Optimization Methods for Mechanical Design (ME7223)

Assignment 9

November 22, 2020

Max marks: 20 **Deadline:** One week before endsem exam date

Instructions

- Answer all questions.
- Assume any missing data appropriately.
- Implement optimization algorithms in MATLAB.
- Append the graphs to the scanned version of the answer sheets.
- Contact the TA (Mayank Raj) if you have any questions.

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1. Consider the following optimization problem:

$$\min f(\mathbf{X}) = (x_1 - 1)^2 + (x_2 - 2)^2 - 4$$

subject to

$$x_1 + 2x_2 \leq 5$$

$$4x_1 + 3x_2 \leq 10$$

$$6x_1 + x_2 \leq 7$$

$$x_i \geq 0, i = 1, 2$$

Using the starting point as $\mathbf{X}_1 = \{1, 1\}$, perform the following tasks:

(a) Minimize using Zoutendijk's method and perform two one-dimensional minimization steps of the process. (4)

(b) Complete one iteration of Rosen's gradient projection method. Comment on your observations. (4)

2. Consider the problem:

$$\min f(x_1, x_2) = (x_1 - 1)^2 + (x_2 - 2)^2$$

subject to

$$2x_1 - x_2 = 0$$

$$x_1 \leq 5$$

Construct the function ϕ_k according to the interior penalty function approach. Plot the countours of ϕ_k for for different values of k and complete the minimization of ϕ_1. Comment on your observations. (4)

3. Construct the ϕ_k function according to the exterior penalty function approach and complete the minimization of ϕ_k for the following problem.

$$\min f(x) = (x-1)^2$$

subject to

$$g_1(x) = 2 - x \leq 0$$

$$g_2(x) = x - 4 \leq 0$$

Plot the contours of ϕ_k for different values of k and make an appropriate choice of k for minimization task. Comment on your observations. (4)

4. Transform the following constrained problem into an equivalent unconstrained problem: (4)

$$\max f(x_1, x_2) = \left(9 - (x_1 - 3)^2\right) \frac{x_2^3}{27\sqrt{4}}$$

subject to

$$0 \leq x_1$$

$$0 \leq x_2 \leq \frac{x_1}{\sqrt{3}}$$

$$0 \leq x_1 + \sqrt{3}x_2 \leq 6$$