(2 Pages) **E**

# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION,MAY 2017

**Mechanical Engineering**
**(Machine Design)**

## 01ME6122: Optimization Technique for Engineering

Max. Marks: 60 | Answer two questions from each part. | Duration: 3 Hours

## Part A

1. Find the dimensions of a box of largest volume that can be inscribed in a sphere of unit radius. **(9 Marks)**

2. a) Find the second order Taylor series approximation of the function $f(x_1, x_2, x_3) = x_2^2 x_3 + x_1 e^{x_3}$ **(5 Marks)**

   b) Determine whether the following functions are concave or convex. $i) f(X) = 4x_1^2 + 3x_2^2 + 5x_3^2 + 3x_2^2 + 6x_1x_2 + x_1x_3 - 3x_1 - 2x_2 + 15$ $\quad ii) f(X) = 3x_1^3 - 6x_2^2$. **(4 Marks)**

3. a) Mention any five applications of optimization in the field of mechanical engineering. **(3 Marks)**

   b) What are objective function contours? **(3 Marks)**

   c) Under what conditions can a polynomial in 'n' variables are called a Posynomial? **(3 Marks)**

## Part B

4. Minimize $f(x) = 0.65 - \frac{0.75}{1+x^2} - 0.65x\tan^{-1}(\frac{1}{x})$ in the interval [0, 3] by the Fibonacci method conducting six experiments. **(9 Marks)**

5. Minimize $f(X) = (x_1^2 - x_2)^2 + (1 - x_1^2)$ from the starting point $X_1 = \{-2, -2\}$ using Fletcher - Reeves method. **(9 Marks)**

6. Find the optimal control 'u' that makes the functional $J = \int_0^1 (x^2 + u^2)dt$ Stationary with $x = u$ and $x(0) = 1$. The value of 'x' is not specified at t=1. **(9 Marks)**

**P.T.O**

## Part C

7. Minimize $f(X) = x_1^3 - 6x_1^2 + 11x_1 + x_3$ subject to $g_1(Y): x_1^2 + x_2^2 - x_3^2 \leq 0$, $g_2(Y): x_1^2 + x_2^2 + x_3^2 \leq 4$, $g_3(Y): x_3 - 5 \leq 0$, $g_i(Y): x_i \geq 0, i = 1,2,3 \ldots n$ using penalty function method.
**(12 Marks)**

8. Minimize $f(X) = x_1^2 + x_2^2 + x_3^2 + 40x_1 + 20x_2$ subject to $g_1(Y): x_1 - 50 \geq 0$, $g_2(Y): x_1 + x_2 - 100 \geq 0$, $g_3(Y): x_1 + x_2 + x_3 - 150 \geq 0$. Determine whether the constraint qualification and the Kuhn Tucker conditions are satisfied at the optimum point.
**(12 Marks)**

9. Minimize $f(X) = -3x_1 - 4x_2$ subject to $g_1(Y): 3x_1 - x_2 + x_3 = 12$, $g_2(Y): 3x_1 + 11x_2 + x_4 = 66$, $g_i(Y): x_i \geq 0, i = 1,2,3,4$ using Integer programming.
**(12 Marks)**