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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech II Semester Examinations, February - 2017

ADVANCED OPTIMIZATION TECHNIQUES AND APPLICATION

(Machine Design)

Time: 3 Hours **Max. Marks: 60**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 20 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 8 marks and may have a, b, c as sub questions.

PART - A

5 × 4 Marks = 20

1.a) What are the limitations of classical methods in solving a one-dimensional minimization problem? [4]

b) Why is the steepest descent method not efficient in practice, although the directions used are the best directions? [4]

c) Why are the components numbered in reverse order in dynamic programming? Explain in detail? [4]

d) Describe a systematic procedure for finding a feasible solution to a system of linear inequalities. [4]

e) How do you find the mean and standard deviation of a sum of several random variables? [4]

PART - B

5 × 8 Marks = 40

2.a) What are the differences between elimination and interpolation methods?

b) Find the value of x in the interval (0, 1) which minimizes the function $f = x(x - 1.5)$ to within ±0.05 by the golden section method. [3+5]

OR

3. Find the minimum of the function $f = \lambda^5 - 5\lambda^3 - 20\lambda + 5$ by the following methods:

a) Unrestricted search with a fixed step size of 0.1 starting from $\lambda = 0.0$

b) Unrestricted search with accelerated step size from the initial point 0.0 with a startingstep length of 0.1

c) Exhaustive search in the interval (0, 5). [8]

4.a) When is the grid search method preferred in minimizing an unconstrained function? Explain.

b) An electric power of 100MW generated at a hydroelectric power plant is to be transmitted 400 km to a stepdown transformer for distribution at 11 kV. The power dissipated due to the resistance of conductors is i^2c^{-1}, where i is the line current in amperes and c is the conductance in mhos. The resistance loss, based on the cost of power delivered, can be expressed as 0.15 i^2c^{-1}dollars. The power transmitted (k) is related to the transmission line voltage at the power plant (e) by the relation $k = \sqrt{3}ei$, where e is in kilovolts. The cost of conductors is given by 2c millions of dollars, and the investment in equipment needed to accommodate the voltage e is given by 500e dollars. Find the values of e and c to minimize the total cost of transmission using Newton's method. [3+5]

OR

5.a) Why is a conjugate directions method preferred in solving a general nonlinear problem?

b) Find a suitable transformation or scaling of variables to reduce the condition number of the Hessian matrix of the following function to one:
$f = 4x_1^2 + 3x_2^2 - 5x_1x_2 - 8x_1 + 10.$ [3+5]

6.a) Prove that f = ln x is a concave function for positive values of x.

b) A fertilizer company needs to supply 50 tons of fertilizer at the end of the first month, 70 tons at the end of second month, and 90 tons at the end of third month. The cost of producing x tons of fertilizer in any month is given by $(4500x + 20x^2)$. It can produce more fertilizer in any month and supply it in the next month. However, there is an inventory carrying cost of $400 per ton per month. Find the optimal level of production in each of the three periods and the total cost involved by solving it as an initial value problem. [3+5]

OR

7.a) Each of the n lathes available in a machine shop can be used to produce two types of parts. If z lathes are used to produce the first part, the expected profit is 3z and if z of them are used to produce the second part, the expected profit is 2.5z. The lathes are subject to attrition so that after completing the first part, only z/3 out of z remain available for further work. Similarly, after completing the second part, only 2z/3 out of z remains available for further work. The process is repeated with the remaining lathes for two more stages. Find the number of lathes to be allocated to each part at each stage to maximize the total expected profit. Assume that any nonnegative real number of lathes can be assigned at each stage.

b) Consider a manufacturing firm that produces a certain product. The rate of demand of this product (p) is known to be p = p[x(t), t], where t is the time of the year and x(t) is the amount of money spent on advertisement at time t. Assume that the rate of production is exactly equal to the rate of demand. The production cost, c, is known to be a function of the amount of production (p) and the production rate (dp/dt) as c = c(p, dp/dt). The problem is to find the advertisement strategy, x(t), so as to maximize the profit between t_1 and t_2. The unit selling price (s) of the product is known to be a function of the amount of production as s = s(p) = a + b/p, where a and b are known positive constants. [4+4]

8.a) Consider the problem of scheduling the weekly production of a certain item for the next 4 weeks. The production cost of the item is $10 for the first 2 weeks and $15 for the last 2 weeks. The weekly demands are 300, 700, 900, and 800 units, which must be met. The plant can produce a maximum of 700 units each week. In addition, the company can employ overtime during the second and third weeks. This increases the weekly production by an additional 200 units, but the cost of production increases by $5 per item. Excess production can be stored at a cost of $3 an item. How should the production be scheduled so as to minimize the total costs? Formulate this as an LP problem.

b) The time between failures of a Kencore refrigerator is known to be exponential withmean value 9000 hours (about 1 year of operation) and the company issues a I-year warrantyon the refrigerator. What are the chances that a breakdown repair will be covered by the warranty? [4+4]

OR

9.a) Find an optimal solution to the following linear program by inspection:
Minimize $Z = x_1 - 3x_2 + 2x_3$
Subject to $-2 \leq x_1 \leq 3$ $0 \leq x_2 \leq 4$ $2 \leq x_3 \leq 5$

b) Psychology professor Yataha is conducting a learning experiment in which mice are trained to find their way around a maze. The base of the maze is square. A mouse enters the maze at one of the four corners and must find its way through the maze to exit at the same point where it entered. The design of the maze is such that the mouse must pass by each of the remaining three corner points exactly once before it exits. The multi-paths of the maze connect the four corners in a strict clockwise order. Professor Yataha estimates that the time the mouse takes to reach one corner point from another is uniformlydistributed between 10 and 20 seconds, depending on the path it takes. Develop a sampling procedure for the time a mouse spends in the maze. [4+4]

10.a) A manufacturing firm can produce 1, 2, or 3 units of a product in a month, but the demand is uncertain. The demand is a discrete random variable that can take a value of 1, 2, or 3 with probabilities 0.2, 0.2, and 0.6, respectively. If the unit cost of production is $400, unit revenue is $1000, and unit cost of unfulfilled demand is $0, determine the output that maximizes the expected total profit.

b) Steel rods, manufactured with a nominal diameter of 3 cm, are considered acceptable if the diameter falls within the limits of 2.99 and 3.01 cm. It is observed that about 5 % are rejected oversize and 5 % are rejected undersize. Assuming that the diameters are normally distributed, find the standard deviation of the distribution. Compute the proportion of rejects if the permissible limits are changed to 2.985 and 3.015 cm. [4+4]

OR

11.a) Three cities A, B, and C are to be connected by a pipeline. The distances between A and B, B and C, and C and A are 5, 3, and 4 units, respectively. The following restrictions are to be satisfied by the pipeline:

i) The pipes leading out of A should have a total capacity of at least 3.

ii) The pipes leading out of B or of C should have total capacities of either 2 or 3.

iii) No pipe between any two cities must have a capacity exceeding 2.

Only pipes of an integer number of capacity units are available and the cost of a pipe is proportional to its capacity and to its length. Determine the capacities of the pipe lines to minimize the total cost.

b) Solve the following mixed integer programming problem using a graphical method:

Minimize $f = 4x_1 + 5x_2$

subject to

$10x_1 + x_2 \geq 10$, $5x_1 + 4x_2 \geq 20$

$3x_1 + 7x_2 \geq 21$, $x_2 + 12x_2 \geq 12$

$x_1 \geq 0$ and integer, $x_2 \geq 0$

[4+4]

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