ME 748: Optimum Design of Mechanical Elements and Systems
Spring 2007; Assignment-5

Due: 26th March 2007; 5 pm in ECB 3108 **(Maximum extension of 2 days!!)**
You are welcome to use MATLAB to assist you in answering any of the following problems.

Problem 1: Consider the problem:

$$Min : f = 0.5x_1^2 + 2.5x_2^2$$
$$s.t.\ x_1 - x_2 - 1 \geq 0$$

Find the stationary point graphically. Is the constraint active at the stationary point? Is the stationary point a minima? Justify your claim

Problem 2: Solve the following problem graphically:

$$Min : f = (x_1 - 1)^2 + (x_2 - 1)^2$$
$$x_1 + x_2 - 4 = 0$$
$$x_1 - x_2 - 2 \geq 0$$

Then, verify that the necessary and sufficient conditions are satisfied at the minima.

Problem 3: Consider the problem:

$$Min : f = 3x_1^2 - 2x_1 - 5x_2^2 + 30x_2$$
$$2x_1 + 3x_2 \geq 8$$
$$3x_1 + 2x_2 \leq 15$$
$$x_2 \leq 5$$

Plot the contours and constraints marking the feasible region. Consider the points $(5/3, 5)$, $(1/3, 5)$ and $(3.97, 1.55)$. Are these points stationary? If so classify.

Problem 4: Find the maxima of xy over a unit disk centered over the origin. Pose as an optimization problem, and solve.

Problem 5: Consider

$$P \begin{cases} Min : f(\overline{x}) \\ s.t.\ g(\overline{x}) \leq 0 \end{cases} \quad \text{and the perturbed problem:} \quad P_\varepsilon \begin{cases} Min : f(\overline{x}) \\ g(\overline{x}) + \varepsilon \leq 0 \end{cases}$$

State and prove the relationship between the minimal functional values $f^{\min}$ and $f_\varepsilon^{\min}$ for the two problems.