

**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 $f(x_1, x_2, x_3) = x_2^2 x_3 + x_1 e^{x_1}$. **(5 Marks)**
 b) Determine whether the following functions are concave or convex.
 i) $f(X) = 4x_1^2 + 3x_2^2 + 5x_3^2 + 3x_2^2 + 6x_1 x_2 + x_1 x_3 - 3x_1 - 2x_2 + 15$ 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 be called a Posynomial? **(3 Marks)**

Part B

4. Minimize $f(x) = 0.65 - \frac{0.75}{1+x^2} - 0.65x \tan^{-1}\left(\frac{1}{x}\right)$ 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 $X_I = \{-2, -2\}$ 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)**

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Part C

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