have offered Optimization courses it was decided that EE 510 and MA 651 **will not be offered** any more. The three existing optimization courses will be stream lined so that the student can follow the path: Linear programming (MA515), Optimization theoty (EE 531), and Heuristics in Optimization, which would deal mostly with techniques. This makes the overlap 19%.

Approvals:

Other faculty interested in teaching this course: Siddhartha Sarma, Samar Agnihotri, Satyajit Thakor, Manoj Thakur.

Proposed by: Renu Rameshan and Samar Agnihotri School: SCEE

Signature: Date: 28 October 2017

Recommended/Not Recommended, with comments

Chairperson, Course proposal committee (CPC) Date:

Approved / Not Approved

Chairperson, Senate Date: