

PAPER – 5 : ADVANCED MANAGEMENT ACCOUNTING

QUESTIONS

Decision Making

1. ABC Ltd has three factories at different locations X, Y and Z producing the same product A. Current selling price of the product is Rs 400 and operating results of the current year are as given below :

Rs lakhs

	X	Y	Z	Total
Sales	500	200	300	1000
Variable Cost	300	150	180	630
Fixed Cost :				
Factory Overheads	100	40	50	190
Selling & Admin Overheads	40	30	20	90
Profit	60	(20)	50	90

As the factory Y's performance over the years is deteriorating, the company has decided to close it. It has four following alternative proposals :

Proposal 1 : Close down Y.

Proposal 2 : Close down Y. Expand operation of X by 20%. For X, fixed Factory cost is estimated to go up by 15% and fixed selling & administrative overheads by 5% and additional variable distribution cost will be Rs 10 per unit.

Proposal 3 : Close down Y. Expand operation of Z by 25%. For Z, fixed Factory cost is estimated to go up by 20% and fixed selling & administrative overheads by 10% and additional variable distribution cost will be Rs 12 per unit.

Proposal 4 : Lease the factory Y for a long term to a party who has offered to pay a royalty of Rs 15 per unit. Expected sales will go down by 20%.

Evaluate the proposals and give your suggestion.

2. A Ltd has a plant which undertakes tailor made jobs. A Customer approached for a job with a specification. Planning Engineer prepared a cost sheet which is given below.

	Rs
i) Steel sheet 400 kg @ 200	80,000
ii) Steel rod 200 kg @ 100 per kg	20,000
iii) Other hardware items	20,000
iv) Labour Cost : Grade A 100 hrs @ Rs 100 + Grade B 200 hrs @ Rs 75	25,000

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v) Fabrication work 100 hrs @ 100 per hour	10,000
vi) Welding work 150 hrs @ Rs 200 per hour	30,000
vii) Planning Engineer 50 hours @ Rs 200	10,000
viii) Design Engineer 100 hours @ Rs 200	20,000
Total Cost	2,15,000

Additional information on the above cost sheet :

- i) Steel sheets were purchased one year back. Present price Rs 180 per kg.
- ii) Steel rod were purchased one year back also. Present price 120 per kg. It can be substituted by alloy steel rod @ Rs 110 per kg.
- iii) If accepted, the above work is to be done by Grade A workers only as Grade B workers were already deployed. All workers are permanent.
- iv) Fabrication and welding shops are profit centres with following break up of cost:

	Fabrication	Welding
Variable cost per machine hour	50	80
Fixed Cost	30	50
Profit	20	20

Fabrication shop is fully occupied. Outside rate of fabrication per hour Rs 120.

- v) Hourly rates quoted for Planning Engineer & Design Engineer are for consultancy work but actual rate is Rs 150 per hour.

The offer for the job from the customer is for Rs 1,75,000. As a Management Accountant suggest whether the offer can be accepted.

3. An organization has current sales of 1,50,000 units per annum of its product X.

The cost per unit is as follows :

	Rs
Direct Material	180
Direct Wages	100
Variable Overheads	100
Fixed Cost	100

There is scarcity of the raw material and it is expected that next year there will be substantial increase in component cost of the product : Material cost by 33.33 %, Labour cost by 10%, Variable cost by 5% and fixed cost by 15%.

The Purchase department has found out an alternative source of cheaper raw material which will cost Rs 200 per unit. As the quality of raw material is inferior, on testing it is

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observed that it would cause a rejection of 5% output, increase in labour cost per unit by Rs 5 for better quality control measure and for quality control the fixed expenses will go up by 20 lakhs.

The market research indicates that the sales of the product has direct link with the price and it has projected following sales at different prices :

Price (Rs)	640	680	720	760	800	840	880
Sales ('000 units)	190	170	150	140	125	110	95

You have to give your decision on

- (i) Which source of material will give better profitability.
- (ii) What volume of sales should be projected to maximize profit.

Product Pricing

4. A Company introduced a new product EZY with advanced technology in a product market where there is huge competition with many competitors having individual market share 5% to 10%. Survey on the present market estimates that demand will increase by 80,000 units per year. The company is presently targeting 50% of the additional market demand as competitors will need at least two years to match its product.

The Product EZY passes through three departments. Direct cost per unit of product at present rate : Material cost : Rs 65 and Labour Cost Rs 45. Overheads are absorbed on the basis of normal capacity. The following relevant information is given :

Production Dept	Unit of Measurement	Normal monthly capacity	Monthly Allocated Fixed Overheads (Rs)	Full Over-head cost Rate (Rs)	Hours consumed by product
X	Machine Hour	12,500 machine hrs	Rs 50,000	10.50	2
Y	D Labour Hr	15,000 labour hrs	Rs 60,000	9.00	1.5
Z	D Labour Hr	25,000 labour hrs	Rs 75,000	6.00	3

Company has set a target of Selling and Distribution cost of Rs 3,00,000 irrespective of sales volume. The company normally sets a price by adding a mark-up on cost between 30% to 40%.

You are required to suggest the price so as to take care of competition in the right perspective.

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Pricing Decisions: Computing Minimum Selling Price

5. ABC Ltd. are considering to introduce a new Kitchen Gadget KG. The expenditure so far made by the Research Department to develop the product is Rs. 4.00 lakhs. The production department has provided the following information:

A. Cost of Production per unit	Rs.
Materials	42.50
Labour	27.50
Variable Overheads	<u>10.00</u>
	<u>80.00</u>

- B. Anticipated additional fixed costs per annum :

Rent for additional space Rs. 24 lakhs.

Other additional Fixed costs (excluding Depreciation of machine) i.e Factory, Administrative & Selling) Rs.35 lakhs.

A new machine is required to be built for commercial production of the product for which the estimated cost Rs 8.0 lakhs. After-tax cost of capital is 10%. It is expected that the commercial life of the machine will be 10 years and the full cost of the machine will be depreciated on straight line basis which is allowed for taxation also, over a period of 10 years. Tax rate is 40%. Scrap value of the machine at the end of 10th year is 2,00,000.

- C. The market research department has estimated demand for product as follows:

Year 1-5		Year 6-10	
Demand (units)	Probability	Demand (units)	Probability
20,000	0.10	12,000	0.2
10,000	0.65	8,000	0.5
6,000	0.25	2,000	0.3

- D. DCF Factors

1-5 Years (cumulative)	3.79
6-10 Years (cumulative)	2.355
10th Year	0.386

Compute Minimum Selling Price of the product. KG.

Transfer Pricing

6. AB Ltd producing a kitchen product UX which has good market but its sales volume is clearly depends on price of the product. It has two division A and B in its factory. Division A manufactures set of components and transfer them in sets to division B which is using the same to produce final product X. The volume of production of division B depends on supply of Component sets from A and Division A has serious capacity

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constraints whereby cost per set increases with increase in volume of its production. Division B does assembling of components and undertake other finishing work, packing and sells the final product. Variable expenses in Division B is Rs 100 per unit and other fixed cost is Rs 600 lakhs. The volume of transfer and cost of division A and Revenue and Profit of division B is given below :

Division A		Division B
Component sets (‘000 ‘units)	Cost (Rs lakhs)	Revenue (Rs Lakhs)
600	600	2900
700	700	3250
800	840	3570
900	1000	3870
1000	1200	4185
1100	1450	4380
1200	1750	4580

Division A is asking for transfer price of Rs 150 per set.

- Find out the optimum volume of production.
- Justify the acceptance or non-acceptance of transfer price offered by Division A.

Service Cost

- A Hotel having 100 Single Bed rooms, 30 Double Bed room and 30 Triple Bed Suite. Occupancy of the rooms are as follows :

	Normal season	Winter season
Single Bed rooms	90%	50%
Double bed room	80%	20%
Triple Bed Suite	60%	20%
Annual fixed expenses		(Rs. Lakh)
Salary of the staff (excluding room attendant)		310
Repair & Maintenance		160
Depreciation on Building & Furniture		150
Other fixed expenses like dusting, sweeping etc.		<u>91</u>
Total		711
Variable expenses		Rs lakhs
Linen, Laundry & security support		Rs. 30.00
Electricity & Other facilities		Rs. 50.00
Misc expenses like attendant etc		Rs 31.36

- Normal season (8 months) and Winter . season (4 months) in a year and (take 30 days month).

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- ii) Fixed expenses are apportioned in the ratio 1: 1.5 : 2 to Single, Double and Triple Bed rooms
- iii) Management wishes to make a margin of 25% of total cost.
 - (a) Calculate the tariff rate for three types of rooms. .
 - (b) Management is proposing 20% cut in tariff during winter season to improve occupancy by 30% in all types of rooms during winter.

Budgeting

8. XYZ Ltd made a flexible budget last year at three different levels and operated at 70% capacity. Seeing the last year's performance and market trend, management of the Company has decided to operate at 85% capacity.

Last years flexible budget at three different capacity levels (Rs lakhs) as given below :

	60%	70%	80%
Direct Material	180	210	240
Direct Labour	120	140	160
Production Overheads	75	85	95
Selling & Distribution Overheads	40	45	50
Administration Overheads	50	50	50
Total	465	530	595

- (a) Draw a budget at 85% capacity with the following expected increase in cost :
Material, Variable Prod. Overhead and Variable Selling & Distribution overheads @ 8% Direct Labour, Fixed Prod Overheads, Fixed Selling Overheads and Admin Overheads @ 10%.
- (b) Suggest the Management to take care of possible problems which you anticipate due to the increase of capacity utilization.

Budgetary Control and Standard Costing

9. Budgetary control and standard costing are used within GIC Ltd. an insurance company and a standard cost of Rs. 20 has been set for obtaining and issuing each new health insurance policy.

Prior to the commencement of the annual financial period, the health insurance business manager had forecast that 7,500 policies would be sold during the year 2010-11 and the Rs. 20 standard cost was based on the following budgeted costs for the department. Actual costs are also shown.

Code	Budget Rs.	Actual Rs.
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105	Sales staff salaries	60,000	67,500
106	Sales staff commission	60,000	57,000
107	Sales staff expenses	30,000	26,000
205	Salaries – underwriting staff	90,000	1,00,000
377	Other administration costs	<u>60,000</u>	<u>66,000</u>
		<u>3,00,000</u>	<u>3,16,500</u>

At the end of the year, it was ascertained that:

1. 6,750 new health policies had been issued.
2. the sales staff and underwriting staff received as salaries pay award of 12.5% which had been back-dated to the beginning of the year and this had not be included in the budget.
3. expenses on codes 106, 107 and 205 are regarded as direct costs which vary with activity, and those on code 105 are treated as a direct fixed cost while those on code 377 are an indirect fixed cost.

You are required to

- (i) Present a statement (or control report) for the health insurance business manager showing the variances which have arisen,
 - (ii) comment on the likely cause or causes for each variance identifying, so far as you can from the information given, how much of each variance arises from price differences and how much can be related to efficiency or inefficiency.
10. S & M Ltd. manufactures product IRIS of a specific quality in lots to each special order from its overseas customers.

The standard costs for one unit of IRIS are:

Direct material (24 kg @ Rs. 11)	Rs. 264
Direct labour (3 hours @ Rs. 49)	147
Overheads (3 hours @ Rs. 40)	<u>120</u>
Standard cost per unit	<u>531</u>

During July, 2010 it worked on three orders, for which the month's job cost records show the following:

<i>Lot No.</i>	<i>Units</i>	<i>Materials used</i>	<i>Hours worked</i>
110(Australia)	1,700	40,440 kg	5,130
111 (China)	1,200	28,825 kg	2,890
112(Malaysia)	1,000	24, 100 kg	2,980

Additional Information:

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- (a) The company bought 95,000 kg of material during July at a cost of Rs. 10,64,000. The material price variance is recorded when materials are purchased. All inventories are carried at cost.
- (b) Direct labour during July amounted to Rs. 5,50,000. The employees were paid at Rs. 50 per hour.
- (c) Overheads during the month amounted to Rs. 4,56,000.
- (d) A total of Rs. 57,60,000 was budgeted for overheads for the year 2010-11, based on estimated production of the plant's normal capacity of 48,000 units annually. Overheads at the level of production is 40% fixed and 60% variable. Overheads is applied on the basis of direct labour hours.
- (e) There was no work in progress at the beginning of July. During July, lot nos. 110 and 112 were completed. All material were issued for lot no. 111 which was 80% complete as regards conversion.

Required:

- (A) Computation of standard cost of production of the per unit as well as in total for lots no. 110. and 112.
- (B) Find out the variation in quantity of material used and labour hours worked for each lot as well as in total.
- (C) Calculate the material price variance; labour rate variance; variable overheads efficiency variance and fixed overheads volume variance.

Learning Curve

11. A Company has developed a Electronic gadget. Material cost per unit Rs 20,000.
The assembling of the product follows a learning curve of 80% i.e Learning curve index 0.322
The first unit was produced for demonstration purpose which consumed 200 labour hours @ Rs 200.
Seeing the demo, one party gave order of 20 units. The company offered a rate based on labour hours required, charging production overheads of 120% of labour cost and 20% profit on price quoted.
The company supplied the 20 units with full satisfaction of the party. Subsequently, another party placed an order for 50 units on the basis of the quotation placed by the company according to the above pricing policy.
After receiving the supply of half of the quantity, the second party cancelled the order for balance qty.
First unit produced will be preserved for demonstration and will not be sold.
Calculate the profit in supplying 25 units to the second party.
12. (a) Define Total Quality Management (TQM). Explain in brief six C_s of T.Q.M. for its

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successful implementation.

- (b) How can Value Chain Analysis be used to assess competitive advantage. Give a diagram for value chain activities within the firm with suitable classifications under primary and support activities and also the industry value chain indicating what the end use consumer pays for.
13. (a) What is Target Costing and what are the stages to the methodology ?
(b) What is total-life-cycle costing approach? Why is it important?
14. (a) Describe the concept of Back flushing as used in the JIT system. What problems need to be addressed before implementing such a concept? Briefly discuss.
(b) Define the Term Value Chain. How can Value Chain Analysis be used to assess competitive advantage.
15. Solve graphically the following L.P.P.

$$\text{Maximize } Z = x_1 + x_2$$

$$\text{Subject to } -2x_1 + x_2 \leq 1$$

$$x_1 \leq 2$$

$$x_1 + x_2 \leq 3$$

$$x_1, x_2 \geq 0.$$

Linear Programming

16. Using Simplex Method to solve the following L.P.P.

$$\text{Minimize } Z = 2x_1 + x_2$$

Subject to

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 \geq 6$$

$$x_1 + 2x_2 \leq 3$$

$$x_1, x_2 \geq 0.$$

The Assignment Problem

17. An organization producing 4 different products viz. A, B, C and D having operators viz. P, Q, R and S, who are capable of producing any of the four products, works effectively 7 hours a day. The time (in minutes) required for each operator for producing each of the product are given in the cells of the following matrix along with profit (Rs. Per unit).

Operator	Product
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	A	B	C	D
P	6	10	14	12
Q	7	5	3	4
R	6	7	10	10
S	20	10	15	15
Profit (Rs./unit)	3	2	4	1

Find out the assignment of operators to products which will maximize the profit.

Critical Path Analysis and PERT

18. The following tables gives data on normal time and cost and crash time and cost for a project.
- (a) Draw the network and identity the critical path.
 - (b) What is the normal project duration and associated cost ?
 - (c) Find out total float for each activity.
 - (d) Crash the relevant activities systematically and determine the optimum project time and cost.

Activity	Normal		Crash	
	Time (weeks)	Cast (Rs.)	Time (weeks)	Cast (Rs.)
1-2	3	300	2	400
2-3	3	30	3	30
2-4	7	420	5	580
2-5	9	720	7	810
3-5	5	250	4	300
4-5	0	0	0	0
5-6	6	320	4	410
6-7	4	400	3	470
6-8	13	780	10	900
7-8	10	1000	9	1200

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Indirect costs are Rs. 50 per week.

Transportation Problem

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- 19 Find the optimum solution of the following transportations problem.

	A	B	C	D	
1	42	48	38	37	160
2	40	49	52	51	150
3	39	38	40	43	190
	80	90	110	160	

Simulation

- 20 A car manufacturing company manufactures 40 cars per day. The sale of cars depends upon demand which has the following distribution.

Sales of Cars	Probability
37	0.10
38	0.15
39	0.20
40	0.35
41	0.15
42	0.05

The production cost and sale price of each car are Rs. 4 lakhs and Rs. 5 lakhs respectively. Any unsold car is to be disposed off at a loss of Rs. 2 lakhs per car. There is a penalty of Rs. 1 lakh per car, if the demand is not met. Using the following random numbers, estimates total profit/loss for the company for the next ten days.

9, 98, 64, 98, 94, 01, 78, 10, 15, 19

If the company decides to produce 39 cars per day, what will be its impact on profitability?

Time Series Analysis & Forecasting

21. Apply the method of link relatives to the following data and calculate seasonal indices.

	Quarterly Figures				
Quarter	1995	1996	1997	1998	1999
I	6.0	5.4	6.8	7.2	6.6
II	6.5	7.9	6.5	5.8	7.3

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III	7.8	8.4	9.3	7.5	8.0
IV	8.7	7.3	6.4	8.5	7.1

Time Series Analysis and Forecasting

22. The following table relates to the tourist arrivals during 1990 to 1996 in India:

Years :	1990	1991	1992	1993	1994	1995	1996
Tourists arrivals :	18	20	23	25	24	28	30
(in millions)							

Fit a straight line trend by the method of least squares and estimates the number of tourists that would arrives in the year 2000.

Testing of hypothesis

23. A manufacturer claimed that at least 95% of the equipment which he supplied to a factory conformed to specifications. An examination of a sample of 200 pieces of equipment revealed that 18 were faulty. Test this claim at a significance level of (i) 0.05 (ii) 0.01.

SUGGESTED ANSWERS/HINTS

1. Proposal 1 :

Rs lakhs

	X	Z	Total
Sales	500	300	800
Variable Cost	300	180	480
Fixed Cost :			
Factory Overheads	100	50	150
Selling & Admin Overheads	40	20	60
Total Cost	440	250	690
Profit	60	50	110

Proposal 2 :

Rs lakhs

	X	Z	Total
Current units of sale	1,25,000	75,000	
Expected sales units	1,50,000	75,000	
Sales	600	300	900
Variable Cost	360	180	540
Additional Variable distb. Cost	15		15

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Fixed Cost :			
Factory Overheads	115	50	165
Selling & Admin Overheads	42	20	62
Total Cost	532	250	782
Profit	68	50	118

Proposal 3 :

Rs lakhs

	X	Z	Total
Current units of sale	1,25,000	75,000	
Expected sales units	1,25,000	93,750	
Sales	500	375	900
Variable Cost	300	225	540
Additional Variable distb. Cost		11.25	15
Fixed Cost :			
Factory Overheads	100	60	180
Selling & Admin Overheads	40	22	64
Total Cost	440	318.25	
Profit	60	56.75	116.75

Proposal 4 : Present sales unit of Y factory = 50,000

Expected sale when factory Y is given to lease = $50,000 \times 0.80 = 40,000$ units

Royalty receivable @ Rs 15 per unit = Rs 6 lakhs

Total earning = Rs (60 + 6 + 50) = 116.

Proposal 2 is giving best profitability and hence the same should be opted.

2. Here, for decision making, let us consider the relevant costs :

Items of cost	Reason	Amt (Rs)
Steel Sheet 400 x 180	Current price is relevant	72,000
Steel rod 200 x 110	Substitute material price is relevant	22,000
Hardware	unavoidable	20,000
Labour cost	Fixed Cost – not relevant	
Fabrication @ Rs 120 per hour	Outside rate is relevant as shop is fully occupied	12,000
Welding @ Rs 80 per hour	Variable cost is relevant	12,000
Planning Engineer + Design Eng	Fixed cost – not relevant	
Total Cost		138,000

Thus, the offer at Rs 1,75,000 should be accepted.

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3 (i) Comparison of cost & profitability for raw materials of two different sources :

Cost Component	Cost per unit (Rs)	
	Present source	Alternative Source
Direct Material	240	200
Direct Wages	110	115
Variable Overheads	105	105
Total Variable Cost	455	420
Effective Cost per	455	442
Cost difference higher per unit	13	

Due to rejection, 95% of good quality of output will be produced.

Thus, effective cost per unit = Rs (420 x 100/95) = Rs 442 approx

Normal rise in fixed cost will be same in both the cases.

Difference in contribution at 1,50,000 units = 150000 x Rs 13 = Rs 195 lakhs.

As increase in fixed cost for quality control is more than the additional contribution, the present source may be opted for production.

(ii) Optimum Sales Projection

Price	640	680	720	760	800	840	880
V. Cost / unit	455	455	455	455	455	455	455
Contribution/unit	185	225	265	305	345	385	425
Units ('000)	190	170	150	140	125	110	95
Contribution Rs lakhs	351.50	382.50	397.50	427.00	431.30	423.50	403.80

From the above table, sales of 1,25,000 at price of Rs 800 will best give best profitability.

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Department	Normal monthly capacity	Allocated monthly Fixed Overhead (Rs)	Fixed Overheads per Hour (Rs)	Full overhead cost per hour (Rs)	Variable overhead per hour (Rs)	Fixed overhead per unit (Rs)	Variable overhead per unit (Rs)
X	12,500	50,000	4.00	10.50	6.50	8.00	13.00
Y	15,000	60,000	4.00	9.00	5.00	6.00	7.50
Z	25,000	75,000	3.00	6.00	3.00	9.00	9.00

50% of the additional demand = 80,000 x 0.75 = 40,000 unit.

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Cost of the product :

Direct Material	Rs 65.00
Direct Labour	Rs 45.00
Variable Factory Overheads	Rs 29.50
Fixed Factory Overhead	Rs 23.00
Selling & Distribution Overheads	Rs 7.50
Total cost	Rs 170.00

Selling Price will be in the range of (170 x 1.3 and (170 x 1.4) i.e between 221 and 238.

The company can go for lower price as it covers full cost and ensure good profit. Lower price will give better penetration in the market and keep competitors away for longer term to match technology and price.

5 As treatment of R&D cost is not indicated, it is treated as sunk costs.

Expected sales volume

$$1-5 \text{ yrs} = (200000 \times 0.1) + (10,0000 \times 0.65) + (60000 \times 0.25) = 1,00,000 \text{ units}$$

$$6-10 \text{ yrs} = (120000 \times 0.2) + (80000 \times 0.5) + (20000 \times 0.3) = 70,000 \text{ units}$$

Let X = sales price per unit of product KG

Particulars	Rs			
	Year	Year	Year	Year
	0	1-5	6-10	10
i) Outflow - machine cost (Refer to working note 1)	8,00,000			
ii) Inflow - sales revenue (A)		1,00,000X	70,000 X	
less outflow cost				
Materials + labour + V Overheads		80,00,000	56,00,000	
Fixed overhead		59,00,000	59,00,000	
Depreciation of machine		80,000	80,000	
Total cost: (B)		1,39,80,000	1,15,80,000	
Profit before tax : (A) – (B)		1,00,000X – 1,39,80,000	70,000 X – 1,15,80,000	
Less : Tax @ 40%		40,000 X – 55,92,000	28,000X – 46,32,000	
Profit after tax before depreciation		60,000 X – 83,88,000	42,200X – 69,48,000	
Add Depreciation		80,000	80,000	
Salvage / Scrap				2,00,000

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Net Flows : (C)	–8,00,000	60,000 X – 83,08,000	42,000X – 68,68,000	2,00,000
DCF Factors: (D)		3.79	2.355	0.386
Discounted Cash Inflows: (C)×(D)	–8,00,000	2,27,400 X – 3,14,87,320	98,910 X – 1,61,74,140	77,200

Net cash inflow := 3,26,310 X – Rs.4,85,38,660

For determining minimum selling price the net cash inflows should be zero i.e.

$$3,26,310 X = \text{Rs. } 4,85,38,660$$

$$\text{Or } X = \text{Rs. } 148.75 = \text{Rs } 149 \text{ approx.}$$

6 Incremental Cost and Incremental Revenue (in Rs. lakhs) for the organization is calculated as below :

Output ('000 'units)	Division A Incremental Cost	Division B Incremental Cost	Total Incremental Cost	Incremental Revenue
600				
700	100	100	200	350
800	140	100	240	320
900	160	100	260	300
1000	200	100	300	315
1100	250	100	350	200
1200	300	100	400	200

The above table shows that the optimum output is 10 lakhs units.

If the transfer Price is 150 per set, realization of Division A = 1500 lakhs i.e net margin = 300 lakhs 25% margin on total cost of Division A.

Cost incurred at Division B :

Variable cost including cost of material from A = (1500 +1000) =Rs 2500 lakhs

Fixed Cost = 600 lakhs

i.e Total cost = Rs 3100 lakhs.

Margin for Division B = Rs lakhs (4185 – 3100) = Rs 1085 i.e 35% of its total cost.

Hence the transfer price offered by division A may be accepted to allow both the divisions work as profit centres.

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Occupancy during normal season	Room-days	No of guests
S Room (100 x 0.90 x 8 x 30)	21600	21600

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D Room	(30 x 0.80 x 8 x 30)	5760	11520
T Room	(30 x 0.60 x 8 x 30)	4320	12960
Total		31680	46080
Occupancy during winter		Room-days	No of guests
S Room	(100 x 0.50 x 4 x 30)	6000	6000
D Room	(30 x 0.20 x 4 x 30)	720	1440
T Room	(30 x 0.20 x 4 x 30)	720	2160
Total		7440	9600
Total Occupancy			Equivalent Single Room
S Room		27600	27600
D Room		6480	9720
T room		5040	10080
Total		39,120	47400

Fixed Expenses per Single Bed Room = Rs 711 / 47,400 = Rs 1500

Fixed Expenses per Double Bed room =Rs 2250

Fixed Expenses per Triple Bed room =Rs 3000

Total Variable Cost = Rs lakhs (30+50+31.36) = Rs 111.36 lakhs.

Variable cost per guest = Rs 111.36 lakhs / 55680 = Rs 200

Cost & Rent for rooms

	Single Room	Double Room	Triple Bed Suite
Cost (Fixed Cost + V Cost x No of guest)	1700	2650	3600
Rent = Cost + 25 % profit on cost (Rs.)	2125	3312.5	4500
Winter occupancy	6000	720	720
Revenue (Rs lakhs)	127.50	23.85	32.40
Decreased Rent by 25% (Rs.)	1700	2650	3600
Increased occupancy	7800	936	936
Revenue (Rs. in lakhs) (on proposed reduction in rent)	132.60	24.80	33.69

As the reduction in rent and consequential increase in occupancy during winter is giving more revenue, the management may go for it .

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8 (a) At 80% capacity (Rs. in lakhs)

	Variable	Fixed
Production overhead	80	15
Selling and distribution overhead	40	10

Budget at 85% capacity (Rs in lakhs)

Items	At on last year cost		At increased cost		Total
	Variable	Fixed	Variable	Fixed	
Direct Material	255		275.4		275.4
Direct Labour	170		187		187
Production Overheads	85	15	91.8	16.5	108.3
Selling & distribution Overheads	42.5	10	45.9	11	56.9
Administrative Overheads		50		50	50
Total					677.6

(b) The following are the suggestions to take care of some possible problems which may arise due to increase in sudden increase in capacity utilization :

- If market does not absorb additional production, it may cause rise in stock level.
- Additional fund requirement may be arranged to operate at higher capacity.
- More conscious arrangement of managing three critical issues -work force, productivity and quality should be done.

9

Code		<i>Fixed Budget</i>	<i>Flexible Budget</i>	<i>Actual Budget</i>	<i>Variances</i>	<i>Variances</i>
		<i>7500 units</i>	<i>6750 units</i>	<i>7650 units</i>	<i>On the basis of flexible budget</i>	<i>On the basis of fixed budget</i>
		Rs.	Rs.	Rs.	Rs.	
301	Sales salaries	60,000	60,000	67,500	7,500(A)	-
302	Sales staff commission	60,000	54,000	57,000	3,000(A)	6000(F)
303	Sales expenses	30,000	27,000	26,000	1,000(F)	3000(F)

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431	Salaries	–	90,000	81,000	1,00,000	19,000(A)	9000(F)
	Underwriting Staff						
599	Sales Other Adm.						
	Costs		<u>60,000</u>	<u>60,000</u>	<u>66,000</u>	<u>6,000(A)</u>	<u>–</u>
			<u>3,00,000</u>	<u>2,82,000</u>	<u>3,16,500</u>	<u>34,500(A)</u>	<u>18000</u>

(ii) Sales Salaries-

Rs. 7500 (A) Rate variance is due to unanticipated pay award.

Sales Commission –

Rs. 6,000 (F) is due to drop in activity and

Rs. 3000 (A) may be due to increasing sales commission on selected policies or due to inefficiency.

Sales Expenses –

Rs.3000 reduction due to drop in activity and

Rs. 1000 (F) for improved control.

Underwriting Salaries –

Rs. 9,000 (F) due to drop in activity,

Rs. 10,125 (A) due to unbudgeted salary increases and Rs. 8,875 (A) due to inefficiency.

Other Administration Costs –

Rs. 6,000 (A) seem to have been caused by changes due to high cost suppliers or hiring temporary office staff.

10 (A) Statement showing standard cost of production per unit and total

<i>Lot No.</i>	<i>Cost per unit</i>	<i>Production in units</i>	<i>Total standard cost</i> <i>Rs.</i>
110(Australia)	531.00	1,700	9,02,700
111 (China)	477.60*	1,200	5,73,120
112(Malaysia)	531.00	1,000	<u>5,31,000</u>
		Total	<u>20,06,820</u>

*Direct material (100% complete) Rs. 264

Direct labour (80% complete as regards conversion cost of Rs. 267) 213.60

477.60

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(B) Statement showing variation between standard material and actual material used.

<i>Lot Nos.</i>	<i>Production in units</i>	<i>Standard Qtt. Per unit (kg)</i>	<i>Total standard Qty.(kg)</i>	<i>Total Actual Qty. (kg)</i>	<i>Variation in kgs.</i>
110(Australia)	1,700	24	40,800	40,440	360(F)
111 (China)	1,200	24	28,800	28,825	25(A)
112(Malaysia)	1,000	24	<u>24,000</u>	<u>24,100</u>	<u>100(A)</u>
			<u>93,600</u>	<u>93,365</u>	<u>235(F)</u>

Statement showing variation between standard labour hours and actual labour hrs worked

<i>Lot Nos.</i>	<i>Production in units</i>	<i>Standard labour hours. Per unit.</i>	<i>Total std. labour hrs.</i>	<i>Total actual labour hrs.</i>	<i>Variation in hours</i>
110(Australia)	1,700	3	5,100	5,130	30(A)
111 (China)	960 @	3	2,880	2,890	10(A)
112(Malaysia)	1,000	3	<u>3,000</u>	<u>2,980</u>	<u>20(F)</u>
			<u>10,980</u>	<u>11,000</u>	<u>20(A)</u>

@ 80% of 1200 = 960 units.

(C) For Material Price Variance

	Rs
Actual cost of material purchased (95,000 kg) – given	10,64,000
Standard cost of material purchased (95,000 kg x Rs.11)	10,45,000

Material Price Variance = Actual cost of material purchased – Standard cost of material purchased

= Rs. 10,64,000 - 10,45,000 = Rs. 19,000 (A)

(Note: It is given that material price is calculated at the time of purchase of material)

For Labour Rate Variance

Actual payment for actual hours worked (given)	5,50,000
Actual hours worked at standard rate = or 11,000 hrs. x Rs. 49	5,39,000

Labour Rate Variance = Actual payment for actual hours worked – Actual hours worked at standard rate

= Rs. 5,50,000 – 5,39,000 = Rs. 11,000 (A)

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For Variable Overhead Efficiency Variance

Actual hours worked at standard variable overhead rate (Standard variable rate = Rs. 40 x 0.60 = Rs. 24) or 11,000 x Rs. 24 = Rs. 2,64,000

Standard variable overhead for production.

Lot 110 = 1700 units x 3 hrs x Rs. 24 =	1,22,400
Lot 112= 1000 units x 3 hrs x Rs. 24 =	72,000
Lot 111= 1200 units x 0.80 x 3 hrs x Rs.24 =	<u>69,120</u>
	<u>2,63,520</u>

Variable Overhead Efficiency Variance = Actual hours worked at standard variable overhead rate Standard variable overhead for production= Rs. 2,64,000 – Rs. 2,63,520 = Rs. 480 (A)

For Fixed overhead volume variance

Budgeted Fixed Overhead = 12,000 units X 16	1,92,000
Standard fixed overhead for production	
Lot 110 = 1700 units X 3 hrs. x Rs. 16 =	81,600
Lot 112= 1000 units X 3 hrs. x Rs. 16 =	48,000
Lot 111= 1200 units X 0.80 x 3 hrs. x Rs. 16	<u>46,080</u>
	<u>1,75,680</u>

Fixed overhead volume variance = Budgeted Fixed Overhead – Standard fixed overhead for production

= Rs. 1,92,000 - Rs. 1,75,680 = Rs. 16,320 (A)

Note: The production relating to lot No. 46 is only 80% complete as regards conversion. This is not relevant in material and labour variances, as only material expenditure and labour rate variance have been asked

11 As the assembly of the product follows learning curve theory, average labour hours per unit will follow

the equation $y = ax^{-b}$

where y = average labour hours per unit

a = labour hours required for first unit

x = cumulative number of units produced

b = learning curve index.

Labour hours required for units produced :

No of Unit	1	21	71	46
Labour hours for first unit	200	200	200	200

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Value of x^b	$1^{-0.322}$	$21^{-0.322}$	$71^{-0.322}$	$46^{-0.322}$
(values from the working below)	1	0.37518	0.25345	0.29147
Hours required per unit for the lot	200	75.036	50.69	58.294
Cumulative Hours required	200	1575.756	3598.99	2681.524
Labour hrs for lot (cum hrs - cum lot 21)			2023.234	1105.768
Lot size			50	25
Average labour hrs per unit			40.46	44.23
Cost per unit of the lot :				
Material Cost			20,000	20,000
Labour cost			8092	8846
Production overheads			9710	10615
Total Cost per unit			37802	39461
Profit 25% on cost			9451	
Price quoted per unit			47253	
Profit per unit for supplying half lot (Rs 47253- 39461)				7792
Total Profit for 25 units				194850

Note :

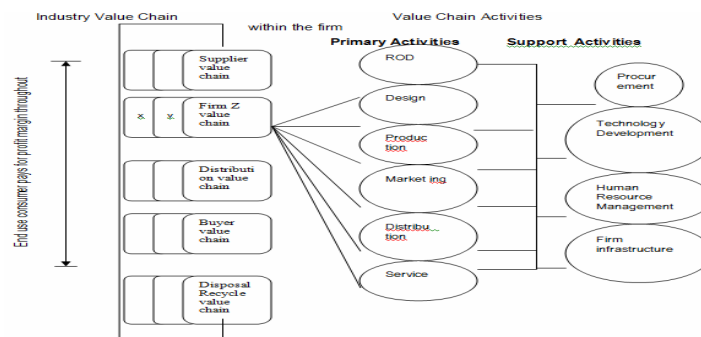
	b	Log(x)	b*log(x)	Antilog
1. $\log (21^{-0.322}) = -0.322*\log(21)$	-0.322	1.32222	-0.42575	0.37518
$\log (71^{-0.322}) = -0.322*\log(71)$	-0.322	1.85126	-0.59611	0.25345
$\log (46^{-0.322}) = -0.322*\log(46)$	-0.322	1.66276	-0.53541	0.29147
2. Quotation was based on lot size 50 and was Rs 47,256 per unit. Cost was for half lot i.e Rs 39,462 per unit.				

- 12 (a) Total Quality Management:** Traditional focus was primarily on the financial performance of an organisation. Now a days it is crucial for organisation to monitor performance in many non financial areas as well. For many companies, quality is at the forefront of the area in which non financial performance is critically important. Monitoring product quality coupled with measuring and reporting quality costs helps companies program of total quality management (TQM) . TQM refers to the broad set of management and control processes designed to focus the entire organisation and all of its employees on providing products or services that do the best possible job of satisfying the customers.

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Six Cs of TQM

- (i) Commitment - If a TQM culture is to be developed, so that quality improvement becomes normal part of everyone's job, a clear commitment, from the top must be provided. Without this all else fails.
 - (ii) Culture - Training lies at the centre of effecting a change -in culture and attitudes. Negative perceptions must be changed to encourage individual contributions.
 - (iii) Continuous improvement - TQM is a process, not a program, necessitating that we are committed in the long term to the never ending search for ways to do the job better.
 - (iv) Co-operation: The on-the-job experience of all employees must be fully utilized and their involvement and co-operation sought in the development of improvement strategies and associated performance measures.
 - (v) Customer focus: Perfect service with zero defects in all that is acceptable at either internal or external levels.
 - (vi) Control: Documentation, procedures and awareness of current best practice are essential if TQM implementations are to function appropriately The need for control mechanisms is frequently overlooked, in practice.
- (b) In order to gain a competitive advantage over its competitors , a company needs to profitably satisfy or even exceed the needs and expectations of its various customers. This can be done by the use of Value Chain Analysis . This analysis can be used to better understand which segments, distribution channels, price points, product differentiation , selling propositions and value chain configurations will yield the firm its greatest competitive advantage. The use of VCA to assess competitive advantage involves the following analyses'
- Internal cost analysis
 - Internal differential analysis
 - Vertical linkage analysis
 -



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13. (a) **Target Costing:** It is a management tool used for reducing a product cost over its entire life cycle. It is driven by external Market factors. Marketing management prior to designing and introducing a new product determines a target market price. This target price is set at a level that will permit the company to achieve a desired market share and sales volume. A desired profit margin is then deducted to determine the target maximum allowable product cost. Target costing also develops methods for achieving those targets and means to test the cost effectiveness of different cost-cutting scenarios.

Stages of Target Costing:

1. **Conception (planning) Phase:** Under this stage of life cycle, competitors products are to be analysed, with regard to price, quality, service and support, delivery and technology. The features which consumers would like to have like consumer value etc. established. After preliminary testing, the company may be asked to pinpoint a market niche, it believes, is under supplied and which might have some competitive advantage.
 2. **Development phase:** The design department should select the most competitive product in the market and study in detail the requirement of material, manufacturing process along with competitors cost structure. The firm should also develop estimates of internal cost structure based on internal cost of similar products being produced by the company. If possible the company should develop both the cost structures (competitors and own) in terms of cost drivers for better analysis and cost reduction.
 3. **Production phase:** This phase concentrates its search for better and less expensive products, cost benefit analysis in different features of a product priority wise, more towards less expensive means of production, as well as production techniques etc.
- (b) **Total life cycle costing approach:** Life cycle costing estimates, tracks and accumulates the costs over a product's entire life cycle from its inception to abandonment or from the initial R & D stage till the final customer servicing and support of the product. It aims at tracing of costs and revenues on product by product basis over several calendar periods throughout their life cycle. Costs are incurred along the product's life cycle starting from product's design, development, manufacture, marketing, servicing and final disposal. The objective is to accumulate all the costs over a product life cycle to determine whether the profits earned during the manufacturing phase will cover the costs incurred during the pre and post manufacturing stages of product life cycle.

Product life cycle costing is important for the following reasons:

- (i) When non-production costs like costs associated with R & D, design, marketing, distribution and customer service are significant, it is essential to identify them for target pricing, value engineering and cost management. For example, a poorly designed software package may involve higher costs on marketing, distribution and after sales service.

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- (ii) There may be instances where the pre-manufacturing costs like R & D and design are expected to constitute a sizeable portion of life cycle costs. When a high percentage of total life cycle costs are likely to be so incurred before the commencement of production, the firm needs an accurate prediction of costs and revenues during the manufacturing stage to decide whether the costly R & D and design activities should be undertaken.
- (iii) Many costs are locked in at R & D and design stages. Locked in or Committed costs are those costs that have not been incurred at the initial stages of R & D and design but that will be incurred in the future on the basis of the decisions that have already been taken. For example, the adoption of a certain design will determine the product's material and labour inputs to be incurred during the manufacturing stage. A complicated design may lead to greater expenditure on material and labour costs every time the product is produced. Life cycle budgeting highlights costs throughout the product life cycle and facilitates value engineering at the design stage before costs are locked in.

Total life-cycle costing approach accumulates product costs over the value chain. It is a process of managing all costs along the value chain starting from product's design, development, manufacturing, marketing, service and finally disposal.

- 14 (a)** Traditional accounting systems record the flow of inventory through elaborate accounting procedures. Such systems are required in those manufacturing environment where inventory/WIP values are large. However, since JIT systems operate in modern manufacturing environment characterized by low inventory and WIP values, usually also associated with low cost variances, the requirements of such elaborate accounting procedures does not exist.

Back flushing requires no data entry of any kind until a finished product is completed. At that time the total amount finished is entered into the computer system which is multiplied by all components as per the Bill of materials (BOM) for each item produced. This yields a lengthy list of components that should have been used in the production process and this is subtracted from the opening stock to arrive at the closing stock to arrive at the closing stock/inventory.

The problems with back flushing that must be corrected before it works properly are:

- (i) The total production quantity entered into the system must be absolutely correct, if not, then wrong components and quantities will be subtracted from the stock.
- (ii) All abnormal scrap must be diligently tracked and recorded. Otherwise materials will fall outside the back flushing system and will not be charged to inventory.
- (iii) Lot tracing is impossible under the back flushing system. This is required when a manufacturer needs to keep records of which production lots were used to create a product in case all the items in a lot need be recalled.

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- (iv) The inventory balance may be too high at all times because the back flushing transactions that relieves inventory usually does so only once a day, during which time other inventory is sent to the production process. This makes it difficult to maintain an accurate set of inventory records in the warehouse.
- (b) Value chain may be defined as a series of internal processes or activities a company performs, " to design, produce, market, deliver and support its product." "A firms value chain and the way it performs individual activities are a reflection of its history, its strategy, its approach of implementing strategy , and the underlying economics of the activities themselves." For further details refer to Chapter 13 of Cost Management Book of the Institute

In order to gain a competitive advantage over its competitors , a company needs to profitably satisfy or even exceed the needs and expectations of its various customers. This can be done by the use of Value Chain Analysis . This analysis can be used to better understand which segments, distribution channels, price points, product differentiation , selling propositions and value chain configurations will yield the firm its greatest competitive advantage. The use of VCA to assess competitive advantage involves the following analysis:

- (i) **Internal Cost Analysis** : Organisations use the value chain approach to identify sources of profitability and to understand the cost of their internal processes or activities. The principal steps of internal cost analysis are :
1. Identify the firm's value-creating processes.
 2. Determine the portion of the total cost of the product or services attributable to each value-creating process.
 3. Identify the cost drivers for each process.
 4. Identify the links between processes.
 5. Evaluate the opportunities for achieving relative cost advantage.
- (ii) **Internal Differentiation Analysis** : The value chain approach is also used by organisations to identify opportunities for creating and sustaining superior differentiation. In this situation, the primary focus is on the customer's perceived value of the products and services.

As with internal cost analysis, internal differentiation analysis requires firms to first identify their value-creating processes and primary cost drivers. They are then ready to perform a differentiation analysis using the following guidelines :

1. Identify the customers' value-crating processes;
2. Evaluate differentiation strategies for enhancing customer value; and
3. Determine the best sustainable differentiation strategies.

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- (iii) **Vertical Linkage Analysis** : Linkages among value-creating processes do not end with the activities within a firm. The greatest competitive advantage may come out of linkages between a firm's value-creating activities and those of its suppliers, channels or users.

Vertical linkage analysis is a much broader application of internal cost and differentiation analysis that includes all upstream and downstream value-creating processes throughout the industry. Vertical linkage analysis considers all links from the source of raw materials to the disposal and/or recycling of the product.

15 We shall convert the in-eqn. Given in L.P.P. as eqn.

$$-2x_1 + x_2 = 1 \quad \dots(1)$$

$$x_1 = 2 \quad \dots(2)$$

$$x_1 + x_2 = 3 \quad \dots(3)$$

Consider the line (1)

$$-2x_1 + x_2 = 1$$

When $x_2 = 0$

$$-2x_1 = 1$$

$$x_1 = -\frac{1}{2} = -0.5$$

then line (1) cuts x_1 axis at $(-0.5, 0)$

When $x_1 = 0$, $x_2 = 1$

The line (1) cuts x_1 axis at $(0, 1)$

Consider the line (2), $x_1 = 2$

Consider the line (3), $x_1 + x_2 = 3$

When,

$$x_2 = 0, x_1 = 3$$

The line (3) cuts x_1 axis at $(3, 0)$

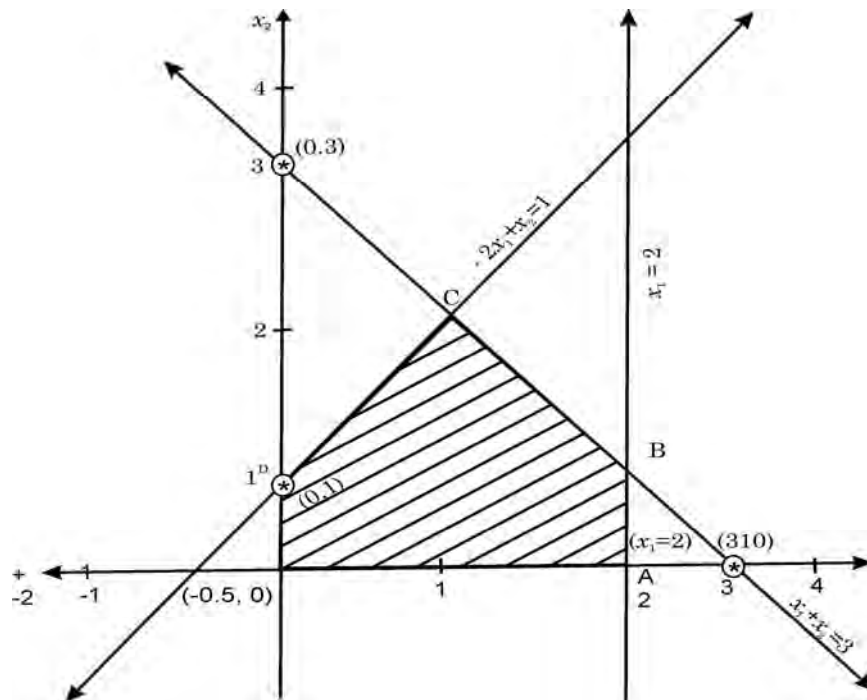
When,

$$x_1 = 0, x_1 + x_2 = 3$$

$$x_2 = 3$$

The line (3) cuts x_2 axis at $(0, 3)$.

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From the figure the region OABCD is called solution space.

The point O = (0, 0)

The point A = (2, 0)

The point D = (0, 1)

We shall find B, and C.

We shall solve B

$$x_1 = 2,$$

$$x_1 + x_2 = 3 \Rightarrow 2 + x_2 = 3$$

$$x_2 = 1$$

∴ The point B (2, 1)

We shall solve C

$$-2x_1 + x_2 = 1$$

$$x_1 + x_2 = 3$$

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$$-3x_1 = -2$$

$$x_1 = \frac{2}{3} = .666 = .67$$

$$x_1 + x_2 = 3$$

$$.67 + x_2 = 3$$

$$x_2 = 3 - .67 = 2.33$$

∴ The point C (0.67, 2.33)

No at O = (0, 0), Z = 0

At A = (2, 0), Z = 2 + 0 = 2

At B = (2, 1), Z = 2 + 1 = 3

At C = (0.67, 2.33) Z = 0.67 + 2.33 = 3.0

At D = (0, 1), Z = 0 + 1 = 1

∴ The solutions are $x_1 = 2$, $x_2 = 1$ and $x_1 = 0.67$, $x_2 = 2.33$ and Minimum Z = 3

16 The given L.P.P. is

Minimize $Z = 2x_1 + x_2$

Subject to

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 \geq 6$$

$$x_1 + 2x_2 \leq 3, \quad x_1, x_2 \geq 0$$

We shall convert the constraints into eqn.

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 - x_3 = 6$$

$$x_1 + 2x_2 + x_4 = 3$$

Where $x_1, x_2, x_3, x_4 \geq 0$ and x_3 is called surplus variables and x_4 is called slack variable.

We shall add artificial variables in the above equations.

$$3x_1 + x_2 + x_5 = 3$$

$$4x_1 + 3x_2 - x_3 + x_6 = 6$$

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$$x_1 + 2x_2 + x_4 = 3$$

Here, x_5, x_6 are called artificial variable.

The no. of variables $n = 6$

The no. of constraints $m = 3$

$$\therefore n - m = 6 - 3 = 3.$$

Let us assume that

$$x_1 = 0, x_2 = 0, x_3 = 0$$

$\therefore$ The starting basic feasible solution is

$$x_5 = 3, x_6 = 6, x_4 = 3$$

Now, then new objective function.

$$Z = 2x_1 + x_2 + 0x_3 + 0x_4 + Mx_5 + Mx_6$$

		C (2 1 0 M M 0)							
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_5	Y_6	Y_4	Min Ratio
M	Y_5	3	3	1	1	1	0	0	$\frac{3}{3} = 1$ ←
M	Y_6	6	4	3	-1	0	1	0	$\frac{6}{4} = 1.5$
O	Y_4	3	1	2	0	0	0	1	$\frac{3}{1} = 3$
		$Z=9M$	7M-2 ↑	4M-2	-M	0	0	0	

Therefore, Y_1 is the entering variable and Y_5 is the leaving variable and 3 is the leading common element.

		C (2 1 0 M 0)						
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_6	Y_4	Min. Ratio
2	Y_1	1	1	1/3	0	0	0	$\frac{1}{1/3} = 3$
M	Y_6	2	0	5/3	-1	1	0	$2 \times \frac{3}{5} = 1.2$ ←

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O	Y_4	2	0	$\frac{5}{3}$	0	0	1	$\frac{6}{5}=1.2$
		$Z = 2M+2$	0	$\frac{5M-1}{5}$	-M	0	0	

Y_2 is the entering variable

Y_6 is the leaving variable

$\frac{5}{3}$ is the leading common element.

		C	(.2	1	0	0)
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_4
2	Y_1	$\frac{3}{5}$	1	0	$\frac{1}{5}$	0
1	Y_2	$\frac{6}{5}$	0	1	$-\frac{3}{5}$	0
0	Y_4	0	0	0	1	1
		$Z=12/5$	0	0	$-\frac{1}{5}$	0

Since all the element $Z_j - C_j$ of non-positive. The above table gives the optimum solution.

∴ The solution is $x_1 = \frac{3}{5}$, $x_2 = \frac{6}{5}$ and $Z = \frac{12}{5}$

- 17 Using the information that factory works effectively 7 hours (= 420 minutes) a day and the time required by each operator for producing each of the products, we obtain the following production and profit matrices.

Production Matrix (units)				
Operator	Product			
	A	B	C	D
P	70	42	30	35
Q	60	84	140	105
R	70	60	42	42
S	21	42	28	28

Profits Matrix				
Operator	Product			
	A	B	C	D
P	210	84	120	35
Q	180	168	560	105
R	210	120	168	42
S	63	84	112	28

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In order to apply the assignment algorithm for minimizing losses, Let us first convert this profit matrix to a loss matrix by subtracting all the elements of the given matrix from its highest element which is equal to Rs. 560. The matrix so obtained is given below :

Operator	Product			
	A	B	C	D
P	350	476	440	525
Q	380	392	0	455
R	350	440	392	518
S	497	476	448	532

Now apply the assignment algorithm to the above loss matrix subtracting the minimum element of each row from all elements of that row, we get the following matrix.

Operator	Product			
	A	B	C	D
P	0	126	90	175
Q	380	392	0	455
R	0	90	42	168
S	49	28	0	84

Now subtract the minimum element of each column from all the elements of that column to get the following matrix.

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Operator	Product			
	A	B	C	D
P	0	98	90	91
Q	380	364	0	371
R	0	62	42	84
S	49	0	0	0

Draw the minimum number of lines to cover all zeros. The minimum number of lines to cover all zeros is three which is less the order of the square matrix (i.e., 4), thus the above matrix will not give the optimal solution. Subtract the minimum uncovered element (= 62) from all uncovered elements and add it to the elements lying on the intersection of two lines, we get the following matrix.

Operator	Product			
	A	B	C	D
P	0	36	90	29
Q	380	302	0	309
R	0	0	42	22
S	111	0	62	0

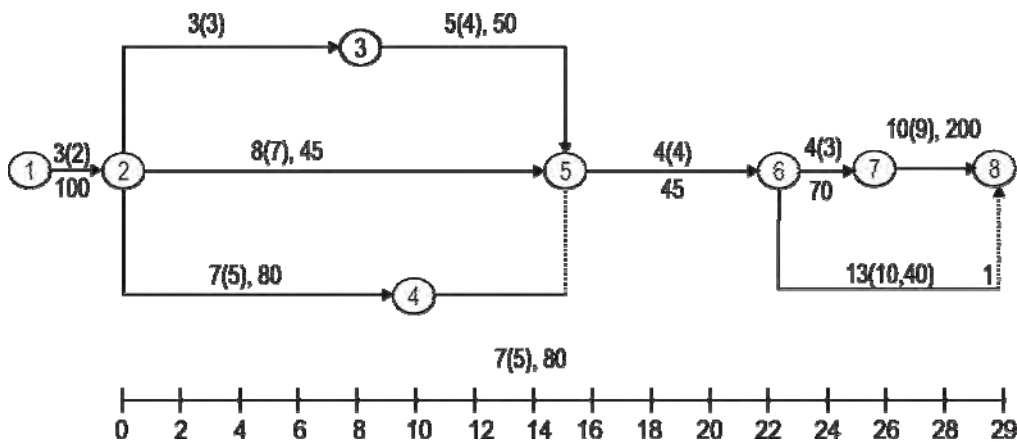
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The minimum number of lines which cover all zeros is 4 which is equal to the order of the matrix hence, the above matrix will give the optimal solution. Specific assignments in this case are as below :

Operator	Product			
	A	B	C	D
P	0	36	90	29
Q	380	302	0	309
R	0	0	42	22
S	111	0	62	0

Operator	Product	Profit (Rs.)
P	A	210
Q	C	560
R	B	120
S	D	28
Total	Profit (Rs.)	918

- 18 If the activities are crashed future the crash cost/week will be more than Rs. 50 and hence further crashing is not done. The project is in figure.



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The above results are summarized in the table below:

Duration (Week)	Normal direct cost (Rs.)		Crash cost (Rs.)	Indirect cost (Rs.)	Total Cost
32	4220	-	1600	5820	
31	4220	45	1550	5815	
30	4220	90	1500	5810	
29	4220	135	1450	5805	

•

• •

Optimum project duration = 29 weeks.

Optimum total project cost = Rs. 5805.

- 19** The given problem is un-balanced T.P.

∴ We add dummy column (E).

	A	B	C	D	E	
1	42	48	38	37	0	160
2	40	49	52	51	0	150
3	39	38	40	43	0	190
	80	90	110	160	60	500

Now, the above problem is balanced.

- (i) First, using VAM method to find basic feasible solution.

The diagram consists of a main grid on the left and a smaller grid on the right. The main grid is 6 columns wide and 10 rows high. The right grid is 6 columns wide and 4 rows high. Arrows indicate connections between the two grids.

Main Grid Data:

42	48	36	37	0	
			160		
40	40	52	51	0	
00		10		00	
30	30	00	43	0	
	00	100			
100	100	100	100	100	
1	10	2	0	0	
1	10	2	0		
1	1	2	0		
		2	0		
		2			

Right Grid Data:

37	1	1	1	36	36
40	9	11	1	52	
30	1	1	3	40	40

Arrows and Connections:

- From the top row of the main grid, arrows point to the top row of the right grid.
- From the second row of the main grid, an arrow points to the second row of the right grid.
- From the third row of the main grid, an arrow points to the third row of the right grid.
- From the fourth row of the main grid, an arrow points to the fourth row of the right grid.
- From the fifth row of the main grid, an arrow points to the fifth row of the right grid.
- From the sixth row of the main grid, an arrow points to the sixth row of the right grid.
- From the seventh row of the main grid, an arrow points to the seventh row of the right grid.
- From the eighth row of the main grid, an arrow points to the eighth row of the right grid.
- From the ninth row of the main grid, an arrow points to the ninth row of the right grid.
- From the tenth row of the main grid, an arrow points to the tenth row of the right grid.

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The transportation cost

$$\begin{aligned}
 &= 37 \times 160 + 40 \times 80 + 52 \times 10 + 0 \times 60 + 38 \times 90 + 40 \times 100 \\
 &= 5,920 + 3,200 + 520 + 3,420 + 4,000 \\
 &= 17,060.
 \end{aligned}$$

(ii) To find optimum solution using Modi Method.

42	48	38	37	0	
2	-2	-14	-160	0	0
40	49	52	51	0	
80	-1	10	14	60	0
39	38	40	43	0	
11	90	100	18	12	-12
40	50	52	37	0	

42	48	38	37	0	
2	-1	-13	160	0	0
40	49	52	51	0	
80	10	1	14	60	0
39	38	40	43	0	
10	80	110	17	11	-11
40	49	51	37	0	

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42	48	38	37	0	
3	0	-12	160	1	48
	39		50	-1	
40	49	52	51	0	49
80	10	1	13	60	
		51	38		
39	38	40	43	0	38
10	80	110	21	+49	
	29		27	-49	
-9	0	2	-11	-49	

42	48	38	37	0	
15	12	0	160	13	-13
	27	36		-13	
40	49	52	51	0	0
80	10	1	1	60	
	1	51	50		
39	38	40	43	0	-11
0	80	110	4	11	
	39		39	-11	
40	49	51	50	0	

∴ The above table gives the optimum cost.

∴ The optimum T. P. cost = $38 \times 0 + 37 \times 60 + 40 \times 80 + 49 \times 10 + 0 \times 60 + 38 \times 80 + 40 \times 110$
 $= 5,920 + 3,200 + 490 + 3,040 + 4,400 = 17,050.$

∴ The optimum cost = Rs. 17,050

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- 20** First of all, random numbers 00-99 are allocated in proportion to the probabilities associated with the sales of cars as given below:

Table 1

Sales of Car	Probability	Cumulative Probability	Range for random number
37	0.10	0.10	00-09
38	0.15	0.25	10-24
39	0.20	0.45	25-44
40	0.35	0.80	45-79
41	0.15	0.95	80-94
42	0.05	1.00	95-99

Based on the given random numbers, we simulate the estimated sales and calculate the profit/loss on the basis of specified units of production.

Table 2 :

Day	Random Numbers	Estimated Sale	Profit (Production 40 Cars /(day) (Rs. laksh)	Profit (Production 39 cars /day
1	9	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
2	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
3	64	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
4	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
5	94	41	$40 \times 1 - 1 \times 1 = 39$	$39 \times 1 - 2 \times 1 = 37$
6	01	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
7	78	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
8	10	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
9	15	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
10	19	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$

Total = 359

Total = 359

There is no additional profit or loss if the company decides to reduce production to 39 cars per day.

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21 Calculation of seasonal indices by the method of link relatives.

Year	Quarter			
	I	II	III	IV
1995	–	108.3	120.0	111.5
1996	62.1	146.3	106.3	86.9
1997	93.2	95.6	143.1	68.8
1998	112.5	80.6	129.3	113.3
1999	77.5	110.6	109.6	88.8

$$\text{Arithmetic average} = \frac{345.4}{4} = 86.35 \quad \frac{541}{5} = 108.28$$

$$\frac{608.3}{5} = 121.66 \quad \frac{469.3}{5} = 93.86$$

$$\text{Chain relatives } 100 = \frac{100 \times 108.28}{100} = 108.28$$

$$= \frac{121.66 \times 108.28}{100} = 131.73$$

$$= \frac{93.86 \times 131.73}{100} = 123.65$$

$$\text{Corrected chain relatives } 100 = 108 - 1.675 = 106.605$$

$$131.73 - 3.35 = 128.38$$

$$123.64 - 5.025 = 118.615$$

$$\text{Seasonal indices } \frac{100 \times 100}{113.4} \quad \frac{106.605}{113.4} \times 100 \quad \frac{128.38}{113.4} \times 100$$

$$\frac{118.615}{113.4} \times 100$$

$$= 88.18 \quad = 94.01 = 113.21 \quad = 104.60$$

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The calculation in the above table are explained below :

Chain relative of the first quarter (on the basis of first quarter = 100)

Chain relative of the first quarter (on the basis of the last quarter)

$$= \frac{86.35 \times 123.64}{100} = 106.7$$

The difference between these chain relatives = $106.7 - 100 = 6.7$

$$\text{Difference per quarter} = \frac{6.7}{4} = 1.675$$

Adjusted chain relatives are obtained by subtracting 1×1.675 , 2×1.675 , 3×1.675 from the chain relatives of the 2nd, 3rd and 4th quarters respectively.

Average of corrected chain relatives

$$= \frac{100 + 106.605 + 128.38 + 118.615}{4} = \frac{453.6}{4} = 113.4$$

$$\text{Seasonal variation index} = \frac{\text{Correct chain relatives}}{113.4} \times 100$$

22 Fitting straight line Trend by the Method of Least square

Year	Tourist Arrivals (in millions) Y	X	XY	X ²
1990	18	-3	-54	9
1991	20	-2	-40	4
1992	23	-1	-23	1
1993	25	0	0	0
1994	24	1	24	1
1995	28	2	56	4
1996	30	3	90	9

N = 7

$\Sigma y = 168$

$\Sigma x = 0$

$\Sigma xy = 53$

$\Sigma x^2 = 28$

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The equation of the straight line trend is :

$$Y = a + bx$$

$$\text{Since } \sum x = 0, a = \frac{\sum y}{N} = \frac{168}{7} = 24$$

$$\text{And } b = \frac{\sum xy}{\sum x^2} = \frac{53}{28} = 1.893$$

$$\text{Hence } Y = 24 + 1.893x$$

Estimated Number of tourists that would arrive in 2000

$$Y = 24 + 1.893 (7) = 24 + 13.251 = 37.251 \text{ million.}$$

- 23** In the usual notations, we are given $n = 200$. x = No. of pieces conforming to specifications in the sample = $200 - 18 = 182$.

$$\therefore P = \text{Proportion of pieces conforming to specifications in the sample} = \frac{182}{200} = 0.91.$$

Null hypothesis. $H_0 : P \geq 0.95$, i.e., the proportion of pieces conforming to specifications in the lot is at least 95%.

Alternative Hypothesis. $H_1 : P < 0.95$ (Left-tailed alternative).

It will suffice to test $H_0 : P = 0.95 \Rightarrow Q = 1 - P = 0.05$

Level of significance (i) $\alpha = 0.05$, (ii) $\alpha = 0.01$

Test statistic. Under H_0 , the test statistic is $Z = \frac{P - E(P)}{SE(P)} = \frac{P - P}{\sqrt{PQ/n}} \sim N(0,1),$

Since sample is large

$$= \frac{0.91 - 0.95}{\sqrt{0.95 \times 0.05/200}} = \frac{-0.04}{\sqrt{0.00237}} = \frac{-0.04}{0.0154} = -2.6.$$

- (i) Significance at 5% level of significance.

Since the alternative hypothesis is one-sided (left-tailed), we shall apply left-tailed test for testing significance of Z . The significant value of Z at 5% level significance for left-tail test is -1.645 .

Since computed value of $Z = -2.6$ is less than -1.645 (or since $|z| > 1.645$), we say Z is significant (as it lies in the critical region) and we reject the null hypothesis at 5% level of significances. Hence, the manufacturer's claim is rejected at 5% level of significance.

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- (ii) Significance at 1% level of significance. The critical value of Z at 1% level of significance for single-tailed (left-tailed) test is -2.33 . Since the computed value $Z = -2.6$ is less than -2.33 (is $|z| > 2.33$),
 $\therefore H_0$ is rejected at 1% level of significance also.