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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Third Year- Semester II Examination –October/November 2017

MAT 3217 – NON-LINEAR PROGRAMMING

Time: Two (02) hours

Answer ALL Questions.
Calculators will be provided.

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1. a) Explaining each step clearly, obtain the Lagrange multiplier equation, $\nabla f = \lambda \nabla g$ to find the extreme value of $f(x, y)$, subject to the constraint $g(x, y) = c$, where c is a constant.

(25 marks)

b) An editor has been allocated ~~allotted~~ \$60,000 to spend on the development and promotion of a new book. It is estimated that if x thousand dollars is spent on development and y thousand on promotion, approximately $f(x, y) = 20x^{\frac{3}{2}}y$ copies of the book will be sold.

i. How much money should the editor allocate to development and how much to promotion in order to maximize sales?

ii. Suppose the editor's allocation is increased to \$61,000 to spend on the development and promotion of the new book. Estimate how the additional \$1000 will affect the maximum sales level.

(75 marks)

2. a) State necessary conditions to solve a quadratic programming problem.

(25 marks)

b) Solve the following quadratic programming problem:

$$\begin{aligned} &\textit{Maximize } Z = x_1 + x_2 - x_1^2 - x_2^2 \\ &\textit{subject to,} \quad 2x_1 + x_2 \leq 5 \\ &\qquad\qquad\qquad x_1, x_2 \geq 0 \end{aligned}$$

(75 marks)

3. a) Geometric programming deals with problems in which the objective and constraint functions are of the following type:

$$\text{Minimize } z = \sum_{j=1}^{N} U_j \text{ ; where } U_j = c_j \prod_{i=1}^{n} x_i^{a_{ij}} \quad j = 1,2,,\ldots, N$$

Let z^* be the minimum value of z and $y_j = \dfrac{U_j^*}{z^*}$

Show that

$$z^* = \prod_{j=1}^{N} \left(\frac{c_j}{y_j^*} \right)^{y_j^*}$$

(40 marks)

b) Solve the geometric problem given below:

$$Min\, z = 5x_1 x_2^{-1} x_3^{2} + x_1^{-2} x_3^{-1} + 10x_2^{3} + 2x_1^{-1} x_2 x_3^{-3}; \quad x_1, x_2, x_3 > 0$$

(60 marks)

4. a) For each of the following functions determine whether it is convex, concave or neither:

I. $f(x) = 6 - x^2$

II. $f(x) = x^4 + 2x^2 - 2x$

III. $f(x) = 2x^3 + x^2$

IV. $f(x) = 4x^3 - 3x^2$

(60 marks)

b) Taking the initial bounds as $\underline{x} = -1, \overline{x} = 4$, and error tolerance $\varepsilon = 0.08$, solve the following problem using the One dimensional procedure:

$$Maximize\ f(x) = 48x^5 + 42x^3 + 3.5x - 16x^6 - 61x^4 - 16.5x^2$$

(40 marks)

END