Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: **ME6xxM** (suggested)
2. Course Title: **Basic Nonlinear Optimization**
3. Per Week Lectures: **3** (L), Tutorial: ___(T), Laboratory: ___ _(P), Additional Hours[0-2]: ___(A),
   Credits (3*L+2*T+P+A): **5** Duration of Course: **Modular** [Half a Semester]
4. Proposing Department/IDP : **Mech Engg**

   Other Departments/IDPs which may be interested in the proposed course:

   All Engg Departments, Physics, Mathematics, Economics etc.

   Other faculty members interested in teaching the proposed course: **V R Iyer, U Roy, M K Das**
5. Proposing Instructor(s): **P Wahi and B Dasgupta**
6. Course Description:

A) Objectives: This **Modular Course** intends to acquaint the students with the Basic Concepts and Methods of Optimization, in a general (nonlinear) setting --- handling convex problems mostly in a sense of corollary --- for `Engg Analysis, Design and Research' in applications as well as in optimization algorithms themselves. Further, it covers the basic algorithms and problems in a variety of areas: including univariate/multivariate, unconstrained/constrained, linear/nonlinear and classical/special formulations; with a focused reference to the linear/nonlinear least square problems which are of universal interest among learners and researchers.

Thus, this modular course, in the space of half a semester, covers the essential and basic elements of optimization, enabling the student to pursue the individual areas through other specialized/advanced courses (for example, the follow-up proposal of ME8xxM) OR informed self-study.

B) Contents (*preferably in the form of 5 to 10 broad titles)*:

S. No.	Broad Title	Topics	Lectures
1.	Fundamental Concepts	Application and Scope, Historical Development, Mathematical Background, Concept of Convexity; Optimization Problems,Formulation, Algorithms.	5
2.	Univariate Optimization	Basic Theory, Derivative Based Methods,Region Elimination Methods; Idea of Line Search.	2
3.	Multivariate Optimization	Fundamentals, Direct Methods, The Method of Steepest Descent, Newton's Method.	4
4.	Equation Solving and Least Square Problems	Hybrid Method, Solution of Nonlinear Equations and Systems, Least Square Problems.	2
5.	Framework of Constrained Optimization	Constraints, First and Second Order Conditions, Sensitivity and Duality; Families of Methods for Constrained Optimization --- Basic Operational Rules of Lagrange Methods and Penalty Methods.	5
6.	Special Topics (time allowing)	A few selected topics (problems and methods) outside the `above' framework.	2

C) Pre-requisites, if any (*examples: a- PSO201A,or b- PSO201A or equivalent*): **None**

D) Short summary for including in the Courses of Study Booklet: **This course intends to acquaint the students with the Basic Concepts and Methods of Nonlinear Optimization --- including, among examples, general nonlinear problems as well as LP, QP and other Convex Programming Problems as special cases --- for Engg Analysis, Design and `Research in application areas as well as in optimization algorithms themselves'. Further, it covers the basic algorithms of a variety of optimization methods and problems; with special reference to the linear/nonlinear least square problems which are of universal interest among learners and researchers.**

7. Recommended books:

Textbooks:

(*a) ``Optimization for Engineering Design: Algorithms and Examples'' by K Deb.*

(b) ``Optimization Concepts and Applications in Engineering'' by Belegundu and Chandrupatla.

Reference books:

(a) ``Linear and Nonlinear Programming'' by Nash and Sofer.

(b) ``Engineering Optimization: Theory and Practice'' by S S Rao.

8. Any other remarks: [A rich course in optimization methods remains a valued legacy among department/institute students for around four decades (possibly longer) in the institute. This enabling/optional attempt to extract out of it a pair of modular courses (ME6xxM and ME8xxM) is intended to make/keep it more relevant with time for different sections of its audience, also making it easier to offer for instructors in busy semesters.]

Dated:_____ Proposer:_____

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____