# *Introduction to the Course*

Lecture 01
Optimization Techniques
IE 601



Industrial Engineering and Operations Research
Indian Institute of Technology Bombay

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# *About the Course*

## Main Theme

- Algorithms for linear and nonlinear constrained optimization
- Analysis for understanding
  - correctness of these algorithms
  - main difficulties they face
  - speed at which they converge

## Audience

- Core course of IE MTech, MSc and PhD students
- Elective for others

## Prerequisites

- Prior exposure to optimization modeling, basic algorithms etc
- Comfort with mathematical writing and notation

# *About the Course*

- Grading scheme, references, topics etc are listed in 'About the Course' on Moodle and Course Webpage
- Moodle will be used for grading and emails only
- Lecture slides, assignments etc will be available on the Course Webpage

**The Following Topics will not be Covered**

- Applications of optimization
- Modeling and using software to solve models
- Optimization under uncertainty
- Discrete/combinatorial optimization
- Heuristic methods

# *About the Course*

**Miscellaneous**

- Tutorial in Slot 13A (Monday 7pm-8pm)
- Room to be announced
- Tutorial may be used for make up classes
- Two text-books: highly recommended that you obtain them – available and inexpensive

# *Introduction to Optimization*

Optimization is

- Widely used in engineering, business, policy, games and entertainment
- a generic term
- We will focus on special types of mathematical optimization problems and their solution techniques
- Sometimes hard (so the theory is not well understood, and the ideas are easy)
- Sometimes easy (but the theory is so well developed, it requires hard work to understand)
- My favorite topic
- Something I am quite bad at

Can you solve the problem:

$$\min_{x_1} \sin(x_1) + \cos(x_1)$$

How about

$$\min_{x_1} \sin(x_1) + \cos(x_1) + \log(1 + x_1^2)?$$

- Even problems in one variable do not have closed form solutions
- Numerical techniques or algorithms based on search are required

What is the solution to this linear optimization problem? And how would you explain it to others?

$$\min_{x \in \mathbb{R}^4} 3x_1 + 5x_2 - 7x_3 - x_4$$
$$\text{subject to: } x_1 + x_2 + x_3 + x_4 = 1.$$

Now consider

$$\min_{x \in \mathbb{R}^4} 3x_1 + 5x_2 - 7x_3 - x_4$$
$$\text{subject to: } x_1 + x_2 + x_3 + x_4 = 1,$$
$$x_1, x_2, x_3, x_4 \geq 0.$$

Can you prove (explain why) the minimum value is $-7$?