

PAPER – 5 : ADVANCED MANAGEMENT ACCOUNTING
QUESTIONS

Basic Cost Concepts for Decision Making: Application of Differential Cost Techniques in Managerial Decision

Decision making – Make or Buy

1. A pump manufacturing company needs four components W, X, Y and Z. The manufacturing Components may be procured from outside. The cost, purchase price for the components and other information are given below:

	W (Rs.)	X (Rs)	Y (Rs.)	Z (Rs.)
Direct Material	60	70	75	60
Direct wages	30	40	60	40
Direct Expenses @ Rs. 20 per machine hour	40	30	40	40
Fixed Cost	20	20	15	25
Total Cost	150	160	190	165
Purchase price from market	150	160	200	135
Units required for the year	3,000	3,500	2,000	3,000

- (i) There are constraints in machine time in manufacturing all components. Total machine hours available is only 12,000.
- (ii) Other alternative is to use machine time in a second shift which will attract 20% extra wages and other fixed overheads @Rs. 3,000 for 1000 hours or part thereof.

Give your suggestion about the course of action for maximization of profit.

Decision Making – Make or Buy

2. A manufacturer of household Pressure Cooker buys 20,000 components annually from a supplier @ Rs.45. Production manager has given a proposal of manufacturing the component in their own factory, the detailed cost estimates are given below:

	For 20,000 units	Per unit (Rs.)
Direct Material	Rs.4.00 lakh	20.00
Direct wages	Rs.3.50 lakh	17.50
Factory overheads (60% Variable)	Rs.1.75 lakh	8.75
Total Cost	Rs.9.25 lakh	46.25

Moreover, production manager argument is that in-house facilities will provide better flexibility to enhance the production to the extent of 25, 000 units of Pressure cooker. It has been indicated that for enhancing the production the banker of the company has in principle agreed to arrange additional working capital requirement of Rs 20.00 lakhs at a

cost of 12% annum .However, marketing department has indicated that price of Pressure cooker may require reduction in price by at least 4% to take care of additional sale. Existing per unit sales price of Pressure Cooker Rs.1,300 and Contribution is Rs.250.

As the production cost is more than the procurement price from the market, management of the company seek your views as Management Accountant on Make or Buy decision.

Decision Making -Profit maximization

3. ABC Ltd has prepared the following budget estimates;

	Product A	Product B
Sales Units	6,000	16,000
	Rs/ unit	Rs / unit
Selling Price	40.	64
Direct Material	12	22
Direct wages Rs. 8 per labour hour	8	12
Variable overheads	4	6
Fixed overheads	8	12
Total cost	32	52
Profit	8.00	12.00

Capacity in linked with labour hours usage. After finalization of the above manufacturing programme, it was observed that one third of the capacity still remained idle.

In order to improve the working in the plant, the following proposals are put up for consideration:

- (i) Discontinue product A and capacity so released may be utilized for production of B. Selling price of product B will, however be decreased by Rs 2 per unit to take care of increased volume of sale.
- (ii) Discontinue Product B and use the capacity so released to produce product C which has demand is export market. Sales price and cost of manufacturing per unit of C is given below :

Selling price	Rs 52
Direct Material	15
Direct Wages	10
Variable overheads	5

- (iii) Utilize the idle capacity for meeting an export demand for product D whose sales price and cost data are given as below :

Selling price	Rs 72
Direct Material	20

Direct Labour	20
V. overheads	10

Additional Fixed Cost for production of D will be Rs 70,000.

(iv) Hire out the idle capacity for Rs 60,000 annually . .

Evaluate each proposal and give you views.

Decision Making – Profit Maximization

4. XYZ Ltd is manufacturing two products X and Y, the details of which are given below :

	Product X	Product Y
Sales Unit	5000	10000
Capacity utilized	25%	40%
Selling Price	Rs 1000	Rs 1200
Direct Material	300	500
Direct Wages (Rs 100 per worker-day)	250	200
Variable Overheads (100 % of D Wages)	250	200

Fixed Overheads of Rs 20 lakhs will remain unchanged at present level of production.

While making a production plan for the next year, the following changes which are expected to have impact on cost are given below :

- (i) Rise in Cost : Direct Material and Direct Wages is expected to rise by 5%. Variable overheads will remain 100% of Direct Wages.
- (ii) Rise in Price : Present volume of sale can be achieved with 6% rise of Price of A and 4% rise in B.

Proposal 1 : Use idle capacity to produce X, keeping present price to take care of additional sale.

Proposal 2 : Produce Y with idle capacity with no increase in price. Efficiency may go down because of newly recruited workers.

Proposal 3 : A new product Z may be manufactured which requires 3 worker-day per unit and the estimated selling Price, direct material per unit will be Rs 1350, Rs 400 respectively. Variable Overheads will be 100% of Direct Wages, Selling & Distribution Expenses and other fixed costs are expected to go up by Rs 6.50 lakhs.

Considering the rise in cost, you are required to examine the above three proposals and compare with the profitability of the next year with normal production of current year.

Decision Making : Relevant Costing

5. A company has undertaken a market survey and accordingly decided to launch a new Product P which is expected to have demand of 1,00,000 units in a year @ Rs.200. The following information has been furnished by the company.

- (i) Material – The manufacturing of P requires one unit of 3 types of material :

Raw Material	Current Stock Unit	Cost per Unit (Rs.)		
		Original Cost	Current Replacement Cost	Resale Value
A (Regular in use)	1,00,000	20	25	17.50
B (Old Stock)	60,000	35	35	10.00
C (New)	-	-	60	-

- (ii) Direct Labour –

Skilled Labour 0.25 hrs / unit @ Rs.100 per hour

Unskilled Labour 2 hrs / unit @ Rs.70 per hour

Skilled workers' contribution per hour is Rs.150 per hour.

There is abundant unskilled labour in the factory but according to agreement with Union, no worker can be retrenched.

- (iii) Machine: Two Machine M1 and M2 are required to produce C. M1 is in regular use and M2 is in the process of selling out. Company charges depreciation on straight line basis.

		At the start year	At the end of year
Machine M1	Replacement Cost	Rs.16 lakh	Rs.13.0 lakh
	Resale Value	Rs.12 lakh	Rs.9.4 lakh
Machine M2	Replacement Cost	Rs.2.6 lakh	Rs.1.8 lakh
	Resale Value	Rs.2.2 lakh	Rs.1.7 lakh

- (iv) Overheads: Variable overhead – Rs.15 per unit, Fixed overhead allocated for the product C is Rs.18 lakhs p.a. (Depreciation of machine not included).

Estimate Cost of Product C based on relevant costing

Decision Making – Buying a Machine

6. AB Ltd. Received an order from a valuable client of supplying 3,00,000 pieces of components @Rs. 750 unit a year at a rate of 25,000 per month. Cost of manufacturing of the component is estimated as:

	<i>Rs. /Unit</i>
Material	500
Labour	50
Variable overhead 40% of labour	20
Variable selling & distribution overhead	2
Fixed Production overheads is 30 lakhs.	

There is a penalty/ reward clause of Rs. 30.00 per unit for supplying less / more than 25,000 units per month. To adhere to the schedule of supply, company procured a special machine costing Rs. 20 lakhs, which is expected to fetch Rs. 5 lakhs after the end of the contract of supply of components. After supply of machine, supplier offered another advanced technology machine (new in the market) with 20% more output per hour but there will be material wastage 0.5%. The new machine cost is Rs. 15 lakhs but will have no resale value after completion of the project. If advanced version machine is purchased, earlier machine recently supplied will be immediately taken back at Rs 15 lakhs. Fixed cost of maintenance for the advanced version will increase by Rs. 20,000 per month. Entire job is expected to be completed within 10 months. Advise whether the company should go for the improved version machine.

Pricing of an Export Order.

7. A company is operating at 60% capacity with a turnover Rs. 86.40 lakhs.
 - (i) If the Company works at 100% capacity, the sales-cost relation is: Factory Cost is two-third of sales value.
 - (ii) Prime Cost is 75% of Factory Cost.
 - (iii) Administrative and selling expenses (75% variable) is 20 % of sales value.
 - (iv) Factory overhead will vary according to operating capacity as given below :

Operating Capacity	60%	80%	100%	120%
Factory overhead (Rs. Lakhs)	19.80	21.60	24.00	30.00

The company has planned to operate at 80% capacity. Moreover, it has received an export order and the execution of the same will involve 40 % of capacity. The prime cost of the order is estimated as Rs. 12.00 lakhs and shipping expenses involved will be Rs 2.00 lakhs. Taking same percentage of profit on domestic sale, determine minimum price to be quoted for the export order.

Product Pricing

8. A company has launched a new product in its consumer product division with an investment of Rs 30.00 lakhs.. The product is packed in pastic bags of 100 gms and cartooned in boxes of 50 each. The following information for the first two quarters are extracted from books of Accounts :

	Quarter Ending on 30.09.2010	Quarter Ending on 31.12.2010
Box (Nos)	3000	5000
Sales (Rs lakhs)	15.00	25.00

Production Cost (Rs lakhs)	9.50	14.50
Selling & Dist Exp (Rs Lakhs) (50% variable)	4.40	6.40

The Sales Department expects that there will be an increase in sales next year by 20% compared to quarter ending with 31.12.2010. It is anticipated that there will be increase in variable cost by 10%. Variable Selling & distribution expenses will remain same for the next year but it is budgeted to increase Fixed Selling & Distribution expenses by 25% to consolidate the market position of the product. The company expects 15% post tax return on investment (tax 50%).

Calculate the price at which the product is to be sold next year and give your comments.

Service Cost

9. A Hotel having 50 single rooms is having 80% occupancy in normal season (8 months) and 50% in off. season (4 months) in a year (take 30 days month).

Annual fixed expenses	(Rs. Lakh)
Salary of the staff (excluding room attendant)	7.50
Repair & Maintenaance	2.60
Depreciation on Building & Furniture	2.40
Other fixed expenses like dusting, sweeping etc.	<u>3.25</u>
Total	<u>15.75</u>

Variable expenses (per guest per day)

Linen, Laundry & security support	Rs. 30.00
Electricity & Other facilities	Rs. 20.00
Misc expenses like attendant etc	Rs 25.00

Management wishes to make a margin of 25% of total cost.

- Calculate the tariff rate per room.
- Calculate the Break Even Occupancy in normal season assuming 50% occupancy is off-season.
- Management is proposing 20% cut in tariff to improve occupancy at 100% and 70% in normal season and off-season respectively,. Give your views on it.
- What is the minimum rise in occupancy % to takes care of risk of fall in profit due to tariff-cut ?

Transfer Pricing

10. AB Ltd. has two divisions A & Division B. Division A produces components, two units of which is required for one unit of final product produced by division B. Division A has a capacity to produce 20,000 units and entire quantity is supplied to Division B @ Rs.200 per unit. Variable cost of component at Division A is Rs.190 and fixed cost is Rs.20 per

unit. For final product of Division B, per unit variable cost (excluding component) is Rs.700, fixed cost Rs.200 and selling price is Rs 1500.

Division A has placed an proposal for increasing the transfer price to Rs.220 i.e. their market price. Division A's facility can be rented out @ Rs.3.00 lakh annually. Division A argument is that instead of making loss on transfer, facilities can be rented out.

Division B's argument is that it can buy the same component from outside market @ Rs.210.

Division A has given another proposal to augment its capacity to 40,000 units with an investment of Rs 15 lakhs so that it can sell 20,000 units to external market and transfer 20,000 units to Division B at Rs 210 per unit. Fixed cost for Division A will go up by Rs 1.00 lakhs.

You have evaluate the following and give your views :

- (a) Division A facilities rented out and Division B buys components @ Rs 210 from outside market.
- (b) Division A sells components to outside @ Rs.220 and Division B buys components @ Rs 210 from market.
- (c) Proposal of enhancement of capacity of Division A to 40,000 units. (assume capital cost @ 12%)

Transfer Pricing

11. XY Ltd has two divisions X Ltd and Y Ltd. X division has maximum capacity of producing 10 lakhs components but producing at present 9.0 lakh components annually and selling the same to external market @ Rs 250 per unit.

Y division procures 5.0 lakhs units same component X to manufacturing the final product Y @ Rs 220 per unit. Through a negotiation between X division and Y division, Y division has agreed to take all its 5 lakh unit components X @ price of Rs 240 per unit as saving on account of distribution cost will help X division to maintain the same profit of Rs 70 per unit. X division will use its maximum capacity to satisfy the demand of external market.

In order to maximize the profit of the company, give your views on transfer price under following scenario :

Scenario 1 : Tax rate of X division is 40% and that of Y division is 50%

Scenario 2 : Tax rate of X division is 50% and that of Y division is 40%

Target Costing

12. A company has sales of 1.00 units at a price of Rs 200.00 per unit and profit of Rs 40.00 lakhs in the current year. Due to stiff competition, the company has to reduce its price of product next year 5% to achieve same volume target of sales. The cost structure and profit for the current year is given as below :

	<i>Rs lakhs</i>
Direct Material	60.00
Direct wages	45.00
Variable Factory Overheads	20.00
Fixed Overheads including sales & admin exp	<u>35.00</u>
Total Cost	<u>160.00</u>

To achieve the target cost to maintain the same profit, the company is evaluating the proposal to reduce labour cost and fixed factory overheads. A vendor supplying machine for suitable for the company's operation has offered an advanced technology semi-auto machine of Rs 20 lakhs as replacement of old machine of worth 5.0 lakhs. The vendor is agreeable to take back the old machine at Rs 2.70 lakhs only. Company's policy is to charge depreciation @ 10% on WDV. The maintenance charge of the existing machine is Rs 1.20 lakhs per annum whereas there will be warranty of services free of cost for the new machine first two years. There are ten (10) supervisors whose salary is Rs 1.50 lakhs per annum.

The new machine having conveyor belt is expected to help in cost cutting measures in the following ways :

- (i) improving productivity of workers by 20%
- (ii) cut down material wastage by 1.0 %
- (iii) Elimination of services of supervisors because of auto facilities of the machine
- (iv) Saving in packaging cost by Rs 1.5 lakhs.

Assuming cost of capital to be 15%, calculate how many supervisors are to removed from the production activities to achieve the target cost.

Budgeting

13. In your company, budgeted sales for following months of year 2010 are given below :

	March	April	May	June	July	Aug
Sales in Rs Lakhs	600.00	650.00	620.00	620.00	630.00	640.00

- (i) Cash sales is 20% and Credit sales is 80%. Credit for one month only.
- (ii) Contribution/ Sales ratio is 40%.
- (iii) Fixed cost for the whole year is budgeted to be Rs 300.00 lakhs expected to be evenly distributed over all months. Fixed cost does not include depreciation of Rs 14.4 lakhs. Fixed costs incurred are paid in the same month.
- (iv) 40% of each month's sale is produced in the previous.
- (v) 50% of the direct material required for production is purchased in the previous month.

- (vi) 60% of variable costs are direct material cost. Material is procured at one month's credit.
- (vii) 30% of variable costs are direct labour cost which is paid in the same month.
- (viii) remaining variable costs are variable overheads. 40% of variable overheads are paid in the same month and balance in the next month.
- (ix) Balance required as on 1st of April, 2010 is Rs 40.00 lakhs.

You are required to prepare for the quarter April – June 2010 (a) A statement of profit & loss and (b) Cash budget for the period

Variance Analysis

14. ABC Ltd. is following a standard costing system. The standard output for a period is 20,000. Details of the standard cost and profit per unit are given below:

Direct Material (3 units @ Rs.150)	Rs 450.00
Direct Labour (3 hour @ Re.100)	300.00
Direct Expenses	50.00
Factory overhead-Variable	25.00
-Fixed	30.00
Admin Overhead	<u>30.00</u>
Total Cost	885.00
Profit	<u>115.00</u>
Sales Value	<u>1000.00</u>

Actual production and sales for the year was 14, accounts. There has been two price revision during the period. The following are variance worked out of the end of the period.

	Favourable (Rs.'000)	Adverse (Rs.'000)
Direct Material		
Price		425
Usage	105	
Direct Labour		
Rate		400
Efficiency	320	
Factory Overhead		
Variable Expenditure	40	
Fixed Expenditure	40	

Fixed Volume	168
Administrative overhead	
Expenditure	40
Volume	168

Calculate actual cost and profit for the period.

Activity Based Costing

15. A Company is manufacturing 4 products A, B, C, D. The details of production and cost components are given below. The company at present is following the system of overheads distribution based on machine hours used by the products. Some details of different service activities, which are at present included in total factory overheads, and usage pattern of these activities by the products are also indicated.

	A	B	C	D
Output in units	720	600	480	504
Cost Per Unit :				
Direct Material	162	105	125	108
Direct Wages	70	75	60	80
Machine Hours per unit	4	3	2	1
Details of activities :		Cost Driver		Amount (Rs)
Machine Operation				94,500
Set Up Cost		No of Production Run		40,000
Stores Receiving		No of Requisitions		5,000
Inspection		No of Production Run		10,000
Material Handling		No of Orders		2,532

- (i) Machine Operation Cost should be divided to Set –up cost, Stores and Inspection in 4:3:2 ratio.
- (ii) Production run is for each 24 units.
- (iii) Number of separate requisitions for each product is 50
- (iv) No of Orders placed for each batch of production of 12 units

You are to calculate the costs of these different products on the present system and on the basis of Activity Based Costing, show the differences and give your comments.

Learning Curve Theory

16. In your company, production manager has observed that learning curve theory is very much applicable in the newly procured machine @ 90%. A batch of production is of 50 units. The average labour cost for the first batch is Rs 100. Material Cost and Overheads are Rs 150 and 50 per unit respectively. If profit margin is 25% on cost, estimate the price per unit if the order size is for (a) 400 units and (b) 800 units (c) 1000 unit

JIT & Service Costing

17. (a) What do you mean by back-flushing in JIT system? What are the problems that must be corrected before it will work properly?
 (b) What is Target Costing and list the steps involved in target costing process .

Quality Management & Value Chain Analysis

18. (a) Define Total Quality Management? What are the six Cs for successful implementation of TQM?
 (b) What is the concept of 'Value-chain' and what steps are involved in value chain analysis approach for assessing competitive advantages?

Linear Programming

19. A manufacturer producer two products P₁ & P₂ with raw material M₁ & M₂. Requirement and availability of raw material and labour units are given in the following table. Contribution for unit of products are given:

Products	Requirements permit		Minimum Contribution per day
	P ₁	P ₂	
Material M ₁ (kg)	2	1	18 kg
Material M ₂ / kg	1	1	12 kg
Labour (hr)	3	2	34 hours (max available per day)
Contribution per unit	Rs.50	Rs.30	

How many units of each products should be produced to maximize profit. ?

Program Evaluation & Review Technique

20. The following information is given on different activities of a projects:

Activity	(1-2)	(2-3)	(2-4)	(3-5)	(4-6)	(5-6)	(5-7)	(6-7)
Pessimistic time (week)	3	9	6	8	8	0	5	8
Most likely time (weeks)	3	6	4	6	6	0	4	5
Optimistic time (weeks)	3	3	2	4	4	0	3	2

- (a) Draw the network diagram and show the critical path and expected project length.
- (b) Calculate variance of each activity.
- (c) Calculate the probability that the project will be completed in 23 weeks. (For $Z = 1.920$, Probability $P = 0.9726$)

Transportation Problem

21. A Company has 4 manufacturing plants and 5 warehouses. Raw material cost and manufacturing cost and capacity of different plants are given in Table 1. Table 2 gives the sales price, transportation cost from plants and demand at different warehouse locations.

Table 1

Plants ----->	1	2	3	4
Raw Material costs (Rs per Unit)	8	7	7	5
Manufacturing costs (Rs per unit)	12	10	8	7
Capacity (tons per year)	100	200	120	80

Table 2

Warehouse	Transportation cost (Rs. Per unit)				Sale price (Rs.) per unit	Demand
	1	2	3	4		
A	4	7	4	3	30	80
B	8	9	7	8	32	120
C	2	7	6	10	28	150
D	10	7	5	8	34	70
E	2	5	8	9	30	90

- (i) Formulate this into a transportation problem to maximize profit.
- (ii) Find the solution using VAM method.
- (iii) Test for optimality and find the optimum solution.

Assignment Problem

22. The following table gives the past performance of five salesman in different regions in terms of their sales achievement in rupees lakhs.. Find the optimum assignment.

Salesman	Machine				
	R1	R2	R3	R4	R5
S1	26	14	10	12	9
S2	31	27	30	14	16
S3	15	18	16	25	30
S4	17	12	21	30	25
S5	20	19	25	16	10

23. In a travel agency, servicing clients was observed to follow:

Time to deal with clients	minutes	2	4	6	10	14	20	30	=1.0
	Probability	.05	.10	.15	.30	.25	.10	.05	

Time between arrival	minuty	1	8	15	25	= 1.0
	probability	0.2	0.4	0.3	0.1	

(a) Simulate the arrival of 10 clients and their servicing with the following random numbers.

Arrival pattern: 03, 47, 43, 73, 86, 36, 96, 47, 36, 61.

Service pattern: 63, 71, 62, 33, 26, 16, 80, 45, 60, 11

(b) Calculate the number of the served in a week of 6 days, each day is about 8 hours..

Time Series Forecasting

24. Using additive model, estimate the seasonal indices by the method of moving average from the table given below. Deseasonalise personalize the given production figures with the seasonal indices obtained. Explain the significance of deseasonalised data:

Year	Quarterly output '000 tons			
	Q1	Q2	Q3	Q4
2006	74	76	74	80
2007	82	68	50	62
2008	70	74	70	82

Testing of Hypothesis

25. A briefcase manufacturing Company says that 80% of excutives carried their briefcase. Verify its claim, if in a random sample of 900 executives 675 executives used the company's briefcases. Use 5% test of significance.

SUGGESTED ANSWERS / HINTS

1.	W	X	Y	Z
	(Rs.)	(Rs.)	(Rs.)	(Rs.)
Marginal Cost	130	140	175	140
Purchase Price	150	160	200	135
Contribution per unit	20	20	25	- 5
Machine Hrs required per unit	2.0	1.5	2.0	-
Contribution per machine hr	10.00	13.33	12.5	
Rank	3	1	2	-

As the price of Z is less than the marginal cost , it may be procured from outside market.

The plan for manufacturing other components considering the limiting factor is as follows:

X: 3500 units	5250 hrs
Y: 2000 units	4000 hrs
W: 1375 units	2750 hrs
Total	12.000 hrs

Let us calculate cost of manufacturing of balance quantity of W in 2nd shift.

Balance 1625 units of W requires m/c hrs 3250 hrs

Cost of manufacturing of W per unit

Material cost	Rs. 60
Wage Cost (rs 30 x 1.2)	Rs. 36
Direct Expenses	<u>Rs. 40</u>
Total Variable cost	<u>Rs.136</u>

Fixed cost is excluded in calculation because fixed cost is already allocated to product W and for the purpose of decision making here it is a sunk cost.

Variable Cost of production of 1625 units in 2 nd shift @ Rs 136	Rs. 2, 21,000
Extra fixed cost for 3250 hrs (Rs 3000 x 4)	Rs. 12,000
Toal cost of manufacturing 1625 units in 2 nd shift	Rs. 2, 33,000
Purchase price for 1625 unit @Rs. 150/- =	Rs. 2, 43,750

Hence, balance quantity of W should be manufactured in the second shift.

2. Variable Cost for unit of component = Rs.(20.00 + 17.50 + 5.25) = Rs.42.75 which is less than market price and saving per unit will be Rs 2.25.

Hence, the components, may be manufactured in the factory itself.

Present contribution from Mixer-grinder = 20,000 × RS.200 = Rs.40 lakhs

When production and sales go up to 25,000 , sales price of pressure cooker will be reduced Rs 52 per unit.

Contribution per unit will be (Rs.250-52)	=	Rs.198.00
Additional saving from Component	=	Rs. <u>2.25</u>
Contribution per unit	=	Rs. <u>200.25</u>
Total Contribution (Rs 200.25 × 25,000)	=	Rs.50,06,250
Less additional Interest on working capital	=	Rs 2,40,000
Net Contribution	=	Rs 47, 66,250

As, the proposal when implemented will enhance the contribution by Rs 7,66,250, the proposal may be accepted.

- 3.

	Product A	Product B	Total
Number of Units	6000	16000	
Contribution per unit	16	24	
Labour hour per unit	1	1.5	
Contribution per labour hour	16	16	
Total Contribution (Rs)	96,000	3,84,000	Rs 4,80,000
Total Labour hours	6,000	24,000	30,000
Total Fixed Overheads (Rs.)	48,000	1,92,000	Rs 2,40,000
Idle capacity (labour hours)			15,000

- (a) Profitability of the original programme

Total Contribution	=	Rs. 4, 80, 00
Fixed Cost	=	Rs. 2, 40, 00
Profit	=	Rs. 2, 40, 00

- (b) Evaluations of different proposals

- (i) Discontinue A

No. of Product B produced = 6000/ 1.5 = 4,000 units

Contribution from additional units of B (4,000 x 24)= Rs.96,000

Contribution forgone on discontinuance = Rs.96,000

Thus, profitability wise it leads to point of indifference. However, other points of production facilities & sales advantages may be taken into consideration.

(ii) Discontinue product B & Produce product C		
Contribution per unit of C	=	Rs. 22
Labour hours per unit t	=	1.25 hours
Units produced (24,000/ 1.25)	=	19,200 units
Contribution (19,200 x Rs 22)	=	Rs. 4,22,400
Contribute from A	=	Rs. 96,000
	=	Rs. 5, 28,400
Fixed Cost	=	Rs. 2, 40,000
Profit	=	Rs. ,2, 88,400
(iii) Produce D in idle capacity		
Contribute per unit of D	=	Rs. 22
Labour hours per unit	=	2.50 hrs
Units produced (15,000/2.5)	=	6,000
Contribute from D	=	Rs 1,32,000
Total contribution from A & B	=	Rs 4, 80,000
Total contribution from A, B, & D	=	Rs 6,12,000
Fixed Cost	=	Rs 3, 10,000
Profit	=	Rs 3,02,000
(iv) Hiring out of idle capacity of 15,000 Labour capacity		
Contribution from renting out	=	Rs. 60,000
Total contribution from A & B	=	Rs 4,80,000
Total contribution f	=	Rs 540,000
Fixed Cost	=	Rs 2,40,000
Profit	=	Rs 3,00,000

As profit in proposal (iii) i.e production of D using idle capacity will be maximum, the same is recommended. Moreover, renting out of factory to a third party will curtail the flexibility in future production planning.

4. Profitability of the next in case of normal production in the next year :

	Product X	Product Y	Total
Unit	5000	10000	
Selling Price	Rs. 1060	Rs.1248	
Direct Material	315	525	

Direct Wages	262.50	210	
Variable Overheads	262.50	210	
Total Variable cost	840	945	
Contribution per unit (Rs)	220	303	
Total Contribution (Rs Lakhs)	11.00	30.30	41.30
Fixed Overheads			20.00
Profit for next year			21.30
Total Hours required per unit	2.5	2.0	
Total Worker-days	12500	20000	
Capacity	25%	40%	

Hence Idle Capacity (35%) = 17500 worker-days

Proposal 1 :

Units of product X to be produced with idle capacity = $17,500 / 2.5 = 7000$ units

	Product X	Product Y	Total
Unit	12000	10000	
Selling Price	Rs.1000	Rs.1248	
Direct Material	315	525	
Direct Wages	262.50	210	
Variable Overheads	262.50	210	
Total Variable cost	840	945	
Contribution per unit (Rs)	160	303	
Total Contribution (Rs Lakhs)	19.20	30.30	49.50
Fixed Overheads			20.00
Profit for next year under proposal 1			29.50

Proposal 2 :

Units of product Y to be produced with idle capacity = $17,500 / 2 = 8750$ units

	Product X	Product Y	Total
Unit	5000	18750	
Selling Price	Rs.1060	Rs.1200	
Direct Material	315	525	
Direct Wages	262.50	250	

Variable Overheads	262.50	250	
Total Variable cost	840	1025	
Contribution per unit (Rs)	220	175	
Total Contribution (Rs Lakhs)	11.00	32.81	43.81
Fixed Overheads			20.00
Profit for the next year under proposal			23.81

Note : Because of fall in efficiency by 16%, Labour hrs required per unit of B = 2.38

Proposal 3 :

Units of product Z to be produced with idle capacity = $17,500 / 3 = 5833$ units

Variable cost per unit of Z = Rs (400 + 315 + 315) = Rs 1030

Contribution per unit of Z = Rs (1350 - 1030) = Rs 320

Additional Contribution from 5833 units = Rs 18.66 lakhs.

Less Additional Selling & Dist Cost = Rs 6.50 lakhs

Net Contribution from production of Z = Rs 12.16 lakhs

Total Profit under proposal 3 = Rs (21.30 + 12.16) = Rs 33.46 lakhs.

Hence, proposal 3 should be accepted.

5. (Rs. Lakhs for one lakhs Units)

Direct Material			
A	1,00,000 × Rs 25 (Replacement cost)	25.00	
B	60,000 × Rs 10 (old stock at resale value)	6.00	
	40,000 × Rs 30 (New at replacement cost)	12.00	
C	1,00,000 × Rs 60	<u>60.00</u>	103.00
Direct Labour			
	Skilled labour 25,000 hrs @ Rs.150	37.50	
	Unskilled labour (nil)	-	37.50
	Variable overhead Rs.15 × 1,00,000		15.00
	Fixed overheads		18.00
	Depreciation for M1 (Rs 16 – 13) lakhs	3.00	
	Depreciation for M2 (Rs 2.2 – 1.7) (reduction in resale value)	<u>0.50</u>	<u>3.50</u>
	Total Cost		177.00

6.

	Old technology Machine	Advanced technology Machine
Direct . material per unit	Rs. 500	Rs. 502.50
Labour Cost	50	41.67
V. overheads 40% of labour	20	16.70
	570	560.87
	(Rs. Lakhs)	(Rs. Lakhs)
Total variable cost for 3,00,000 unit	1710.00	1682.60
Depreciation	15.00	15.00
Fixed Cost	30.00	32.40
Loss on return of earlier machine		5.00
Bonus earned for 50,000 unit @ 30	-	- 15.00
Total Cost	1741.25	1720.00

Taking into wastage, Material Cost per unit = Rs 500 x 1.005 = Rs 502.5

With Efficiency improvement, Labour cost per unit = Rs 50 / 1.20

Average production per month = 30,000 units

Average advance supply per month (entitled for reward) = 5,000 units

Total advance supply during 10 months (entitled for reward) = 50,000 units

As there will be gain of Rs. 21.25 lakhs in handling the project with the help of advanced technology machine, the company should go for advanced version machine.

7. At 100% capacity.

Sale = 86.40 x 100/60	=	Rs. 144 lakhs
Factory Cost = 1.44 x 2/3	=	Rs. 96 lakhs
Prime Cost = 96 x .75	=	Rs. 72 lakhs
Factory overheads	=	Rs. 24 lakhs
Selling & Distribution Exp	=	Rs. 28.8 lakhs
Variable S/D Exp	=	Rs. 21.6 lakhs
Fixed S/D Exp	=	Rs. 7.2 lakhs

	Operation 80% capacity (Rs. Lakhs)	Export order 40% capacity (Rs lakhs)
Prime Cost	57.60	12.00
Factory overhead (given)	21.60	8.40
Selling & Dist. Cost-variable	17.28	-

Selling & Dist. Cost – fixed	7.20	2.00
Total Cost of Sales	103.68	22.40
Sales Value (at 80% capacity) 144 x 0.80	115.20	
Profit	11.52	2.49
Profit %	10% on sales	10% of export sales value
Export Price to be quoted		24.89
Let , Sales value = x , then profit = 0.1x		
Then 0.9 x = 22.40		
Hence x = 24.89		

8. Variable prod. cost per cartoon = Rs 5,00,000 / 2000 = Rs 250
 Fixed Production Overheads per Quarters = Rs 2.00 lakhs
 Variable Selling & Distribution Expenses per cartoon = 2,00,000/ 2000 = Rs 100
 Fixed Selling & Distribution Expenses per Quarters = Rs 1.40 lakhs
 For Next year Programme :
- Sales targeted for the year = 5000 x 4 x 1.2 = 24,000 cartoons.
- | | | |
|--|---|-----------------------|
| Variable Prod. cost per cartoon = Rs 250 x 1.10 | = | Rs 275.00 |
| Variable Selling Exp per cartoon | = | Rs 100.00 |
| Total Variable cost per cartoon | = | Rs 375.00 |
| Fixed Production Overheads for the year | = | Rs. 8.00 lakhs |
| Fixed Selling & Dist Overheads = Rs 1.40 x 1.25 x 4 | = | Rs. 7.00 lakhs |
| Return on Investment required (post tax 15%) (i.e 30 x .3) | = | <u>Rs. 9.00 lakhs</u> |
| Total Contribution required | | Rs 24.00 lakhs |
| Contribution required per cartoon = Rs 24,00,000/24000 | = | Rs 100.00 |
| Thus, Price for product should be = Variable Cost + Contribution | = | Rs 475 |
- i.e reduction in price by Rs 25 i.e 5%.

Current Price per unit is Rs 500 Present price per unit

The aggressive move on increase in marketing expenses coupled with price reduction may help in achieving the target of sales and profit..

9. (a) Variable cost per room-day = Rs 75
 Total occupancy = (50 x 30 x 8 x 0.8) + (50 x 30 x 4 x 0.5)
 = 12,600 room-days
 Total variable cost = Rs. 9.45 lakhs
 (12,600 x 75)

Fixed Cost	= <u>Rs. 15.75 lakhs</u>
Total Cost	Rs. 25.20 lakhs
Profit	<u>Rs. 6.30 lakhs</u>
	Rs. 31.50 lakhs

Tariff per day = 31, 50,000/12,600 = Rs. 250.00

(b) Contribution per day = Rs. (250 – 75) = Rs. 175.00

BEP (room –day) = 15, 75, 000/175 = 9000 room-days

During off season for 4 months, rooms occupied (50 x 30 x 4 x .5) = 3,000 days

For BEP, occupancy during normal period = 6000 days i.e occupancy 50%

(c) If 10% discount is allowed , tariff will be = 225. per room-day

Contribution per room-day with tariff cut (225 – 75) = Rs 150

Total Occupancy= (50 x 30 x 8) + (50 x 30 x 4 x .0.7) = 16,200 room-days

Total Contribution for year (16,200 x Rs 150) = Rs 24.30 lakhs

Fixed Cost (unchanged) = Rs 15.75 lakhs

Profit = Rs 8.55 lakhs

As the proposal increases the profit, it may be accepted.

(d) To maintain the same profit, contribution required = F + P = Rs 22. 05 lakhs

With new tariff, contribution per day = Rs 150

Number of room-days occupied = Rs 22,05,000/ 150 = 14,700 room-days

Increase % in occupancy required = (14,700 – 12600) / 12,600 = 16.67 %

10. Present position on transfer of component at Rs 200:

	Rupees		Rs lakhs
	Division A	Division B	AB Ltd
Contribution per unit	10	400	42.00
Fixed Cost per unit	20	200	24.00
Profit per unit	-10	200	
Profit	-2,00,000	20,00,000	18.00

(a) Renting out Division A's facility & and Div B procures components @ Rs 210

	A division (Rs)	B division (Rs)	AB Ltd (Rs lakhs)
No of Units		10,000	
Variable Cost per unit		1120	

Contribution per unit		380	
Total Contribution		38,00,000	38.00
Fixed Cost		20,00,000	20.00
Profit		28,00,000	18.00
Income from Rent	3,00,000		3.00
Total Profit			21.00

(b) Division A sells components at @ 220.00 and Div B procures it @ Rs 210

	A division (Rs)	B division (Rs)	AB Ltd (Rs lakhs)
No of Units	20,000	10,000	
Variable Cost per unit	190	1120	
Contribution per unit	30	380	
Total Contribution	6,00,000	38,00,000	44.00
Fixed Cost	4,00,000	20,00,000	24.00
Profit	2,00,000	18,00,000	20.00

(c) Enhancement of capacity of Division A sells components at @ 220.00 and Div B procures it @ Rs 210

	A division (Rs)		B division (Rs)	AB Ltd (Rs lakhs)
	Sale	Transfer		
No of Units	20,000	20,000		
Variable Cost per unit	190	190	1120	
Contribution per unit	30	20	380	
Total Contribution	6,00,000	4,00,000	38,00,000	48.00
Fixed Cost	4,00,000	1,00,000	20,00,000	25.00
Cost of Capital		1.80,000		1.80
Profit	2,00,000	1.20,000	18,00,000	21.20

11.

	<i>Rs in lakhs</i>			
	<i>Scenario 1</i>		<i>Scenario 2</i>	
	<i>Before transfer</i>	<i>After Transfer</i>	<i>Before transfer</i>	<i>After Transfer</i>
(a) Contribution of X Div	630	700	630	700
(b) Change in contribution of Y Div	0	- 100	0	-100

(c) Tax of X division	252	252	315	350
(d) Tax differential for Y division	0	-50	0	- 40
(e) Profit differential for XY Ltd	378	398	315	290
(a + b) – (c + d)				
Net gain/ loss for XY Ltd		20		- 25

Thus under scenario 2, the transfer is not advantageous to the company as a whole.

12. Due to cut in price of product, sales value will decrease by Rs 10.00 lakhs.

For maintaining same profit margins i.e Rs 40 lakhs, cost has to be down by Rs 10.00 lakhs. With improvement of labour productivity, wages will be $(45/1.20) = \text{Rs } 37.50$

	Rs lakhs
Reduction in wages	7.50.
Elimination of wastage of materials	0.60
Saving in Packaging Cost	1.50
Saving in Maintenance cost	1.20
Loss in disposal of selling of old machine	- 2.30
Difference in Depreciation	- 1.50
Cost of capital investment	<u>- 3.00</u>
Effective cost reduction	4.00
Additional reduction required for target cost	6.00

Hence, number of supervisors to be eliminated = 4

- 13.

	March	April	May	June	July	Aug
Sales	600.00	650.00	620.00	620.00	630.00	640.00
Variable cost (60% of sales)	360.00	390.00	372.00	372.00	378.00	384.00
Variable cost of actual production(V) (60% of Cur month + 40% of next)	372.00	382.80	372.00	374.40	380.40	
Material Cost of actual prod (V x 0.6)	223.20	229.68	223.20	224.64	228.24	
Actual Material Procured (M) 50% of Current month + 50% of next	226.44	226.44	223.92	226.44		
Labour cost of actual production (L)	111.60	114.84	111.60	112.32		
Variable Overheads (VO)	37.20	38.28	37.20	37.44		
Fixed Overheads (FO)		25	25	25		
Depreciation (D)		1.2	1.2	1.2	Total	
Total cost (V + FO+D)		409.00	398.20	400.60	1207.80	

Closing balance of production at variable cost	148.80		149.76
Closing balance of material	111.60		112.32
(a) Statement for the period of quarter : April- June 2010			
Total Sales			1890.00
Opening balance of production	148.80		
Opening balance of material	<u>111.60</u>	260.40	
Cost of Production		<u>1207.80</u>	1468.20
			421.80
Closing Balance of production	149.76		
Closing balance of material	<u>112.32</u>		<u>262.08</u>
Profit			683.88

Note 1 : Opening Balance & Closing Balance at Variable cost

Note 2 : Adjustment for variable cost expenses not done

(b) Cash Budget for quarter April- June 2010

	April	May	June
Opening balance	40.00	249.33	489.20
Receipts			
Cash Sales	130.00	124.00	124.00
Credit Sales	480.00	520.00	496.00
Total in	650.00	893.33	1109.20
Payments			
Material	223.20	229.68	223.20
Labour	114.84	111.60	111.60
Overheads	37.63	37.85	37.30
Fixed Overheads	25.00	25.00	25.00
Total Out	400.67	404.13	397.10
Closing balance	249.33	489.20	712.10

14.

(Rs.'000)

	Standard Cost	Adjustment Variance	Actual Cost
Direct Material Cost (14,000 × 450)	6480		
Material Price Variance (A)		+ 425	
Material Usage Variance (F)		- 105	
Actual Material Cost			6800

Direct Labour Cost (14,400 × 300)	4320		
Labour Rate Variance (A)		+ 400	
Labour Efficiency Variance (F)		- 320	
Actual Labour Cost			4400
Direct Expenses (14,400 × 50)	720		720
Actual Prime Cost			11920
Variable factory overhead (14,400 × 25)	360		
Variable Expenditure Variance		- 40	
Actual Variable Overheads			320
Fixed Factory Overhead (14,400 × 30)	432		
Fixed Volume Variance (A)		+ 168	
Fixed Expenditure Variance (F)		- 40	
Actual Fixed overhead			560
Administrative overhead (14,400 × 30)	432		
Adm. Expenditure Variance (A)		+ 40	
Adm. Volume Variance (A)		+ 168	
Actual Administrative Overhead			640
Total Actual Cost			13440
Sales (14,400 × Rs.1,000)			14400
Actual Profit			9600

15. Total Production Overheads = Rs 1,67,400

Total Machine Hours = (720 x 4) + (600 x 2) + (480 x 2) + (502 x 2) = 6144 hrs

Production Overheads per Machine Hours = Rs 172,032/ 6144 = Rs 28

Thus, cost per unit in the present system :

	A	B	C	D
Direct Material	162	105	125	108
Direct Wages	70	75	60	80
Production Overheads	112	84	56	28
Total Cost	344	264	241	216

Production Run = No of Requisition = (720 + 600 + 480 + 504) / 24 = 96

No of orders = 2304 / 12 = 192

No of Requisitions = 50 x 4 = 200

Machine Operation Cost (Rs 94,500) will be distributed to Set Up, Stores and Inspection in the ratio of 4:3:2 . Thus their shares are : Rs 42,000, Rs 31,500, 21,000

Activities	Cost Driver	Cost per unit of Cost Driver
Set Up Cost (42,000 + 40,000) = Rs 82,000	96	Rs 854.17
Stores Receiving (31,500 + 15,000) = Rs 46,500	200	Rs 232.50
Inspection (21,000 + 10,000) = Rs 31,000	96	Rs 322.92
Material Handling Rs 12532	192	Rs 65.27

Thus, Cost of activities on the basis of Activity Costing :

	A	B	C	D
No of Unit	720	600	480	504
Production Run	30	25	20	21
No of Requisition	50	50	50	50
No Of Order	60	50	40	42

	A	B	C	D
Set up Cost	25625.10	21354.25	17083.40	17937.57
Stores Receiving	11625.00	11625.00	11625.00	11625.00
Inspection	9687.60	8073.00	6458.40	6781.32
Material Handling	3916.20	3263.50	2610.80	2741.34
Total	50853.90	44315.75	37777.60	39085.23
	70.63042	73.85958	78.70333	77.55006
Direct Material / Unit	162.00	105.00	125.00	108.00
Direct Labour / Unit	70.00	75.00	60.00	80.00
Overheads Per Unit	70.63	73.86	78.70	77.55
Total Cost /Unit According to ABC	302.63	253.86	263.70	265.55
Total Cost according to present system	344.00	264.00	241.00	216.00
Difference	+41.37	+10.14	-22.70	-49.55

The distribution of overhead under present system on an arbitrary basis distorts apportionment of overheads and thereby misleads calculation of costs of products and decision making. Cost of A & B are shown higher whereas in the case of C & D, costs are shown lower. Differences in cases of A & D are huge.

16. Average labour cost for first 50 units = Rs 100.00

Average labour cost for first 100 units = $0.90 \times 100 = \text{Rs } 90$

Average labour cost for first 200 units = $0.90 \times 90 = \text{Rs } 81$

Average labour cost for first 400 units = $0.90 \times 81 = \text{Rs } 72.90$

Average labour cost for first 800 units = $0.90 \times 72.90 = \text{Rs } 65.61$

We know that learning curve equation :

$$Y = ax^b$$

Where y = average time for producing x units

a = time spent on first unit / batch

b = co-efficient of learning curve

$$b = \frac{\log(1 - \% \text{ decrease})}{\log 2} = \frac{\log(1 - 0.10)}{\log 2} = \frac{-0.0458}{0.3010} = -0.15206$$

Thus, for 1000 units, batch = $1000/50 = 20$

$$Y = 100 \times 20^{-0.15206}$$

$$\log y = \log(100) - 0.15206(\log 20) = 2 - 0.15206 \times 1.3010 = 1.802172$$

Thus y = antilog (1.802172) = 63.41

Thus, average labour cost for 1000 units = Rs 63.41

Thus the price to be quoted :

	First 400 units (Rs)	First 800 units (Rs)	First 1000 unit (Rs)
Material @ Rs 150	60000	120000	150000
Labour Cost	29160	52488	63410
Overheads	20000	40000	50000
Total Cost	109160	212488	263410
Profit	27290	53122	65852
Price to be quoted	136450	265610	329262

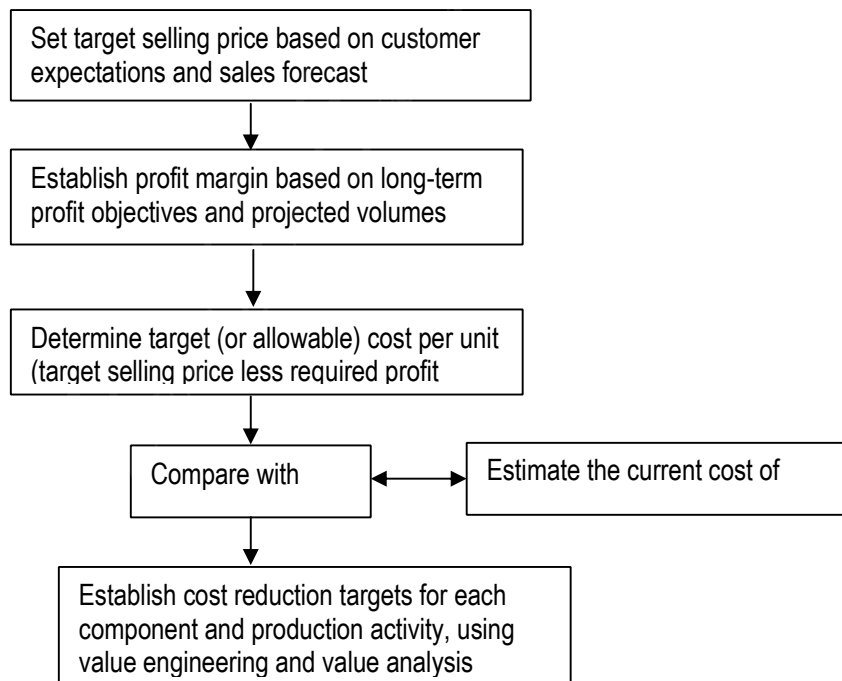
17. (a) Backflushing requires no data entry of any kind until a finished product is completed. At that time the total amount finished is entered into the computer system, which multiplies it by all the components listed in the bill of materials for each item produced. This yields a lengthy list of components that should have been used in the production process and which is subtracted from the beginning inventory balance to arrive at the amount of inventory that should now be left of hand. Back the entire production process. Given the large transaction volumes associated with JIT, this is an ideal solution to the problem.

The following problems must be corrected before it will work properly:

- (i) Production reporting
- (ii) Scrap reporting
- (iii) Lot tracing
- (iv) Inventory accuracy.

(b) **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.

Target Costing Process



18. (a) The total quality management is a set of concepts and tools for getting all employees focused on continuous improvement in the eyes of the customer. Quality is an important aspect of world-class manufacturing. The success of Japanese companies is grass rooted in their long-term commitment to improvement of quality. A world class manufacturing approach demands that the quality must be designed into product and the production process, rather than an attempt to remove poor

quality by inspection. This means that the objectives of quality assurance in a world-class-manufacturing environment, is not just reject defective product, but to systematically investigate the cause of defects so that they can be gradually eliminated. Though the goal is zero defect, the methodology is one of continuous improvement.

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) **Value chain** is the linked set of value creating activities from the basic raw materials and components sources to the ultimate end use of the product or service delivered to the customer.

The six business functions contained in the value chain are (i) Research and Development, (ii) Design (iii) Production (iv) Marketing (v) Distribution and (vi) Customer service.

Most corporations define their mission as one of creating products and services. In contrast, the other companies are acutely aware of the strategic importance of individual activities within their value chain, They are concentrating on those activities that allow them to capture maximum value for their customers and themselves.

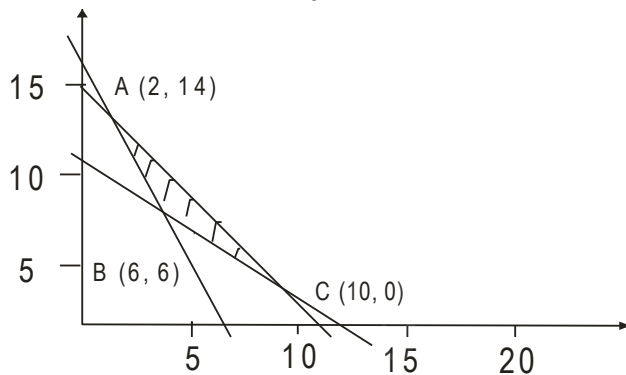
These firms use the value chain analysis approach to better understand which segments, distribution channels, price points. product differentiation. selling propositions and value chain configuration will yield them the greatest competitive advantage.

The way the value chain approach helps these organizations to assess competitive advantage includes the use of following steps of analysis.

- (i) **Internal cost analysis** - to determine the sources of profitability and the relative cost positions of internal value creating processes;
- (ii) **Internal differentiation analysis** - to understand the sources of differentiation with internal value-creating process; and
- (iii) **Vertical linkage analysis** - to understand the relationships and associated costs among external suppliers and customers in order to maximize the value delivered to customers and to minimize the cost.

The value chain approach used for assessing competitive advantages is an integral part of the strategic planning process. Like strategic planning, value chain analysis is a continuous process of gathering, evaluating and communicating information for business decision-making.

19. We solve the problem with graphical method.



Mathematical formulation of the problem :

$$\text{Maximize } Z = 50x_1 + 30x_2$$

Subject to constraints:

$$2x_1 + x_2 \geq 18$$

$$x_1 + x_2 \geq 12$$

$$3x_1 + 2x_2 \leq 34$$

Co-ordinate of extreme points

$$A (2, 14), B (6, 6), C (10, 2)$$

$$\text{At } A (2, 14), Z = 50 \times 2 + 30 \times 14 = 520$$

$$\text{At } B (6, 6), Z = 50 \times 6 + 30 \times 6 = 480$$

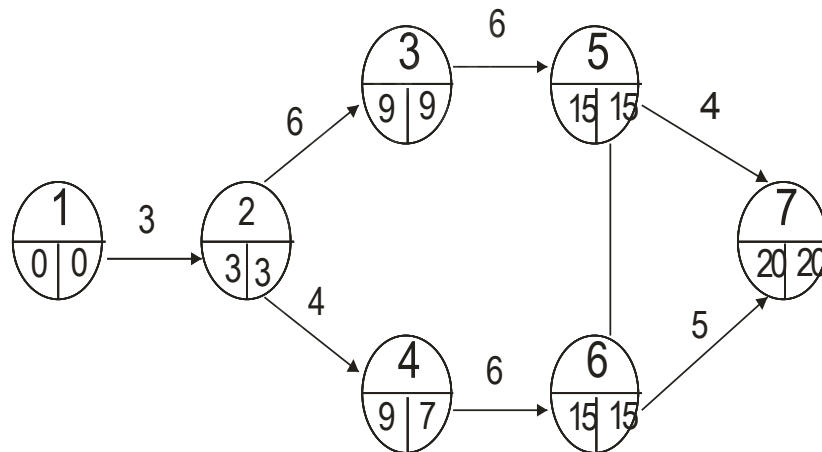
$$\text{At } C (10, 2), Z = 50 \times 10 + 30 \times 2 = 560$$

Thus solution is $x_1 = 10, x_2 = 2, \max Z = 560$

20. (a) Calculation of Expected time and variance of each activity.

Activity	t_0	t_m	t_p	$t_6 = \frac{1}{6}(t_0 + 4t_m + t_p)$	$a^2 = \frac{1}{6}(t_p - t_0)^2$
1-2	3	3	3	3	0
2-3	3	6	9	6	1
2-4	2	4	6	4	4/9
3-5	4	6	8	6	4/9
4-6	4	6	8	6	4/9
5-6	0	0	0	0	0
5-7	3	4	5	4	1/9
6-7	2	5	8	5	1

(b)



Critical path : 1 - 2 - 3 - 5 - 6 - 7

Expected project length = 20 weeks.

Variance in project = $\sigma^2 = 0 + 1 + 4/9 + 0 + 1 = 2.444$

(c) Probability that the project will be completed in 23 weeks

$$\begin{aligned}
 &= P\left(0 \leq Z \leq \frac{23 - 20}{\sqrt{2.444}}\right) \\
 &= P(0 \leq Z \leq 1.920) = 0.9726, \\
 &= 97.26\%
 \end{aligned}$$

21. Based on the given data, profit matrix is derived by the equation is drawn below :

$$\text{Profit} = \text{Sales price} - \text{production cost} - \text{raw material cost} - \text{transportation cost}$$

Warehouse	Profit (Rs. Per unit)					Dummy	Demand
	1	2	3	4			
A	6	6	11	15	0	80	
B	4	6	10	12	0	120	
C	6	4	7	6	0	150	
D	4	10	14	14	0	70	
E	8	8	7	9	0	90	
Supply	100	200	120	80	10	510	

Problem is on maximization of profit. We have to convert the same to minimization one by drawing an equivalent minimization of loss by subtracting all the profit values in the table from the highest profit value (i.e., 15). We apply Vogel's method to find the initial basic feasible solution as shown in table 3 below:

TABLE 3: INITIAL BASIC FEASIBLE SOLUTION – VAM

Warehouse	Plants					Demand
	1	2	3	4	Dummy	
A	9	9	4	0	15	80
B	11	9	5	3	15	120
C	9	11	8	9	15	150
D	11	5	1	1	15	70
E	7	7	8	6	15	90
Supply	100	200	120	80	10	510

Since the number of occupied cells are 8 which is one less than the required number $m + n - 1 = 9$, the solution is degenerate and after making an allocation of ϵ the cell (D, 4), the initial solution is tested for optimality in table 4 using MODI method.

TABLE 4: INITIAL SOLUTION – NON-OPTIMUM

Warehouse	Plants					Demand	u_i
	1	2	3	4	Dummy		
A	9	9	4	0	15	80	$u_1 = -7$
	7	5	4	80	7		
B	11	9	5	3	15	120	$u_2 = -2$
	4	70	50	•	2		
			(-)	-2	(+)		
C	9	11	8	9	15	150	$u_3 = 0$
	100	40	1	2	10		
D	11	5	1	1	15	70	$u_3 = -6$
	8	0	70	ϵ	6		
			(+)	(-)			
E	7	7	8	6	15	90	$u_3 = -4$
	4	90	5	3	4		
Supply	100	200	120	80	10	510	
v_j	$v_1 = 9$	$v_2 = 11$	$v_3 = 7$	$v_4 = 7$	$v_5 = 15$		

Since the cell (B, 4) has the negative opportunity cost (i.e., -2), it is admitted as an entering variable (cell) in the solution. On constructing closed loop or path, we find that ϵ units should be shipped from (B, 3) or (D, 4) to (B, 4). This yields the solution as given in table 5.

TABLE 5: REVUSED SOLUTION - IPTIMUM

Warehouse	Plants					Demand	u_i
	1	2	3	4	Dummy		
A	9	9	4	0	15	80	$u_1 = 6$
	5	3	2	5			
B	11	9	5	3	15	120	$u_2 = 9$
	4	70	50	ϵ	2		
C	9	11	8	9	15	150	$u_3 = 11$
	100	40	1	4	10		
D	11	5	1	1	15	70	$u_3 = 5$
	8	0	70	2	6		
E	7	7	8	6	15	90	$u_3 = 7$
	2	90	5	5	4		
Supply	100	200	120	80	10	510	
v_j	$v_1 = -2$	$v_2 = 0$	$v_3 = -4$	$v_4 = -6$	$v_5 = 4$		

Table 5 gives optimum solution.

Maximum Profit = $15 \times 80 + 6 \times 70 = 10 \times 50 + 6 \times 100 + 4 \times 40 + 14 \times 70 + 8 \times 90 = \text{Rs } 4580$

22. **Step 1:** The problem is for maximization of objective function. We have to convert it to a minimization one (is assignment algorithm is for minimization) of subtracting all elements from maximization element 31.

Salesman	Regions				
	R1	R2	R3	R4	R5
S1	5	17	21	19	22
S2	0	4	1	17	15
S3	16	13	15	6	1
S4	14	19	10	1	6
S5	11	12	6	15	21

Step 2: Row Subtraction.

Salesman	Machine				
	R1	R2	R3	R4	R5
S1	0	12	16	14	17
S2	0	4	1	17	15
S3	15	12	14	5	0
S4	13	18	9	0	5
S5	5	6	0	9	15

Step 3: Column subtraction & drawing straight lines to cut all 280 elements.

Salesman	Regions				
	R1	R2	R3	R4	R5
S1	0	8	16	14	17
S2	0	0	1	17	15
S3	15	8	14	5	0
S4	13	14	9	0	5
S5	5	0	0	9	15

Step 4: Since the number of lines are 5, the optimality criteria is satisfied.

Salesman	Regions				
	R1	R2	R3	R4	R5
S1	0	8	16	14	17
S2	0	0	1	17	15
S3	15	8	14	5	0
S4	13	14	9	0	5
S5	5	0	0	0	15

Optimum Salesman	Assignment Region	Sales
S1	R1	26
S2	R2	27
S3	R5	30
S4	R4	30
S5	R3	25
Total		138

23.

Table 1

Time to deal with clients

Time (min)	Probability	Cum Probability	Assigned numbers
2	0.05	0.05	00 – 04
4	0.10	0.15	05 – 14
6	0.15	0.30	15 – 29
10	0.30	0.60	30 – 59
14	0.25	0.85	60 – 84
20	0.10	0.95	85 – 94
30	0.05	1.00	95 – 99

Table 2:

Time between arrival

Time (min)	Probability	Cum Probability	Assigned numbers
1	0.2	0.2	00 – 19
8	0.4	0.6	20 – 59
15	0.3	0.9	60 – 89
25	0.1	1.0	90 – 99

Table 3 Work Sheet (time is minuty)

Client	Time between arrival (Table 2)	Arrival Time	In Time	Service Time (Table 1)	Out time	Waiting Time
1	1	1	1	14	15	-
2	8	9	15	14	29	6
3	8	17	29	14	43	12
4	15	32	43	10	53	11
5	15	47	53	6	59	6
6	8	55	59	6	65	4
7	25	80	80	14	94	-
8	8	88	94	10	104	6
9	8	96	104	14	118	8
10	15	111	118	4	122	7

For 10 Clients, service time = 122 mins = 2 hours 2 mins

40 clients can be served in a day of extended day of 8 hours and 8 minutes.

According to simulation in 6 days a week No. of clients may be served = 6 X 40 = 240.

24. At first Trend (T) is estimated by taking moving average for the period of 4 quarters. It is then eliminated from the original data by subtraction.

$$Y - T = (T + S + C + I) - T = S + C + I$$

When these 'deviation from trend' are averaged for each quarter, the cyclical (c) and irregular (I) components are removed to a large extent.

This leaves only seasonals (S), which are suitably adjusted.

Table 1 : Computation of Moving Averages (Trend)

Year & Quarter		Output '000 Tons	4 Quarters moving total	2 Period Moving Total of Lot 3	4 Quarterly Moving Average	Deviation
(1)		(2)	(3)	(4)	(5) = (4) ÷ 8	(6) = (2) – (5)
2006	I	74				
	II	76				
	III	74	304	616	77.00	- 3.00
	IV	80	312	616	77.00	3.00
2007	I	82	304	584	73.00	9.00
	II	68	280	542	67.75	0.25
	III	50	262	512	64.00	- 14.00
	IV	62	250	506	63.25	- 1.25
2008	I	70	256	532	66.50	3.50
	II	74	276	572	71.50	2.50
	III	70	296			
	IV	82				

Table 2 : Computation of Seasonal Variation (Additive Model)

Year	Deviation				Total
	I	II	III	IV	
2006			- 3.00	3.00	
2007	9.00	0.25	- 14.00	- 1.25	
2008	3.50	2.50			
Total	12.50	2.75	- 17.00	1.75	0
Average	6.25	1.375	- 8.50	0.875	0
Seasonal indices = Avg. – Grand Avg.	6.25	1.375	-8.50	0.875	0

Adjustment = Grand average with sign reversed.

Seasonal index = Average for each quarter + adjustment (Total of all seasonals = zero).

In additive model, seasonal indices S are subtracted. In multiplicative model, seasonal indices are used for deseasonalisation with the formula $\frac{Y}{S} \times 100$.

Table 3 : Computation of Deseasonalisation of time series data.

Year & Quarter (1)		Output '000 Tons (2)	Seasonal indices (3)	Deseasonalised Data (4) = (2) – (3)
2006	I	74	6.250	67.750
	II	76	1.375	74.625
	III	74	- 8.500	82.500
	IV	80	0.875	79.125
2007	I	82	6.250	75.750
	II	68	1.375	66.625
	III	50	- 8.500	58.500
	IV	62	0.875	61.725
2008	I	70	6.250	63.750
	II	74	1.375	72.625
	III	70	- 8.500	78.500
	IV	80	0.875	81.125

The significance of deseasonalisation of data is to take care of deviations due to variation of climate, change in season, festivals, custom etc.

25. Null Hypothesis $H_0 : p = 80\%$

$$n = 900$$

$$p = \text{portion of executives using company's briefcase} = 675 / 900 = 0.75$$

$$\text{Population proportion } P = 0.80$$

$$Z = (0.075 - 0.80) / \text{SE of } p$$

$$= -0.05 / \sqrt{(0.80 \times 0.20) / 900} = -(0.05 \times 30) / 0.4 = -1.5 / 0.4 = -3.75$$

Critical value of Z at 95% level of confidence = ± 1.96

As $|Z| > 1.96$, H_0 is rejected.