Indian Statistical Institute, Bangalore
M.S. (QMS) First Year
First Semester - Operations Research I

Final Exam | Duration: 3 Hrs | Date: 16 November, 2016 | Max. Marks: 100

Answer as many questions as you can

1. A company manufactures two products, A and B. The unit revenues are \$2 and \$3 respectively. Two raw materials, M1 and M2, used in the manufacture of the two products have daily availabilities of 8 and 18 units, respectively. One unit of A uses 2 units of M1 and 2 units of M2, and 1 unit of B uses 3units of M1 and 6 units M2. [20]
   (a) Determine the dual prices of M1 and M2 and their feasibility ranges.
   (b) Suppose that 4 additional units M1 can be acquired at the cost of 30 cents per unit. Would you recommend the additional purchase?
   (c) What is the most the company should pay per unit of M2?
   (d) If the unit revenues c_A and c_B are changed simultaneously to \$5 and \$4, respectively, determine the new optimum solution.

2.Consider the following LP model: [14]

Minimize $z = 2x_1 + x_2$

Subject to $3x_1 + x_2 - x_3 = 3$

$4x_1 + 3x_2 - x_4 = 6$

$x_1 + 2x_2 + x_5 = 3$

$x_i \geq 0$ for all i

Compute the entire simplex tableau associate with the following basic solution, and check it for optimality and feasibility.

Basic variables = (x_1, x_2, x_5), Inverse = $\boxed{\begin{matrix} 3/5 & -1/5 & 0 \\ -4/5 & 3/5 & 0 \\ 1 & -1 & 1 \end{matrix}}$

3. Solve the**dual**of the following LP Problem by the **Dual-Simplex** Method [20]

Maximize $Z = 3x_1 + 2x_2 + x_3 + 2x_4$
Subject to

$x_1 + 2x_2 + x_3 + 3x_4 \leq 6$

$3x_1 + 4x_2 + 2x_3 + x_4 \leq 8$

$2x_1 + 3x_2 + 3x_3 + x_4 \leq 9$

$2x_1 + x_2 + 2x_3 + 2x_4 \leq 12$

$x_i \geq 0, \quad i = 1, 2, 3, 4.$

4. A transport company is supplying bags of cements from four factories (sources) to four warehouses (destinations). The daily demand of each warehouse, daily output of each factory and the cost of transporting one bag of cement from each factory to each warehouse are given in the following table: [6 + 14 + 10 = 30]

Source	Destination				Available
	1	2	3	4	
1	7	5	4	3	700
2	5	4	4	3	800
3	6	5	6	7	1100
4	3	4	7	9	500
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(a) Formulate the above Transportation problem as an L.P. Problem

(b) Find ***Initial Feasible Solutions*** using (i) North West Corner Rule and (ii) Vogel's Approximation method (VAM). For each of these feasible solutions, also calculate the transportation cost incurred.

(c) Verify whether the basic feasible solution obtained by using VAM is optimal or not by using the ***optimality test.***

5. [14+8]

(a). An airline has two-way flights between two cities A and B. The crew based in city A (B) and flying to city B (A) must return to city A (B) on a later flight either on the same day or a following day. An A based crew can return on an A destined flight only if there is at least 90 minutes between the arrival time at B and the departure time of the A destined flight. The objective is *to pair the flights so as to minimize the total layover time by all the crews.* Solve the problem as an assignment model using the timetable given below:

Flight	From A	To B	Flight	From B	To A
1	6:00	8:30	10	7:30	9:30
2	8:15	10:45	20	9:15	11:15
3	13:30	16:00	30	16:30	18:30
4	15:00	17:30	40	20:00	22:00

(b). Solve the following assignment problem using Hungarian Method. The Figures in the matrix show the cost associated with assigning each worker to each job.

Worker	Jobs	Available
	1 2 3 4 5	
1	6 5 9 4 6	1
2	3 8 3 9 5	1
3	27 6 5 6	1
4	5 9 8 3 8	1
5	1 3 7 4 2	1
Required	1 1 1 1 1	
