DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

CVL 773 QUANTITAVE METHODS IN CONSTRUCTION MANAGEMENT

MINOR 1

Date: 28th August 2016 Venue: LT 316,

Time: 02:30 - 03:30 PM Max Marks: 20

NOTE:

1. **CELL PHONE NOT ALLOWED EVEN IN SWITCHED OFF MODE. KEEP IT AWAY FROM YOU EITHER IN YOUR BAG OR HAND IT OVER TO THE INVIGILATOR DUIRING EXAMINATION.**
2. **USE YOUR OWN CALCULATOR. EXCAHNGE OF CALCULATORS IS NOT ALLOWED.**

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1. A fabricating unit uses full time and part-time help to meet fluctuating demand during the day. The following table presents minimum projected need for workers at different times of the day.

Time		Workers needed	Time		Workers needed
9:00 AM	10:00 AM	4	1:00 PM	2:00 PM	8
10:00 AM	11:00 AM	5	2:00 PM	3:00 PM	4
11:00 AM	12:00 Noon	9	3:00 PM	4:00 PM	3
12:00 Noon	1:00 PM	10	4:00 PM	5:00 PM	6

There is a maximum of four full-time workers and the other workers are part-time workers. Each full time worker is there from 9:00 AM until 5:00 PM, while the part-time workers will work for four consecutive hours at a cost of ₹40.00 per hour. The cost of the full-time worker is ₹500 per day. The company wishes to minimize total cost while meeting the demands. Formulate this as a linear programming problem.

4 marks

2. (a) Given below is the Primal of LP problem. Develop the first iteration table with all slack, surplus and artificial variables, where necessary.

$$\text{Max} \quad 2A + 3B$$

$$\text{Subject to} \quad 3A + 2B \le 19 \quad \text{(Dept 1 hour)}$$
$$A + 4B \le 23 \quad \text{(Dept 2 hour)}$$
$$5A + 6B \le 18 \quad \text{(Dept 3 hour)}$$
$$7A + 8B \le 36 \quad \text{(Dept 4 hour)}$$
$$A + 9B \le 24 \quad \text{(Dept 5 hour)}$$
$$4A + B \le 27 \quad \text{(Dept 6 hour)}$$
$$A, B \ge 0$$

(b) Convert the above primal into dual and also develop the complete table of first iteration of the dual problem with all slack, surplus and artificial variables, where necessary.

2+4 = 6 marks

3. Dewgan Industry manufactures two types of roll bars for their rolling shutters. Model **DRB** is bolted to the frame using existing holes in the shutter frame. Model **DRW** is a heavier roll bar that must be welded to the shutter frame. Model **DRB** required 20kg of the special alloy steel, 40 minutes of manufacturing time, and 60 minutes of assembly time. Model **DRW** requires 25kg of the special high steel, 100 minutes of manufacturing time, and 40 minutes of assembly time. Dewgan Industry's steel supplier indicated that 40,000 kg of the special high alloy steel will be available next quarter. In addition, Dewgan Industry estimates that 2000 hours of manufacturing time and 1600 hours of assembly time will be available next quarter. The profit contributions

are $200 per unit for model **DRB** and $280 per unit of model **DRW**. The linear programming model for this problem is as follows:

Max $200\mathbf{DRB} + 280\mathbf{DRW}$

Subject to $20\mathbf{DRB} + 25\mathbf{DRW} \leq 40{,}000$ (steel available)

$40\mathbf{DRB} + 100\mathbf{DRW} \leq 120{,}000$ (Manufacturing minutes)

$60\mathbf{DRB} + 40\mathbf{DRW} \leq 96{,}000$ (Assembly minutes)

$\mathbf{DRB}, \mathbf{DRW} \geq 0$

The management scientist solution is shown in Table 1

a) What are the optimal solution and the total profit contribution?

b) Another supplier offered to provide Dewgan Industry with an additional 500 kg of the steel alloy at $2 per kg. Should Dewgan Industry purchase the additional kg of the steel alloy? Explain

c) Dewgan Industry is considering using overtime to increase the available assembly time. What would you advise Dewgan Industry to do regarding this option? Explain.

d) Because of increased competition, Dewgan Industry is considering reducing the price of model such that the new contribution to profit is $175 per unit. How would this change in price affect the optimal solution? Explain

e) If the available manufacturing time is increased by 500 hours, will the dual price for the manufacturing time constraint change? Explain

5 x 2 marks = 10 marks

Table 1: OPTIMUM SOLUTION SUMMARY

Final iteration No: 3

Objective value (max) = 424000.00

Variable	Value	Obj Coeff	Obj Val Contrib
DRB	1000.00	200.00	200000.00
DRW	800.00	280.00	224000.00

Constraint	RHS	Slack(-)/Surplus(+)
1 (<)	40000.00	0.0000
2 (<)	120000.00	0.0000
3 (<)	96000.00	4000.00

SENSITIVITY ANALYSIS

Objective coefficients -- Single Changes:

Variable	Current Coeff	Min Coeff	Max Coeff	Reduced Cost
DRB	200.00	112.00	224.00	0.00
DRW	280.00	250.00	500.00	0.00

Right-hand Side -- Single Changes:

Constraint	Current RHS	Min RHS	Max RHS	Dual Price
1 (<)	40000.00	30000.00	40909.09	8.80
2 (<)	120000.00	114285.71	160000.00	0.60
3 (<)	96000.00	92000.00	infinity	0.00