Optimization Methods for Mechanical Design (ME7223)

Assignment 7

October 24, 2020

Max marks: 20 **Due Date:** 26 Oct 2020

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.

---

1. Determine whether the following vectors serve as conjugate directions for minimizing the function $f = 2x_1^2 + 16x_2^2 - 2x_1x_2 - x_1 - 6x_2 - 5$. (2)

   (a) $\mathbf{S_1} = [\ 15, -1]^{\ T}$, $\mathbf{S_2} = [\ 1, 1]^{\ T}$

   (b) $\mathbf{S_1} = [\ -1, 15]^{\ T}$, $\mathbf{S_2} = [\ 1, 1]^{\ T}$

2. Minimize the function $f(x_1, x_2) = 8x_1^2 - 6x_1x_2 + 8x_2^2 - x_1 + x_2$ using: (8)

   (a) Steepest descent method

   (b) Conjugate gradient descent method

   (c) Netwon's method

   (d) Marquardt method

   For all the methods, assume the initial guess to be $(100, 0)$. For Marquardt method, $a = 10^4$ where $\tilde{\mathbf{J}} = \mathbf{J} + a\mathbf{I}$ ($\mathbf{J}$ and $\mathbf{I}$ are the Hessian and Identity matrices respectively). Assume the other parameters appropriately.

   Do a maximum of four iterations for each of the methods and compare them in terms of final accuracy. Mark the value of design variables on contour plot of the objective function and tabulate the values of variables at each step of all the four methods. Comment on your observation/s.

3. Minimize the function $f(x_1, x_2) = 100\,(x_2 - x_1^2)^2 + (1 - x_1)^2$ using: (8)

   (a) Steepest descent method

   (b) Conjugate gradient descent method

   (c) Netwon's method

(d) Marquardt method

Assume the starting point to be (-1.2, 1.0) for all the methods and follow the other instructions given in the Problem 2.

4. State, with appropriate justification, the advantages of Marquardt method over the Newton's method and Conjugate gradient descent method. (2)