

PAPER – 5 : COST MANAGEMENT

QUESTIONS

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

1. Salabhi Arora, Sales Manager for Green Industries, has been asked by a potential foreign customer to sell 10,000 units of a certain gear for Rs. 100 per unit. Green normally sells this item for Rs. 150 per unit, but they have had some excess manufacturing capacity in recent months. It is anticipated that this would be a one-time order from this customer. The product unit cost report for this type gear is as follows:

	Rs.
Direct materials	30
Direct labour	25
Variable manufacturing overhead	12.50
Fixed manufacturing overhead	25
Variable selling and administrative expense	17.50
Fixed selling and administrative expense	<u>22.50</u>
Total per unit cost	<u>132.50</u>

After looking at the product cost report, Salabhi advises the customer as follows:

"I may not be an accountant, but I am smart enough to know that I will lose Rs. 32.50 per unit if I make this sale. Therefore, I must refuse your offer."

Required:

- From the list of costs in the product cost report, which costs would be relevant to the decision to sell at the special price ?
- What will be the amount of the total relevant cost per unit in regard to this order ?
- What would be the differential income (loss) to Green Industries if this order were accepted ?
- Are there any non-financial factors that you would consider in making this decision ?

Marginal Costing: CVP Analysis

2. Vikas Travel Agency (VTA) specializes in flights between Delhi to Bangalore. It books passengers on Dolphin Airlines at Rs. 9,000 per round-trip ticket. Until last month, Dolphin paid VTA as a commission of 10% of the ticket price paid by each passenger. This commission was VTA's only source of revenues. VTA's fixed costs are Rs. 1,40,000 per month (for salaries, rent and so on) and its variable costs are Rs. 200 per ticket

purchased for a passenger. This Rs. 200 includes Rs. 150 per ticket delivery fee paid to Senti Express. (Rs. 150 delivery fee applies to each ticket).

Dolphin Airlines has just announced a revised payment schedule for travel agents. It will now pay travel agents a 10% commission per ticket up to a maximum of Rs. 500. Any ticket costing more than Rs. 5,000 generates only a Rs. 500 commission, regardless of the ticket price.

Required:

- i. Under the old 10% commission structure, how many round-trip tickets must VTA sell each month (a) to break-even and (b) to earn an operating income of Rs. 70,000.
- ii. How does Dolphin revised payment schedule affect your answers to (a) and (b) in requirement (i) ?

Decision Making: Product Mix Decision

3. STC company currently manufactures 5000 units of product A per annum by making full use of the machine capacity. The data relating to the product are as under:

	Rs.	Rs. per unit
Selling price		1800
Direct material cost	400	
Variable machine costs (Rs.200 per machine hour)	300	
Manufacturing overheads	360	
Marketing & Administrative overheads	<u>400</u>	<u>1460</u>
Profit		<u>340</u>

The company can sell an additional 3000 units of product A by buying them on subcontract basis. An associate company has agreed to supply 6000 units of product A per year at a price of Rs.1300 per unit delivered at the company's factory. In that event the company can use the machine capacity to produce product B. The company can sell upto 12000 units of product B annually. The estimated cost per unit to produce and sell product B as above is as under:

	Rs.	Rs. per unit
Selling price		1200
Direct materials	400	
Variable machine costs Rs.(200 per machine hour)	100	
Manufacturing overheads	120	
Marketing & Administrative overheads	<u>220</u>	<u>840</u>
Profit		<u>360</u>

Additional Information:

The fixed manufacturing overheads amount to Rs.6 lacs per annum. These are absorbed on machine hour basis.

Variable marketing & administrative costs per unit are as under:

Manufactured product A	Rs.160
Purchased product A	Rs. 80
Manufactured product B	Rs.120

Fixed marketing & administrative costs for the year amount to Rs.12 lacs.

Required:

- (i) Calculate the quantity of each product the company should manufacture and/or purchase to maximise the profit.
- (ii) Compute the profit as per your decision in (i) above.

Decision Making: Marketing Decision

4. A company is organised into two processes. Raw material is introduced into Process A and its output becomes the raw material for Process B. The finished goods of Process B is sold in the market. Process A has a capacity to process an input of 200,000 kg. of raw material per annum. The normal scrap is 10% and 5% of input in Process A and Process B respectively. The realizable value of scrap is Re.1 and Rs.2 per kg. respectively for Processes A and B. The operating data for a year are as under:

	Process A	Process B
Direct Wages	Rs.22,00,000	21,00,000
Overheads	Rs.9,56,000	13,45,800

There are three suppliers of raw material whose price quotations and terms are as under:

Supplier	Price Rs./Kg.	Terms
P	10.00	Maximum quantity offered is Rs.1,20,000 kg.
Q	11.20	Maximum quantity offered is 1,60,000 kg.
R	11.00	If the entire quantity of 2,00,000 kg. is ordered. Otherwise, for any quantity less than 2,00,000 kg. the price charged is Rs.11.60 per kg.

In each case, the raw material is to be collected from the supplier's factory. The variable transport cost for bringing the raw materials is as under:

Supplier	P	Q	R
Variable transport cost per Kg.	Rs.1.20	1.00	1.00

The fixed transport cost will be Rs.2,00,000 per annum irrespective of the supplier from whom the raw material is purchased.

The output of the company emerging from Process B can be sold to three customers at the prices and terms given below:

Customer	Price Rs. /Kg.	Discount	Condition
K	65.00	2%	Maximum quantity acceptable to K is 80,000 Kg.
L	64.00	2%	Maximum quantity acceptable to L is 1,60,000 Kg.
M	61.80	—	Provided the entire production of the company is sold to M

In the case of customers K and L, fixed delivery costs of Rs.5,000 in total per month will be incurred. The variable delivery costs in respect of customers K and L respectively are Rs.2.60 and Rs.1.44 per Kg. Customer M will collect the output from the company's factory at his own cost.

- You are required to indicate with supporting calculations the choice of (a) suppliers and (b) customers.
- Based on your recommendation in (i) above, prepare a statement showing the process wise costs and profit of the company for the year.

Standard Costing and Variance Analysis

- ABC Ltd. uses flexible budgets and standard costing for its single product PCM 30 produced at its factory at Solan. The following details relate to a particular months 'Actual' & also provide brief details of 'Standards' established,

Standard Quantity required for producing 1 unit of PCM 30	3 Kgs
Standard cost of the raw material	Rs 4.40 per kg
Cost of actual material purchased and used in the relevant month	Rs 3,36,000
Actual price paid for the raw material in the relevant month	Rs 4.20 per kg
Standard labour time required to produce 1 unit of PCM 30	30 minutes
Standard wage rate	Rs 5 per hour
Actual wage rate	Rs 5.40 per hour

Sufficient direct labour time, equivalent for producing 28,000 units of PCM 30 was utilised, although the actual production in the relevant month was only 25,000 units.

The company has a normal operating capacity of 15,000 hours per month and flexible overhead budgets are:

Hours of operation	12,500	14,000	15,000
Variable production overhead	Rs.1,50,000	Rs. 1,68,000	Rs. 1,80,000
Fixed production overhead	2,70,000	2,70,000	2,70,000
Total	4,20,000	4,38,000	4,50,000

Actual fixed overheads incurred did not deviate from the budgeted amounts . However, the variable overheads incurred amounted to Rs 1,60,000 in the concerned month.

You are required to:

- calculate the appropriate variances for material, labour and overhead;
- show the variances in a statement suitable for presentation to management, reconciling the standard cost with the actual cost of production.

Standard Costing and Variance Analysis

- A company using a standard costing system furnishes the following statement showing the details relating to a month.

	Budget	Actual
Product and sales volume in units	10000	9000
Selling price per unit	Rs.60.00	61.50
Costs for the month:		
Direct materials	Rs.2,50,000	2,57,400
Direct wages	Rs.2,25,000	2,20,500
Variable overheads	Rs.10,000	9,250
Fixed overheads	Rs.25,000	23,240
Direct labour hours	50,000	42,000
Per unit data:		
Direct materials kg/unit	25	26
Direct materials price/ kg	Rs.1.00	1.10
Direct labour hours / unit	5	4.5
Direct labour rate / hour	Rs.4.50	5.25

You are required to compute all variances and reconcile the budgeted profit with actual profit.

Pricing Decisions: Pricing Policies

- (a) Firm A charges Rs. 100 for one unit of its Product 'Y'. Firm B, produces a similar

product as firm A, sets its product price at Rs. 99 on the consideration of what firm A is charging in the market. Name the pricing policy followed by the firm B and write a short note on it.

- (b) Write short note on (i) Going rate pricing and (ii) Sealed bid pricing

Pricing Decisions: Pareto Analysis

8. The following information of manufacture and sale is obtained from the records of Vee Aar Ltd. for the 12 months ending 31.12.2008:

Product	Contribution (Rs.)
A	500
B	200
C	1,500
D	75
E	100
F	<u>125</u>
Total	<u>2,500</u>

You are required to prepare a Pareto product contribution chart and comment on the results.

Costing of Service Sector

9. Red Jet Airline company operates a single aircraft from station A to Station B. It is licensed to operate 3 flights in a week each way thereby making a total of 312 flights in a year. While the seating capacity of the aircraft is 160 passengers, the average number of passengers actually carried per flight is 120 only. The fare charged per passenger for one way flight is Rs.8000. The cost data are as under:

- Variable ATF costs per flight Rs.1,60,000
- Food served on board the flight (not charged to passengers) Rs.200 per passenger
- Commission paid to travel agents (on an average 80% of the seats are booked through travel agents) 5% of fare
- Fixed annual lease costs allocated to each flight Rs.400000 per flight
- Fixed ground and landing charges Rs.100000 per flight
- Fixed salaries of flight crew allocated to each flight Rs.60000 per flight

Required:

- (i) Compute the operating income on each one-way flight between stations A and B.
- (ii) The company has been advised that in case the fare is reduced to Rs.7500 per flight per passenger, the average number of passengers per flight will increase to 132. Should this proposal be implemented? Show your calculations.

Transfer Pricing

10. L Ltd. and M Ltd. are subsidiaries of the same group of companies. L Ltd. produces a branded product sold in drums at a price of Rs. 20 per drum.

Its direct product costs per drum are:

Raw material from M Ltd.: At a transfer price of Rs. 9 for 25 litres.

Other products and services from outside the group: At a cost of Rs. 3.

L Ltd.'s fixed costs are Rs. 40,000 per month. These costs include process labour whose costs will not alter until L Ltd.'s output reaches twice its present level.

A market research study has indicated that L Ltd.'s market could increase by 80% in volume if it were to reduce its price by 20%.

M Ltd. produces a fairly basic product, which can be converted into a wide range of end products. It sells one third of its output to L Ltd. and the remainder to customers outside the group.

M Ltd.'s production capacity is 10,00,000 kilolitres per month, but competition is keen and it budgets to sell no more than 7,50,000 kilolitres per month for the year ending 31 December.

Its variable costs are Rs. 0.20 per Kilolitre and its fixed costs are Rs. 60,000 per month.

The current policy of the group is to use market prices, where known, as the transfer price between its subsidiaries. This is the basis of the transfer prices between M Ltd. and L Ltd.

You are required to calculate

- (a) the monthly profit position for each of L Ltd. and M Ltd. if the sales of L Ltd. are
 - (i) at their present level, and
 - (ii) at the higher potential level indicated by the market research, subject to a cut in price of 20%.
- (b) (i) Explain why the use of a market price as the transfer price produces difficulties under the conditions outlined in (a) (ii) above;
- (ii) Explain briefly, as Chief Accountant of the group, what factors you would consider in arriving at a proposal to overcome these difficulties.

Target Costing

11. You are the manager of a paper mill (XYZ Ltd) and have recently come across a particular type of paper, which is being sold at a substantially lower rate (by another company –ABC Ltd) than the price charged by your own mill. The value chain for one use of one tonne of such paper for ABC Ltd is as follows,

ABC Ltd. —————> Merchant —————> Printer —————> Customer

ABC Ltd sells this particular paper to the merchant at the rate of Rs 1,466 per tonne. ABC Ltd pays for the freight which amounts to Rs 30 per tonne. Average returns and allowances amount to 4% of sales and approximately equals Rs 60 per tonne.

The value chain of your company, through which the paper reaches the ultimate customer is similar to the one of ABC Ltd. However, your mill does not sell directly to the merchant, the latter receiving the paper from a huge distribution center maintained by your company at Haryana. Shipment costs from the mill to the Distribution Center amount to Rs 11 per tonne while the operating costs in the Distribution Center have been estimated to be Rs 25 per tonne. The return on investments required by the Distribution Center for the investments made amount to an estimated Rs 58 per tonne.

You are required to compute the “Mill manufacturing Target Cost” for this particular paper for your company. You may assume that the return on the investment expected by your company equals Rs 120 per tonne of such paper.

Life Cycle Costing: Introduction and Benefits

12. What is 'Product life cycle costing'? What are the benefits of product life cycle costing?

Material Requirement Planning: Introduction and Operation

13. What is 'Material Requirement Planning'? What are the core data requirements for operating a Material Requirement Planning?

Activity Based Costing

14. Apna Bazar has decided to increase the size of its store. It wants information about the profitability of individual product lines, soft drinks, fresh produce and packaged food. Apna Bazar provides following data for 2008 for each product line:

	Soft Drinks	Fresh Produce	Packaged Food
Revenues	Rs. 3,17,400	Rs. 8,40,240	Rs. 4,83,960
Cost of goods sold	Rs. 2,40,000	Rs. 6,00,000	Rs. 3,60,000
Cost of bottles returned	Rs. 4,800	0	0
Number of purchase orders placed	144	336	144

Number of deliveries received	120	876	264
Hours of shelf-stocking time	216	2,160	1,080
Items sold	50,400	4,41,600	1,22,400

Apna Bazaar also provides the following information for 2008:

Activity (1)	Description of Activity (2)	Total Costs (3)	Cost-Allocation Base (4)
		Rs.	
1. Bottle returns	Returning of empty bottles to store	4,800	Direct tracing to soft-drink line
2. Ordering	Placing of orders for purchases	62,400	624 purchase orders
3. Delivery	Physical delivery and receipt of merchandise	1,00,800	1,260 deliveries
4. Shelf-stocking	Stocking of merchandise on store shelves and ongoing restocking	69,120	3,456 hours of shelf-stocking time
5. Customer support	Assistance provided to customers, including checkout and bagging	1,22,880	6,14,400 items sold
Total		<u>3,60,000</u>	

Required:

- Apna Bazaar currently allocates store support costs (all costs other than cost of goods sold) to product lines on the basis of cost of goods sold of each product line. Calculate the operating income and operating income as a percentage of revenues for each product line.
- If Apna Bazaar allocates store support costs (all costs other than cost of goods sold) to product lines using an ABC system, calculate the operating income and operating income as a percentage of revenues for each product line.
- Comment on your answers in requirements 1 and 2.

Total Quality Management

- TQ Ltd. implemented a quality improvement programme and had the following results:

	2007	2008
	(Figures in Rs. '000)	
Sales	6,000	6,000
Scrap	600	300
Rework	500	400
Production inspection	200	240
Product warranty	300	150
Quality training	75	150
Materials inspection	80	60

You are required to:

- (i) Classify the quality costs as prevention, appraisal, internal failure and external failure and express each class as a percentage of sales.
- (ii) Compute the amount of increase in profits due to quality improvement.

Value Chain Analysis: Definition and Competitive Advantage

16. (a) Define the Term Value Chain .
- (b) How can Value Chain Analysis be used to assess competitive advantage.

Budgetary Control: Preparation of Budgets

17. RNRB Company's budgeted unit sales for the year 2008 were:

Bike tyres	60,000
Bus tyres	12,500

The budgeted selling price for Bus tyres was Rs. 15,000 per tyre and for Bike tyres was Rs. 4,500 per tyre. The beginning finished goods inventories were expected to be 2,500 Bus tyres and 6,000 Bike tyres, for a total cost of Rs. 2,00,25,500, with desired ending inventories at 2,000 and 5,000, respectively, with a total cost of Rs. 1,63,23,900. There was no anticipated beginning or ending work in process inventory for either type of tyre.

The standard materials quantities for each type of tyre were as follows:

	Bus	Bike
Rubber	35 lbs.	15 lbs.
Steel belts	4.5 lbs.	2.0 lbs.

The purchase prices of rubber and steel were Rs. 150 and Rs. 100 per pound, respectively. The desired ending inventories for rubber and steel were 60,000 and 6,000 pounds, respectively. The estimated beginning inventories for rubber and steel were 75,000 and 7,500 pounds, respectively.

The direct labour hours required for each type of tyre were as follows:

	Molding Department	Finishing Department
Bus tyre	0.20	0.10
Bike tyre	0.10	0.05

The direct labour rate for each department is as follows:

Molding Department	Rs. 650 per hour
Finishing Department	Rs. 750 per hour

Budgeted factory overhead costs for 2008 were as follows:

	Rs.
Indirect materials	85,28,000
Indirect labour	79,40,000
Depreciation of building and equipment	49,16,000
Power and light	<u>63,00,000</u>
Total	<u>2,76,84,000</u>

Required:

Prepare each of the following budgets for RNRB for the year ended 2008:

- (i) Sales budget
- (ii) Production budget
- (iii) Direct material budget
- (iv) Direct labour budget
- (v) Factory overhead budget
- (vi) Cost of goods sold budget.

Budgetary Control: Preparation of Budgets

18. The sales manager of XYZ Ltd bases his sales budget for 2008 on sales of 10,000 tons of castings at Rs 2,500 per ton and submits it to you , in your capacity as CFO of the company. The production manager, however, tells you that his normal capacity is for 8,000 tons only.

Data for the 2008-operating budget for 8,000 tons have been prepared as follows:

	Rs	Rs
Sales 8,000 tons @Rs 2,500 per ton		2,00,00,000
Expenses		

Raw materials(all variable)	30,00,000	
Direct wages(all variable)	1,20,00,000	
15,00,000 hours@ Rs 8 per hour		
Production overheads(50% fixed)	14,00,000	
Administrative overheads(all fixed)	6,00,000	
Selling and distribution(80% fixed)	10,00,000	1,80,00,000
Sales less Expenses		20,00,000

The production manager suggests three ways in which production could be increased to 10,000 tons:

- subcontracting the production of 2,000 tons to a competitor whose price would be Rs 2,050 per ton;
- introduction of an additional shift, providing 4,00,000 extra direct labour hours at an estimated cost of Rs 10 per hour, without increase in fixed production overhead costs;
- the provision of additional plant to increase normal working capacity , which would involve an increase of Rs 2,70,000 in fixed production overheads for the year but no alteration to the variable expense rate per ton.

In each instance there would arise additional non production fixed overhead costs in respect of :

Administration	Rs 1,00,000
Selling and distribution	Rs 2,00,000

Required

- Prepare a statement of sales, costs and profit to be expected from each of the three ways of increasing production.
- Prepare a revised operating budget, in final form for presentation to management, based on your choice of action.

Budgetary Control: Budget Ratios

- What are 'Budget Ratios'? Which ratios are usually used by the management to measure development from the budget? Give example.

Linear Programming

- A firm plans to purchase at least 200 quintals of scrap contain high quality metal X and low quality metal Y. If decides that the scrap to be purchased must contain at least 100 quintals of X-metal and not more than 35 quintals of Y-metal. The firm can purchase the scrap from two suppliers (A and B) in unlimited quantities. The percentage of X and Y metals in terms of weight in the scraps supplied by A and B in given below:

Metals	Supplier A	Supplier B
X	25%	75%
Y	10%	20%

The price of A's scrap is Rs. 200 per quintal and that of B's is Rs. 400 per quintal. Formulate this problem as LP model and solve it to determine the quantities that the firm should buy from the two suppliers so as to minimize total purchase cost.

The Assignment Problem

21. 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			
	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.

The Assignment Problem

22. A car hire company has one car at each of 5 depots a, b, c, d and e. A customer in each of the 5 towns A, B, C, D and E requires a car the distance (in miles) between the depots (origins) and the towns (destination) where the customers are (is given in the following distance matrix).

	a	b	c	d	E
A	160	130	175	190	200
B	135	120	130	160	175
C	140	110	125	170	185
D	50	50	80	80	110
E	55	35	80	80	105

How should the cars be assigned to the customer so as to minimize the distance travelled.

Transportation Problem

23. Solve the following Transportation Problem.

5	4	8	6	5	600
4	5	4	3	2	400
5	6	5	8	4	1000
450	400	200	350	300	

Critical Path Analysis & PERT

24. A project has the following time schedules:

Activity	Time in Weeks
1-2	2
1-3	2
1-4	1
2-5	4
3-6	8
3-7	5
4-6	3
5-8	1
6-9	5
7-8	4
8-9	3

Construct PERT network and compute

- Total float for each activity and
- Critical path and its duration.

Critical Path Analysis & PERT

25. The required data for a small project consisting different activities are given below:

Activity	Dependence	Normal duration (days)	Normal Cost (Rs.)	Crash duration (days)	Crash cost (Rs.)
A	—	6	300	5	300
B	—	8	400	6	600

C	A	7	400	5	600
D	B	12	1000	4	1400
E	C	8	800	8	800
F	B	7	400	6	500
G	D, E	5	1000	3	1400
H	F	8	500	5	700

- (i) Draw the network and find out the normal project length and minimum project length.
- (ii) If the project is to be completed in 21 days with minimum cost which activities should be crashed by how many days ?

SUGGESTED ANSWERS/HINTS

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

- 1 (i) The relevant costs in this case are the ones that will change if the special order is accepted. These include the variable costs, which are:
Direct materials
Direct labour
Variable manufacturing overhead
Variable selling and administrative expenses*
*Some of the usual variable selling and administrative expenses may not be incurred if the special order is accepted, because the customer came to Salabhi unsolicited. For the remainder of this solution, the assumption is that all of this expense is relevant.
- (ii) The additional costs that will be incurred per unit if the special order is accepted are as follows:

	Rs.
Direct materials	30
Direct labour	25
Variable manufacturing overhead	12.50
Variable selling and administrative expense	<u>17.50</u>
Total per unit relevant cost	<u>85.00</u>

- (iii) To determine the differential profit (loss) to the company if the order is accepted, the differential (additional) revenue from the order must be compared to the differential (additional) costs that will be incurred if the order is accepted. The differential revenue is computed as follows:

$$10,000 \text{ units} \times \text{Rs. } 100 / \text{unit} = \text{Rs. } 10,00,000$$

The differential costs consist of the Rs. 85 of variable costs per unit that will only be incurred if the order is accepted:

$$10,000 \text{ units} \times \text{Rs. } 85 / \text{unit} = \text{Rs. } 8,50,000$$

To compute the differential income (profit), the differential revenue must be compared to the differential costs:

	Rs.
Differential revenue	10,00,000
Differential costs	<u>8,50,000</u>
Differential income	<u>1,50,000</u>

- (iv) Non-financial factors to be considered include whether:

- (a) the excess capacity is sufficient to produce the 10,000 units without taking away from the manufacture of units that can be sold at full price;
- (b) this selling price will become known to regular customers who then will demand a similar price;
- (c) this will be a one-time order or if this customer will be a source of future business, thus demanding the same price breaks on follow-up orders.

Marginal Costing: CVP Analysis

- 2 (i) Vikas receives a 10% commission on each ticket: $10\% \times 9,000 = \text{Rs. } 900$, thus,

$$\text{Selling price} = \text{Rs. } 900 \text{ per ticket}$$

$$\text{Variable cost per unit} = \text{Rs. } 200 \text{ per ticket}$$

$$\text{Contribution margin per unit} = \text{Rs. } 900 - \text{Rs. } 200 \text{ per ticket} = \text{Rs. } 700 \text{ per ticket}$$

$$\text{Fixed costs} = \text{Rs. } 1,40,000 \text{ per ticket.}$$

$$(a) \text{ Break-even number of tickets} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}} = \frac{\text{Rs. } 1,40,000}{\text{Rs. } 700 \text{ per ticket}} = 200 \text{ tickets}$$

- (b) When target operating income = Rs. 70,000 per month:

$$\begin{aligned} \text{Quantity of tickets required to be sold} &= \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per unit}} = \frac{\text{Rs. } 1,40,000 + \text{Rs. } 70,000}{\text{Rs. } 700 \text{ per ticket}} \\ &= \frac{\text{Rs. } 2,10,000}{\text{Rs. } 700 \text{ per ticket}} = 300 \text{ tickets.} \end{aligned}$$

- (ii) Under the new system, Wembley would receive only Rs. 500 on the Rs. 9,000 per ticket. Thus,

Selling price	= Rs. 500 per ticket
Variable cost per unit	= Rs. 200 per ticket
Contribution margin per unit	= Rs. 500 – Rs. 200 = Rs. 300 per ticket
Fixed costs	= Rs. 1,40,000 per month

$$(a) \text{ Break - even number of tickets} = \frac{\text{Rs. 1,40,000}}{\text{Rs. 300 per ticket}} = 467 \text{ tickets (rounded up)}$$

$$(b) \text{ Quantity of tickets required to be sold} = \frac{\text{Rs. 2,10,000}}{\text{Rs. 300 per ticket}} = 700 \text{ tickets}$$

The Rs. 500 cap on the commission paid per ticket causes the break-even point to more than double (from 200 to 467 tickets) and the tickets required to be sold to earn Rs. 70,000 per month to also more than double (from 300 to 700 tickets). As would be expected, travel agents reacted very negatively to the Dolphin Airlines decision to change commission payments.

Decision Making: Product Mix Decision

3. Working note:

Computation of variable and fixed manufacturing overhead per unit :

Products	A	B
Variable machine costs per unit (Rs.)	300	100
Rate per hour (Rs.)	200	200
Machine hour per unit	1.5	0.5
Present machine capacity (in hours) (5,000 units of A x 1.5 hours)	7,500	—

Fixed manufacturing overheads (Rs.)	6,00,000
Total machine capacity hours	7,500
Fixed Manufacturing overhead per machine hour (Rs.) (Rs.6,00,000 / 7,500 hours)	80

Fixed manufacturing overhead:

Cost per unit

A – 1.5 hours x Rs.80	120
B – 0.5 hours x Rs.80	40

Variable manufacturing cost per unit:

A – (Rs.360 – Rs.120)	240
B – (Rs.120 – Rs.40)	80

(i) Decision to make or buy A :

	Make	Buy
Selling price (per unit) : Rs. (I)	<u>1,800</u>	<u>1,800</u>
Variable costs:		
Direct materials: (Rs)	400	
Variable machine costs	300	
Variable marketing and administration overheads	160	80
{(5000 units x Rs.400 – Rs.12,00,000) / 5000 units}		
Buying cost		1300
Variable manufacturing overheads	<u>240</u>	
Manufacturing and Buying cost: II	<u>1,100</u>	<u>1,380</u>
Contribution per unit : (Rs.) (I – II)	700	420
Ranking	1	2

Based on the above computation, it is clear that the company should make the product A

Comparison making of A and B:

Products	A	B
Selling price per unit: (Rs) : I	<u>1,800</u>	<u>1,200</u>
Variable costs:		
Direct materials: (Rs)	400	400
Variable machine costs: (Rs)	300	100
Variable manufacturing overheads: (Rs)	240	80
(Refer to working note)		
Variable marketing and administration overheads: (Rs)	160	120
Total variable costs : (Rs) : II	<u>1,100</u>	<u>700</u>
Contribution: (Rs) : (I – II)	700	500

Machine hours per unit	1.5	0.5
Contribution per hour (Rs)	466.67	1,000
	(Rs.700 / 1.5 hours)	(Rs 500 / 0.5 hours)
Ranking	2	1

Based on the above computation, it is clear that the firm should utilize its machine hour capacity for making 12,000 units of product B, which would utilize 6,000 machine hours. The remaining 1,500 hours should be utilized for making 1,000 units of product A. In order to maximize profit the concern should buy 6,000 units from outside to meet the market demand. The required product mix thus would be:

(ii) Product Mix :

Product mix		Units	Contribution / unit Rs.	Total contribution Rs.
Manufacture	B	12,000	500	60,00,000
Manufacture	A	1,000	700	7,00,000
Purchase	A	6,000	420	<u>25,20,000</u>
Total contribution				92,20,000
Less: Total fixed costs				<u>18,00,000</u>
Profit				<u>74,20,000</u>

Decision Making : Marketing Decision

4. (i) (a) Purchases:

	P	Q	R	
	Upto	Upto	Any	Equal to
	1,20,000 kg	1,60,000 kg	quantity	2,00,000 kg.
Price (Rs.)	10.00	11.20	11.60	11.00
Variable transport cost (Rs.)	<u>1.20</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
Total	<u>11.20</u>	<u>12.20</u>	<u>12.60</u>	<u>12.00</u>

Plan I	Quantity (kgs.)	1,20,000	80000	
	Cost (Rs.)	13,44,000	9,76,000	Total 23,20,000
Plan II	Quantity (kgs.)			2,00,000
	Cost (Rs.)			24,00,000

Plan I being lesser in cost therefore it should be adopted, buy 1,20,000 kg from P and 80,000 kg from Q.

Fixed transport cost being constant is not relevant to the decision.

(b)		Kg.
Production	Process A Input	2,00,000
	Loss 10%	<u>20,000</u>
	Output	1,80,000
	Process B Loss 5%	<u>9,000</u>
	Final output	<u>1,71,000</u>

Sales	K	L	M
	Upto	Upto	1,71,000 kg
	80,000 kg	1,60,000 kg	
Selling Price Rs.	65.00	64.00	61.80
Discount 2%	<u>1.30</u>	<u>1.28</u>	—
Net selling price	63.70	62.72	61.80
Transport (V)	<u>2.60</u>	<u>1.44</u>	—
Net realization	<u>61.10</u>	<u>61.28</u>	<u>61.80</u>

Plan I sell quantity	1,71,000 kg to M	Sales Revenue (Rs.)	1,05,67,800
Plan II sell quantity	(kgs.)11,000 to K	1,60,000 to L	
	(Rs.) 6,72,100	98,04,800	1,04,76,900
Fixed delivery charges	Rs. 5,000 × 12		<u>60,000</u>
			<u>10,41,6,900</u>

Since sales realisation is greater on selling to M, entire quantity should be sold to M

(ii) Costs & profit statement

Process A	Kg	
Raw materials	2,00,000	23,20,000
Fixed transport		2,00,000
Wages		22,00,000
Overheads		<u>9,56,000</u>
Total		56,76,000
Sale of scrap	<u>20,000 @ 1/-</u>	<u>(20,000)</u>
Net cost	<u>1,80,000</u>	<u>56,56,000</u>

Process B		
Process A	1,80,000	56,56,000
Wages		21,00,000
Overheads		<u>13,45,800</u>
Total	1,80,000	91,01,800
Sale of scrap	<u>9,000 @ 2/-</u>	<u>(18,000)</u>
Net cost	1,71,000	90,83,800
Net sales		<u>1,05,67,800</u>
Profit (Rs.)		<u>14,84,000</u>

Standard Costing and Variance Analysis

5. (i) Standard Variable Overhead rate = Rs. 1,80,000 ÷ 15,000 = Rs. 12 per hr.

Standard Fixed Overhead rate = 2,70,000 ÷ 15,000 = Rs.18 per hr.

Material Variances (Actual Production : 25,000 Units)

Std Qty of RM /FG	Std Price of RM/kg	Std Qty of RM on Actual Production	Actual Qty of RM on Actual Production	Actual Price paid for RM	Usage Variance(Rs)	Price Variance(Rs)
(a)	(b)	(c)	(d)	(e)	(c – d) × b	(b – e) × d
3 kg	Rs 4.40	75,000 kgs	80,000	Rs 4.20	(22,000)	16,000

Labour Variances

St time / FG	Std rate per hour	Std time on Actual Production	Actual time on Actual Production	Actual rate per hour	Efficiency Variance(Rs)	Rate Variance(Rs)
(a)	(b)	(c)	(d)	(e)	(c – d) × b	(b – e) × d
30 min	Rs 5	12,500 hrs	14,000 hrs	Rs 5.4	(7,500)	(5,600)

Variable Overhead Variances

Actual variable overhead = Rs. 1,60,000 (a)

(Rs. 4,30,000 – Rs. 2,70,000)

Standard Variable Overhead for actual labour hrs. worked = Rs. 1,68,000 (b)

(28,000 × 0.5 hr × Rs. 12)

Standard Variable Overhead for actual production = Rs. 1,50,000 (c)

(25,000 units × 0.5 hr × Rs. 12)

Variable Overhead Expenditure Variance	= (a) – (b)
	= Rs. 1,60,000 –Rs. 1,68,000
	= Rs. 8,000 (F)
Variable Overhead Efficiency Variance	= (b) – (c)
	= Rs. 1,68,000 –Rs. 1,50,000
	= Rs. 18,000 (A)

Fixed Overhead Variances

Actual fixed overhead incurred	= Rs. 2,70,000 (a)
Budgeted Fixed Overhead	= Rs. 2,70,000 (b)
Expenditure Variance	= (a) – (b) = Nil
Budgeted production	= 30,000 Units
Actual production	= 25,000 Units
Unutilised capacity	= 5,000 Units or 2,500 Hrs
Production volume variance	Unutilised capacity x standard fixed overhead rate
	= 2,500 Hrs × Rs 18 per hr
	= Rs 45,000(A)

(ii) Reconciliation

Standard Cost (25,000×Rs. 30.70)		7,67,500
Variances		
Materials	FavourableAdverse	
Price	Rs. 16,000	
Usage	Rs. 22,000	
Labour		
Rate	5,600	
Efficiency	7,500	
Variable OH		
Expenditure	8,000	
Efficiency	18,000	
Fixed OH.		
Expenditure	-	
Volume	45,000	74,100(A)
Actual cost		8,41,600

Standard Costing and Variance Analysis

6. Computation of material variances:

Standard data for actual output			Actual output 9,000 units Actual data		
Qty kgs	S.P per kg	Amount Rs.	Qty kgs	Actual Price per kg	Amount Rs.
2,25,000	1	2,25,000	2,34,000	1.10	2,57,400

Material cost variance :

$$= (S.C - A.C) = \text{Rs.} 2,25,000 - \text{Rs.} 2,57,400 = \text{Rs.} 32,400 \text{ (A)}$$

Material price variance:

$$= (S.P - A.P) A.Q = (1 - 1.10) 2,34,000 = \text{Rs.} 23,400 \text{ (A)}$$

Material usage variance:

$$= (S.Q - A.Q) S.P = (2,25,000 - 2,34,000) \text{ Re.} 1 = \text{Rs.} 9,000 \text{ (A)}$$

Computation of labour variances:

Standard data for actual profit				Actual output 9,000 units Actual data			
Std hours	Std rate per hour	Amount Rs.	Actual hours	Production hours	Idle time hrs	Rate per hour Rs.	Amount Rs
45000	4.50	2,02,500	42,000	40,500	1,500	5.25	2,20,500

Labour cost variance :

$$= (S.C - A.C) = (\text{Rs.} 2,02,500 - \text{Rs.} 2,20,500) = \text{Rs.} 18,000 \text{ (A)}$$

Labour rate variance:

$$= (S.R - A.R) A.H = (4.50 - 5.25) 42,000 = \text{Rs.} 31,500 \text{ (A)}$$

Labour efficiency variance:

$$= (S.H - \text{Actual production hrs}) S.R = (45,000 - 40,500) 4.50 = \text{Rs.} 20,250 \text{ (F)}$$

Idle time variance

$$= \text{Idle time hours} \times \text{standard rate per hour}$$

$$= 1,500 \text{ hours} \times \text{Rs.} 4.50$$

$$= \text{Rs.} 6,750 \text{ (A)}$$

Computation of Fixed overhead variances:

Budgeted / Standard data		Actual data	
Budgeted overheads (Rs)	25,000	Fixed overheads (Rs)	23,240
Budgeted output (units)	10,000	Actual output (units)	9,000
Budgeted (hours)	50,000	Actual production (hours)	40,500
		Idle hours	1,500
Standard rate per unit	Rs.2.5		
Standard rate per hour	0.50		
Standard time per unit	5 hours		

Total fixed overhead cost variance:

$$= \{ \text{Fixed overhead recovered on actual output} - \text{Actual fixed overhead incurred} \}$$

$$= \{ 9,000 \times \text{Rs.2.50} - \text{Rs.23,240} \} = \text{Rs.740 (A)}$$

Expenditure variance:

$$= [\text{Budgeted fixed overheads} - \text{Actual fixed overheads}]$$

$$= [\text{Rs.25,000} - \text{Rs.23,240}] = \text{Rs.1,760 (F)}$$

Volume variance:

$$= [\text{Budgeted volume} - \text{Actual volume}] \text{ Std. rate per unit}$$

$$= (10,000 - 9,000) \text{ Rs.2.50} = \text{Rs.2,500 (A)}$$

Efficiency variance:

$$= (\text{Standard hours for actual output} - \text{Actual production hours}) \text{ Std rate per hour}$$

$$= (45,000 \text{ hours} - 40,500 \text{ hours}) 0.50 = \text{Rs.2,250 (F)}$$

Capacity variance:

$$= (\text{Budgeted hours} - \text{Actual hours}) \text{ Std rate per hour}$$

$$= (50,000 \text{ hours} - 42,000 \text{ hours}) 0.50 = \text{Rs.4,000 (A)}$$

Idle time variance:

$$= \text{Idle time hours} \times \text{Std rate per hour}$$

$$= 1,500 \text{ hours} \times 0.50 = \text{Rs.}7.50 \text{ (A)}$$

Computation of variable overhead variances:

Budgeted / Standard data		Actual data	
Budgeted variable overheads for actual production hours (Rs)	8,100	Actual variable overheads (Rs)	9,250
		Actual output (units)	9,000
		Actual production (hours)	40,500
Standard hours per unit		5	
Standard variable overhead rate per hour (Rs.)		0.20	
Standard variable overhead rate per unit		Re.1	

Total variable overhead cost variance:

$$= (\text{Variable overhead recovered on actual output} - \text{Actual variable overhead incurred})$$

$$= (9,000 \text{ units} \times \text{Re.1} - \text{Rs.}9,250) = \text{Rs.}250 \text{ (A)}$$

Expenditure variance:

$$= [\text{Budgeted variable overheads} - \text{Actual variable overheads}]$$

$$= [\text{Rs.}8,100 - \text{Rs.}9,250] = \text{Rs.}1,150 \text{ (A)}$$

Efficiency variance:

$$= [\text{Standard hours for actual output} - \text{Actual hours}] \text{ Std. rate per unit}$$

$$= (45,000 - 40,000) 0.20 = \text{Rs.}900 \text{ (F)}$$

Computation of sales variances:

Standard / Budgeted data			Actual data		
Budgeted qty units	S.P per unit Rs.	Amount Rs.	Actual qty units	Actual S.P. per unit	Amount Rs.
10,000	60	6,00,000	9,000	61.50	5,53,500

Total sales value variance:

$$\begin{aligned} &= [\text{Budgeted sales value} - \text{Actual sales value}] \\ &= (\text{Rs.6,00,000} - \text{Rs.5, 53,500}) = \text{Rs.46, 500 (A)} \end{aligned}$$

Sales price variance:

$$\begin{aligned} &= [\text{Budgeted selling price} - \text{Actual selling price}] \text{AQ} \\ &= (60 - 61.50) 9,000 = \text{Rs.13,500 (F)} \end{aligned}$$

Sales volume variance:

$$\begin{aligned} &= [\text{Budgeted volume} - \text{Actual volume}] \text{Budgeted S.P per unit} \\ &= (10,000 - 9,000) 60 = \text{Rs.60,000 (A)} \end{aligned}$$

Standard gross margin volume variance:

$$\begin{aligned} &= (\text{Budgeted volume} - \text{Actual volume}) \text{Std. gross margin per unit} \\ &= (10,000 - 9,000) (\text{Rs.60} - \text{Rs.51}) = \text{Rs.9,000 (A)} \end{aligned}$$

Reconciliation of budgeted profit with actual profit:

	Rs.
Budgeted profit	90,000
Sales gross margin volume variance	<u>9,000(A)</u>
Standard profit	81,000
Sales price variance	<u>13,500(F)</u>
Total	94,500

Cost variances:

Direct material	32,400 (A.)	
Direct labour	18,000 (A.)	
Variable overhead	250 (A)	
Fixed overhead	<u>740 (A)</u>	<u>51,390 (A)</u>
Actual profit		<u>43,110</u>

Pricing Decisions: Pricing Policies

7. (a) Competitive pricing: When a company sets its price mainly on the consideration of what its competitors are charging, its pricing policy under such a situation is called competitive pricing or competition-oriented pricing. Thus pricing policy adopted by

firm B is the competitive pricing. It is not necessary under competitive pricing to charge the same price as charged by the concern's competitors. But under such a pricing the concern may keep its prices lower or higher than its competitors by a certain percentage. Competitive price so determined does not maintain a rigid relation between its price, cost or demand. Its own costs or demand may change, but the concern maintains its price because its competitors maintain their prices. Conversely, the concern will change its price when its competitors change their price, even if its own costs or demand have not altered.

- (b) (i) Going rate pricing: It is a competitive pricing method under which a firm tries to keep its price at the average level charged by the industry. The use of such a practice of pricing is specially useful where it is difficult to measure costs. Adoption of going rate pricing will not only yield fair return but would be least disruptive for industry's harmony.

Going rate pricing primarily characterizes pricing practice in homogeneous product markets, although the market structure itself may vary from pure competition to pure oligopoly. The concern selling a homogeneous product in a highly competitive market has actually very little choice about the setting of its price. There is apt to be a market determined price for the product, which is not established by any single firm or clique of firms but through the collective interaction or a multitude of knowledgeable buyers and sellers. The concern which is going to charge more than the going rate would attract virtually no customers. The concern should not charge less because it can dispose of its entire output at the going rate. Thus, under highly competitive conditions in a homogeneous product market (such as food, raw materials and textiles) the concern really has no pricing decision to make. Infact it hardly has any significant marketing decisions also to make. The major challenge before such a concern is good cost control. Since promotion and personnel selling are not in the picture, the major marketing costs arise in physical distribution.

In pure oligopoly, where a few large concerns dominate the industry, the concern also tends to charge the same price as is being charged by its competitors. Since there are only a few concerns, each firm is quite aware of others' prices, and so are the buyers.

This does not mean that the going price in an oligopoly market will be perpetuated indefinitely. It cannot, since industry costs and demand change over time. Usually, the industry takes collective action to raise the price, or in rare cases, to lower the price. This is done when one firm assumes the role of price leader. The others follow any change in price by the leader.

- (ii) Sealed bid-pricing: Competitive pricing also dominates in those situations where firms compete for jobs on the basis of bids, such as original equipment manufacture and defence contract work. The bid is the firms offer price, and it is a prime example of pricing based on expectations of how competitors will

price rather than on a rigid relation based on the concern's own costs or demand. The objective of the firm in the bidding situation is to get the contract, and this means that it hopes to set its price lower than that set by any of the other bidding firms. Yet the firm does not ordinarily set its price below a certain level. Even when it is anxious to get a contract in order to keep the plant busy, it can not quote price below marginal cost without worsening its position. On the other hand, if it raises its price above marginal cost, it increases its potential profit but reduces its chance of getting the contract.

The main obstacle in the use of formal bidding theory is guessing the probability of getting the contract at various bidding levels. This estimate requires information about what the competitors are likely to bid, and to know all about this is really a difficult task. Therefore the concern has to rely on conjecture, trade gossip or past bidding history.

Pricing Decisions: Pareto Analysis

8. Let us rearrange the products in descending order of contribution and find out the cumulative contribution percentage.

Product	Contribution (Rs.)	Cumulative contribution (Rs.)	Cumulative contribution (%)
C	1,500	1,500	60
A	500	2,000	80
B	200	2,200	88
F	125	2,325	93
E	100	2,425	97
D	<u>75</u>	2,500	100
	<u>2,500</u>		

On analysis it is found that 80% of the total contribution is earned by two products C and A. The position of these products needs protecting, perhaps through careful attention to branding and promotion. The other products should be investigated to see whether their contribution can be improved through increased prices, reduced costs, increased sales volume, etc.

Costing of Service Sector

- 9 (i) Red Jet Airlines
Statement of Operating Income

	Rs.	Rs
Fare collection (120 × Rs.8000)		9,60,000
Commission (80% of Rs. 9,60,000) = Rs.7,68,000		

5% commission on Rs. 7,68,000		<u>38,400</u>
Net fare		9,21,600
Expenses:		
ATF	160000	
Food (120 × Rs.200)	<u>24000</u>	
Total variable cost		<u>184000</u>
Contribution		737600
Fixed costs:		
Annual lease apportioned	4,00,000	
Ground handling charges	1,00,000	
Crew salaries	<u>60,000</u>	<u>5,60,000</u>
Operating income		<u>1,77,600</u>
(ii)		
Fare collections (132 × Rs.7,500)		9,90,000
Commission(5% of 80% of Rs.9,90,000)		<u>39,600</u>
Net fare		9,50,400
Expenses :		
ATF	1,60,000	
Food 132 × Rs.200	<u>26,400</u>	
Total variable cost		<u>1,86,400</u>
Contribution		7,64,000
Fixed costs		<u>5,60,000</u>
Profit		<u>2,04,000</u>
Excess of income is 2,04,000 – 1,77,600 = Rs.26,400		
Hence reduction in fare is recommended.		

Transfer Pricing

10. (a) (i) Monthly profits at present level of L & M Ltd.

	(Rs.' 000)
L Ltd.: Sales (10,000 drums* @ Rs.20 per drum)	200
Less : Costs: Raw materials @ Rs. 9 per drum	90
Other costs @ Rs.3 per drum	<u>30</u>
Contribution	80
Less : Fixed costs	<u>40</u>
Profit	<u>40</u>

M Ltd.: Sales (7,50,000 kilolitres at Rs. 9 per 25 litres)	270
Less: Costs: Variable (@Rs. 0.20 per Kilolitre)	<u>150</u>
Contribution	120
Less : Fixed costs	<u>60</u>
Profit	<u>60</u>

Note:

*Sales of L Ltd. = (2,50,000 kilolitres internal transfers / 25 litres per drum.)
= 10,000 drums

(ii) Monthly profits at higher sales level

(Rs.' 000)

L Ltd.: Sales (18,000 drums* at Rs.16 per drum)	288
Less: Costs: Raw materials (Rs. 9 per drum)	162
Other expenses (Rs.3 per drum)	<u>54</u>
Contribution	72
Less: Fixed costs	<u>40</u>
Profit	<u>32</u>
M Ltd. Sales (9,50,000 kilolitres* at Rs. 9 per 25 litres)	342
Costs: Variable (@ Rs.0.20 per kilolitre)	<u>190</u>
Contribution	152
Less : Fixed costs	<u>60</u>
Profit	<u>92</u>

Note:

* Internal transfers (18,000) drums of 25 litres per drum) plus 5,00,000 kilolitres external sales.

- (b) (i) The use of a market price as the transfer price produces difficulties because L Ltd. is not motivated to reduce the selling price, in order to increase volume, because its profit declines from Rs. 40,000 to Rs. 32,000. However, the profits of M Ltd. increase from Rs. 60,000 to Rs. 92,000. Thus, the profits for the company as a whole increase by Rs. 24,000. Hence the transfer price does not encourage goal congruence in this particular situation.
- (ii) In order to overcome the above difficulties, there is a need to offer some inducement to L Ltd. such that its profits will increase as a result of

lowering the selling price in order to increase volume. Factors to consider are the following:

- (1). The significance of the loss in profits arising from the difference between profits at the optimum output level and profits based on the output using the current transfer pricing system.
- (2). Savings in selling and distribution costs arising from internal transfers compared with external sales. The savings per unit should be deducted from the market price.

Target Costing

11. Computation of Target Cost

	Per tonne (in Rs)
ABC Ltd selling price to the merchant	1,466
Less freight paid by ABC Ltd	(30)
Less normal sales returns and allowances	(60)
XYZ Ltd Capital charge	(120)
Target cost for XYZ Ltd	1,256
Ship to Distribution Centre	(11)
Distribution Centre operating cost	(25)
Subtotal	1,220
Distribution centre capital charge	(58)
Mill target manufacturing cost	1,162

Life Cycle Costing : Introduction and Benefits

12. Life cycle costing as its name implies costs the cost object i.e., product, project etc. over its projected life. It is used to describe a system that tracks and accumulates the actual costs and revenues attributable to cost object from its inception to its abandonment. The profitability of any given cost object can therefore be determined at the end of its economic life.

Life cycle costing is different to traditional cost accounting system which report cost object profitability on a calendar basis i.e. monthly, quarterly and annually. In contrast life cycle costing involves tracing cost and revenues on a product by product bases over several calendar periods. Costs and revenue can be analysed by time period, but the emphasis is on cost revenue accumulation over the entire life cycle of each product.

The benefits of product life cycle costing are summarized as follows :

- (i) The product life cycle costing results in earlier actions to generate revenue or to lower costs than otherwise might be considered. There are a number of factors that need to be managed in order to maximise return on a product.
- (ii) Better decisions should follow from a more accurate and realistic assessment of revenues and costs, at least within a particular life cycle stage.
- (iii) Product life cycle thinking can promote long-term rewarding in contrast to short-term profitability rewarding.
- (iv) It provides an overall framework for considering total incremental costs over the entire life span of a product, which in turn facilitates analysis of parts of the whole where cost effectiveness might be improved.

Material Requirement Planning : Introduction and Operation

13. Material Requirements Planning (MRP) is a software based production planning and inventory control system used to manage manufacturing processes. Although it is not common nowadays, it is possible to conduct MRP by hand as well.

An MRP system is intended to simultaneously meet three objectives:

- (i) Ensure materials and products are available for production and delivery to customers.
- (ii) Maintain the lowest possible level of inventory.
- (iii) Plan manufacturing activities, delivery schedules and purchasing activities.

The core data requirements for operating a Material Requirement Planning include the following :

- (a) The Master Production Schedule: This schedule specifies the quantity of each finished unit of products to be produced, and the time at which each unit will be required.
- (b) The Bill of material file: The bill of material file specifies the sub-assemblies, components and materials required for each finished good.
- (c) The inventory file: This file maintains details of items in hand for each sub-assemblies, components and materials required for each finished goods.
- (d) The routing file: This file specifies the sequence of operations required to manufacture components, sub-assemblies and finished goods.
- (e) The master parts file: This file contains information on the production time of sub-assemblies and components produced internally and lead times for externally acquired items.

Activity Based Costing

- 14 (i) The following table shows the operating income and operating income as a percentage of revenues for each product line. All store support costs (all costs other than cost of goods sold) are allocated to product lines using cost of goods sold of each product line as the cost-allocation base. Total store support costs equal Rs. 3,60,000 (cost of bottles returned, Rs. 4,800 + cost of purchase orders, Rs. 62,400 + Cost of deliveries, Rs. 1,00,800 + cost of shelf-stocking, Rs. 69,120 + cost of customer support, Rs. 1,22,880). The allocation rate for store support costs = $\text{Rs. } 3,60,000 \div \text{Rs. } 12,00,000 = 30\%$ of cost of goods sold. To allocate support costs to each product line, Apna Bazaar multiplies the cost of goods sold of each product line by 0.30.

	Soft drinks	Fresh Produce	Packaged Food	Total
Revenues	<u>Rs. 3,17,400</u>	<u>Rs. 8,40,240</u>	<u>Rs. 4,83,960</u>	<u>Rs. 16,41,600</u>
Cost of goods sold	Rs. 2,40,000	Rs. 6,00,000	Rs. 3,60,000	Rs. 12,00,000
Store support cost (Rs. 2,40,000; Rs. 6,00,000; Rs. 3,60,000) $\times 0.30$	<u>Rs. 72,000</u>	<u>1,80,000</u>	<u>1,08,000</u>	<u>3,60,000</u>
Total costs	<u>3,12,000</u>	<u>7,80,000</u>	<u>4,68,000</u>	<u>15,60,000</u>
Operating income	<u>Rs. 5,400</u>	<u>Rs. 60,240</u>	<u>Rs. 15,960</u>	<u>Rs. 81,600</u>
Operating income $\div$ Revenues	1.70%	7.17%	3.30%	4.97%
Items sold	50,400	4,41,600	1,22,400	1,22,400

- (ii) Under an ABC system, Apna Bazar identifies bottle-return costs as a direct cost because these costs can be traced to the soft drink product line. Apna Bazaar then calculates cost-allocation rates for each activity area. The activity rates are as follows:

Activity	Cost Hierarchy	Total costs	Quantity of Cost-Allocation Base	Overhead Allocation Rate
(1)	(2)	(3)	(4)	(5) = (3) $\div$ (4)
Ordering	Batch-level	Rs. 62,400	624 purchase orders	Rs. 100 per purchase order
Delivery	Batch-level	Rs. 1,00,800	1,260 deliveries	Rs. 80 per delivery

Shelf-stocking	Output level	unit-	Rs. 69,120	3,456	shelf-stocking hours	Rs. 20 per stocking-hour
Customer support	Output level	unit-	Rs. 1,22,880	6,14,400	items sold	Rs. 0.20 per item sold

Store support costs for each product line by activity are obtained by multiplying the total quantity of the cost-allocation base for each product line by the activity cost rate. Operating income and operating income as a percentage of revenues for each product line are as follows:

	Soft drinks	Fresh Produce	Packaged Food	Total
Revenues	<u>Rs. 3,17,400</u>	<u>Rs. 8,40,240</u>	<u>Rs. 4,83,960</u>	<u>Rs. 16,41,600</u>
Cost of goods sold	Rs. 2,40,000	Rs. 6,00,000	Rs. 3,60,000	Rs. 12,00,000
Bottle-return costs	4,800	0	0	4,800
Ordering costs (144;336;144) purchase orders × Rs. 100	14,400	33,600	14,400	62,400
Delivery costs (120;876;264) deliveries × Rs. 80	9,600	70,080	21,120	1,00,800
Shelf-stocking costs (216;2,160;1,080) stocking hours × Rs. 20	4,320	43,200	21,600	69,120
Customer-support costs (50,400;4,41,600;1,22,400) items sold × Re. 0.20	<u>10,080</u>	<u>88,320</u>	<u>24,480</u>	<u>1,22,880</u>
Total costs	<u>2,83,200</u>	<u>8,35,200</u>	<u>4,41,600</u>	<u>15,60,000</u>
Operating income	<u>Rs. 34,200</u>	<u>Rs. 5,040</u>	<u>Rs. 42,360</u>	<u>Rs. 81,600</u>
Operating income ÷ Revenues	10.78%	0.60%	8.75%	4.97%

- (iii) Managers believe the ABC System is more credible than the simple costing system. The ABC System distinguishes the different types of activities at Apna Bazaar more precisely. It also tracks more accurately how individual product lines use resources. Rankings of relative profitability – operating income as a percentage of revenues – of the three product lines under the simple costing system and under the ABC System are:

Simple Costing System			ABC System		
1.	Fresh produce	7.17%	1.	Soft drinks	10.78%
2.	Packaged food	3.30%	2.	Packaged food	8.75%
3.	Soft drinks	1.70%	3.	Fresh produce	0.60%

The percentage of revenues, cost of goods sold, and activity costs for each product line are as follows:

	Soft Drinks	Fresh Produce	Packaged Food
Revenues	19.34%	51.18%	29.48%
Cost of goods sold	20.00	50.00	30.00
Bottle returns	100.00	0	0
Activity areas:			
Ordering	23.08	53.84	23.08
Delivery	9.53	69.52	20.95
Shelf-stocking	6.25	62.50	31.25
Customer support	8.20	71.88	19.92

Soft drinks consume fewer resources than either fresh produce or packaged food. Soft drinks have fewer deliveries and require less shelf-stocking time than required for either fresh produce or packaged food. Most major soft-drink suppliers deliver merchandise to the store shelves and stock the shelves themselves. In contrast, the fresh produce area has the most deliveries and consumes a large percentage of shelf-stocking time. It also has the highest number of individual sales items. The simple costing system assumed that each product line used the resources in each activity area in the same ratio as their respective individual cost of goods sold to total cost of goods sold. Clearly, this assumption is incorrect. The simple costing system is an example of averaging that is too broad.

Apna Bazaar managers can use the ABC information to guide decisions such as how to allocate a planned increase in floor space. An increase in the percentage of space allocated to soft drinks is warranted. Note, however, that ABC information should be but one input into decisions about shelf-space allocation. Apna Bazaar may have minimum limits on the shelf space allocated to fresh produce because of shoppers' expectations that supermarkets will carry products from this product line. In many situations, companies cannot make product decisions in isolation but must consider the effect that deemphasizing a product might have on customer demand for other products.

Pricing decisions can also be made in a more-informed way with ABC information. For example, suppose a competitor announces a 5% reduction in soft-drink prices. Given the 10.77% margin, Apna Bazaar currently earns on its soft-drink product line, it has flexibility to reduce prices and still make a profit on this product line. In contrast, the simple costing system erroneously reported that soft drinks only had a 1.70% margin, leaving little room to counter a competitor's pricing initiatives.

Total Quality Management

15. (i)	Classification of Quality Costs	Figures Rs. '000		
	2007	% of sales	2008	% of sales
	<u>6,000</u>		<u>6,000</u>	
Sales				
Prevention				
Quality training	<u>75</u>	1.25	150	2.5
Appraisal				
Product Inspection	<u>200</u>		240	
Materials Inspection	<u>80</u>		<u>60</u>	
	<u>280</u>	4.67	<u>300</u>	5
Internal Failure				
Scrap	600		300	
Rework	<u>500</u>		<u>400</u>	
	<u>1100</u>	18.33	<u>700</u>	11.67
External Failure				
Product warranty	<u>300</u>	<u>5</u>	<u>150</u>	<u>2.5</u>
	<u>1755</u>	<u>29.25</u>	<u>1300</u>	<u>21.67</u>

- (ii) Cost reduction was effected by 7.58% (29.25 – 21.67) of sales, which is an increase in profit by Rs.4,55,000.

Value Chain Analysis : Definition and Competitive Advantage

16. (a) 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
- (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 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-creating processes;
2. Evaluate differentiation strategies for enhancing customer value; and
3. Determine the best sustainable differentiation strategies.

(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.

Budgetary Control : Preparation of Budgets

- 17 (i) In preparing the sales budget, the forecasted unit sales must be multiplied by the budgeted selling price to obtain the sales volume in rupees.

RNRB Company
Sales Budget
For the year ended December 31, 2008

Product	Unit Sales Volume	Unit Selling Price Rs.	Total Sales Rs.
Bike	60,000	4,500	27,00,00,000
Bus	<u>12,500</u>	15,000	<u>18,75,00,000</u>
Total	<u>72,500</u>		<u>45,75,00,000</u>

- (ii) In preparing the production budget, the forecasted unit sales from the sales budget are added to the desired ending inventory to determine the total units needed, then the estimated beginning inventory is deducted from that total to determine the unit production needed.

RNRB Company
Production Budget
For the year ended December 31, 2008

	Units	
	Bike tyres	Bus tyres
Sales (from sales budget)	60,000	12,500
Plus desired ending inventory, Dec. 31	<u>5,000</u>	<u>2,000</u>
Total	65,000	14,500
Less estimated beginning inventory, Jan. 1	<u>6,000</u>	<u>2,500</u>
Total production	<u>59,000</u>	<u>12,000</u>

- (iii) In preparing the direct materials budget the quantities of materials needed for production must be added to the desired ending inventory of materials to determine the materials needed. Then, the estimated beginning inventory must be subtracted from this total to determine the quantity of materials to be purchased.

RNRB Tyre Company
Direct Materials Budget
For the year ended December 31, 2008

	Direct Materials		Total
	Rubber (lbs.)	Steel Belts (lbs.)	
Quantities required for production:			

Bike tyres:		
59,000 × 15 lbs.	8,85,000	
59,000 × 2.0 lbs.		1,18,500
Bus tyres:		
12,000 × 35 lbs.	4,20,000	
12,000 × 4.5 lbs.		54,000
Plus desired ending inventory, Dec. 31	<u>60,000</u>	<u>6,000</u>
Total	13,65,000	1,78,000

Less: Estimated beginning inventory, Jan. 1	<u>75,000</u>	<u>7,500</u>
Total quantity to be purchased	12,90,000	1,70,500

Unit price	<u>Rs. 150</u>	<u>Rs. 100</u>	
Total direct materials purchases	<u>Rs. 19,35,00,000</u>	<u>Rs. 1,70,50,000</u>	<u>Rs. 21,05,50,000</u>

- (iv) In preparing the direct labour budget the total direct labour hours that should be worked on all products must be determined for each department, and then multiplied by the wage rate for that department.

RNRB Tyre Company
Direct Labour Budget
for the year ended December 31, 2008

	Department		Total
	Molding	Finishing	
Hours required for production:			
Bike tyres:			
59,000 × .10	5,900		
59,000 × .05		2,950	
Bus tyres:			
12,000 × .20	<u>2,400</u>		
12,000 × .10		<u>1,200</u>	
Total	8,300	4,150	
Hourly rate	<u>Rs. 650</u>	<u>Rs. 750</u>	
Total direct labour cost	<u>Rs. 53,95,000</u>	<u>Rs. 31,12,500</u>	<u>Rs. 85,07,500</u>

- (v) In this problem, the budgeted costs for each factory overhead item are given. In practice, the challenge is to determine the variable and fixed components of semi-variable factory overhead costs.

RNRB Company
Factory Overhead Budget
for the year ended December 31, 2008

	Rs.
Indirect materials	85,28,000
Indirect labour	79,40,000
Depreciation of building and equipment	49,16,000
Power and light	<u>63,00,000</u>
Total factory overhead cost	<u>2,76,84,000</u>

- (vi) The information from the direct materials, direct labour and factory overhead budgets, in addition to data on desired beginning and ending inventories, is used to prepare the cost of goods sold budget.

RNRB Company
Cost of Goods Sold Budget
for the year ended December 31, 2008

	Rs.	Rs.
Finished goods inventory, Jan. 1		200,25,500
Direct materials inventory Jan. 1 ¹	1,20,00,000	
Direct materials purchases	<u>21,05,50,000</u>	
Total direct materials available	22,25,50,000	
Less: Direct materials inventory, Dec. 31 ²	<u>96,00,000</u>	
Cost of direct materials used	21,29,50,000	
Direct labour	85,07,500	
Factory overhead	<u>2,76,84,000</u>	
Cost of goods manufactured		<u>24,91,41,500</u>
Cost of goods available for sale	26,91,67,000	
Less: Finished goods inventory, Dec. 31	<u>1,63,23,900</u>	
Cost of goods sold	<u>25,28,43,100</u>	

1.	Rubber	75,000 lbs. × 150	Rs. 1,12,50,000
	Steel belts	7,500 lbs. × 100	<u>7,50,000</u>
			Rs. <u>1,20,00,000</u>
2.	Rubber	60,000 lbs. × 150	Rs. 90,00,000
	Steel belts	6,000 lbs. × 100	<u>6,00,000</u>
			Rs. <u>96,00,000</u>

Budgetary Control : Preparation of Budgets

- 18 (i) Statement of sales, costs and profit expected from alternative ways of increasing production

	Subcontract	Additional shift	Additional plant
	Rs	Rs	Rs
Additional sales (2,000 tons)	50,00,000	50,00,000	50,00,000
Cost increases:			
Materials (Rs 30,00,000/8000=Rs 375per ton)		7,50,000	7,50,000
Direct wages		40,00,000	30,00,000
Subcontractor	41,00,000		
Production variable overhead (Rs 7,00,000/8,000=Rs 87.5 per ton)		1,75,000	1,75,000
Production fixed overhead			2,70,000
Distribution variable overhead (Rs 2,00,000/8,000= Rs 25 per ton)	50,000	50,000	50,000
Administration overhead	1,00,000	1,00,000	1,00,000
Selling and distribution overhead	2,00,000	2,00,000	2,00,000
	44,50,000	52,75,000	45,45,000
Additional profit/ loss	5,50,000	(2,75,000)	4,55,000
Original budgeted profit	20,00,000	20,00,000	20,00,000

(ii) Revised operating budget based on subcontract :

	Rs' 000	Rs '000
Sales:10,000 tons @Rs 2,500 per ton		2,500
Variable costs		
Materials	300	
Direct wages	1,200	
Subcontract	410	
Production overhead 50% variable	70	
Total production variable cost	1,980	
Distribution – 20% variable	<u>25</u>	<u>2,005</u>
Contribution		495
Fixed costs		
Production	70	
Administration	70	
Selling and distribution	<u>100</u>	<u>240</u>
Profit		<u>255</u>

Budgetary Control : Budget Ratios

19. Budget ratios provide information about the performance level, i.e., the extent of deviation of actual performance from the budgeted performance and whether the actual performance is favourable or unfavourable. If the ratio is 100% or more, the performance is considered as favourable and if ratio is less than 100% the performance is considered as unfavourable.

The following ratios are usually used by the management to measure development from the budget.

1. Capacity usage ratio - This relationship between the budgeted number of working hours and the maximum possible number of working hours in a budget period.

Example :

- (i) Budgeted number of working hours after deducting the hours expected to be lost because of surplus capacity 4,000
 - (ii) Maximum possible number of working hours in a budget period before deduction of surplus capacity 5,000
- Capacity usage ratio = $4000/5000 \times 100 = 80\%$

In ascertaining both the levels of hours, normal idle time should be deducted.

2. Standard capacity employed ratio - This ratio indicates the extent to which facilities were actually utilised during the budget period.

Example :

Actual hours worked 3,600

Budgeted hours 4,000

Standard capacity employed ratio = $3600/4000 \times 100 = 90\%$

3. Level of activity ratio - This may be defined as the number of standard hours equivalent to work produced expressed as a percentage of the budget of standard hours.

Example :

Actual production converted into standard hours 5,600

Budgeted production converted into standard hours 6,000

Level of activity ratio = $5600/6000 \times 100 = 93.33\%$

The level of activity ratio is arrived at by comparing the actual production with the anticipated production as shown in the budget. The standard capacity employed ratio takes no account of either actual or estimated production but only measures working of machine hours.

4. Efficiency ratio - This ratio may be defined as standard hours equivalent of work produced expressed as a percentage of the actual hours spent in producing the work.

Example :

Standard hours work produced 5,600

Actual hours worked 5,000

Efficiency ratio : $5600/5000 \times 100 = 112\%$

5. Calendar ratio - This ratio may be defined as the relationship between the number of working days in a period and the number of working days in the relative budget period.

Example :

Actual working days 26

Budgeted working days 25

Calendar ratio : $26/25 \times 100 = 104\%$

Note: All the Questions are arranged in a sequence as per the syllabus of 'Cost Management' [Paper 5 of Final (old) Course]. The topic has been quoted as a heading against all theory/ practical questions.

Linear Programming

20. The appropriate mathematical formulation of the given problem is:

$$\text{Minimize (total cost) } Z = 200x_1 + 400x_2$$

$$\text{S.t } x_1 + x_2 \geq 200$$

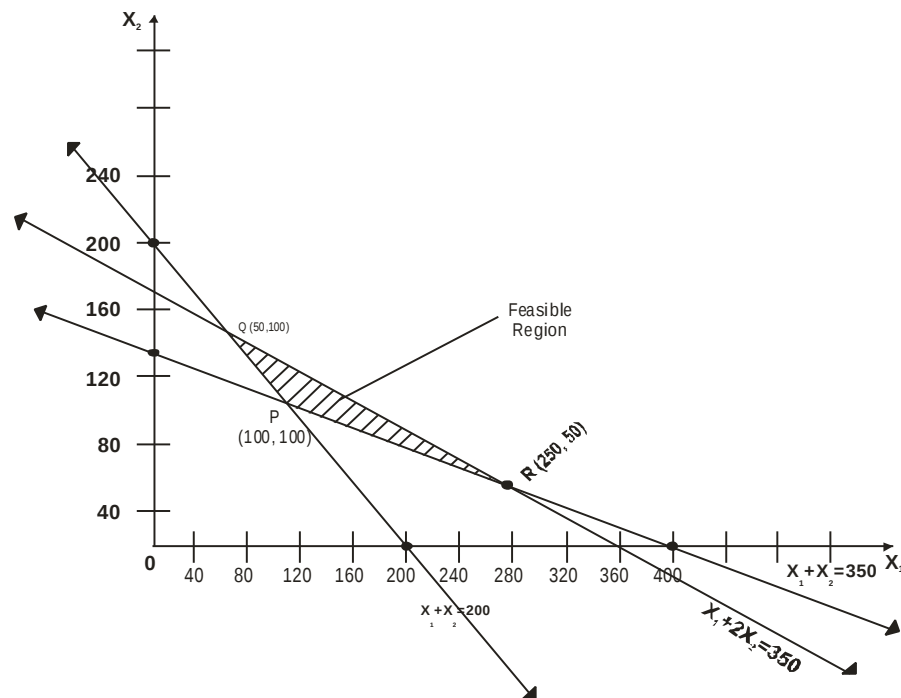
$$\frac{1}{4}x_1 + \frac{3}{4}x_2 \geq 100 \text{ or } x_1 + 3x_2 \geq 400$$

$$\frac{1}{10}x_1 + \frac{1}{5}x_2 \leq 35 \text{ or } x_1 + 2x_2 \leq 350$$

$$x_1 \geq 0, x_2 \geq 0$$

Where x_1, x_2 represent the number of quintals of scrap from two suppliers A and B respectively.

Clearly each point (x_1, x_2) satisfying condition $x_1 \geq 0, x_2 \geq 0$ must lie in the first quadrant only. Also since $x_1 + x_2 \geq 200, x_1 + 3x_2 \geq 400$ and $x_1 + 2x_2 \leq 175$, the desired point (x_1, x_2) lies somewhere on the feasible region. PQR Shown in fig.



The co-ordinates of the extreme points of the feasible region are :

P (100, 100), Q (50, 150) and R (250, 50).

The value of the objective function at each of the extreme points is evaluated as follows:

Extreme point	Co-ordinate (x_1 , x_2)	Objective function value $Z = 200x_1 + 400x_2$
P	(100, 100)	$200(100) + 400(100) = 60,000$
Q	(50, 150)	$200(50) + 400(150) = 70,000$
R	(250, 50)	$200(250) + 400(50) = 70,000$

Since Z has the minimum value at the extreme point P = (100, 100), the solution to the given problem is $x_1 = 100$, $x_2 = 100$ and minimum Z = 60,000.

Hence the firm should purchases 100 quintals of scrap metal from supplier A and 100 quintals of scrap metal from supplier B in order to maintain a minimum cost of Rs. 60,000.

Assignment Problem

21. 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

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.

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

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

The Assignment Problem

22.

Tabel 1

	a	b	c	d	e
A	30	0	45	60	70
B	15	0	10	40	55
C	30	0	15	60	75
D	0	0	30	30	60
E	20	0	45	45	70

Table 2

	a	b	c	d	e
A	30	0	35	30	15
B	15	0	0	10	0
C	30	0	5	30	20
D	0	0	20	0	5
E	20	0	35	15	15

In table 2, the no. of minimum lines $N = 3$

$$\therefore N < n$$

Table 3

The order of matrix $n = 5$

Table 4

	a	b	c	d	e
A	25	0	30	25	10
B	15	5	0	10	0
C	25	0	0	25	15
D	0	5	20	0	5
E	15	0	30	10	10

$N < n$

	a	b	c	d	e
A	15	0	30	15	10
B	5	5	0	0	0
C	15	0	0	15	15
D	0	15	30	0	15
E	5	0	30	0	10

$N < n$

∴ We can get minimum assignment schedule.

	a	b	c	d	e
A		○			
B			⊗	⊗	○
C		⊗	○		
D	○			⊗	
E		⊗		○	

Down Depots

A → b
 B → e
 C → c
 D → a
 E → d

∴ Minimum distance travelled

$$= 130 + 175 + 125 + 50 + 80$$

$$= 560 \text{ (miles).}$$

The Transportation problem

23. The given problem is un-balanced transportation problem

5	4	8	6	5	0	600
4	5	4	3	2	0	400
3	6	5	8	4	0	1000
450	400	200	350	300	300	

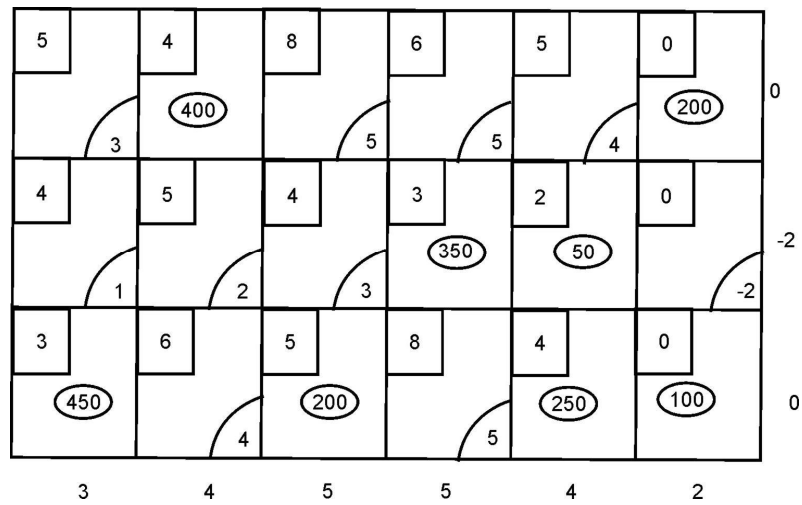
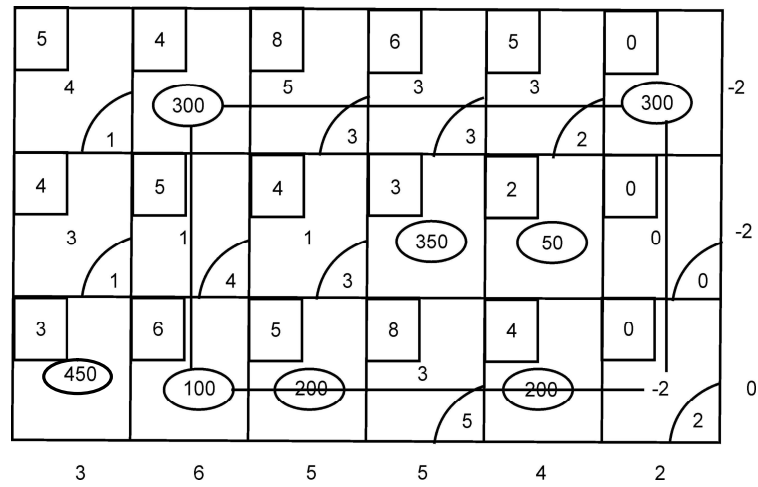
Here we have added a fictitious (imaginary) column. So that the given problem becomes a balanced T.P.

5	4	8	6	5	0	600 300	4	1	1	1	1		
	300				300								
4	5	4	3	2	0	400 50	2	1	← 2				
			300	50									
3	6	5	8	4	0	1000 200	3	1	1	1	1	1	3
450	100	200		250									
450	400 100	200	350										
1	1	1	3	2	0								
1	1	1	3 ↑	2									
1	1	1		2									
2	2	3 ↑		1									
2	↑ 2			1									
3	6 ↑			4									
3			4 ↑										
3													

The transportation cost.

$$\begin{aligned}
 &= 4 \times 300 + 0 \times 300 + 3 \times 350 + 2 \times 50 + 3 \times 450 + 6 \times 100 + 5 \times 200 + 4 \times 250 \\
 &= 1,200 + 0 + 1,050 + 100 + 1,350 + 600 + 1,000 + 1,000 \\
 &= 6,300
 \end{aligned}$$

Optimum solution is

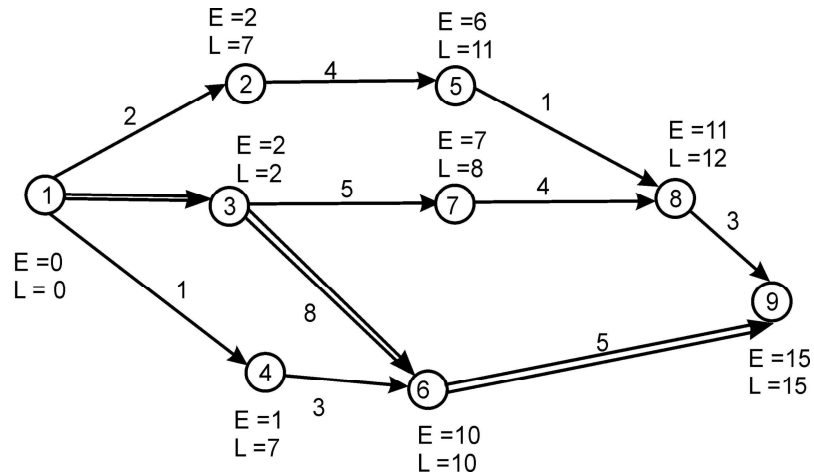


Transportation cost

$$\begin{aligned}
 &= 4 \times 400 + 0 \times 200 + 3 \times 350 + 2 \times 50 + 3 \times 450 + 5 \times 200 + 4 \times 250 + 0 \times 100 \\
 &= 1,600 + 1,050 + 100 + 1,350 + 1,000 + 1,000 = 6,100
 \end{aligned}$$

Critical Path Analysis & PERT

24. The required PERT network is given below:



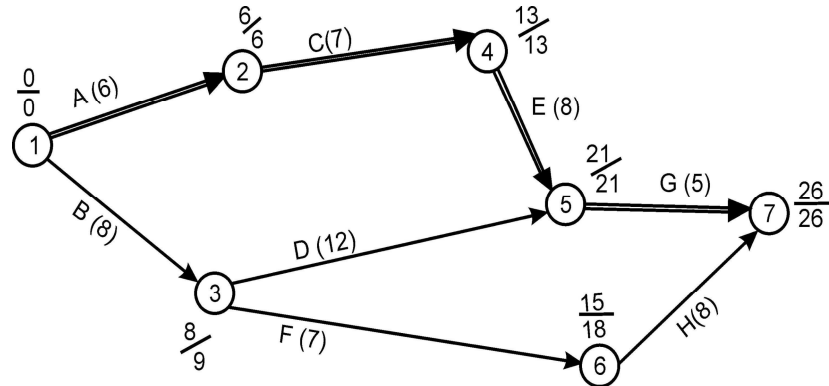
(i) Total float of each activity is calculated below :

Activity	Duration (in weeks)	Start		Finish		total (LST-EST)
		Earliest (EST)	Latest (LST)	Earliest (EFT)	Latest (LFT)	
1-2	2	0	5	2	7	5
1-3	2	0	0	2	2	0
1-4	1	0	6	1	7	6
2-5	4	2	7	6	11	5
3-6	8	2	2	10	10	0
3-7	5	2	3	7	8	1
4-6	3	1	7	4	10	6
5-8	1	6	11	7	12	5
6-9	5	10	10	15	15	0
7-8	4	7	8	11	12	1
8-9	3	11	12	14	15	1

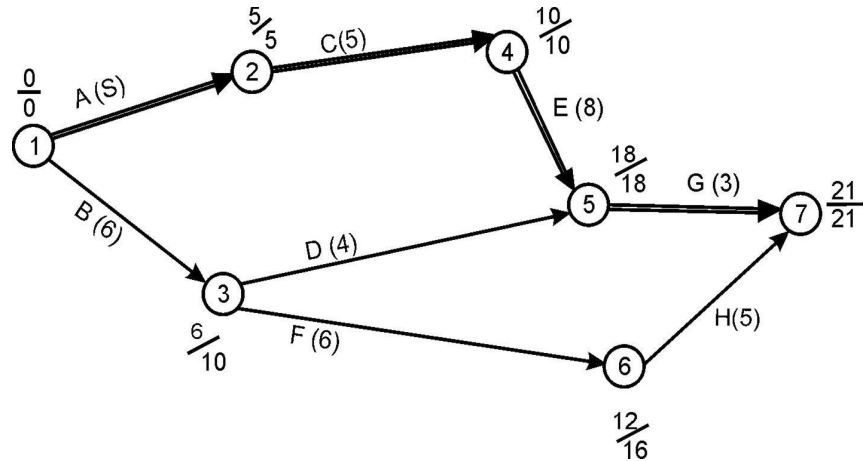
(ii) The critical path is given by 1-3-6-9 and the project duration is 15 weeks.

Critical Path Analysis & PERT

25. (i) The network with the normal time of the project activities is shown in figure. Path 1-2-4-5-7 is the critical path and the project duration is 26 days.



Network diagram 1:



Network diagram 2:

Thus, the minimum duration of the project = 21 days

Activity	:	A	B	C	D	E	F	G	H
Node	:	(1, 2)	(1, 3)	(2, 4)	(3, 5)	(4, 5)	(3, 6)	(5, 7)	(6, 7)
Crash cost	:	100	100	100	200	0	100	200	$\frac{200}{3}$

- (ii) To find the additional cost of the project for minimum project duration, activities are crashed as below step-by-step.

Step 1 :In the network draw in the first figure, there are three paths, viz.

Path 1-2-4-5-7 with project duration = 26 days

1-3-5-7 with project duration = 25 days

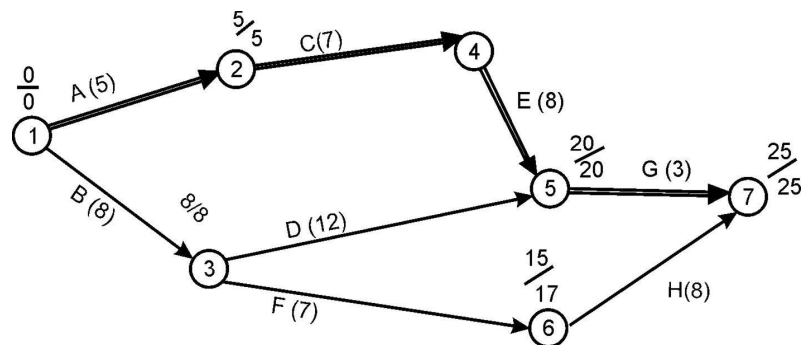
1-3-6-7 with project duration = 23 days.

Thus, the path 1-2-4-5-7 which is critical path also takes 1 day more than the next path 1-3-5-7. So, we crash the path 1-2-4-5-7 for 1 day as below

Activity	Possible crash (days)	Crashing cost (per day)
1-2	1	100
2-4	2	100
4-5	0	—
5-7	2	200

We crash activity 1-2 by one day at an additional cost of Rs. 100 with project duration of 25 days.

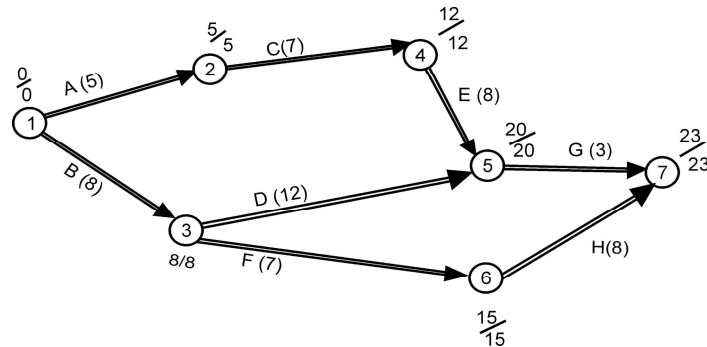
Step 2 :The revised network is given below:



Path	Duration (days)
1-2-4-5-7	25
1-3-5-7	25
1-4-6-7	23

The critical paths are 1-2-4-5-7 and 1-3-5-7. Activity 5-7 is common in both the paths. We, therefore, crash 5-7 by 2 days at an additional cost of Rs. 400 with project duration of 23 days.

Step 3: The revised network is given below:



Path	Duration (days)
1-2-4-5-7	23
1-3-5-7	23
1-3-6-7	22

Step 4 : We consider the following activities for crashing.

Activity	Possible crash (days)	Crashing cost (per day)
2-4	2	100
1-3	2	100
3-5	8	200
3-6	1	100
6-7	3	200/3

We, therefore, crash activity 6-7 by 2 days at a cost of Rs. $\frac{400}{3}$, activity 2-4 by 2 days costing Rs. 200 and activity 3-5 by 2 days costing Rs. 400. Addition Cost = Rs. $\frac{400}{3}$ + Rs. 200 + Rs. 400 = Rs. 733.33.

Project duration = 21 days.

No further crashing is possible. Hence the total additional cost for minimum project duration of 21 days is

Rs. 100 + Rs. 400 + Rs. 733.33 = Rs. 1233.33.