ME7223 - Optimization Methods for Mechanical Design
End Semester Examination

Date: 26-December-2020 Maximum Marks: 50

Submission Deadline: 24 hours

INSTRUCTIONS

- Write/Type your NAME and ROLL NUMBER on all the answer sheets.
- Write/Type the page number on each side of the page as Page X of $Total\ Pages$.
- Academic honesty is the most important aspect. If you are found copying and/or involved in the process, you will get ZERO marks for the entire endsem exam.
- Show all the intermediate steps clearly and they carry marks. Final answer alone is NOT sufficient.
- Prepare a detailed report of your answers. Show all the intermediate steps.
- The programs should be properly commented. **Programs without comments will not be evaluated.** You should write comments for each variable in the program and also write the description of all the important calculations as comments in the program.
- The figures should have captions describing what they show.
- Assume any data that is missing.
- Submit all the programs and the report (in pdf format only) as a single zip file in the moodle submission portal.
- The constants in the questions will be different for each student.
- If your roll number is ME21B345, then use the following formula to find out the constants to be used in your work.

A	ratio of the year field to the last three digits, i.e., for the example case, it is 21/345.
B	largest digit in the last three digits of the roll number, i.e., $B = 5$ for the example.
C	sum of the last three digits,i.e., $C = 3 + 4 + 5 = 12$.
D	difference between the largest and smallest number in the last three digits, i.e., 5-3=2.
E	smallest digit (greater than zero) in the last three digits, i.e., E=3.

1. Minimize $f(x_1, x_2) = (x_1 - D)^2 + (x_2 - C)^2$ subject to (10)

$$\begin{aligned} -x_1^2 + x_2 &\leq D \\ -(x_1 - 2)^2 + x_2 &\leq E \end{aligned}$$

using (a) graphical method and (b) K-K-T conditions. The contours of the objective functions and constraints have to be shown using a Matlab routine.

2. Using golden section method, maximize the function (10)

$$f(x) = C + x^3 - Bx - D\exp(x)$$

in the interval $(-2, 2)$ within 1% accuracy. The student is free to write a MATLAB program or use pen and paper approach.

3. Minimize $f(x_1, x_2) = (x_1^2 + x_2 - B)^2 + (x_1 + x_2^2 - E)^2$ using (a) conjugate gradient method and (b) Quasi-Newton method. Compare both the solutions and their convergence behaviour. In your report, comment on the convergence behaviour of both the methods. You are also required to plot the objective function contours and show the minimization path for both the methods. Also, show the convergence of the algorithm to the solution by choosing two different starting points and comment on the convergence trend. The programs should be properly commented as mentioned in the instructions. (20)

4. Given $f(x_1, x_2) = (x_1 - E)^2 + (x_2 - E)^2$. Minimize $f(x_1, x_2)$ subject to (10)

$$\begin{aligned} x_1 - x_2 - D &= 0, \\ x_1 + x_2 - 0.5 &\leq 0 \end{aligned}$$

using Lagrange multiplier method.