# Assignment Number - 1
## ME 60353 ; MF41601

1. Define the following terms related to optimization by taking a suitable example: (i) decision variables, (ii) objective function, (iii) functional constraints, (iv) geometric constraints.

2. The presence of geometric constraint(s) is a must for an optimization problem but that of functional constraint(s) is optional – justify the statement.

3. Explain the principle of optimization with a suitable example.

4. In a constrained optimization, an optimal point is either a free point or a bound point lying in the feasible zone – justify the statement.

5. Why do the solutions of a steepest descent method get stuck at the local minima ?

6. Discuss briefly the drawbacks of traditional methods of optimization.

7. Determine the minimum/maximum/inflection point of the following functions: (i) $f(x) = x^3$; (ii) $f(x) = x^4$.

8. In case of turning operation carried out on a Lathe, cutting parameters (such as cutting speed $v$ in $m/min$, feed $t$ in $mm/rev$ and depth of cut $d$ in $mm$) are to be selected in such a way that it can produce the smoothest surface after ensuring a minimum life of the cutting tool $TL_{min}$. Let us assume that surface roughness in turning $S$ $(micro-m)$ and life of the turning tool $TL$ $(min)$ are given by the following expressions:

$$S = 15077v^{-1.52}t^{1.004}d^{0.25},$$
$$TL = 1.475 \times 10^9 v^{-4.0}t^{-4.29}d^{-4.35}$$

Formulate it as a constrained optimization problem. The cutting parameters are allowed to vary in the ranges given below.

$$30.0 \leq v \leq 190.0,$$
$$0.01 \leq t \leq 2.5,$$
$$0.5 \leq d \leq 4.0.$$

9. **Minimize** $y = f(x) = \frac{32}{x^2} + x$ in the range of $0.0 < x \leq 10.0$. Use (i) analytical approach based on differential calculus and (ii) exhaustive search method.
(**Hints:** Let the three values of $x$, say $x_1$, $x_2$ and $x_3$ are in ascending order. For a minimization problem, if $f(x_1) \geq f(x_2) \leq f(x_3)$, then the minimum value lies in the range of $(x_1, x_3)$.)

10. **Minimize** $f(x_1, x_2) = 4x_1^2 + x_2^2 - 3x_1x_2 + 6x_1 + 12x_2$ in the range of $-100.0 \leq x_1, x_2 \leq 100.0$. Take the initial solution $X_1 = \begin{Bmatrix} 0.0 \\ 0.0 \end{Bmatrix}$.
(i) Use Random Walk Method. Assume step length $\lambda = 1.0$, permissible minimum value of $\lambda$, that is, $\epsilon = 0.25$ and maximum number of iterations $N = 50$.
(ii) Use Steepest Descent Method.