

Numerical Problems for the Practice

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Unit -3: Aggregate Planning & Inventory Management

Problem – 1 : The ABC company requires 1000 units per month through the year at constant rate. If ordering cost are Rs 250 per order, unit cost of the item is Rs 25 and annual inventory holding cost are charged at 20%, their determine the EOQ for the item. [Ans: EOQ = 1095.45]

Problem – 2 : Alina Bakery uses an average of 20 kg wheat per day. It operates 300 days a year. Storage and handling costs for the wheat are Rs 5 per year per kg and it costs approximately Rs 150 to order and receive a shipment of wheat. Calculate:

- i. EOQ
- ii. Total annual cost
- iii. Reorder level if desired safety stock 400 kg, lead time 10 days.

[Ans: EOQ = 600 units, Total Annual Cost = Rs. 3,000, and ROL = 600 units]

Problem – 3: Assume you have a product with the following parameters:

- ❖ Demand = 360
- ❖ Holding cost per year = \$ 1.00 per unit
- ❖ Order cost = \$ 100 per order
- ❖ Delivery lead time = 15 days

What is the EOQ? Assuming a 300-day work year; how many orders should be processed per year? What is the expected time between orders? What is the total cost for the inventory policy? What may be ROL?

[Ans: EOQ = 268 items, Number of orders = 1.34 per year, Expected time between the order = 224 days, Total cost = \$268 and ROL = 18 units]

Problem – 4: A company purchased 2000 units of a particular item per year at a unit cost of Rs 20. The ordering cost is Rs 50 per order, and the inventory carrying cost is 25%. Find the optimal

order quantity. If a 3% discount is offered by the supplier on lots of 1000 or more, should the company accept the offer?

[Ans: Discount offer should not be accepted because cost increased by Rs. 400].

Problem – 5 : For a given item of constant demand rate, the yearly demand is 70,000 units. The price of the item per units is Rs. 50. The ordering cost is Rs. 200 per order and the inventory carrying cost is 40% p.a. What is the optimal ordering policy? The vendor offers 1% discount if 1500 units are purchased at a time. Do you accept the discount offer?

[Ans: Discount offer should be accepted]

Problem – 6 : For a given item, there is constant demand rate. Annual demand is 60,000 nos. the price per item is Rs. 30. The ordering cost is estimated as Rs. 300 per order and inventory carrying cost is 30% per annum. What should be the optimal ordering quantity? If 3000 units purchased at time, a discount of 5% on unit price, is offered by the supplier. Do you accept this offer?

[Ans: EOQ = 2000 units, Discount offer should be accepted]

Problem – 7: We need 1,000 electric drills per year. The ordering cost for these is \$100 per order and the carrying cost is assumed to be 40% of per unit cost. In orders of less than 120, drills cost \$78; for orders of 120 or more, the cost drops to \$50 per unit. Should we take advantage of the quantity discount?

[Ans: Optimum order quantity = 120 units with total and minimum cost of Rs. 52, 033]

Problem –8: A supplier for St. LeRoy Hospital has introduced quantity discounts to encourage larger order quantities of a special catheter. The price schedule is:

Order Quantity	Price per unit
0 to 299	\$60.00
300 to 499	\$58.80
500 or more	\$57.00

The hospital estimates that its annual demand for this item is 936 units, its operating cost is \$45.00 per order, and its annual holding cost is 25 percent of the catheter's unit price. What quantity of this catheter should the hospital order to minimize total costs? Suppose price for quantities between 300 and 499 is reduced to \$58.00. Should the order quantity change?

[Ans: EOQ = 77 units, $TC_{75} = \$57,284$, EOQ = 76 units, $TC_{300} = \$57,382$, EOQ₆₀ = 75 units, $TC_{500} = \$56,999$, optimum order quantity = 500 units, Order Quantity change to 300 units]

Problem – 9: ABC company proposes to buy an item for which the annual demand is 2,000 units. The ordering cost is estimated at Rs. 25 per order and the inventory carrying costs are charged at 30% p.a. The price schedule quoted by the supplier is as below:

Order Quantity	Price per Unit (Rs.)
1 to 99	50
100 to 499	45
500 & above	40

- What is the optimal order quantity?

[Ans: Optimum order quantity = 500 units and $TC_{500} = \text{Rs } 83,100$]

Unit-4: Quality System

Statistical Process Control Charts

Problem –1: A machine is set to deliver packets of a given weight 10 samples of size 5 each were recorded. Below are given the relevant data:

S.No.	1	2	3	4	5	6	7	8	9	10
Mean (\bar{X})	15	17	15	18	17	14	18	15	17	16
Range (R)	7	7	4	9	8	7	12	4	11	5

Draw mean and Range charts and the comment the results.

[Ans: $UCL_{\bar{X}} = 20.49$, $LCL_{\bar{X}} = 11.91$, $UCL_R = 15.614$, $LCL_R = 0$,]

Problem – 2: Form the following information given, develop mean chart and range chart assuming that the sample size is 6.

S.No.	1	2	3	4	5	6	7	8	9	10
Mean (\bar{X})	5	18	12	6	9	12	11	10	15	6
Range (R)	2	5	3	1	6	2	1	3	7	2

Problem – 3: The Watson Electric Company produces light bulbs. The following data on the number of lumens for 40-watt light bulbs were collected when the process was in control.

Samples	Observations			
	1	2	3	4
1	604	612	588	600
2	597	601	607	603
3	581	570	585	592
4	620	605	595	588
5	590	614	608	604

- Calculate the control limits for an R-chart and a Mean-chart.
- Since these data were collected, some new employees were hired. A new sample obtained the following readings: 570, 603, 623, and 583. Is the process still in control?

[Ans: a) $UCL_R = 51.12$, $LCL_R = 0$, $UCL_{\bar{x}} = 614.53$, $LCL_{\bar{x}} = 581.87$;]

Unit-5: Decision Theory

Uncertainty Conditions

Example 1

Identify the best alternative using maximax and minimin criteria for the following informations.

Payoff Matrix (Maximax Criterion)

Alternatives	States of nature (or product demand)			
	High	Moderate	Low	Nill
Expand	20	25	-15	-25
Construct	70	30	-40	-80
Subcontract	12	20	-22	-40

Cost Matrix (Minimin Criterion)

Alternatives	States of nature (or product demand)			
	High	Moderate	Low	Nill
Expand	20	25	-15	-25
Construct	70	30	-40	-80
Subcontract	12	20	-22	-40

Example 2

A food products company is contemplating the introduction of a revolutionary new product with new packaging or replace the existing product at much higher price (S_1) or a moderate change in the composition of the existing product with a new packaging at a small increase in price (S_2) or a small change in the composition of the existing product except the word 'New' with a negligible increase in price (S_3). The three possible states of nature or events are: (i) high increase in sales (N_1), (ii) no change in sales (N_2) and (iii) decrease in sales (N_3). The marketing department of the company worked out the

payoff in terms of yearly net profits for each of the strategies of three events (expected sales). This is represented in the following table.

Strategies	States of Nature		
	N ₁	N ₂	N ₃
S ₁	7,00,000	3,00,000	1,50,000
S ₂	5,00,000	4,50,000	0
S ₃	3,00,000	3,00,000	3,00,000

Which strategy should the concerned executive choose on the basis of (a) Maximin criterion (b) Maximax criterion (c) Minimax regret criterion (d) Laplace criterion?

Example 3

A Super Bazar must decide on the level of supplies it must stock to meet the needs of its customers during Dashain days. The exact number of customers is not known, but it is expected to be in one of the four categories; 300, 350, 400, or 450 customers. Four levels of supplies are thus suggested with level j being ideal (from the viewpoint of incurred costs) if the number of customers falls in category j. Deviations from the ideal levels results in additional costs either because extra supplies one stocked needlessly or because cannot be satisfied. The table below provides these costs in thousands of rupees.

Customer category	Supplies levels			
	A ₁	A ₂	A ₃	A ₄
E ₁	7	12	20	27
E ₂	10	9	10	25
E ₃	23	20	14	23
E ₄	32	24	21	17

Example 4

A person wants to invest in one of three alternative investment plans; Stock, Bonds, Debentures. It is assumed that the person wishes to invest all of the funds in a plan. The payoff matrix based on three potential economic conditions is given in the adjoining table:

Alternative Investment	Economic Conditions		
	High Growth (Rs.)	Normal Growth (Rs.)	Slow Growth (Rs.)
Stock	10,000	7,000	3,000
Bonds	8,000	6,000	1,000
Debentures	6,000	6,000	6,000

Determine the best investment plan using each of the following criteria: (i)Laplace (ii) Maximin (iii) Maximax.

Example 5

A pay-off matrix with decision alternatives and states of nature is given below.

Alternatives	State of nature			
	N ₁	N ₂	N ₃	N ₄
S ₁	1	3	8	5
S ₂	2	5	4	7
S ₃	4	6	6	3
S ₄	6	8	3	5

Find the best alternative under the following criteria

- (a) Optimistic (b) pessimistic (c) Equal probability (d) Minimax regret (e) Hurwicz's criterion, the degree of optimism (α)= 0.75 (BBA, T.U. – 2007)

Example 6

From the given pay off table, give the decision according to (a) Maximax criterion, (b) Maximin criterion, (c) Minimax regret criterion, (d) Laplace criterion and (e) Hurwicz criterion, the degree of optimism being 0.75.

States of nature	Strategy			
	S ₁	S ₂	S ₃	S ₄
A ₁	16	10	12	7
A ₂	13	12	9	9
A ₃	11	19	15	14

(BBA, T.U. – 2006 & 2008)

Risk Conditions

Example 1

A distribution of past daily sales of a commodity is as follows:

Daily sales (units)	1,000	1,200	1,400	1,600	1,800
Probability	0.05	0.15	0.35	0.30	0.15

If selling price per unit is Rs. 40, cost price per unit is Rs. 25 and salvage price is Rs. 5 per unit.

Required:

- (a) Optimum quantity and maximum expected profit using expected monetary value (EMV) criterion
- (b) Minimum expected opportunity loss (EOL) or regret value
- (c) Expected profit with perfect information (EPPI)
- (d) Expected value with perfect information (EVPI)

Example 2

A newspaper boy estimates the probability of the demand for a new magazine as follows:

Demand	1	2	3	4
Probability	0.40	0.30	0.20	0.10

A copy of the magazine sells for Rs. 5 that costs Rs. 4

- a. Find the optimal number of the newspaper that would maximize the profit
- b. Find the expected profit with perfect information
- c. Find the expected value of perfect information.

Example 3

The Captain Table is a mail-order distributor of Lobsters. The company buys these for Rs. 40 per kg and sells them for Rs. 75 per kg. The per week shipment distribution is as follows:

Shipment per week kg	Probability of occurrence
300	0.05
500	0.20
800	0.20
1200	0.40
1800	0.15
	1.00

The company has been approached by a consulting firm specialization in sales forecasting and offers a sales forecasting model, which will cost Rs. 9,000 a week. What advice will you give to the co. regarding the purchase and not purchasing the model?

Example 4

A toy manufacturer is considering a project of manufacturing a dancing doll with three different movement designs. The doll will be sold at an average of Rs. 10. The first movement design using gears and levels' will provide the lowest tooling and set up cost of Rs. 1,00,000 and Rs. 5 per unit of variable cost. A second design with spring action will have a fixed cost of Rs. 1,60,000 and variable cost of Rs. 4 per unit. Yet another design with weights and pulleys will have a fixed cost of Rs. 3,00,000 and variable cost Rs. 3 per unit. One of the following demand events can occur for the doll with the probabilities:

	Demand (units)	Probability
Light demand	25,000	0.10
Moderate demand	1,00,000	0.70
Heavy demand	1,50,000	0.20

- (a) Construct a payoff table for the above project.
- (b) Which is the optimum design?
- (c) How much can the decision-maker afford to pay to obtain perfect information about the demand?

Example 5

The probability of demand for lorries for hiring on any day in a given district is as follows:

Number of lorries demanded	0	1	2	3	4
Probabilities	0.10	0.20	0.30	0.20	0.20

Lorries have a fixed cost of Rs. 90 each day to the daily hire charges (net of variable costs of running) as Rs. 200.

- (a) If the lorry-hire company owns 4 lorries, what is its daily expectation?
- (b) If the company is about to go into business and currently has no lorries, how many lorries should it buy?

Unit-6: Linear Programming

A. Simplex Table Method of LPP

Problem – 1: Solve the linear programming using simplex method.

i. Maximize $Z = 5X_1 + 3X_2$
 Subject to
 $5X_1 + 3X_2 \leq 30$
 $X_1 + 2X_2 \leq 18$
 and $X_1, X_2 \geq 0$
 [Ans. $x_1 = 6, x_2 = 0, S_2 = 12$ Max (Z) = 30]

ii. Maximize $Z = 10X_1 + 5X_2$
 Subject to
 $4X_1 + 5X_2 \leq 100$
 $5X_1 + 2X_2 \leq 125$
 and $X_1, X_2 \geq 0$
 [Ans. $x_1 = 25, x_2 = 0, \text{Max } (Z) = 250$]

Problem – 2

A manufacturer makes two products P₁ and P₂ using two machines M₁ and M₂. Profit margin from P₁ and P₂ is Rs. 2 and Rs. 10 per unit respectively. Product P₁ requires 5 hours on machine M₁ and no time on machine M₂, product P₂ requires 1 hour on machine M₁ and 3 hours on machine M₂. There are 16 hours of time per day available on machine M₁ and 30 hours on M₂. What should be the daily production mix to maximize profit?

[Ans. P₁ = 1.2, P₂ = 10, Max (Z) = 102.40]

Problem – 3

A dealer wishes to purchase a number of fans and electric iron. He has only Rs. 5,760 to invest and

has space for at most 20 items. A fan cost him Rs. 360 and an electric iron Rs. 240. His expectation is that he can sell a fan at a profit of Rs. 22 and electric iron at a profit of Rs. 18. Assuming that he can sell all the items the he can buy, how should he invest his money in order to maximize his profit?

[Ans. Fans = 8, Irons = 12, Max (Z) = 392]

Problem – 4: Solve the following problems by simplex method

i. Minimize $Z = 60x + 80y$

Subject to

$$20x + 30y \geq 900$$

$$40x + 30y \geq 1200$$

where

$$x, y \geq 0$$

[Ans. $x = 15, y = 20, \text{Min}(Z) = 2500$]

ii. Minimize $Z = 8X_1 + 5X_2$

Subject to

$$20X_1 + 12X_2 \geq 200$$

$$8X_1 \geq 40$$

$$6X_2 \geq 30$$

and $X_1, X_2 \geq 0$

[Ans. $x_1 = 7, x_2 = 5, \text{Min}(Z) = 81$]

Problem – 7

Bajaj Company combines factor A and B to manufacture Pulsar which must weight exactly 150 kgs. Factor A costs Rs. 2 per unit and B costs Rs. 8 per unit. At least 14 units of B and no more than 20 units of A must be used. Each unit of A weights 5 kgs and each unit of B weights 10 kgs. How much each type of raw materials should be used for each unit of Pulsar, if company wishes to minimize cost?

[Ans: A = 2 kgs, , B = 14 kgs, $S_1 = 18$ and $Z_{\max} = \text{Rs. } 116$]

Unit-7: Transportation

Problem – 1

A Company provided the following cost information:

[T.U. BBA 2008]

Factory	Warehouse				Supply
	W ₁	W ₂	W ₃	W ₄	
F ₁	6	4	1	5	14
F ₂	8	9	2	7	16
F ₃	4	3	6	2	5
Demand	6	10	15	4	35

Required: Suggest an optimum transportation plan with a view to minimize cost.

[Ans. Rs. 114]

Problem – 2

Solve the following Transportation Problem. The table below shows the details about the unit transportation cost, supply and demand accordingly. [T.U. BBA 2011]

From	To			Supply (Units)
	A	B	C	
P	120	100	80	40
Q	80	90	110	65
R	100	140	120	75
Demand (Units)	50	60	70	180

[Ans. Rs. 17,100]

Problem – 3

Solve the following transportation problem using VAM:

Plant	Warehouse			Capacity
	San Antonio	Hot Springs	Sioux Falls	
Phoenix	5	6	5.4	400
Atlanta	7	4.6	6.6	500
Requirements	200	400	300	900

[Ans. Rs. 4580]

Problem – 4

Find optimal transportation schedule to minimize cost from the following information. [TU 2055]

Plants	Stores					Capacities
	S ₁	S ₂	S ₃	S ₄	S ₅	
P ₁	7	10	5	4	12	45
P ₂	3	2	0	9	1	70
P ₃	8	13	11	6	14	125
Order size	10	20	30	80	100	240

[Ans. Rs. 1415]

Problem – 5

The cost per shipment of cooking gas in rupees to three major consuming cities of Nepal from the three boarder entry points are shown in the table below along with the respective demand in the cities and the supply capacity of the entry points. Solve the problem to get the minimum cost using Vogel's Approximation Method (VAM).

Destinations Entry Points	Kathmandu	Pokhara	Dharan	Capacity
Jogbani	5000	6000	3000	250
Birgunj	2000	3000	5000	150
Sunauli	3000	2000	4000	200
Demand	400	250	100	

[Ans: Rs. 1750]

Unit-8: Assignments Problems

Problem – 1

A project work consists of four major jobs for which four contractors have submitted tenders. The tender amounts quoted in lakhs of rupees are given in the matrix below:

Contractor	Job			
	A	B	c	d
1	10	24	30	15
2	16	22	28	12
3	12	20	32	10
4	9	26	34	16

Find the assignment which minimizes the total cost of project [each contract has to be assigned and only one job.]

[Ans: Rs. 71 lakhs]

Problem – 2

Coley's Machine Shop has four machines on which to do the three jobs. Each job can be assigned to one and only one machine. The cost of each job on each machine is given in the following table.

Job	Machine			
	P	Q	R	S
A	\$18	\$24	\$29	\$35
B	8	13	17	19
C	10	19	15	22

What are the job assignments which will minimize cost?

[Ans: \$46]

Problem – 3

A department has four subordinates and four tasks to be performed. The subordinates differ in efficiency and the tasks differ in their intrinsic difficulty. The estimates of the profit in rupees each man would earn is given in the effectiveness matrix below. How should the tasks be allocated, one to each man, so as to maximize the total earnings? [T.U. 2066]

		Tasks			
		1	2	3	4
(Subordinates)	1	5	40	20	5
	2	25	35	30	25
	3	15	25	20	10
	4	15	5	30	15

[Ans: Rs. 110]

Problem – 4

There are four machines on which to do three jobs. The costs of each job on each machine are given in the following table. [T.U. BBA 2006]

Job/Machine	M ₁	M ₂	M ₃	M ₄
A	18	24	28	32
B	8	13	17	19
C	10	15	19	22

Assign jobs to each machine in order to minimize cost.

[Ans. Rs. 50]

Problem – 5

Mrs. Sharma, a marketing manager of XYZ Airways wishes to assign four counters A, B, C and D to four different sales people W, X, Y and Z. The yield matrix is as follows: [T.U. BBA 2012]

Sales People	Counters			
	A	B	C	D
W	7	12	37	18
X	25	27	18	25
Y	16	3	17	23
Z	10	25	14	9

Give the assignment for maximizing the sale.

[Ans. Rs. 110]

Unit-9: Game Theory

Problem 1 _____

Solve the game whose payoff matrix is given by

Player A	Player B		
	B ₁	B ₂	B ₃
A ₁	1	3	1
A ₂	0	-4	-3
A ₃	1	5	-1

Ans: 1

Problem 2 _____

Determine which of the following two-person zero-sum games are strictly determinable and fair. Give optimum strategies for each player in the case of strictly determinable games:

(a)

Player A	Player B	
	B ₁	B ₂
A ₁	-5	2
A ₂	-7	-4

(b)

Player A	Player B	
	B ₁	B ₂
A ₁	10	6
A ₂	8	2

Ans: (a) -5 (b) 6

Problem 3 _____

Solve the game whose payoff matrix is given by:

Player A's Strategy	Player B's Strategy			
	B ₁	B ₂	B ₃	B ₄
A ₁	16	60	56	-58
A ₂	-20	28	-18	-24
A ₃	24	8	0	24

Ans: 9.74

Problem 4 _____

For the following game, find optimal strategies of A and B and value of game using principle of dominance:

Player A Strategies	Player B Strategies			
	B ₁	B ₂	B ₃	B ₄
A ₁	7	6	8	9
A ₂	-4	-3	9	10

A ₃	3	0	4	2
A ₄	10	5	-2	0

Ans: 6

Example 5 _____

For the following cost matrix for firm A, determine the optimal strategies for both Firm A and Firm B and the value of the game:

Firm A	Firm B				
	B ₁	B ₂	B ₃	B ₄	B ₅
A ₁	3	-1	4	6	7
A ₂	-1	8	2	4	12
A ₃	16	8	6	14	12
A ₄	1	11	-4	2	1

Problem 6 _____

Solve the following game:

Player A	Player B			
	I	II	III	IV
I	3	2	4	0
II	3	4	2	4
III	4	2	4	0
IV	0	4	0	8

Ans: 4

Problem 7 _____

In a game of matching coins with two players, suppose A wins two units of value when there are two heads, wins nothing when there are two tails and losses 1 unit of value when there is one head and one tail. Determine the payoff matrix, the best strategies for each player and the value of the game to A.

Ans: 1/4

Best of Luck

Note: If you got any problem, please feel free to contact me. Thank You

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