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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: VI**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME6DEOPT **Max Marks: 100**
Course: Optimization Techniques **Date: 27.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Find the rank of the below given matrix **04**

$$\begin{bmatrix} 2 & -1 & -3 & -1 \\ 1 & 2 & 3 & -1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & -1 \end{bmatrix}$$

b) Solve the following system of linear equation by Gauss-Seidel method to obtain the final solution correct to three places of decimals (Note: All the iteration calculation needs to be shown) **08**

$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$
$$20x + y - 2z = 17$$

c) Use the Newton's method to find the minimizer of the given function (Note: at least four iterations calculation steps need to be shown) **08**

$f(x) = x^4 - 14x^3 + 60x^2 - 70x$

$Initial\ guess, x_0 = 1.5, residual = 10^{-4}$

UNIT - II

2 a) Find the dimensions of a cylindrical tin (r = radius of the cylinder and h = height of the cylinders) made up of sheet metal using Lagrange multiplier method. Consider this as a constrained problem and maximize its volume such that the total surface area is equal to $A_0 = 24\pi$. Also calculate the Hessian matrix. (Note: consider top and bottom surface in the calculation). **08**

b) Solve the below minimization problem by establishing the KKT condition. Also show that the function is minimum at the obtained extremisers. **12**

Minimize $f(X) = (x_1 - 3)^2 + (x_2 - 2)^2$

Subjected to $-x_1^2 - x_2^2 + 4 \geq 0$

$x_1 + x_2 - 2 \geq 0$

$x_1, x_2 \geq 0$

OR

3 a) What kind of optimization problems are solved by using method of Lagrange multipliers? Explain the algorithm to solve an optimization problem using the above method. **05**

b) What kind of optimization problems are solved by using Karush Kuhn Tucker (KKT) condition? Explain the algorithm to solve an optimization problem using the above method. **05**

c) Determine the extremisers of the following constrained function using the Lagrange multipliers method and also find out whether the function is maximum or minimum at the obtained extremisers. **10**

Minimize $y = x_1^2 + x_2^2 + x_3^2 + 40x_1 + 20x_2$

Subjected to $50 - x_1 = 0$

$100 - x_1 - x_2 = 0$

$150 - x_1 - x_2 - x_3 = 0$

$x_1, x_2, x_3 \geq 0$

UNIT - III

4 a) List the points that need to be followed while solving the quadratic programming problem using active set method. **06**

b) Consider a constrained equality optimization problem as given below. Find the optimum using Newton's method. **14**

$$y = 3x_1^2 + 4x_2^2 + 2x_1x_2 - 2x_1 - 3x_2$$

Subjected to $3x_1 + 2x_2 = 6$

$x_1, x_2 \geq 0$

OR

5 Consider a constrained inequality minimization optimization problem as given below. Find the optimum using quadratic programming algorithm. **20**

$$y = x_1^2 + x_2^2$$

Subjected to $x_1 + x_2 \geq 2$

$-x_1 + \frac{2}{3}x_2 \geq -4$

$x_1, x_2 \geq 0$

UNIT - IV

6 Write a note on the following practical issues that can occur while solving optimization problem (i) infeasible constraints (ii) Taylor series expansion and central difference method along with order of accuracy (iii) rank deficient constraints, (iv) constraint redundancy (v) Taylor series expansion and backward difference method along with order of accuracy **20**

UNIT - V

7 It is desired to maximize the parameter **20**

$$y = \frac{2.5 + 6.2x^{0.8}}{1.3 + 0.08x^{1.8}}$$

the range of $1.5 \leq x \leq 4.5$m/s, Using the genetic algorithms (GA), perform 3 iterations with an initial population size of 4n and 2 decimal accuracy to determine the extremisers. (Note: need to show how many numbers of bits selected, number of populations, conversion to binary to decimal and other way and one sample calculation for each iteration) Use the following values as an initial population for x = 1.87, 2.53, 3.16 and 4.23

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