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MANIPAL INSTITUTE OF TECHNOLOGY Manipal University, Manipal – 576 104

END SEMESTER EXAMINATION II SEM M.Tech. ENGINEERING MANAGEMENT OPERATIONS RESEARCH (HUM 5201) REVISED CREDIT SYSTEM APRIL 2017

Time: 3 Hours.

MAX.MARKS: 50

Instructions to Candidates:

- Answer ALL the questions.
- Answer to the point.
- Missing data may be suitably assumed.
- 1A An Investment company considers investing in following alternatives: A1: Speculative (05) stocks, A2: Blue Chip stocks and A3: Government Bonds. It has considered three future states of nature: S1-War, S2-Peace without economic recession and S3-Peace with economic recession. The preliminary analysis yields the following payoff matrix in terms of rate of return.

	S1	S2	S3
A1	15	1	-6
A2	9	8	0
A3	4	4	4

- a) What course of action does the following decision criterion indicate: Laplace, Maximin, Minimax and Hurwicz Rule with α =0.5?
- b) Which investment do you prefer? Why?
- 1B

You have reported at XYZ Ltd as an operations manager which manufactures two types of ⁽⁰⁵⁾ leather belts. Your predecessor had started preparing the production plan for the next planning period before he was relieved from duty. The plan is as shown below:

					-			
Profit/	Sol	Cj	4	3	0	0	0	0
unit	Var	Q	X1	X2	(Time)	(Leather)	(Buckle)	(Buckle)
					S1	S2	S3	S4
0	S1	1000	2	1	1	0	0	0
0	S2	800	1	1	0	1	0	0
0	S3	400	1	0	0	0	1	0
0	S4	700	0	1	0	0	0	1
	Zj	0	0	0	0	0	0	0
	Cj-Zj		4	3	0	0	0	0

Before you decide on any course of action, you would like to verify if your predecessor was

right in quantifying the problem. Formulate the problem as an LPP from the above set of data and describe qualitatively.

 2 A firm produces electric motors for washing machines X₁ and X₂

LPP has been formulated as

Maximize Z=70X1+80X2 (profit in \$)

Subject to: $2X_1+X_2 \le 19$ (Production hours)

 $X_1+X_2 \le 14$ (Steel in Kgs.) $X_1+2X_2 \le 20$ (Wire in meters) $X_1,X_2 \ge 0$

Given below is the final solution to the above problem. The variables S_1 , S_2 , S_3 relate to the constraints in the same sequence as presented above.

	Cj					
Basis	Q	X ₁	X ₂	S₁	S ₂	S₃
X ₁	6			2/3		-1/3
S ₂	1			-1/3		-1/3
X ₂	7			-1/3		2/3
Zj	(980)					
	Cj-Zj					

a. Complete the above table. Interpret and explain to the company what its production (01) plan should be and implications of adopting it.

- b. Conduct sensitivity analysis w.r.t RHS values and profit coefficients.
- c. Given a choice between securing more production hours and more length of wire, (01) which should management select? Why?
- d. Formulate the dual and find the values of dual variables. (01)
- e. Company plans to introduce a new product that requires 1 unit of each resource. (02)
 The new product will generate a profit of \$60 per unit. Should it be produced? What will be the additional profit at the optimum?
- ³ A store requires following monthly quantities of 3 different sizes of refrigerators:

Size	А	В	С
No. Required	16	24	15

The store has received quotations from 4 manufacturers who are able to supply not more than the quantities below (of all sizes combined)

Manufacturer	1	2	3	4
Max. Supply	24	8	23	5

The stores estimates that its profit per refrigerator will vary with size and manufacturer as shown in the following table:

(05)

Size	А	В	С
1 (Mfg)	20	15	13
2	19	12	21
3	17	13	18
4	22	12	18

- a. How should the orders be optimally placed? What is the monthly profit for the store? (05)
- b. Suppose that the store has already entered into contract with manufacturer 1 to buy (02) 7 units monthly of size C, what is the maximum sum the store would be willing to pay (per month) to be released from this obligation?
- c. Total supplies from manufacturer 2 and 3 are fixed but the amounts obtained from 1 (01) and 4 can be varied (for the same overall total). How could this flexibility be best employed?
- d. Suppose that the demand for size B increases to 30 units monthly and only the (02) manufacturer 2 can increase the supply. By how much could the maximum profit increase?
- ^{4A} The government recently awarded \$750000 to the city for road improvements. The city received bids (in 000's dollars) from 5 contractors for the work in 4 suburbs:

	Suburb						
		1	2	3	4		
Contractor	А	210	242	202	243		
	В	222	232	205	250		
	С	205	225	244	210		
	D	265	206	200	270		
	Е	215	211	253	212		

None of the contractors can take up more than one job. From the bids it is clear to the city council that Government funds would not cover road improvements in all four suburbs. Therefore, they sought the following information from their engineer.

- a. What is the minimum amount of money that city council must add to the Government (03) grant such that work may be done in all four suburbs?
- b. Which of the contractor should not be awarded the contract? To qualify for the (02) contract, what is the minimum amount by which he has to reduce one of his bids?
 Use assignment algorithm.

^{4B} A company has budgeted \$ 5 million for capital improvements to be allocated among its three plants A, B and C. Each plant can make use of any amount of capital between \$0 and \$4 million, in blocks of \$1 million. The expected return (discounted present value of increase in the cash flow) associated with each level of capital investment are given below:

Capital Investment	Expected returns (\$ Millions)				
(\$ million)	Plant A	Plant A Plant B			
0	0	0	0		
1	2	3.5	4		
2	6	5	7		
3	8	7	10		
4	9	9	11		

- a. Use dynamic programming and determine the optimal allocation of \$5 million among (04) the 3 plants.
- b. Suppose that the company decides to invest only \$ 4 million rather than \$ 5 million, (01) what will be the optimal allocation?
- 5A Print machines in a print shop must be serviced after each job. The jobs arrive according to (04) poission fashion at a mean rate of 12 per day. The down time for the machine being serviced (or awaiting service) costs \$600 per day. Assume 1 working day= 8 hours. Two applicants A & B to service the machine are being considered. A charges \$100 per day and will be able to service the machine in a mean time of 20 minutes. B charges \$140 per day and claims to service the machine in a mean time of 15 minutes. Assume exponential service. Recommend which applicant should be hired.
- ^{5B} In a company, each employee has to make frequent visit to the firms stores to get materials ⁽⁰⁶⁾ for his next job. They have to join a single queue and wait at the service counter. The time between the arrivals (IAT) at the store and service times are described by the following discrete probability distribution.

IAT (minutes)	1	2	3	4	5
Probability	0.15	0.19	0.17	0.27	0.22

Service Time (minutes)	3	4	5
Probability	0.55	0.30	0.15

Analyse the behaviour of the queuing system for 10 employees using Monte Carlo simulation technique and determine (a) Expected waiting time (b) Expected time spent by the employee in the system (c) Utilization of the service clerk (d) Comment on the results. Are the results obtained reliable? Justify your answer.

Use the below Random Numbers:

Random numbers for Arrival: 19, 65, 51, 17, 63, 85, 37, 89, 76, 71. Random numbers for service: 63, 62, 06, 34, 41, 79, 53, 36, 02, 95.
