

MIB / II Sem.

A

Course 521 – OPERATIONS RESEARCH FOR BUSINESS DECISIONS

Time : 3 hours

Maximum Marks : 70

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt all questions. All parts of a question should be answered together and in the given order.

Use of simple calculator is allowed.

1. A company manufactures and sells three models of large sized pressure cookers for canteen use. While market demands pose no constraints, supplies of aluminum limited to 750 kg per week and availability of machine time limited to 600 hours per week restrict the product-mix. The resource usage of the three models and their profitability are given below:

	Model		
	M ₁	M ₂	M ₃
Aluminum/unit	6	3	5
Machine-time/unit	3	4	5
Contribution Rs /unit	60	20	80

- (a) Formulate the problem as an LPP and solve for optimal solution.
 (b) Using the information in optimal solution tableau, determine whether and how the current solution would be sensitive to the following changes. Treat each of the conditions given below independently.
- An additional 150 kg of aluminum would become available.
 - The labour available would reduce from current level of 600 hours to 450 hours.
 - What minimum contribution of M₂ would make it feature in the optimal solution?
 - A new model has been developed requiring 3 kg of aluminum and 3 hours of machine time per unit, with an estimated unit contribution of Rs 40. Would it be worthwhile manufacturing this new model?

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OR

- (a) Write dual to the following linear programming problem:

$$\text{Maximize } Z = 7x_1 + 2x_2 - 5x_3$$

Turn over

$$\text{Subject to } x_1 + 2x_2 + 3x_3 \leq 50$$

$$2x_1 + 3x_2 - 4x_3 \geq 40$$

$$3x_1 + 4x_2 + 5x_3 = 75$$

$$x_1, x_2 \geq 0, x_3: \text{ unrestricted in sign}$$

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- (b) Kelson Sporting Equipment Ltd makes two different types of baseball gloves: a regular model and a catcher's model. The firm has 900 hours of production time available in its cutting and sewing department, 300 hours available in its finishing department, and 100 hours available in its packaging and shipping department. The production time requirements and the profit contribution per glove are given in following table.

Model	Production time (hours)			Profit per glove
	Cutting and Sewing	Finishing	Packaging and Shipping	
Regular model	1	1/2	1/8	Rs 5
Catcher's model	3/2	1/3	1/4	Rs 8

Assuming that the company is interested in maximizing the total profit contribution, answer the following:

- What is the linear programming model for this?
- Find the optimal solution using the graphical solution procedure. How many gloves of each model should Kelson manufacture?
- What is the profit contribution it can earn with the listed production quantities?
- How many hours of production time will be scheduled in each department and what is the slack time?

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2. Answer any two parts:

- (a) Solve the following transportation problem for minimum cost.

Source	Destination				Supply
	M_1	M_2	M_3	M_4	
P_1	8	5	7	5	110
P_2	9	6	9	3	34
P_3	4	8	6	7	31
Demand	72	15	69	19	175

Is the optimal solution obtained by you unique? If not, find another optimal solution.

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(b) The average time between successive arrivals of vehicles to a repair shop, which works 8 hours a day, is 30 minutes. The shop has one mechanic who can repair the incoming vehicles at an average rate of 3 per hour. The mechanic is paid at the rate of Rs 14 per hour, while the cost of waiting time in terms of customer dissatisfaction and goodwill lost is Rs 20 per hour of the time spent waiting in the queue. The shop owner is contemplating to replace the mechanic by another one who demands Rs 18 per hour and is capable of repairing 4 vehicles per hour on an average. Under the conditions of single server model, calculate the total cost per day if the present mechanic is replaced and also that when the present mechanic is retained. Is it advisable to replace the existing mechanic?

(c) Two firms are competing for an increase in the market share. Each of the firms has four strategies to choose from. The strategies are defined as follows. A₁, B₁: Decrease price; A₂, B₂: Improve quality; A₃, B₃: Large advertising; and A₄, B₄: Medium advertising

From the payoff matrix given below, obtain the optimal strategies and the value of game. Is the game fair? Why?

Firm A	Firm B			
	B ₁	B ₂	B ₃	B ₄
A ₁	52	-8	22	12
A ₂	7	-13	17	2
A ₃	37	-3	27	-13
A ₄	47	2	42	-3

3. The following table shows for each activity needed to complete the project the normal time, the shortest time in which the activity can be completed of a building contract and the cost per day for reducing the time of each activity. The contract includes a penalty clause of Rs 1,000 per day over 17 days. The overhead cost per day is Rs 1,600. The cost of completing the 8 activities in normal time is Rs 65,000.

Activity	Normal Time (in days)	Shortest Time (in days)	Cost of Reduction per day (Rs)
1-2	6	4	800
1-3	8	4	900
1-4	5	3	300
2-4	3	3	-
2-5	5	3	400
3-6	12	8	2,000
4-6	8	5	500
5-6	6	6	-

Determine,

- the normal duration of the project and its cost
- the lowest cost and the associated time, and
- the shortest time and the associated cost

The management of World Airways wants to determine the minimum amount of time to turn around a plane from the moment it reaches the gate until it is

ready to leave the gate. To that end, the Flight Manager has identified the following tasks that need to be accomplished between arrival and departure. Given also are the estimated task times.

Task	Description	Task Time (minutes)		
		Optimistic	Most Likely	Pessimistic
A	Unload the passengers	12	15	20
B	Unload the luggage	20	25	35
C	Refuel the engines	27	30	40
D	Clean the interior	12	15	20
E	Load the meals	12	15	20
F	Load the luggage	15	20	30
G	Board the passengers	15	20	30
H	Perform the safety check	10	10	10

The meals cannot be loaded nor the interior cleaned until the passengers are unloaded. The departing luggage cannot be loaded until the arriving luggage has been unloaded. The passengers cannot board until the interior is cleaned. The safety check can be performed only after the engines have been fueled and the meals, luggage, and passengers have been loaded.

- (i) Draw the project network.
- (ii) Obtain the expected duration and variance for the project duration.
- (iii) What is the probability of being able to depart in one hour?
- (iv) Management wants 95% of its flights to depart on time, assuming they arrive on time. What is the least amount time (to the nearest minute) management should plan for between arrival at the gate and departure?

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- (b) For an activity in a certain project, the expected duration is 11 weeks with a standard deviation of 3 weeks. Find the optimistic and pessimistic times of the activity given further that its most likely duration is 9 weeks.

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4. Answer any two parts:

(a) Soundly Speaking manufactures loudspeakers of all kinds for stereo systems. The annual demand for its most popular model, which it sells for Rs 30 per speaker, is 10,400 units. The plant can produce about 300 of these speakers each week, but half a week is needed to set up the equipment for making this particular model. The Accounting Department estimates Rs 500 for each set up to cover the administrative costs and recommends a carrying rate of 30%. Use this information and determine the following:

- (i) The optimal set up quantity
- (ii) The reorder point, R
- (iii) The number of production orders per year
- (iv) The total annual relevant cost

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(b) A retailer gets discount for large orders. The discount is 4 percent if the quantity ordered is 500 or more, and an additional 1 percent discount is received if the quantity ordered is 1,000 or more. The product costs Rs 50 and sells uniformly at the rate of 2,500 per year. The fixed order cost is Rs 50, while the inventory carrying cost is 20% of the value of the average inventory held.

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- (i) What is the best order quantity?
- (ii) What is the minimum total annual cost, including the purchasing cost?

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(c) Suppose that new razor blades were introduced in the market by three companies at the same time. When they were introduced, each company had an equal market share, but during the first year the following changes took place:

Company A retained 90 percent of its customers, lost 3 percent to B and 7 percent to C.

Company B retained 70 percent of its customers, lost 10 percent to A and 20 percent to C.

Company C retained 80 percent of its customers, lost 10 percent to A and 10 percent to B.

Assuming that no changes in the buying habits of the customers occur,

- (i) What are the market shares of the three companies at the end of the first year and the second year?
- (ii) What are the long-run market shares of the three companies?

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5. (a) Containers Ltd. is a company that makes containers of many sizes and shapes. It has recently received orders to produce various amounts of five different sizes of kitchen containers. Each container size can be produced on any one of the four machines. Due to different technologies and setup times, the total number of hours, including the setup time, needed to process each container size on each machine varies, as shown in the following table. In the table, the container size is indicated in the first column by its height and diameter in inches.

Container size	Machine			
	1	2	3	4
3 x 4	25	20	28	30
4 x 6	24	22	25	23
6 x 8	30	30	28	25
8 x 12	38	32	30	30
12 x 18	40	40	28	30

Setting up a machine to switch from making one size container to another takes a long time, so management has decided that each machine will produce containers of only one size. As manager of the Production Department, you have been asked to determine which four of the five orders to accept and to develop a production plan that minimizes the total processing time for satisfying those orders.

- (b) Demand during lead time is known to be normally distributed having an average of 750 units with standard deviation of 60 units. What safety stock level will ensure a 98 percent service level?
- (c) In using simplex method, how is each of the following conditions identified: (i) infeasibility and (ii) unbounded solution?

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