Problem set 1

1. Answer True or False.

- Design of a system implies specification for the design variable values.
- The number of "≤ type" constraints must be less than the number of design variables for a valid problem formulation.
- Maximization of *f(x)* is equivalent to minimization of *1⁄ f(x)*.
- A lower minimum value for the cost function is obtained if more constraints are added to the problem formulation.
- Let f_n be the minimum value for the cost function with *n* design variables for a problem. If the number of design variables for the same problem is increased to, say $m = 2n$, then $f_m > f_n$ where f_m is the minimum value for the cost function with m design variables.

2. Develop an appropriate graphical representation (using MATLAB) for the following problems and determine all the local and global minimum and maximum points.

2-1.

$$\begin{aligned} &f(x,y) = 2x + 3y - x^3 - 2y^2 \\ &\text{subject to } \; x + 3y \le 6 \\ &\qquad 5x + 2y \le 10 \\ &\qquad x, y \ge 0 \end{aligned}$$

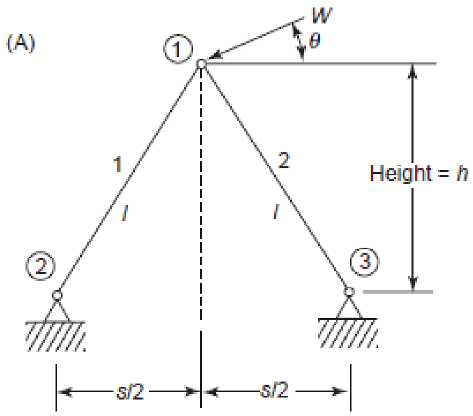
2-2.

$$\begin{aligned} &f(r,t) = (r-4)^2 + (t-4)^2 \\ &\text{subject to } \; 10 - r - t \ge 0 \\ &\qquad 5 \ge r \\ &\qquad r, t \ge 0 \end{aligned}$$

2-3.

$$\begin{aligned} &f(x,y) = -x + 2y \\ &\text{subject to } \; -x^2 + 6x + 3y \le 27 \\ &\qquad 18x - y^2 \ge 180 \\ &\qquad x, y \ge 0 \end{aligned}$$

3. Consider the two-bar truss shown in following Fig. Using the given data, design a minimum mass structure where $W = 100\ kN$;$\theta = 30°$; $h = 1$ m; $s = 1.5$ m; modulus of elasticity, $E = 210$ GPa; allowable stress,$\sigma = 250$ MPa, mass density,$\rho = 7850$ kg/m3. Use Newtons and millimeters as units. The members should not fail on stress and their buckling should be avoided. Deflection at the top in either direction should not be more than 5 cm. Use cross –sectional area A_1 and A_2 of the two members as design variables and let the moment of inertia of the members be given as $I = A^2$. Area must also satisfy the constraint $1 \le A_i \le 50$cm2.



4. For Exercise 3, use the hollow circular tubes as members with mean radius *R* and wall thickness *t* as design variables. Make sure that $R/t \leq 50$. Design the structure so that member 1 is symmetric with member 2. The radius and thickness must also satisfy the constraints $2 \leq t \leq 40$ *mm* and $2 \leq R \leq 40$ *cm*.