PAPER - 16 : STRATEGIC COST MANAGEMENT

SUGGESTED ANSWERS

SECTION – A

1.

(i) (B)

(ii) (B)

(iii) (A)

(iv) (A)

(v) (C)

(vi) (B)

(vii) (C)

(viii) (D)

(ix) (B)

(x) (C)

(xi) (B / D)

(xii) (A)

(xiii) (D)

(xiv) (D)

(xv) (C)

SECTION – B

2.

It is given that "Manufacturing overhead costs" of ₹180 per unit for MH 100 and ₹60 per unit for MH 200, without explicitly separating them into fixed and variable components.

Since MHT uses machine hours as the basis for assigning fixed manufacturing overhead and total fixed manufacturing overhead is given as ₹3,00,000, we should first determine the fixed overhead absorbed per unit and then derive the variable manufacturing overhead.

Calculation of Machine hours for the production of one unit of each of the two products:

Product	Variable machine operating costs (₹)	Hourly Rate (₹)	Machine Hours per unit
MH 100	150	100	1.50
MH 200	50	100	0.50

(a) Calculation of Fixed Manufacturing Overhead Rate:

Current production = 5,000 units

Machine hours used = 5,000 x 1.5 hrs = 7,500 hrs

Fixed overhead rate / machine hour =₹3,00,000/7,500= ₹40 per machine hour

(b) Calculation of Variable Manufacturing Overhead Rate:

MH 100:

Fixed Overhead absorbed per unit= ₹40 x 1.5 = ₹60

Therefore, Variable Manufacturing Overhead = ₹180 -₹60 = ₹120

MH 200:

Fixed Overhead absorbed per unit= ₹40 x 0.5 = ₹20

Therefore, Variable Manufacturing Overhead = ₹60 -₹20 = ₹40

Calculation of Variable costs of production of "MH 100" and "MH 200"

Products	Per unit	
	'MH 100'	'MH 200'
	₹	₹
Direct materials	200	200
Variable machine operating costs	150	50
Variable manufacturing overheads [Note 2 (b)]	120	40
Total variable cost of production per units	470	290

(i) Calculation showing Contribution per unit of manufactured "MH 100" and manufactured 'MH 200':

	Manufactured 'MH 100' ₹	**Manufactured 'MH 200' ₹**
Variable cost of production (Note 3)	470	290
Variable marketing and administrative cost	80	60
Total variable cost per unit: (A)	550	350
Selling price per units (B)	900	600
Contribution per unit {(B) – (A)}	350	250

(ii) Calculation showing Contribution per unit of manufactured "MH 100" and purchased "MH 100"

	Manufactured 'MH 100' ₹	**Purchased 'MH 100' ₹**
Variable cost of production (Note 3)	470	--
Purchase price	--	650
Variable marketing and administrative cost	80	40
Total Variable cost per unit: (A)	550	690
Selling price per unit: (B)	900	900
Contribution per unit {(B) – (A)}	350	210

(iii) To determine the optimal mix, we rank products by contribution per machine hour (i.e. the limiting factor).

	Manufactured 'MH 100'	**Manufactured 'MH 200'**
Contribution per unit (₹)	350	250
Machine Hour per unit (Hr)	1.50	0.50
Contribution per hour (₹)	233 (350 / 1.5)	500 (250 /0.5)
RANKING	II	I

If it is decided to manufacture MH 200, there is profit from MH 200 undoubtedly but at the same time the ability to manufacture MH 100 in-house is also lost. Because MH 100 can be bought from Rex Limited to fulfill the orders, the real question is: "Is the extra profit earned from manufacturing MH 200 high enough to cover the extra cost of buying MH 100 from a supplier instead of making it inhouse?"

If we strictly compare Manufacture MH 100 vs. Manufacture MH 200 without considering the buy option, we would miss the most profitable strategy. Accordingly, the following analysis is made:

	₹ per unit
Variable Cost to manufacture MH 100	550
Purchase Cost	690
Incremental Cost of Buying (690 – 550)	140

To justify buying MH 100 so that the machines can be freed up for MH 200, MH 200 must generate enough additional contribution to cover that ₹140 "penalty." To replace 1 unit of MH 100 (1.5 hours), 3 units of MH 200 can be manufactured.

Those 3 units of MH 200 bring in ₹750 in contribution. The 1 unit of MH 100 gave up making would have brought in ₹350.

Net Gain in manufacturing MH 200 is: ₹750 - ₹350 = ₹400.

Conclusion: Since ₹400 (the gain from switching) is much higher than ₹140 (the cost of buying the unit), the decision to switch is confirmed.

Calculation of Quantity of each product that MHT Limited should manufacture to maximize income:

Product	**Ranking**	**Production**	**Machine hours per unit**	**Machine Hours used**	**Balance Machine Hours**
					7,500
MH 200	I	12,000	0.5	6,000	1,500
MH 100	II	1,000	1.5	1,500	-

Calculation of Quantity of MH 100 to be purchased:

Total Demand for MH 100	8,000 units
Quantity Produced	1,000 units
Unmet Demand	7,000 units
Purchase Limit fixed by Rex Ltd	6,000 units
Quantity to be purchased	6,000 units

The Optimal Product Mix to maximise operating Income is:

- Manufacture 12,000 units of MH 200.
- Manufacture 1,000 units of MH 100.
- Purchase 6,000 units of MH 100.

Alternative Solution:

(a) Calculation of Fixed Manufacturing Overhead Rate:

For MH 100

Fixed overhead rate per unit =₹3,00,000/5,000= ₹60 per unit

For MH 200

Fixed overhead rate per unit =₹3,00,000/12,000= ₹25 per unit

(b) Calculation of Variable Manufacturing Overhead Rate:

MH 100:

Variable Manufacturing Overhead = ₹180 -₹60 = ₹120

MH 200:

Variable Manufacturing Overhead = ₹60 -₹25 = ₹35

Calculation of Variable costs of production of "MH 100" and "MH 200"

Products	Per unit	
	'MH 100'	'MH 200'
	₹	₹
Direct materials	200	200
Variable machine operating costs	150	50
Variable manufacturing overheads [Note 2 (b)]	120	35
Total variable cost of production per units	470	285

(i) Calculation showing Contribution per unit of manufactured "MH 100" and manufactured 'MH 200':

	Manufactured 'MH 100' ₹	Manufactured 'MH 200' ₹
Variable cost of production (Note 3)	470	285
Variable marketing and administrative cost	80	60
Total variable cost per unit: (A)	550	345
Selling price per units (B)	900	600
Contribution per unit {(B) – (A)}	350	255

(ii) Calculation showing Contribution per unit of manufactured "MH 100" and purchased "MH 100"

	Manufactured 'MH 100' ₹	Purchased 'MH 100' ₹
Variable cost of production (Note 3)	470	--
Purchase price	--	650
Variable marketing and administrative cost	80	40
Total Variable cost per unit: (A)	550	690
Selling price per unit: (B)	900	900
Contribution per unit {(B) – (A)}	350	210

(iii) To determine the optimal mix, we rank products by contribution per machine hour (i.e. the limiting factor).

	Manufactured 'MH 100'	**Manufactured 'MH 200'**
Contribution per unit (₹)	350	255
Machine Hour per unit (Hr)	1.50	0.50
Contribution per hour (₹)	233 (350 / 1.5)	510 (255 /0.5)
RANKING	II	I

If it is decided to manufacture MH 200, there is profit from MH 200 undoubtedly but at the same time the ability to manufacture MH 100 in-house is also lost. Because MH 100 can be bought from Rex Limited to fulfill the orders, the real question is: "Is the extra profit earned from manufacturing MH 200 high enough to cover the extra cost of buying MH 100 from a supplier instead of making it inhouse?"

If we strictly compare Manufacture MH 100 vs. Manufacture MH 200 without considering the buy option, we would miss the most profitable strategy. Accordingly, the following analysis is made:

	₹ per unit
Variable Cost to manufacture MH 100	550
Purchase Cost	690
Incremental Cost of Buying (690 – 550)	140

To justify buying MH 100 so that the machines can be freed up for MH 200, MH 200 must generate enough additional contribution to cover that ₹140 "penalty." To replace 1 unit of MH 100 (1.5 hours), 3 units of MH 200 can be manufactured.

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Product	**Ranking**	**Production**	**Machine hours per unit**	**Machine Hours used**	**Balance Machine Hours**
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Total Demand for MH 100	8,000 units
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The Optimal Product Mix to maximise operating Income is:

- Manufacture 12,000 units of MH 200.
- Manufacture 1,000 units of MH 100.
- Purchase 6,000 units of MH 100.

3.(a)

(i) Division Dx buying the component at ₹135 from an outside supplier:

	₹
Purchase cost (from outside supplier) (1,000 units × ₹135 p.u.)	1,35,000.00
Less: Saving in variable cost of Division Dz by reducing division's output (1,000 units x ₹120 p.u.)	1,20,000.00
Net loss	15,000.00

Observation: The company as a whole will incur a loss of ₹15,000 if Division Dx buys the component from an outside supplier at ₹135 p.u.

(ii) Division Dx buying the component at ₹135 from an outside supplier and Division Dz saving ₹18,000:

	₹
Purchase cost (from outside supplier) (1,000 units x ₹135 p.u.)	1,35,000.00
Less:	
a. Saving in variable cost of Division Dz by reducing division's output (1,000 units × ₹120 p.u.)	1,20,000.00
b. Operating savings by using facilities for other activities	18,000.00
c. Total Savings	1,38,000.00
Net Gain	3,000.00

Observation: The company as a whole will benefit by ₹3,000 if Division Dx buys the component from an outside supplier at ₹135 p.u. and Division Dz's facilities are used for other activities.

(iii) There is no alternative use of Division Dz's facilities and the market price per unit for the component drops by ₹20

	₹
Purchase cost (from outside supplier) (1,000 units × ₹115 p.u.)	1,15,000.00
Less: Saving in variable cost of Division Dz by reducing division's output (1,000 units × ₹120 p.u.)	1,20,000.00
Net Gain	5,000.00

Observation: The company as a whole will benefit by ₹5,000 if Division Dx buys the component from an outside supplier at ₹115 p.u.

Alternative Solution:

(i) Range Analysis for Buying at ₹135

Calculate Minimum Transfer Price (Division Dz Perspective)

- Variable cost = ₹120.
- Opportunity cost = ₹0 (as there is no mention of lost sales or alternative uses yet).
- Minimum TP = ₹120.

Calculate Maximum Transfer Price (Division Dx Perspective)

- The maximum Dx will pay is the cost of the outside supplier: ₹135.

Evaluate the Range

- Any price between ₹120 and ₹135 benefits the company.
- Because Division Dz is insisting on ₹150, they are above the maximum price Division Dx is willing to pay.
- However, from a company viewpoint, as long as the internal cost (₹120) is lower than the outside price (₹135), the company loses ₹15 per unit (₹135 - ₹120) if Dx buys outside and total loss is ₹15,000.

(ii) Range Analysis with Alternative Use (₹18,000 savings)

Calculate Minimum Transfer Price (Division Dz Perspective)

- Variable cost = ₹120.
- Opportunity cost per unit = Total savings lost / Units = ₹18,000 / 1,000 units = ₹18 per unit.
- Minimum TP = ₹120 + ₹18 = ₹138.

Calculate Maximum Transfer Price (Division Dx Perspective)

- External market price = ₹135.

Evaluate the Range

- In this case, the Minimum Transfer Price (₹138) is higher than the Maximum Transfer Price (₹135).
- **Conclusion:** There is no "win-win" range. It is cheaper for the company to let Division Dx buy outside for ₹135 and allow Division Dz to realize the ₹18,000 savings. The company as a whole will benefit by ₹3,000.

(iii) Range Analysis if Market Price Drops by ₹20:

Calculate Minimum Transfer Price (Division Dz Perspective)

- With no alternative use, the opportunity cost returns to ₹0.
- Minimum TP = ₹120.

Calculate Maximum Transfer Price (Division Dx Perspective)

- New external price = ₹135 - ₹20 = ₹115.

Evaluate the Range

- The Minimum Transfer Price (₹120) is now higher than the Maximum Transfer Price (₹115).
- Conclusion: Even without alternative facilities, the company is better off if Division Dx buys from the outside supplier because the external cost (₹115) is lower than the company's own variable production cost (₹120). The company as a whole will benefit by ₹5,000.

3. (b)

(i) Calculation of target costs per unit and target costs for the proposed volume showing break up of different elements:

Target Cost per unit:

Target selling price: ₹1,000 less 20%	₹ 800
Less: Target profit margin (10%)	₹ 80
Target costs per unit	₹ 720

Element wise break-up of ₹720 per unit:

Serial	Particulars	₹Per Unit	
1	Direct Manufacturing Costs		
a	Direct materials	385	
b	Direct manufacturing labour	50	
c	Direct machining costs	60	
d	Sub Total (a to c)		495
2	Manufacturing Overheads		
a	Ordering and receiving (21,250 × ₹80) ÷ 2,00,000	8.50	
b	Testing and inspection (30,00,000 × ₹2) ÷ 2,00,000	30.00	
c	Rework (13,000 × ₹100) ÷2,00,000	6.50	
d	Sub Total (a to c)		45
3	Total manufacturing costs (1+2)		540
4	Other operating costs		
a	Research and Design	50	
b	Marketing and Customer service	130	
c	Sub Total (a to b)		180
5	Total Cost (3+4)		720

(ii) Target Product Profitability:

Serial	Particulars	Per unit (₹)	2,00,000 units (₹)
1	Sales	800	16,00,00,000
2	Costs of goods sold:		
a	Direct materials	385	7,70,00,000
b	Direct labour	50	1,00,00,000
c	Direct machining costs	60	1,20,00,000
d	Subtotal (a to c)	495	9,90,00,000
3	Manufacturing overheads	45	90,00,000
4	Total manufacturing costs (2+3)	540	10,80,00,000
5	Gross margin (1-4)	260	5,20,00,000
6	Other Operating costs		
a	Research and Design	50	1,00,00,000
b	Marketing and customer service	130	2,60,00,000
c	Sub Total (a to b)	180	3,60,00,000
7	Operating profit (5-6)	80	1,60,00,000

4. (a)

(i) Calculation of Number of Production Runs and Number of Batches:

Product	A	B	C	D	Total
(a) Output Quantity	720 units	600 units	480 units	504 units	2304
(b) Quantity per Production Run	24 units	24 units	24 units	24 units	96 units
(c) Number of Production Runs (a ÷ b)	30 runs	25 runs	20 runs	21 runs	96 runs
(d) Quantity per Batch Order	12 units	12 units	12 units	12 units	48 units
(e) Number of Batches (a ÷ d)	60 batches	50 batches	40 batches	42 batches	192 batches

Note :

- Machine Operation and Maintenance Cost amounting to ₹63,000 is apportioned among the first three activities in the ratio of 4:3:2. Accordingly, the costs allocated to the respective activities are ₹28,000, ₹21,000 and ₹14,000.

Calculation of Activity Based Costing Recovery Rate:

Activity	Activity Cost Pool	Cost Driver	Quantity	ABC RATE
Set Up	20,000 + 28,000 = ₹ 48,000	No. of Production Runs	96	₹ 500 per Run
Stores Receiving	15,000 + 21,000 = ₹36,000	Requisitions raised	50 x 4 = 200	₹ 180 per Reqn.
Inspection	10,000 +14,000 = ₹ 24,000	No. of Production Runs	96	₹ 250 per Run
Material Handling	Given = ₹2,592	Order executed	192	₹ 13.5 per Batch

(ii) Computation of OH Costs using Activity Based Costing System:

Product	A (₹)	B (₹)	C (₹)	D (₹)	Total (₹)
Setup	500 x 30 = 15,000	500 x 25 = 12,500	500 x 20 = 10,000	500 x 21 = 10,500	48,000
Stores Receiving	9,000	9,000	9,000	9,000	36,000
Inspection	250 x 30 = 7,500	250 x 25 = 6,250	250 x 20 = 5,000	250 x 21 = 5,250	24,000
Material Handling	13.50 x 60 = 810	13.50 x 50 = 675	13.50 x 40 = 540	13.50 x 42 = 567	2,592
(a)Total OH Cost	32,310	28,425	24,540	25,317	1,10,592
(b) Output Quality	720 units	600 units	480 units	504 units	
(c) OH Cost p.u. (a÷b)	44.875	47.375	51.125	50.232	

4. (b)

The classification of the given items under different categories of Quality Costs is as follows:

SL.	Category of Quality Cost	Items
1.	Prevention Costs	(ii), (v)
2.	Appraisal Costs	(i), (vii)
3.	Internal Failure Costs	(iv)
4.	External failure Costs	(iii), (vi)

Alternative Solution:

Sl. No.	Particulars	Category of Quality Costs
(i)	Product acceptance	Appraisal cost
(ii)	Design review	Prevention cost
(iii)	Discount due to defects	External failure cost
(iv)	Re-inspection	Internal failure cost
(v)	Statistical process control activities	Prevention cost
(vi)	Cost of field servicing	External failure cost
(vii)	Depreciation on Testing Equipment	Appraisal cost

5. (a)

Material Cost Variance = Standard Price per unit x Standard Quantity – Actual Price per unit X Actual Quantity

Material	Calculation	Variance (₹)
A	150 x 6,000 – 160 x 6,200	92,000 (A)
B	100 x 4,000 – 90 x 4,500	5,000 (A)
TOTAL		97,000 (A)

Material Price Variance = Actual Quantity x (Standard Price per unit - Actual Price per unit)

Material	Calculation	Variance (₹)
A	6,200 (150 – 160)	62,000 (A)
B	4,500 (100 – 90)	45,000 (F)
TOTAL		17,000 (A)

Material Usage Variance = Standard Price per unit x (Standard Quantity - Actual Quantity)

Material	Calculation	Variance (₹)
A	150 (60/95 x 9,500 – 6,200)	30,000 (A)
B	100 (40/95 x 9,500 – 4,500)	50,000 (A)
TOTAL		80,000 (A)

Material Mix Variance = Standard Price per unit x (Revised Standard Quantity–Actual Quantity)

Material	Calculation	Variance (₹)
A	150 x (6,420* – 6,200)	33,000 (F)
B	100 x (4,280*– 4,500)	22,000 (A)
TOTAL		11,000 (F)

***Revised Standard Quantity has been calculated by the following formula:**
Total Actual Quantity/ Total Standard Quantity X Individual Standard Quantity.

Material A: (10,700/100 x 60) = 6,420
Material B: (10,700/100 x 40) = 4,280

Material Yield Variance = Standard Cost per unit x (Actual Output – Standard Output)
Actual Output = 9,500
Standard Output for actual input = 10,700 x 95% = 10,165
Standard Cost per unit = (60 × 150 + 40 × 100) ÷ 95 = ₹13,000/95
Therefore, Material Yield Variance = 13,000/95 x (9,500 – 10,165)
= 13,000/95 x (– 665)
= 91,000 (A)

Alternative Method to Calculate Material Yield Variance:
Material Yield Variance = Standard Price per unit x (Standard Quantity – Revised Standard Quantity)

Material	Calculation	Variance (₹)
A	150 x (6,000 – 6,420)	63,000 (A)
B	100 x (4,000– 4,280)	28,000 (A)
TOTAL		91,000 (A)

Alternative Solution

Workings for computation of Variances:

M1- Actual Cost of Material used:

Material	Actual Quantity (Kg)	Actual Price (₹)	Amount (₹)
A	6,200	160	9,92,000
B	4,500	90	4,05,000
TOTAL			13,97,000

M2- Standard Cost of Material used:

Material	Actual Quantity (Kg)	Standard Price (₹)	Amount (₹)
A	6,200	150	9,30,000
B	4,500	100	4,50,000
TOTAL			13,80,000

M3- Standard Cost of Material if it had been used in Standard proportion:

Material	Standard Proportion	Standard Price (₹)	Amount (₹)
A	10,700 x 60/100	150	9,63,000
B	10,700 x 40/100	100	4,28,000
TOTAL			13,91,000

M4- Standard Cost of output:

Material	Standard Qty for 9,500 Kg	Standard Price (₹)	Amount (₹)
A	10,700 x 60/95	150	9,00,000
B	10,700 x 40/95	100	4,00,000
TOTAL			13,00,000

Computation of Material Cost Variances:

Variance	Formula	Calculation	Amount (₹)
Material Cost Variance	M4–M1	13,00,000 – 13,97,000	97,000 (A)
Material Price Variance	M2–M1	13,80,000 – 13,97,000	17,000 (A)
Material Usage Variance	M4–M2	13,00,000 – 13,80,000	80,000 (A)
Material Mix Variance	M3–M2	13,91,000 – 13,80,000	11,000 (F)
Material Yield Variance	M4–M3	13,00,000 – 13,91,000	91,000 (A)

5. (b)

(i) Budgeted Profit:

Product	Calculation	Amount (in ₹)
X	25,000 (₹40 – ₹28)	3,00,000
Y	20,000 (₹60 – ₹48)	2,40,000
Z	15,000 (₹80 – ₹64)	2,40,000
Total		7,80,000

Actual Profit:

Product	Calculation	Amount (in ₹)
X	20,000 (₹42 – ₹30)	2,40,000
Y	22,000 (₹56 – ₹50)	1,32,000
Z	16,000 (₹81 – ₹63)	2,88,000
Total		6,60,000

(ii) Variance in profit = Budgeted Profit – Actual Profit

= ₹ 7,80,000 – ₹6,60,000 = ₹1,20,000 (A)

This is analysed into different causes as follows:

(i) Cost Variance = Actual no. of units sold x (Standard cost – Actual cost)

Product	**Calculation**	**Amount (in ₹)**
X	20,000 (₹28 – ₹30)	40,000 (A)
Y	22,000 (₹48 – ₹50)	44,000 (A)
Z	16,000 (₹64 – ₹63)	16,000 (F)
Total		68,000 (A)

(ii) Sales Price Variance = Actual Sales x (Actual Price – Standard price)

Product	**Calculation**	**Amount (in ₹)**
X	20,000 (₹42 – ₹40)	40,000 (F)
Y	22,000 (₹56 – ₹60)	88,000 (A)
Z	16,000 (₹81 – ₹80)	16,000 (F)
Total		32,000 (A)

(iii) Sales Volume Variance = Standard profit x (Actual Sales – Budgeted Sales)

Product	**Calculation**	**Amount (in ₹)**
X	₹12 (20,000 – 25,000)	60,000 (A)
Y	₹12 (22,000 – 20,000)	24,000 (F)
Z	₹16 (16,000 – 15,000)	16,000 (F)
Total		20,000 (A)

6. (a)

Let,

A = units of Product A produced,

B = units of Product B produced,

C = units of Product C produced.

Objective Function

Profit per unit:

Product A = ₹50

Product B = ₹50

Product C = ₹80

Hence, the objective is to maximize total profit. The objective function may be formulated as:

Maximize Z = 50A + 50B + 80C

Constraints:

3A + 4B + 5C ≤ 5,000 (Raw material- I constraints)

5A + 3B + 5C ≤ 7,500 (Raw material- II constraints)

A + B/2 + C/3 ≤ 3,000

A ≥ 600, B ≥ 650, C ≥ 500 (Minimum demand constraints)

A/2 = B/3 = C/4 (Output Proportionality)

A, B, C ≥ 0 (Non-negativity constraints)

The complete LPP may be written as:

Maximize Z = 50A + 50B + 80C

Subject to:

3A + 4B + 5C ≤ 5,000

5A + 3B + 5C ≤ 7,500

A + B/2 + C/3 ≤ 3,000

A ≥ 600, B ≥ 650, C ≥ 500 (Minimum demand constraints)

A/2 = B/3 = C/4 (Output Proportionality)

A, B, C ≥ 0 (Non-negativity constraints)

6. (b)

The problem given is an unbalanced one. To make it balanced we need to insert a dummy customer, say Z, with (25 – 23) = 2 trucks as it's requirement.

Now, the given transportation problem may be tabulated as under:

Site/customers	**W**	**X**	**Y**	**Z**	**Availability**
A	7	3	6	0	5
B	4	6	8	0	10
C	5	8	4	0	7
D	8	4	3	0	3
Requirements	5	8	10	2	25

Now, using Vogel's Approximation Method (VAM) we get the Initial Feasible Solution (IFS) as put in Table –II

Table -II

Site/ Customer	W	X	Y	Z	Availability	Penalty				
A	$\boxed{7}$	5 $\boxed{3}$	$\boxed{6}$	$\boxed{0}$	5	3	3	-	-	-
B	$\boxed{4}$ 5	$\boxed{6}$ 3	$\boxed{8}$	$\boxed{0}$ 2	10	4	2	2	2	2
C	$\boxed{5}$	$\boxed{8}$	7 $\boxed{4}$	$\boxed{0}$	7	4	1	1	4	-
D	$\boxed{8}$	$\boxed{4}$	3 $\boxed{3}$	$\boxed{0}$	3	3	1	1	1	1
Requirements	5	8	10	2	25					
Penalty	1	1	1	0						
	1	1	1	---						
	---	2	1	---						
	----	2	5	---						

7. (a)

The first step is to search for a saddle point. There is no saddle point in the problem.

The second step is to observe if the payoff matrix can be reduced in size by rules of dominance. Since each element of second row is less than the corresponding elements of first row, second row is dominated by first row because payoffs are less attractive for firm A. Thus, after deleting the second row, the reduced matrix becomes:

		FIRM B			
		B1	**B2**	**B3**	**B4**
FIRM A	**A1**	35	35	25	5
	A3	40	50	0	10
	A4	55	60	10	15

In the reduced matrix, each element of second column (B2) is more than the corresponding elements in first column (B1) therefore second column is dominated by first column because payoffs are less attractive (more loss) for B. Thus, after deleting the second column, the reduced matrix becomes:

		FIRM B		
		B1	**B3**	**B4**
FIRM A	**A1**	35	25	5
	A3	40	0	10
	A4	55	10	15

Similarly, A3 row is dominated by A4, hence we may delete row A3 and the reduced payoff matrix is as shown:

		FIRM B		
		B1	**B3**	**B4**
FIRM A	**A1**	35	25	5
	A4	55	10	15

Further, each element of column B1 is more than the corresponding elements of B3, hence B1 is dominated by B3.

		FIRM B	
		B3	**B4**
FIRM A	**A1**	25	5
	A4	10	15

The aforesaid reduced pay-off matrix, also does not have the saddle point. Thus, both the firms A and B use mixed strategies.

For Firm A: Let p_1 and p_2 be the probabilities of selecting strategy A1 (Give coupons) and A4 (Increase advertising) respectively. Then the expected gain to Firm A when Firm B uses its B1and B2 strategies is given by:

$25\ p_1 + 10\ p_2$ and $5\ p_1 + 15\ p_2$, where $p_1 + p_2 = 1$

For Firm A, the probability p_1 and p_2 should be such that expected gains under both conditions are equal, i.e.,

$25\ p_1 + 10\ p_2 = 5\ p_1 + 15\ p_2$

Solving for p_1 and p_2, we get $p_1 = 1/5$ and $p_2 = 1- p_1 = 1 -1/5 = 4/5$

Value of the game = Expected gain to Firm A or Expected Loss to Firm B.

Expected gain of firm A:

(i) $25\ p_1 + 10\ p_2 = 25\ (1/5) + 10\ (4/5) = 13$

or

(ii) $5\ p_1 + 15\ p_2 = 5(1/5) + 15\ (4/5) = 13.$

<u>OR</u>

Expected loss of firm B:

(i) $25\ q_1 + 5\ q_2 = 25(2/5) + 5(3/5) = 13$

or

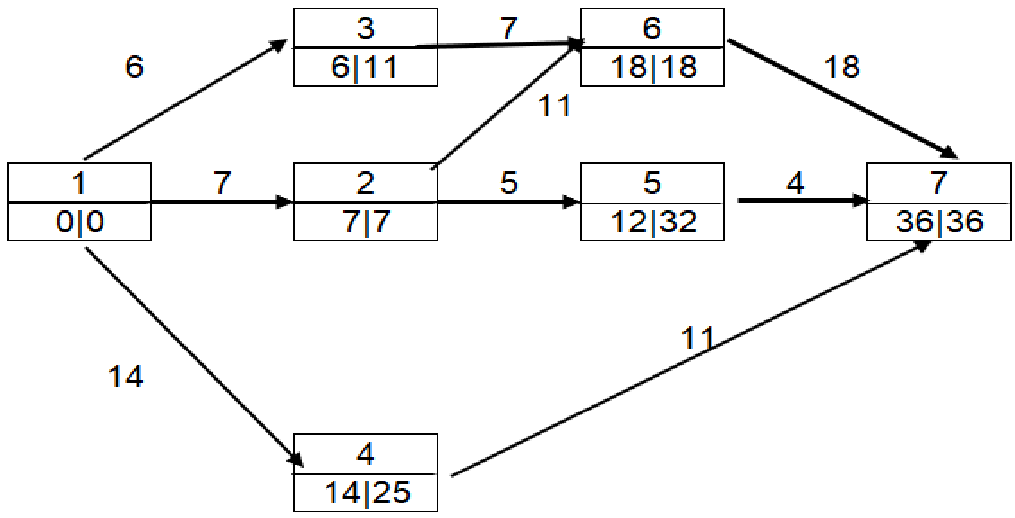
(ii) $10\ q_1 + 15\ q_2 = 10\ (2/5) + 15\ (3/5) = 13$

Decision:

Hence, optimal strategies for both the manufacturers are that firm A should adopt strategy A1(Give coupons) and strategy A4 while firm B should adopt strategy B3 (maintain present strategy) and strategy B4 (Increase advertising), and the value of the game is 13.

7. (b)

(i) Project Network Diagram showing EST and LST for each activity:



(ii) Critical Path and Expected Project Duration:

Calculation showing expected duration and standard deviation of each activity:

Activity	Estimated Duration (weeks)			Expected Duration	Variance
	Optimistic (t_0)	Most Likely(t_m)	Pessimistic (t_p)	$(t_o+4t_m+t_p)/6$	$\{(t_p-t_o)/6\}^2$
1-2	3	6	15	7	4
1-3	2	5	14	6	4
1-4	6	12	30	14	16
2-5	2	5	8	5	1
2-6	5	11	17	11	4
3-6	3	6	15	7	4
4-7	3	9	27	11	16
5-7	1	4	7	4	1
6-7	4	19	28	18	16

Critical path is 1→ 2 → 6 → 7

Expected Project Duration = 7 +11+18 = 36 weeks

(iii) Calculation of Probability that the project will be completed in 38 weeks:

Variance of the project = 4 + 4 + 16 = 24

Standard Deviation of the project = $\sqrt{24}$ = 4.90

Value of Z = (38 -36) / 4.90 = 0.41

Value of Z =0.41 corresponds to area of 0.1591 under standard normal curve

Probability that the project will be completed in 38 weeks = 0.5 +0.1591 = 0.6591 or 65.91%

(iv) Project duration with 95% chance of completion:

Given that, for a 95% chance, Z = 1.65

1.65 = (x -36) / 4.90

x -36 = 4.90 X 1.65

x = 44.085 weeks.

8. (a)

Given

Demand function: $q = \frac{900-p}{3}$

where,

- q= Quantity demanded
- p= Selling price per unit

Variable cost per unit = ₹324

Fixed Cost = ₹1,000

Price that Maximizes Profit:

Let profit be X. $X = pq - 324q - 1000$

Substituting $q = \frac{900-p}{3}$,

$$X = p\left(\frac{900-p}{3}\right) - 324\left(\frac{900-p}{3}\right) - 1000$$

$$X = 300p - \frac{p^2}{3} - 97{,}200 + 108p - 1000$$

$$X = 408p - \frac{p^2}{3} - 98{,}200$$

For maximum profit, $\frac{dX}{dp} = 0$ and $\frac{d^2X}{dp^2} < 0$

$$\frac{dX}{dp} = 0$$

$$408 - \frac{2p}{3} = 0$$

$$\frac{2p}{3} = 408$$

$$p = 408 \times \frac{3}{2}$$

$$\boxed{p = ₹612}$$

Further we have,

$$\frac{d^2X}{dp^2} = -\frac{2}{3}$$

Since it is negative, profit is maximum.

Therefore, Profit is maximum when Price is ₹612

Price that Maximizes Revenue:

Let revenue be R.

$$R = pq$$

$$R = p\left(\frac{900 - p}{3}\right)$$

$$R = 300p - \frac{p^2}{3}$$

For maximum revenue,

$$\frac{dR}{dp} = 0$$

$$300 - \frac{2p}{3} = 0$$

$$\frac{2p}{3} = 300$$

$$p = \frac{300 \times 3}{2}$$

$$\boxed{p = ₹450}$$

Further, we have

$$\frac{d^2R}{dp^2} = -\frac{2}{3}$$

Since it is negative, revenue is maximum.

Therefore, Revenue is maximum when Price is ₹450

Conclusion

- Price that maximizes Profit = ₹612
- Price that maximizes Revenue = ₹450

Since the revenue-maximizing price (₹450) is different from the profit-maximizing price (₹612), the sales department's assertion is incorrect. A firm should aim to maximize profit, not merely revenue.

Alternative Solution:

Let revenue be R.

$R = pq$

Given, $q = (\frac{900-p}{3})$

Or, $3q = 900 - p$

Or, $p = 900 - 3q$

$R = q\,(900 - 3q)$

$R = 900q - 3q^2$

For maximization of Profit, Marginal Revenue = Marginal Cost

Marginal Revenue = $\frac{dR}{dQ}$ = $900 - 6q$

Marginal Cost = Variable Cost = 324

Now, $900 - 6q$ = 324

6q = 576

q = 96 units

Putting q=96 in the demand function, we have, p = 900 – 3 (96) = 612

For Revenue maximization, MR = 0

$900 - 6q = 0$

Or, q = 150.

Further,

$\frac{d^2R}{dq^2} = -6$, hence Revenue is maximum when q = 150.

Substituting, q =150 into the price equation, we have, p = 900 – 3 (150) = 450

Conclusion

Price that maximizes Profit = ₹612

Price that maximizes Revenue = ₹450

Since the revenue-maximizing price (₹450) is different from the profit-maximizing price (₹612), the sales department's assertion is incorrect. A firm should aim to maximize profit, not merely revenue.

8. (b)

Given:

Initial Forecast for April = 200 units

Smoothing Constant (α) = 0.10

We have,

$$E_t = E_{t-1} + \alpha(Y_t - E_{t-1})$$

where:

- E_t= New Forecast
- E_{t-1}= Previous Forecast
- Y_t= Actual Sales

Month	Actual Sales	Old Forecast E_{t-1}	Corrections	New Forecast E_t	Forecast Error
	Given	Only for April	α ($Y_t - E_{t-1}$)	$E_{t-1} + \alpha$ ($Y_t - E_{t-1}$)	$E_t - Y_t$
April	210	200.00	1.00	201.00	9.00
May	214	201.00	1.30	202.30	11.70
June	217	202.30	1.47	203.77	13.23
July	228	203.77	2.42	206.19	21.81
August	235	206.19	2.88	209.07	25.93
September	225	209.07	1.59	210.66	14.34
October	221	210.67	1.03	211.69	9.31

(Forecast Demands are in '000 units)