M. TECH.-II (MECHANICAL CAD/CAM) (CBCS – 2015 COURSE) : WINTER - 2017
SUBJECT: OPTIMIZATION FOR ENGINEERING DESIGN

Day : **Thursday**
Date : **30/11/2017**

W-2017-2819

Time : **11.00 AM TO 02.00 PM**
Max. Marks : 60.

N.B.:

1) All questions are **COMPULSORY.**
2) Figures to the **RIGHT** indicate full marks.
3) Draw neat labeled diagrams **WHEREVER** necessary.

Q.1 Explain the optimality criteria for single variable optimization. Find the local maxima and minima, if any, of the following functions. **(10)**

a) $x^3 - 3x + 1$

b) $x^3 - 3x^2 + 3x - 1$

c) $(3-2x)e^{x^2}$

OR

Q.1 We want to design a cone-shaped paper drinking cup of volume V that requires a minimum of paper to make. That is, we want to minimize its surface area $\pi r\sqrt{r^2+h^2}$, where r is the radius of the open end and h the height. Since $V = \frac{\pi}{3}r^2 h$, we can solve for h to get h = 3V/ (πr^2). Thus the area in terms of r is. **(10)**

$$A(r) = \pi r\left(r^2 + 9\frac{V^2}{\pi^2 r^4}\right)^{\frac{1}{2}} = \left(\pi^2 r^4 + 9\frac{V^2}{r^2}\right)^{\frac{1}{2}}$$

a) Compute the derivative A′(r)

b) Find the radius r at which A(r) is minimized (the solution you get is in fact a minimum).

c) What is the ratio h/r when r has the optimal value?

Q.2 Explain optimality criteria for multivariable optimization. Consider the function $f(x_1, x_2) = x_1 ln x_2$. **(10)**

a) Compute the gradient of *f*.

b) Give the value of the function *f* and give its gradient at the point (3, 1).

c) use the formula for small changes to obtain an approximate value of the function at the point (2.99, 1.05).

OR

Q.2 Consider a conical drinking cup with height *h* and radius *r* at the open end. The volume of the cup is $V(r,h) = \frac{\pi}{3}r^2 h$. **(10)**

a) Suppose the cone is now 5 cm high with radius 2 cm. Compute its volume.

b) Compute the partial derivatives $\partial V/\partial r$ and $\partial V/\partial h$ at the current height and radius.

c) By about what *fraction* (i.e. percentage) would the volume change if the cone were lengthened 10%? (Use the partial derivatives).

d) If the radius were increased 5%?

P.T.O.

Q.3 Explain Bounding phase method and minimize $f(x) = (100 - x)^2$ given the starting point $x_0 = 30$ and a step size $|\Delta| = 5$. **(10)**

OR

Q.3 Find the minimum of

$$f(x) = 8x_1^2 + 4x_1x_2 + 5x_2^2$$

from $x^{(0)} = [-4, -4]^T$ by Hooke-Jeeves pattern search.

Q.4 Minimize $x_1 + x_2 + x_3^2$ **(10)**

subject to

$x_1 = 1$

$x_1^2 + x_2^2 = 1$

OR

Q.4 Suppose we have a refinery that must ship finished goods to some storage suppose further that there are two pipelines. A and B, to do the shipping. The cost of ship units on A is ax^2; the cost of shipping y units on B is by^2, where $a > 0$ and $b > 0$ are given can we ship Q units while minimizing cost? What happens to the cost if Q increases by r%? **(10)**

Q.5 Maximize $x^3 - 3x$ **(10)**

subject to

$x \leq 2$

OR

Q.5 Explain Kuhn-Tucker algorithm. **(10)**

Q.6 Explain Genetic algorithm.

OR

Explain penalty function.

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