Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: **ME8xxM** (suggested)

2. Course Title: **Professional Practice in 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**

5. Proposing Instructor(s): **P Wahi and B Dasgupta**

6. Course Description:

A) Objectives: This **Modular Course** strives to take the students trained in the Basic Concepts and Methods of Optimization, who are keen to explore further depth and breadth of the field or need more advanced algorithms to handle their research problems, up to the professional and advanced levels of nonlinear optimization having a competitive edge in generality and efficiency. Further, it also opens further vistas of open problems in algorithmic research in optimization.

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

S. No.	Broad Title	Topics	No. of Lectures
1.	Introduction	Recapitulation of Basic Concepts and Methods; Exact (Accurate) and Inexact (Inaccurate) Line Search.	2
2.	Methods of Multivariate Optimization	Conjugate Direction and Conjugate Gradient Methods, Quasi-Newton Methods; Broyden's Jacobian Update for Solution of Nonlinear System of Equations.	5
3.	Convex Programming	General Theory, Linear and Quadratic Programming.	3
4.	Constrained Optimization	Penalty Methods, Primal Methods, Dual Methods, Lagrange Methods.	6
5.	Advanced Problems	Multimodal, Multi-Objective and Functional Optimization.	2
6.	Special Topics (as time permits)	Some selected problems and methods `outside' the `above' framework.	2

C) Pre-requisites, if any (*examples: a- PSO201A,or b- PSO201A or equivalent*): **The companion modular course "Basic Nonlinear Optimization" (ME6xxM) or "permission of the instructor".** (If a student has some other course as claimed background, it will be the instructor's responsibility to ascertain if that is enough.)

D) Short summary for including in the Courses of Study Booklet: **From the basic concepts of optimization (which a student is expected to know), this course covers its advanced theory and algorithms up to the frontier edges of practice and research; giving motivated students glimpses of their elegance, generality and efficiency.**

7. Recommended books:

   Textbooks:

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

   (b) ``Linear and Nonlinear Programming'' by D G Luenberger.

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

   Reference Books:

   (a) ``Numerical Optimization'' by Nocedal and Wright.

   (b) ``Maxima and Minima without Calculus'' by I Niven.

   (c) ``Applied Mathematical Methods'' by B Dasgupta.

   (d) ``Numerical Recipes'' by Press, Teukolsky, Vellerling and Flannery.

   (e) ``Practical Methods of Optimization'' by R Fletcher.

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:_____