

PAPER – 5 : COST MANAGEMENT

QUESTIONS

Basic Cost Concepts for Decision Making

1. (a) "Costs may be classified in a variety of ways according to their nature and the information needs of the management" Explain.
- (b) Indicate the major areas of short-term decisions in which differential cost analysis is useful.
- (c) "Relevant cost analysis helps in drawing the attention of managers to those elements of cost which are relevant for the decision." Comment.

Marginal Costing

2. AB Ltd has two divisions A and B. Division A manufacture a product 'AAA' for industrial use whereas division B is manufactures the containers and stores product 'AAA' by using protective materials 'BBB'. AB Ltd is exploring the possibility of closing down the division B and outsource the work to an outside company X Ltd.

- (i) The details of expenses of division B during the previous year is as given below :

	For manufacturing Container (Rs)	For storing Product AAA (Rs)
Direct Material	6,35,000	
Cost of protective material BBB		1,75,000
Direct labour	2,50,000	1,20,000
Maintenance of Machine	96,000	
Depreciation of Machine	44,000	
Rent of warehouse		1,25,000
Manufacturing overheads	1,70,000	
Administrative overheads apportioned to division B	2,40,000	60,000

- (ii) X Ltd after full assessment of requirement offered to manufacture the containers at a cost of Rs 12,00,000 per annum on a contract basis and store the product 'AAA' at a cost of Rs 5,00,000 per annum.
- (iii) The stock of protective materials costing Rs 4,25,000 with division B, if disposed off, will fetch only 60% of its value.
- (iv) In case of closure of manufacturing department of division B, the terminal benefits to be given to employees who can be transferred to division A is estimated to be Rs 2,00,000 whereas the same for store is Rs 1,00,000.

(v) In case of closure of B, 75% of the administrative overheads of B will be curtailed.

(vi) Old machine of division B, if disposed off, would fetch Rs 1,50,000.

You are required to evaluate the following proposals on the basis of 5 years term, taking cost of capital 12% per annum :

Proposal 1 : Closing division B and manufacturing & storing may be given to X Ltd.

Proposal 2 : Continue division B for manufacturing & Storing may be given to X Ltd

Proposal 3 : Continue division for Storing only and manufacturing may be given to X Ltd.

Marginal Costing

3. (a) How is marginal costing different from absorption costing? What are the various limitations attributed to marginal costing?

(b) Jay Kay Limited is a single product manufacturing company. The following information relates to the months of May and June, 2009:

	May Rs.	June Rs.
(i) Budgeted Costs and Selling prices:		
Variable manufacturing cost per unit	2.00	2.20
Total fixed manufacturing cost (based on budgeted output of 25,000 units per month)	40,000	44,000
Total fixed marketing cost	14,000	15,400
Selling price per unit	5.00	5.50
(ii) Actual production and sales:		
	Units	Units
Production	24,000	24,000
Sales	21,000	26,500

(iii) There was no stock of finished goods at the beginning of May, 2009. There was no wastage or loss of finished goods during May or June, 2009.

(iv) Actual costs incurred corresponded to those budgeted for each month.

You are required to calculate the relative effects on the monthly operating profits of applying: (i) Absorption costing and (ii) Marginal costing.

Decision making

4. ABC Ltd is in the business of publishing, printing and distributing a range of catalogues and other manuals. The management have now decided to discontinue printing and distribution and concentrate solely on publishing. Instead of ABC Ltd, XYZ Ltd shall now print and distribute the range of catalogues and other manuals. This shall be done on behalf of ABC Ltd . commencing either at 30 June 2009 or 30 November, 2009. XYZ Ltd

will receive Rs. 65,000 per month for a contract which will commence either at 30 June, 2009 or 30 November 2009.

The results of ABC Ltd for a typical month are as follows:

	Publishing Rs. '000	Printing Rs. '000	Distribution Rs. '000
Salaries and wages	28	18	4
Materials and supplies	5.5	31	1.1
Occupancy costs	7	8.5	1.2
Depreciation	0.8	4.2	0.7

Information related to the possible closure proposals is as follows:

- (i) Two specialist staff from printing will be retained at their present salary of Rs. 1,500 each per month in order to fulfill a link function with XYZ Ltd. One further staff member will be transferred to publishing to fill a staff vacancy through staff turnover, anticipated in July. This staff member will be paid at his present salary of Rs. 1,400 per month which is Rs. 100 more than that of the staff member who is expected to leave. On closure all other printing and distribution staff will be made redundant and paid an average of two months redundancy pay.
- (ii) The printing department has a supply of materials (already paid for) which cost Rs. 18,000 and which will be sold to XYZ Ltd. for Rs. 10,000 if closure takes place on 30 June, 2009. Otherwise the material will be used as part of the July 2009 printing requirements. The distribution department has a contract to purchase pallets at a cost of Rs. 500 per month for July and August, 2009. A cancellation clause allows for non-delivery of the pallets for July and August for a one-off payment of Rs. 300. Non-delivery for August only will require a payment of Rs. 100. If the pallets are taken from the supplier, XYZ Ltd has agreed to purchase them at a price of Rs. 380 for each month's supply which is available. Pallet costs are included in the distribution material and supplies cost stated for a typical month.
- (iii) Company expenditure on apportioned occupancy costs to printing and distribution will be reduced by 15% per month if printing and distribution departments are closed. At present, 30% of printing and 25% of distribution occupancy costs are directly attributable costs which are avoidable on closure, whilst the remainder are apportioned costs.
- (iv) Closure of the printing and distribution departments will make it possible to sub-let part of the building for a monthly fee of Rs. 2,500 when space is available.
- (v) Printing plant and machinery has an estimated net book value of Rs. 48,000 at 30 June, 2009. It is anticipated that it will be sold at a loss of Rs. 21,000 on 30 June, 2009. If sold on 30 November, 2009 the prospective buyer will pay Rs. 25,000.

- (vi) The net book value of distribution vehicles at 30 June, 2009 is estimated as Rs. 80,000. They could be sold to the original supplier at Rs. 48,000 on 30 June, 2009. The original supplier would purchase the vehicles on 30 November, 2009 for a price of Rs. 44,000.

Required:

Using the above information, prepare a summary to show whether ABC Ltd. should close the printing and distribution departments on financial grounds on 30 June, 2009 or on 30 November, 2009. Explanatory notes and calculations should be shown. Ignore taxation.

Decision Making

5. Unique Products manufactures and sells in a year 20,000 units of a particular product to definite customers at a price of Rs.100 per unit. The concern has a capacity to produce 25,000 unit of the product per annum. To produce beyond 25,000 units per annum, the concern will have to install a new equipment at a cost of Rs.15 lakhs. The equipment will have a life span of 10 years and will have no residual value. There is an offer from a client to purchase 10,000 units of the product regularly at a price of Rs.90 per unit. The order accepted, will have to be over and above the existing level of production of 20,000 units.

The cost structure is as under:

	Per Unit
Direct Material	30
Direct Labour	20
Variable Overhead	10
Profit	20
Fixed Overhead	Rs. 4,00,000

During the coming year, it has been estimated that the cost of direct material, as company the current year will increase by 10%. Because of certain wage agreement direct labour will increase by 25%. Fixed overheads will increase by 10%. If the new order for 10,000 is accepted, fixed overheads will increase further by Rs.60,000 due to increased administrative charges.

You are required to analyse whether the concern should accept the order or instead of that try to secure order for the balance unused capacity, as available now, through some sales promotion expenses which will be Rs.50,000 per annum. Ignore financial charges for the new investment.

Areas of Decision Making

6. R Ltd. has spare capacity in two of its manufacturing departments – Department 4 and Department 5. A five-day week of 40 hours is worked, but there is only enough internal work for 3 days per week so that 2 days per week (16 hours) could be available in each department. R Ltd. has sold this time to another manufacturer, but there is some concern about the profitability of this work.

The accountant has prepared a table giving the hourly operating cost in each department. The summarised figures are as follows:

	Department 4	Department 5
	Rs.	Rs.
Power costs	40	60
Labour costs	40	20
Overhead costs	40	40
	120	120

The labour is paid on a time basis and there is no charge in the weekly wage bill whether or not the plant is working at full capacity. The overhead figures are based on firm's current overhead absorption rates (fixed and variable) when the departments are operating at 90% of full capacity (assume a 50 week year). The budgeted fixed overhead attributed to Department 4 is Rs. 36,000 p.a. and that for Deptt. 5 Rs. 50,400 p.a.

As a short term measure the company has been selling processing time to another manufacturer @ Rs. 70 per hour in either departments. The customer is willing to continue this arrangement and to purchase any spare time available, but R Ltd. is considering the introduction of a new product on a minor scale to absorb the spare capacity.

Each unit of the new product would require 45 minutes in Deptt. 4 and 20 minutes in Deptt. 5. The variable cost of the required input material is Rs. 10 per unit. The market study indicated as follows:

- (i) with a selling price of Rs. 100, the demand would be 1,500 units p.a.
- (ii) with a selling price of Rs. 110, the demand would be 1,000 units p.a.
- (iii) with a selling price of Rs. 120, the demand would be 500 units p.a.

You are required to calculate the best weekly programme for the spare time in the two manufacturing departments, to determine the best price to charge for the new product and to quantify the weekly gain that this programme and price should yield.

Standard Costing and variance Analysis

7. ABC Ltd manufactures a product '1+7 ASCS' at its plant at Faridabad, the maximum capacity of which is 200 units per month. Details of raw material which go into the making of 1 unit of '1+7 ASCS' are provided to you below;

S. No.	Raw Material description	Standard quantity per finished unit (No)	Standard purchase price per unit (Rs 00)
1	A	1	6
2	B	2	5
3	C	3	4
4	D	4	3

5	E	5	2
6	F	6	1

Standard Fixed overheads are Rs. 20,00,000 per month whereas the standard variable overhead rate has been estimated as equal to Rs. 1,400 per unit of finished good. You are required to compute the

- standard cost of the product
- compute the production volume variance in case the company produces and sells only 100 units of finished goods in the concerned month.
- compute the usage and material price variances considering the following actual data(actual production and sale: 100 units)

Raw material description	Actual quantity consumed (Nos)	Actual price(Rs 00)
A	102	7
B	201	6
C	310	5
D	415	4
E	540	3
F	610	2

- Assuming no deviations in the actual selling price (Rs 30,000) and the actual overheads from what was projected in standards , you are required to compute actual profits .

Standard Costing and Variance Analysis

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

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

Code	Budget	Actual
301	Rs. 30,000	Rs. 33,750
302	30,000	28,500
303	15,000	13,000
431	45,000	50,000
599	30,000	33,000
	1,50,000	1,58,250

At the end of the year, it was ascertained that

1. 6,750 new life policies had been issued.
2. the sales staff and underwriting staff received as salaries pay award of 12½% which had been back-dated to the beginning of the year and this had not been included in the budget.
3. expenses on codes 302, 303 and 431 are regarded as direct costs which vary with activity, and those on code 301 are treated as a direct fixed cost whilst those on code 599 are an indirect fixed cost.

You are required to

- (i) present a statement (or control report) for the life business manager showing the variances which have arisen,
- (ii) comment on the likely cause or causes for each variance identifying, so far as you can from the information given, how much of each variance arises from price differences and how much can be related to efficiency or inefficiency.

Pricing Decisions

9. (a) A manufacturer has three products X, Y, and Z. Currently sales, cost and selling price details and processing time requirements are as follows:

	Product X	Product Y	Product Z
Annual sales (units)	6000	6000	750
Selling price (Rs.)	20.00	31.00	39.00
Unit cost (Rs.)	18.00	24.00	30.00
Required per unit (hours)	1	1	2

The firm is working at full capacity (13,500 processing hours per year). Fixed manufacturing overheads are absorbed into unit costs by a charge of 200% of variable cost. This procedure fully absorbs the fixed manufacturing overhead. Assuming that:

- (i) processing time can be switched from one product line to another.
- (ii) The demand at current selling prices is:

Product X	Product Y	Product Z
11000	8000	2000

- (iii) The selling prices are not to be altered. You are required to calculate the best production programme for the next operating period and to indicate the increase in net profit that this should yield. In addition identify the shadow price of a processing hour.
- (b) A review of the selling prices is in progress and it has been estimated that, for each product, an increase in the selling price would result in a fall in demand at the rate of 2000 units for an increase of Rs.1 and similarly, that a decrease of Rs.1 would increase demand by 2000 units. Specifically the following price/demand relationships would apply:

Product X		Product Y		Product Z	
Selling Price Rs.	Estimated Demand	Selling Price Rs.	Estimated Demand	Selling Price Rs.	Estimated demand
24.50	2000	34.00	2000	39.00	2000
23.50	4000	33.00	4000	38.00	4000
22.50	6000	32.00	6000	37.00	6000
21.50	8000	31.00	8000	36.00	8000
20.50	10000	30.00	10000	35.00	10000
19.50	12000	29.00	12000	34.00	12000
18.50	14000	28.00	14000	33.00	14000

From this information you are required to calculate the best selling prices, the revised best production plan and the net profit that this plan should produce.

Pricing Decisions

10. Z Electronics Co (ZEC) has made an agreement with Tuzuki of Japan for import of kits of Automatic Washing Machine in completely knocked down (CKD) condition. The terms of agreement are :
- Tuzuki will supply some items keeping 20% margin on cost. These imported items are of value of 40% of FOB price of Washing Machine and balance 60% will be locally manufactured.
 - ZEC will pay a lump sum of Rs 300 lakhs for technical know how and drawing for manufacturing of 3 lakhs washing machines.
 - ZEC will also pay a royalty at 10% of selling price fixed by it in the local market less landed cost of imported kits and cost of locally procured components.

The following related information is also available :

- FOB price for washing machine is Rs 8000.
- Insurance & freight is Rs 300 per set of imported items

- (iii) Effective custom duty is @ 40% on CIF price
- (iv) Assembling & other overhead costs will be Rs 1,000 per set.
- (v) Expected profit is 20% on selling price

You are required to calculate the selling price of Washing machine (rounded to Rs 10)

Transfer Pricing

11. The interdivisional transfer prices at ABC Ltd are fixed by using a cost plus return on investment approach. The budget details for Division A for the year 2008-2009 are as follows;

Investment in Division A	Rs.
Fixed Assets	5,00,000
Current Assets	3,00,000
Debtors	2,00,000
Annual Fixed Cost for the Division	8,00,000
Variable cost per unit of the product	10
Budgeted volume	4,00,000 units per year
Desired ROI	28%

Determine the Transfer price for Division A?

Transfer Pricing

12. ABC Ltd which is manufacturing consumer products has two divisions Assembling and Finishing. The two divisions are operating as cost centres

- (i) Present activities and cost involved in Assembling division & Finishing division and in a year:

Assembly Division :

No of sets assembled : 12,000

Manufacturing of parts (including material) : Rs 6.00 lakhs

Parts purchased from market : Rs 4.00 lakhs

Other Variable cost : Welding cost : Rs 5 lakhs and Assembling cost : Rs 9.00 lakhs

Fixed cost for the unit : Rs 6 lakhs

25% of the production of Assembly division is sold in the market at a price of Rs 300 per set and 75% is transferred to Finishing Division at Rs 280

Cost incurred in Finishing Division :

Painting cost : Rs 5.00 lakhs

Polishing cost : Rs 1.00 lakhs

Other fixed cost Rs 4.00 lakhs.

Selling Price per set is Rs 450.

- (ii) Division Assembly has proposed for expansion of their division for an enhancement of capacity by 20% at a cost Rs 20 lakhs. It is indicated that there will be no change in factory fixed cost in the operation of additional volume of job. Division Assembly proposes to maintain the transfer to finishing division to the existing level and selling additional sets to market at present price.
- (iii) Division Finishing has proposed for a transfer of whole of the output of Assembly division at a price of Rs 280 per unit and the additional units can be sold in the market at existing price which will involve advertisement expenses to the extent of Rs 4.00 lakhs and fixed cost in the division will go up by Rs 1.00 lakhs.
- (iv) Assembly division claims that transfer rate of Rs 280 is irrational in a sense of undue favour to Finishing division at their cost and Finishing Division is given the advantage of market price for their products whereas the Assembly division is deprived of that advantage. Assembly division agreed to transfer the whole of its output to Finishing Division at a price of Rs 300.

You are required to give your recommendation assuming opportunity cost of capital is 15%

Target Costing

13. (a) What is Target Costing and list the steps involved in target costing process with the help of a block diagram.
- (b) 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.

Costing of Service Sector

14. HAL is an aircraft manufacturer that has introduced a new airplane model. It expects the plane to cost Rs. 150,000,000 to manufacture to (not including development cost) but their products have historically exhibited an 85% experience curve. Assuming the same experience rate will apply to this product.
1. Compute the cost of computing the each of the first five planes
 2. Compute the average cost per plane to produce the first 25 planes.

Activity Based Cost Management

- 15 ABC Ltd plans to use activity-based costing to determine its product costs. It presently, uses a single plantwide factory overhead rate for allocating factory overhead to products, based on direct labour hours. The total factory overhead cost is as follows:

Department	Factory overhead Rs.
Production Support	12,25,000
Production (factory overhead only)	<u>1,75,000</u>
Total cost	<u>14,00,000</u>

The Company determined that it performed four major activities in the Production Support Department. These activities, along with their budgeted costs, are as follows:

Production Support Activities	Budgeted Cost Rs.
Set up	4,28,750
Production control	2,45,000
Quality control	1,83,750
Materials management	<u>3,67,500</u>
Total	<u>12,25,000</u>

ABC Ltd estimated the following activity-base usage quantities and units produced for each of its three products:

Products	Number of Units	Direct Labour hours	Setups	Production Orders	Inspections	Material requisitions
Product K	10,000	25,000	80	80	35	320
Product L	2,000	10,000	40	40	40	400
Product M	<u>50,000</u>	<u>1,40,000</u>	<u>5</u>	<u>5</u>	<u>0</u>	<u>30</u>
Total cost	<u>62,000</u>	<u>1,75,000</u>	<u>125</u>	<u>125</u>	<u>75</u>	<u>750</u>

Instructions:

1. Determine the factory overhead cost per unit for Products K, L and M under the single plantwide factory overhead rate method. Use direct labor hours as the activity base.
2. Determine the factory overhead cost per unit for Products K, L and M under activity-based costing.
3. Which method provides more accurate product costing? Why?

Activity Based Cost Management

16. ALPHA Limited specializes in the distribution of pharmaceutical products. It buys from the pharmaceutical companies and resells to each of the three different markets.

- (i) General Supermarket Chains
- (ii) Drugstore Chains
- (iii) Chemist Shops

The following data for the month of April, 2009 in respect of ALPHA Limited has been reported:

	General Supermarket Chains	Drugstore Chains	Chemist Shops
Average revenue per delivery	Rs. 84,975	Rs. 28,875	Rs. 5,445
Average cost of goods sold per delivery	Rs. 82,500	Rs. 27,500	Rs. 4,950
Number of deliveries	Rs. 330	Rs. 825	Rs. 2,750

In the past, ALPHA Limited has used gross margin percentage to evaluate the relative profitability of its distribution channels.

The company plans to use activity –based costing for analysing the profitability of its distribution channels.

The Activity analysis of ALPHA Limited is as under:

Activity Area	Cost Driver
Customer purchase order processing	Purchase orders by customers
Line-item ordering	Line-items per purchase order
Store delivery	Store deliveries
Cartons dispatched to stores	Cartons dispatched to a store per delivery
Shelf-stocking at customer store	Hours of shelf-stocking

The April, 2009 operating costs (other than cost of goods sold) of ALPHA Limited are Rs. 8,27,970. These operating costs are assigned to five activity areas. The cost in each

area and the quantity of the cost allocation basis used in that area for April, 2009 are as follows:

Activity Area	Total costs in April, 2009	Total Units of Cost Allocation Base used in April, 2009
Customer purchase order processing	Rs. 2,20,000	5,500 orders
Line-item ordering	Rs. 1,75,560	58,520 line items
Store delivery	Rs. 1,95,250	3,905 store deliveries
Cartons dispatched to store	Rs. 2,09,000	2,09,000 cartons
Shelf-stocking at customer store	Rs. 28,160	1,760 hours

Other data for April, 2009 include the following:

	General Supermarket Chains	Drugstore Chains	Chemist Shops
Total number of orders	385	990	4,125
Average number of line items per order	14	12	10
Total number of store deliveries	330	825	2,750
Average number of cartons shipped per store delivery	300	80	16
Average number of hours of shelf-stocking per store delivery	3	0.6	0.1

Required:

- Compute for April, 2009 gross-margin percentage for each of its three distribution channels and compute ALPHA Limited's operating income.
- Compute the April, 2009 rate per unit of the cost-allocation base for each of the five activity areas.
- Compute the operating income of each distribution channel in April, 2009 using the activity-based costing information. Comment on the results. What new insights are available with the activity-based cost information?
- Describe four challenges one would face in assigning the total April, 2009 operating costs of Rs. 8,27,970 to five activity areas.

Business Environment & Life Cycle Costing

- What do you understand by MRP? What are its objectives?
 - Describe the concept of Back flushing as used in the JIT system. What problems need to be addressed before implementing such a concept? Briefly discuss.

- (c) What is product life cycle costing? What are the costs that you would include in product life cycle cost?

Total 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?

Budgeting Control and Performance Measurement

19. (a) Distinguish between fixed budget and flexible budget.
- (b) Explain the role of bench marking in continuous improvement in an organisation.
- (c) The performance of a company at two levels of operations during 2008-09 is as under:

Capacity utilisation	50%	60%
Direct materials	Rs.1,00,000	1,20,000
Direct wages	Rs.1,60,000	1,92,000
Production overheads	Rs.6,00,000	6,50,000
Adm. Overheads	Rs.1,20,000	1,20,000
Selling overheads	Rs.2,20,000	2,40,000

The company produced 12,000 units at 60% capacity utilisation. The profit margin is 20% on sales.

During the next year 2009-10, the company is poised for increasing the capacity utilisation to 75%. The company desires to have the same profit margin as in 2008-09. The following percentage changes in costs are expected to be applicable in the next year.

- Direct material prices will increase by 5%
- Direct wage rates will increase by 3%.
- Direct labour efficiency will fall by 4%.
- Variable production overheads will increase by 6%.
- Fixed production overheads will increase by 10% upto 80% capacity utilisation and by 22% thereafter.
- Variable selling expenses will increase by 10%.
- Fixed selling expense will increase by 8%.
- Administrative Overheads will increase by 15%.

The company expects to receive an export order for 3000 units while operating at 75% capacity utilisation. The anticipated export price offer is Rs.92 per unit.

Required:

- (i) Prepare a flexible budget for 2009-10 and determine the cost per unit of output at the capacity utilisation levels of 75% and 90%.
- (ii) Calculate the sales value and profit for 2009-10 at 75% capacity.
- (iii) Advise the management as to whether or not the export order at the price of Rs.92 per unit should be accepted.

Linear Programming

20. (a) The simplex tableau for a maximisation problem of linear programming is given below:

Product mix. (x_i)	x_1	x_2	s_1	s_2	Quantity (b_i)
x_2	1	1	1	0	10
s_2	1	0	-1	1	3
c_j	4	5	0	0	
z_j	5	5	5	0	50
$z_j - c_j$	1	0	5	0	

Answer the following questions, giving reasons in brief:

- (i) Is the above solution optimal?
 - (ii) Are there more than one optimal solution?
 - (iii) Is this solution degenerate?
 - (iv) Is this solution feasible?
 - (v) If s_1 is slack in machine A (in hours/week) and s_2 is slack in machine B (in hours/ week), which of these machines is being used to the full capacity when producing according to this solution?
 - (vi) A customer would like to have one unit of product x_1 and is willing to pay in excess of the normal price in order to get it. How much should the price be increased in order to ensure no reduction of profit?
 - (vii) Machine A (associated with slack s_1 , in hours/week) has to be shut down for repairs for 2 hours next week. What will be the effect on profits?
 - (viii) How many units of the two-product x_1 and x_2 are being produced according to this solution and what is the total profit?
- (b) (a) The management accountant of Atul Enterprises Ltd. has suggested that a linear programming model might be used for selecting the best mix of five possible products, A, B, C, D and E.

- (i) The following information is available:

	Per unit of product				
	A	B	C	D	E
	Rs.	Rs.	Rs.	Rs.	Rs.
Selling price	48	42	38	31	27
Costs:					
Materials	15	14	16	15	16
Direct labour	18	16	6	4	4
Fixed overheads*	9	8	3	2	2
Total costs	42	38	25	21	22
Net profits	6	4	13	10	5

*based on 50% of direct labour cost.

- (ii) Expected maximum unit demand per week for each product at the prices indicated:

A	B	C	D	E
1,500	1,200	900	600	600

- (iii) Cost of materials includes a special component, which is in short supply; it costs Rs.3 a unit. Only 5,800 units will be available to the company during the week. The number of units of the special component needed for a unit of each product is:

A	B	C	D	E
1	1	3	4	5

- (iv) Labour is paid at a rate of Rs.1.50 per hour and only 20,000 hours will be available in a week.
- (v) The management of Atul Enterprises Ltd. has ruled that expenditure on materials must not exceed a sum of Rs.30,000.
- (vi) All other resources are freely available in sufficient quantities for planned needs.

Formulate a linear programming model stating clearly the criterion you use.

The Transportation Problem

21. A ladies fashion shop wishes to purchase the following quantities of summer dresses:

Dress Size	I	II	III	IV
Quantity	100	200	450	150

Three manufacturers are willing to supply dresses. The quantities given below are the maximum they are able to supply of any given combination of orders for dresses:

Manufacturer	A	B	C
Total quantity	150	450	250

The shop expects the profit per dress to vary with the manufacturer as given below:

Manufacturer	Sizes			
	I	II	III	IV
	Rs.	Rs.	Rs.	Rs.
A	2.50	4.00	5.00	2.00
B	3.00	3.50	5.50	1.50
C	2.00	4.50	4.50	2.50

You are required to:

- use the transportation technique to solve the problem of how the orders should be placed on the manufacturers by the fashion shop in order to maximize profits: and
- explain how you know that there is no further improvement possible. Show your workings.

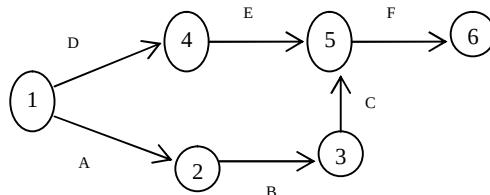
The Assignment Problem

- Methods engineer wants to assign four new methods to work centers. The assignment of new methods will increase Production (in units) and they are given below. If only one method can be assigned to a work center, determine the optimum assignment.

Work Center Methods	A	B	C
1	10	7	8
2	8	9	7
3	7	12	6
4	10	10	8

Critical Path analysis and PERT

- In the project net work shown in the figure given below, the nodes are denoted by numbers and activities by letters. The normal and crash durations of the various activities along with Costs are shown below.



Activity	Normal Duration (Days)	Normal cost (Rs.)	Crash Duration (Days)	Crash cost
A	8	1800	6	2200
B	16	1500	11	2200
C	14	1800	9	2400
D	12	2400	9	3000
E	15	800	14	2000
F	10	2000	8	4000

Determine the least cost for 36 days schedule.

Critical Path Analysis and PERT

24. The activities involved in a PERT project detailed below:

Job	Duration		
	a = optimistic	m = most likely	b = pessimistic
1-2	4	7	16
2-3	7	13	31
3-5	6	12	18
7-8	5	20	29
5-8	2	5	8
6-7	4	10	28
4-5	4	7	16
1-6	3	6	15
2-4	3	6	9

Required:

- Draw a net work diagram.
- Find the critical path after estimating the earliest and latest event times for all nodes.
- Find the probability of completing the project before 35 weeks.
- What is the chance of project duration exceeding 50 weeks?

Simulation

- An investment corporation wants to study the investment projects based on three factors: market demand in units, price per unit minus cost per unit and the investment is required. These factors are felt to be independent of each other. In analyzing a new consumer product, the corporation estimates the probability distributions.

Annual Demand		(Price-Cost) Per unit		Investment Required	
Units	Probability	Rs.	Probability	Rs.	Probability
20000	0.05	3.00	0.10	1750000	0.25
25000	0.10	5.00	0.20	2000000	0.50
30000	0.20	7.00	0.40	2500000	0.25
35000	0.30	9.00	0.20		
40000	0.20	10.00	0.10		
45000	0.10				
50000	0.05				

Using simulation process, repeat the trails 10 times, compute the return on investment for each trail taking these three factors into account .Approximately, what is the most likely return?

SUGGESTED ANSWERS

Basic Cost Concepts for Decision Making

1. (a) Cost classification is the process of grouping costs according to their characteristics. Costs are classified or grouped according to their common characteristics. Costs may be classified according to elements, according to functions or operations, according to their behaviour, according to controllability or according to normality.

The break up of the aggregate costs into relevant types, is an essential pre-requisite of decision making as well as of controlling costs. Classification of costs on different bases is thus necessary for various purposes. For the purpose of decision-making and control, costs are distinguished on the basis of their relevance to different type of decisions and control functions. The importance of distinguishing cost as direct or indirect lies in the fact that direct costs of a product or an activity can be accurately allocated while indirect costs have to be apportioned on the basis of certain assumptions. This is so because direct costs are controllable at the operational level whereas indirect costs are not amenable to such control.

- (b) Cost information is required both for short-term and long-run managerial problems. Differential costs are of particular use in short-term problems which are non-repetitive, onetime, ad-hoc problems. The following are the most common short-term problems and areas where differential costs analysis may be deployed.
 1. Accept – or – reject special order decisions.
 2. Make – or – buy decisions.
 3. Sell – or – process decisions.

4. Reduce – or – maintain price decisions.
 5. Add – or – drop product decisions.
 6. Operate – or shut down decisions.
- (c) Relevant costs are pertinent or valid costs for a decision. These bear upon or 'influence decision' and are directly related to the decisions to be made. These are critical to the decisions, and have significance for it. These are the costs which generally respond to managerial decision making, and have significance in arriving at correct conclusions. These costs are capable of making a difference in user-decisions and enter into a choice between alternative courses of action. In specific terms relevant costs for decisions are defined as "expected future costs that will differ under alternatives".

Relevant costs are futuristic in nature. These are the costs that are expected to occur during the time period covered by the decisions. These costs are different between alternative being considered. Only costs that differ among decisions alternatives are relevant to a decision.

Marginal Costing

2.

	Saving in case B discontinue Manufacturing	Saving in case B discontinue Storing
Direct Material / protective material	635	175
Direct Labour	250	120
Maintenance of Machine	96	
Depreciation of machine	44	
Rent of warehouse		125
Manufacturing overheads	170	
Reduction in administrative overheads	180	45
Total	1375	465

Evaluation of the proposals :

	Proposal 1	Proposal 2	Proposal 3
Saving of manufacturing expenses	1375		1375
Saving of storing expenses	465	465	
Total avoidable expenses (A)	1840	465	1375
Additional expenses to be incurred :			
Loss in sale of protective materials	170		170

Terminal benefit to employees	300	100	200
Total (B)	470	100	370
Net saving (A - B)	1370	365	1005
Sale value of Machine ©	150		150
Cash inflow in first year (D= A - B + C)	1520	365	1155
Contract value (E)	1700	500	1200
Net Cash flow in the first year(F= D - E)	-180	-135	-45
Cash flow in subsequent years (A - E)	140	-35	175
Cumulative cash flow value from 2nd year to 5th year (multiple factor 3.038 for 12%) (G)	425.32	-106.33	531.65
NPV (F + G)	245.32	-241.33	486.65

Hence, proposal 3 may be accepted i.e Division B may continue with storing and manufacturing may be given to outside firm X Ltd.

3. (a) Marginal Costing vs. Absorption Costing

1. While applying Marginal Costing only variable costs are considered for Product Costing and Inventory Valuation purposes whereas both fixed and variable costs are considered while using Absorption Costing.
2. Expenses are classified on the basis of their nature i.e, fixed or variable in Marginal Costing whereas the classification of expenses is done on the basis of functions while applying Absorption Costing.
3. Marginal Costing considers fixed costs as period costs whereas the same costs are considered to be inventoriable costs for Absorption Costing purposes.
4. Marginal Costing reports emphasise more on the Contribution quantum whereas Absorption Costing highlights Net Profits.
5. The difference in the magnitude of the opening and the closing stock does not effect the unit cost of production in case Product Costing is done using the Marginal Costing concepts. However, in case Absorption Costing is used the unit cost of production may be effected due to the impact of fixed overheads.
6. There is no related Volume Variance in case a Marginal Costing system is used. However, in case of an Absorption Costing system, Volume Variance plays a prominent role for decision making and control purposes.

Limitations of Marginal Costing

- ◆ The use of Marginal Costing necessitates the need to classify expenses as fixed and variable. Frequently most of the expenses are semi-variable and so

need to be divided amongst their variable and fixed components. This is difficult in practical situations.

- ◆ Contribution by itself is not a guide towards attaining optimum profitability. It needs to be interpreted along with the key factor.
- ◆ It is not practical to exclude overheads of fixed nature for valuing work-in-progress of large contracts. The use of Marginal Costing does not provide with useful results for decision making purposes nor does it give a correct valuation of the work-in-progress in such cases.
- ◆ Marginal Costing ignores the time factor as well as the investment involved for decision making purposes. For example two products may have the same Marginal Cost , however one of them can be produced in a shorter time and hence it should be the preferable produce. However , Marginal Costing ignores this time factor. Similarly the quantum of investment involved for alternative uses available are not considered in Marginal Costing.

(b) (a) Quantity tally:

		May 2009	June 2009
Opening Stock	units	—	3,000
Production	units	<u>24,000</u>	<u>24,000</u>
Total	units	<u>24,000</u>	<u>27,000</u>
Sales	units	21,000	26,500
Closing Stock	units	3,000	500
Fixed manufacturing overheads	Rs.	40,000	44,000
Budgeted output	units	25,000	25,000
Fixed overheads absorption rate per unit	Rs.	1.60	1.76

(i) Profitability based on absorption costing:

	May 2009	June 2009
	Rs.	Rs.
Sales:		
May: 21,000 units @ Rs. 5.00	1,05,000	
June: 26,500 units @ Rs. 5.50		1,45,750
Production Costs:		
Variable: May 24,000 units @ Rs. 2.00	48,000	
June 24,000 units @ Rs. 2.20		52,800
Fixed: May 24,000 units @ Rs. 1.60	38,400	
June 24,000 units @ Rs. 1.76		42,240

Total production costs	86,400	95,040
Add: Opening stock		
May Nil		
June 3,000 units @ Rs. 3.60*		10,800
Total	86,400	1,05,840
Less: Closing stock		
May 3,000 units @ Rs. 3.60*	10,800	
June 500 units @ Rs. 3.96*		1,980
Production cost of goods sold	75,600	1,03,860
Marketing fixed costs	14,000	15,400
Total cost of goods sold	<u>89,600</u>	<u>1,19,260</u>
Profit (Sales – COGS)	15,400	26,490
Budgeted output		
Actual output		
Shortfall		
Under recovery of fixed overheads		
May 1,000 units @ Rs. 1.60	1,600	
June 1,000 units @ Rs. 1.76		1,760
Net profit	<u>13,800</u>	<u>24,730</u>
*Total cost = VC + FC		
May $2.00 + 1.60 = 3.60$		
June $2.20 + 1.76 = 3.96$		

(ii) Profitability based on marginal costing:

	May 2009	June 2009
	Rs.	Rs.
Sales	1,05,000	1,45,750
Production cost – variable	48,000	52,800
Add: Opening stock		
May Nil		
June		<u>6,000</u>
Total	48,000	58,800
Less: Closing stock		
May 3,000 units @ Rs. 2.00	6,000	
June 500 units @ Rs. 2.20		1,100

Variable cost of goods sold			42,000	57,700
Contribution			63,000	88,050
Fixed costs:	May	June		
Production	40,000	44,000		
Marketing	14,000	15,400	54,000	59,400
Net profit			9,000	28,650

Decision Making

4. The costs/benefits of closing on 30 November, 2009 instead of closing on 30 June, 2009 are:

	Rs.	Rs.
Payments to XYZ Ltd avoided (5 months @ Rs. 65,000)		3,25,000
*Salaries and wages cost		
5 months @ (Rs. 18,000 + Rs. 4,000 – Rs. 3,000 + Rs. 1,300)		(1,01,500)
**Printing materials		
(5 months @ Rs. 31,000) – Rs. 18,000 + Rs. 10,000)		(1,47,000)
***Distribution materials		(5,280)
Occupancy costs		
****Printing	17,212.50	
*****Distribution	<u>2,175.00</u>	
		(19,387.50)
Loss of sub-letting income (5 months @ Rs. 2,500)		(12,500)
*****Additional loss on sale of plant		(2,000)
Additional loss on sale of vehicles (Rs. 48,000 – Rs. 44,000)		<u>(4,000)</u>
Net benefit of closing on 30 November		<u>33,332.50</u>

The plant should remain open until 30 November.

- * The total salaries equal Rs. 22,000 (Rs. 18,000 + Rs. 4,000) but two staff will be retained so the net saving of closing on 30 June is reduced by their salaries (Rs. 3,000 per month). If closure does not occur until November, the vacancy in the publishing department will need to be filled (at Rs. 1,300 per month) until closure in November when the transfer occurs. The redundancy pay will arise whenever closure occurs and is therefore irrelevant.
- ** The future cash outflow on printing materials is Rs. 31,000 per month for five months less the Rs. 18,000 held in stock. However, the opportunity to sell the stock is lost, therefore, there is an additional cost of Rs. 10,000.
- *** If the department is closed then the options are (from note (ii) in the question):

- (i) Accept both deliveries, pay for them and sell the goods to XYZ Ltd:
 $(2 \times \text{Rs. } 500) - (2 \times \text{Rs. } 380) = \text{Rs. } 240$ net cost.
- (ii) Accept the July delivery, pay for it, sell it to XYZ Ltd and pay the cancellation cost for August:
 $(\text{Rs. } 500 - \text{Rs. } 380) + \text{Rs. } 100 = \text{Rs. } 220$ net cost.
- (iii) Cancel both deliveries at a net cost of Rs. 300.

The lowest cost option would be selected if closure occurred, therefore this is a benefit of continuing to November.

The distribution material costs to November are (5 months @ Rs. 1,100) – Rs. 220 = Rs. 5,280.

**** Attributable costs are $[(\text{Rs. } 8,500 \times 30\%) + (\text{Rs. } 8,500 \times 70\% \times 15\%)] \times 5 \text{ months} = \text{Rs. } 17,212.50$.

***** Attributable costs are $[(\text{Rs. } 1,200 \times 25\%) + (\text{Rs. } 1,200 \times 75\% \times 15\%)] \times 5 \text{ months} = \text{Rs. } 2,175$.

*****	Rs.
Net book value	48,000
June sale	<u>21,000</u> loss
Therefore June proceeds	27,000
November proceeds	<u>25,000</u>
Additional loss	<u>2,000</u>

Decision Making

5. Comparative profit Statement (based on Revised Cost Structure)

	Proposal 1 Sell 20,000 units only	Proposal 2 Secure orders for 5,000 additional units (unused capacity) and sell 25,000 units	Proposal 3 Accept the new order for 10,000 additional units and sell 30,000 units
	Rs.	Rs.	Rs.
Total sales revenue (A)	20,00,000	25,00,000	29,00,000
	(Rs.20,000 units × Rs.100)	25,000 units × Rs.100	(20,000 units × 100 + 10000 units × 90)
Direct Material	6,60,000	8,25,000	9,90,000
	(20000 units × Rs. 33)	(25,000 units × Rs. 33)	(30,000 units × Rs. 33)
Director Labour	5,00,000	6,25,000	7,50,000

	(20,000 units × Rs.25)	(Rs.25,000 units × Rs. 25)	(30,000 units × Rs.25)
Variable overhead	2,00,000	2,50,000	3,00,000
	(20,000 units × Rs.10)	(25,000 units × Rs.10)	(30,000 units × Rs.10)
Fixed overheads	4,40,000	4,40,000	4,40,000
	(Rs.4,00,000+ Rs.40,000)		
Add: Administrative charges	-	-	60,000
Add: Sales promotion expenses	-	50,000	-
Depreciation (New equipment)			1,50,000
Total costs (B)	18,00,000	21,90,000	26,90,000
Profit (C) = [(A) – (B)]	2,00,000	3,10,000	2,10,000

Analysis

An analysis of the profit figures of M/s Unique products under three proposals clearly shows that it is maximum under proposal 2. Therefore, it is advisable for the concern to produce and sell 25,000 units @ Rs.100/- per unit and utilise its full production capacity.

Areas of Decision Making

- The relevant cost of producing the new product is the variable cost plus the lost contribution from selling the processing time to another manufacturer. It is given that, the main product will absorb 3 days per week.

Calculation of variable overhead rates

	Dept. 4	Dept. 5
Normal Hrs.per annum (0.9×40 hr×50 wks)	1,800 hrs	1,800hrs
Fixed O.H. rate/hr. (Rs.)	20 (36,000/1,800)	28(50,400/1800)
Total O.H. rate/hr (given) (Rs.)	40	40
Thus variable OH rate/hr (Rs.)	20	12

The variable costs per hour are:

Department 4 : Power Cost Rs 40 + Variable Cost Rs 20 = Rs 60

Department 5 : Power Cost Rs 60 + Variable Cost Rs 12 = Rs 72

Note: labour costs are fixed (given).

If the new product is not developed, dept. 4 shall sell unused processing time at Rs. 70 per hour. It is not profitable for Dept. 5 to sell processing time at Rs. 70 per hour since the variable costs is more at Rs. 72. Therefore the relevant cost per processing hour are

Dept. 4 Rs. 70 (Rs. 60 variable cost + Rs. 10 lost contribution for selling processing time)

Dept. 5 Rs. 72

Relevant cost for producing the new product

	Rs
Direct Material (Given)	10.00
Dept. 4, variable operating cost (0.75 hr × Rs. 70)	52.50
Dept. 5 variable operating cost (0.33 hr. × Rs. 72)	24.00
Relevant cost	86.50

Additional contribution for various selling prices/demand levels

	Rs.	Rs.	Rs.
Selling price per unit	100	110	120
Restricted demand (Units)	* 1067	1000	500
Relevant cost (Rs)	86.50	86.50	86.50
Contribution (Rs)	13.50	23.50	33.50
Total Contribution (Rs)	14,404.50	23,500	16,750

* Dept 4 (800 Hrs × $\frac{4}{3}$) = 1,067 units

* Dept. 5 (800 Hrs × 3) = 2400 units

Hence selling 1000 units @ Rs. 110 per unit will achieve optimum contribution.

Computation of spare time for production of 1,000 units pa

	Department 4	Department 5
Time required per unit (Hours)	$\frac{3}{4}$	$\frac{1}{3}$
Total time for producing 1,000 units (Hours)	750	334
Time available (Hours)	800	800
Spare time (Hours)	50	466
Spare time per week (Hours)	1	9.32

Therefore Dept 4 can sell 1 hr. per week at Rs. 70 per hour.

It is not profitable to sell spare capacity of 9.32 hrs. / week at the existing rate of Rs. 70 per hour.

Weekly gain from this programme

	Rs.
Selling price	110
Variable cost	
Direct materials	10
Dept. 4 variable operating cost 0.75×60	45
Dept. 5 variable operating cost 0.33×72	24
	79
Contribution / unit	31
Weekly sale	20 units
Additional contribution / week	620
Plus contribution of selling 1 hr (selling price – variable cost = 70-60)	10
Total contribution	630
Without the new product the weekly contribution 16 hours $\times$ Rs. 10 per hr	160
Additional gain for introducing the new product	470

Standard Costing and Variance Analysis

7. (a) Standard Cost Sheet

Description	Cost per unit of Finished Good
Standard Raw Material Cost	Rs 5,600
Variable Overheads	Rs 1,400
Standard Fixed Overheads	Rs 10,000
Standard Cost per Unit of Finished Good	Rs 17,000

(b) Production Volume Variance

Unutilised capacity $\times$ Standard Fixed Cost per Finished Good

$100 \times \text{Rs } 10,000 = \text{Rs } 10,00,000$ Adverse

(c) Usage and Material Price Variance (Actual Production : 100 Units)

Raw Mat.	Std Qty/F G	Std Qty on actual prod	Actual Qty on actual prod	Act Price per Ut of RM(Rs)	Std Price per Ut of RM (Rs)	Usage Variance (Rs)	Price Variance (Rs)
A	1	100	102	700	600	(1,200)	(10,200)
B	2	200	201	600	500	(500)	(20,100)

C	3	300	310	500	400	(4,000)	(31,000)
D	4	400	415	400	300	(4,500)	(41,500)
E	5	500	540	300	200	(8,000)	(54,000)
F	6	600	610	200	100	(1,000)	(61,000)
						(19,200)	(2,17,800)

(d)

Standard Profit (Rs 13,000 × 100)	Rs 13,00,000
Usage Variance	(19,200)
Price Variance	(2,17,800)
Production Volume Variance	(10,00,000)
Actual Profit	63,000

Standard Costing and Variance Analysis

8. (i) Control Report

Code		Fixed budget 7,500 units	Flexed Budget 6,750 units	Actual 6750	Variances
301	Sales salaries	Rs. 30,000	Rs. 30,000	33,750	Rs. 3750 (A)
302	Staff Commission	30,000	27,000	28,500	1,500 (A)
303	Staff expenses	15,000	13,500	13,000	500 (F)
431	Underwriting Staff	45,000	40,500	50,000	9,500 (A)
599	Other Admin Costs	30,000	30,000	33,000	3,000 (A)
		1,50,000	1,41,000	158,250	17,250 (A)

(ii) Sales Salaries. Rs. 3,750 (A) Rate Variance is due to unanticipated pay award.

Sales Commission – Rs. 3000 (F) is due to drop in activity and Rs. 1500 (A) may be due to increasing sales commission on selected policies or due to inefficiency.

Sales Expenses – Rs. 1500 reduction due to drop in activity and Rs. 500 (F) for improved control.

Underwriting Salaries – Rs. 4,500 (F) due to drop in activity, Rs. 5062 (A) due to unbudgeted salaries increases and Rs. 4,438 (A) due to inefficiency.

Other Administration – Rs. 3,000 (A) seem to have been caused by changes due to high cost suppliers or hiring temporary office staff

Product Pricing

9. (a) The question states that fixed manufacturing costs are absorbed into the unit costs

by a charge of 200% of variable cost. Therefore unit variable cost is one third of total unit cost.

Contribution per processing hour			
	Product X	Product Y	Product Z
Selling price	20	31	39
Variable cost	6	8	10
Production contribution	14	23	29
Contribution per processing hour	14	23	14.50
Ranking	3	1	2
Optimal programme			
	Output	Hours used	Contribution(Rs.)
Product Y	8000	8000	184000
Z	2000	4000	58.00
X	1500	1500	21.00
			263.00

Existing programme			
	Output	Hours used	Contribution(Rs.)
Product X	6000	6000	84,000
Y	6000	6000	1,38,000
Z	750	1500	21,750
			2,43,750

Contribution and profits will increase by Rs.19250 if the optimal production programme is implemented. An additional hour of processing would be used to increase product X by one unit, thus increasing contribution by Rs.14. Therefore the shadow price (or opportunity cost) of one scarce processing hour Rs.14.

Capacity is limited to 13500 hours. It is therefore necessary to allocate output on the basis of marginal contribution per hour. Products X and Y each require processing hour, whereas product Z requires 2 processing hours. To simplify the calculations, hours are allocated in 2000 blocks. Consequently, the allocation of the fiALPHA 2000 hours will yield a marginal contribution of Rs.37000 from X, RS.52000 from Y and 29500 from Z Note that an output of 2000 units of Z will require 4000 processing hours, and will yield a contribution of Rs.59,000 In other words, the marginal contributions for X and Y in the above schedule are expressed in terms of blocks of 2000 hours, whereas the marginal contribution for Z is expressed in terms of blocks of 4000 hours. To express the marginal contribution of

Z in terms of blocks of 2000 hours, if is necessary to divide the final column of the above schedule by 2.

Processing hours are allocated as follows.

	Hours	Marginal contribution(Rs.)
Product Y	FiALPHA 2000	52000
Y	Next 2000	48000
Y	2000	44000
Y	2000	40000
X	2000	37000
Y	2000	36000
X	1500 (balance)	24250
	13500	281250

Note

$$*3500 \times (\text{Rs.}23.50 - \text{Rs.}6) - \text{Rs.}37000 = \text{Rs.}24250$$

The optimum output is Rs.10,000 units of product B at a selling price of Rs.30 and 3500 units of Y at a selling price of Rs.23.50, and contribution will be maximized at Rs.2,81,250 . It is assumed that it is company policy to change selling prices only in steps of Rs.1

(b)

Demand	Product X			Product Y			Product Z		
	Price (Rs.)	Total contribut- ion (Rs,000)	Marginal contribut- ion (Rs,000)	Price (Rs.)	Total contribut- ion (Rs,000)	Marginal contribut- ion (Rs,000)	Price (Rs.)	Total contribut- ion (Rs,000)	Marginal contribut- ion (Rs,000)
2000	24.50	37	37	34	52	52	39.50	59	59
4000	23.50	70	33	33	100	48	39.00	116	57
6000	22.50	99	29	32	144	44	38.50	171	55
8000	21.50	124	25	31	184	40	38.00	224	53
10000	20.50	145	21	30	220	36	37.50	275	51
12000	19.50	162	17	29	252	32	37.00	324	49
14000	18.50	175	13	28	280	28	36.50	371	47

Pricing Decisions

10.

	(Rs)
FOB price of complete Washing Machine	8000
Value of imported items (40% of FOB price)	3200

Value of locally manufactured items (60% of FOB Price)	4800
A. Cost of imported Items :	
(i) FOB price of imported parts	3200
(ii) Freight & Insurance	300
(iii) CIF value	3500
(iv) Custom duty 40% on CIF value	1400
Landed cost of imported kits (iii) +(iv)	4900
B. Cost of material - both imported + local (4800 +4900)	9700
C. Assembling cost	1000
D. Technical know how cost per machine	100
E. Total cost excluding royalty (B+ C + D)	10800
F. Royalty	434
G. Total Cost	11234
H. Profit (25% of Cost)	2806
Selling Price of Washing Machine (G + H)	14040

Working note for calculation of royalty :

$$\begin{aligned}
 \text{Let Royalty} &= X \\
 \text{Cost} &= (10800 + X) \\
 \text{Selling price} &= (10800 + X) \times 1.25 \\
 &= (13500 + 1.25 X) \\
 \text{Royalty} &= (\text{Selling Price} - \text{landed cost of imported kits} - \text{landed cost of local items}) \times 0.10 \\
 \text{Or } X &= (13500 + 1.25 X - 9700) \times 0.10 \\
 \text{Or } X &= 380 + 0.125 X \\
 \text{Or } 0.875 X &= 380 \\
 \text{Or } X &= 434
 \end{aligned}$$

Transfer Pricing

11. Assumptions

Investments include fixed assets and net working capital.

Current liabilities and creditors may be taken as nil as they have been not been provided for in the question.

Investments	Rs	Rs
Fixed Assets		5,00,000
Net working capital		

Current Assets	3,00,000	
Debtors	2,00,000	5,00,000
Total investments		10,00,000
The desired rate of return is 28%		
Therefore the profit margin = 28% of Rs 10,00,000		
	= Rs 2,80,000	
Budgeted volume	= 4,00,000 units	
Profit margin per unit	= Re 0.70	
Fixed cost per unit	= Rs 2.00	
(Rs 8,00,000 ÷ 4,00,000 units)		
Variable cost per unit	=Rs 10.00	
Transfer price per unit	= Rs 12.70	

Transfer Pricing

12.

(i) Existing profitability of divisions & company		
Assembly Division		Rs lakhs
Total Sales value (3000 x 300 + 9000 x 280)		34.20
Total Variable cost for Division		24.00
Contribution		10.20
Fixed cost		6.00
profit for division Assembly		4.20
Finishing Division		
Total sales value 9000 set @ Rs 450		40.50
Variable cost (9000 x 280) + 6 lakhs		31.20
Contribution		9.30
Fixed Cost		4.00
Profit for division Finishing		5.30
Total Profit of the company		9.50
(ii) Evaluation of the proposal : Expansion of assembly division & transfer to Finishing division at existing level		
Total Sales value (5400 x 300 + 9000 x 280)		41.40
Total Variable cost for Division (24 x 1.2)		28.80
Contribution		12.60

Fixed cost + opportunity cost of capital invested (6.00 +20 x 0.15)	9.00
Profit for division Assembly	3.60
Finishing Division	
Total sales value 9000 set @ Rs 450	40.50
Variable cost (9000 x 280) + 6 lakhs	31.20
Contribution	9.30
Fixed Cost	4.00
Profit for division Finishing	5.30
Total Profit of the company	8.90
(iii) Evaluation of the proposal : Expansion of assembly division & transfer of whole assembly output to Finishing division at a price of Rs 280	
Assembly Division	
Total Sales value (14400 x 280)	40.32
Total Variable cost for Division (24 x 1.2)	28.80
Contribution	11.52
Fixed cost + opportunity cost of capital invested (6.00 +20 x 0.15)	9.00
Profit for division Assembly	2.52
Finishing Division	
Total sales value 14400 set @ Rs 450	64.80
Variable cost (14400 x 280) + 6 lakhs	46.32
Contribution	18.48
Fixed Cost + Advertisement cost	9.00
Profit for division Finishing	9.48
Total Profit of the company	12.00
(iv) Evaluation of the proposal : Expansion of assembly division & transfer of whole assembly output to Finishing division	
Total Sales value (14400 x 300)	43.20
Total Variable cost for Division (24 x 1.2)	28.80
Contribution	14.40
Fixed cost + opportunity cost of capital invested (6.00 +20 x 0.15)	9.00
Profit for division Assembly	5.40
Finishing Division	
Total sales value 14400 set @ Rs 450	64.80
Variable cost (14400 x 300) + 6 lakhs	49.20

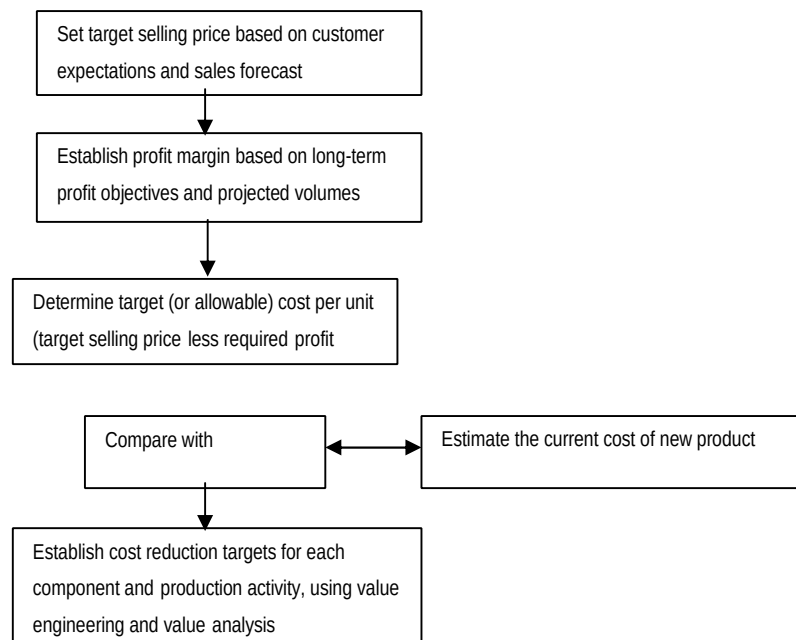
Contribution	15.60
Fixed Cost + Advertisement cost	9.00
Profit for division Finishing	6.60
Total Profit of the company	12.00

The proposal (iv) i.e transfer of all units from Assembly to Finishing Division at a transfer price of Rs 300 is recommended. With adoption of this price, profitability of the company as a whole will go up and each division will get its due share of profitability.

Target Costing

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

Target Costing Process



(b) 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 Ltds 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

Costing of Service Sector

14. Using the 85% experience curve the cost of first five planes should be approximately

$$T_1 = \text{Rs. } 150,000,000 \times 1.0000 = \text{Rs. } 150,000,000$$

$$T_2 = \text{Rs. } 150,000,000 \times 0.8500 = \text{Rs. } 127,500,000$$

$$T_3 = \text{Rs. } 150,000,000 \times 0.7730 = \text{Rs. } 115,950,000$$

$$T_4 = \text{Rs. } 150,000,000 \times 0.7230 = \text{Rs. } 108,450,000$$

$$T_5 = \text{Rs. } 150,000,000 \times 0.6860 = \text{Rs. } 102,900,000$$

From the 85% column in table the total time factor for 25 units is 14.801, so the total cost for the 25 planes will be Rs. $150,000,000 \times 14.801 = \text{Rs. } 2,220,150,000$. Dividing this by 25 gives the average cost of Rs. 88,806,000.

Activity Based Cost Management

$$15. \quad 1. \quad \text{Single plantwide factory overhead rate} = \frac{\text{Rs. } 14,00,000}{1,75,000 \text{ direct labour hours}}$$

$$= \text{Rs. } 8 \text{ per direct labour hour}$$

Factory overhead cost per unit:

	Product K	Product L	Product M
Number of direct labour hours	25,000	10,000	1,40,000
Single plant wide factory overhead rate	<u>$\times \text{Rs. } 8/\text{dlh}$</u>	<u>$\times \text{Rs. } 8/\text{dlh}$</u>	<u>$\times \text{Rs. } 8/\text{dlh}$</u>
Total factory overhead	Rs. 2,00,000	Rs. 80,000	Rs. <u>11,20,000</u>
Number of units	<u>$\div 10,000$</u>	<u>$\div 2,000$</u>	<u>$\div 50,000$</u>
Cost per unit	<u>Rs. 20.00</u>	<u>Rs. 40.00</u>	<u>Rs. 22.40</u>

2. Under activity-based costing, an activity rate must be determined for each activity pool:

Activity	Activity Cost Pool Budget	÷	Estimated Activity Base	=	Activity Rate
Set up	Rs. 4,28,750	÷	125 set ups	=	Rs. 3,430 per setup
Production control	Rs. 2,45,000	÷	125 production orders	=	Rs. 1,960 per production order

Activity	Activity Cost Pool Budget	÷	Estimated Activity Base	=	Activity Rate
Quality control	Rs. 1,83,750	÷	75 inspections	=	Rs. 2,450 per inspection
Materials management	Rs. 3,67,500	÷	750 requisitions	=	Rs. 490 per requisition
Production	Rs. 1,75,000	÷	1,75,000 direct labour hours	=	Rs. 1 per direct labour hour

These activity rates can be used to determine the activity-based factory overhead cost per unit as follows:

Product K

Activity	Activity –Base Usage	×	Activity Rate	=	Activity Cost
Set up	80 setups	×	Rs. 3,430	=	Rs. 2,74,400
Production control	80 production orders	×	1,960	=	1,56,800
Quality control	35 inspections	×	2,450	=	85,750
Materials management	320 requisitions	×	490	=	1,56,800
Production	25,000 direct labour hours	×	1	=	<u>25,000</u>
Total factory overhead					Rs.6,98,750
Unit volume					<u>÷ 10,000</u>
Factory overhead cost per unit					<u>Rs. 69.88</u>

Product L

Activity	Activity –Base Usage	×	Activity Rate	=	Activity Cost
Set up	40 setups	×	Rs. 3,430	=	Rs. 1,37,200
Production control	40 production orders	×	1,960	=	78,400
Quality control	40 inspections	×	2,450	=	98,000
Materials management	400 requisitions	×	490	=	1,96,000

Production	10,000 direct labour hours	×	1	=	<u>10,000</u>
Total factory overhead					Rs.5,19,600
Unit volume					<u>÷ 2,000</u>
Factory overhead cost per unit					<u>Rs. 259.80</u>

Product M

Activity	Activity –Base Usage	×	Activity Rate	=	Activity Cost
Set up	5 setups	×	Rs. 3,430	=	Rs. 17,150
Production control	5 production orders	×	1,960	=	9,800
Quality control	0 inspections	×	2,450	=	0
Materials management	30 requisitions	×	490	=	14,700
Production	1,40,000 direct labour hours	×	1	=	<u>1,40,000</u>
Total factory overhead					Rs.1,81,650
Unit volume					<u>÷ 50,000</u>
Factory overhead cost per unit					<u>Rs. 3.63</u>

3. Activity-based costing is more accurate, compared to the single plant wide factory overhead rate method. Activity-based costing properly shows that Product M is actually less expensive to make, while the other two products are more expensive to make. The reason is that the single plant wide factory overhead rate method fails to account for activity costs correctly. The setup, production control, quality control, and materials management activities are all performed on products in rates that are different from their volumes. For example, Product L requires many of these activities relative to its actual unit volume. Product L requires 40 setups over a volume of 2,000 units (average production run size = 50 units), while Product M has only 5 setups over 50,000 units (average production run size = 10,000 units). Thus, Product L requires greater support costs relative to Product M.

Product M requires minimum activity support because it is scheduled in large batches and requires no inspections (has high quality) and few requisitions. The other two products exhibit the opposite characteristics

Activity Based Cost Management

16. (i)

ALPHA Limited's

Statement of operating income and gross margin percentage for each of its three distribution channel

	General Super Market Chains	Drugstore Chains	Chemist Shops	Total
Revenues: (Rs.)	2,80,41,750 (330 x Rs. 84,975)	2,38,21,875 (825 x Rs. 28,875)	1,49,73,750 (2,750 x Rs. 5,445)	6,68,37,375
Less: Cost of goods sold: (Rs.)	2,72,25,000 (330 x Rs 82,500)	2,26,87,500 (825 x Rs 27,500)	1,36,12,500 (2,750 x Rs 4,950)	635,25,000
Gross Margin: (Rs.)	8,16,750	11,34,375	13,61,250	33,12,375
Less: Other operating costs: (Rs)				<u>8,27,970</u>
Operating income: (Rs.)				<u>24,84,405</u>
Gross Margin	2.91%	4.76 %	9.09%	4.96%
Operating income %				3.72

(ii) Computation of rate per unit of the cost allocation base for each of the five activity areas for April 2009

	Rs.
Customer purchase order processing (Rs. 2,20,000/ 5,500 orders)	40/ order
Line item ordering (Rs. 1,75,560/ 58,520 line items)	3/ line item order
Store delivery (Rs. 1,95,250/ 3,905 store deliveries)	50/ delivery
Cartons dispatched (Rs. 2,09,000/ 2,09,000 dispatches)	1/ dispatch
Shelf-stocking at customer store (Rs.) (Rs. 28,160/ 1,760 hours)	16/ hour

(iii) Operating Income Statement of each distribution channel in April-2009 (Using the Activity based Costing information)

	General Super market Chains	Drugstore Chains	Chemist Shops
Gross margin (Rs.) : (A)	8,16,750	11,34,375	13,61,260
(Refer to (i) part of the answer)			

Operating cost (Rs.) : (B) (Refer to working note)	1,62,910	1,90,410	4,74,650
Operating income (Rs.) : (A–B)	6,53,840	9,43,965	8,86,600
Operating income (in %) (Operating income/ Revenue) x 100	2.33	3.96	5.96

Comments and new insights: The activity-based cost information highlights, how the 'Chemist Shops' uses a larger amount of ALPHA Ltd's resources per revenue than do the other two distribution channels. Ratio of operating costs to revenues, across these markets is:

General supermarket chains (Rs. 1,62,910/ Rs. 2,80,00,750) x 100	0.58%
Drug store chains (Rs. 1,90,410/ Rs. 2,38,21,875) x 100	0.80%
Chemist shops (Rs. 4,74,650/ Rs. 1,49,73,750) x 100	3.17%

Working note:

Computation of operating cost of each distribution channel:

	General Super market Chains Rs.	Drugstore Chains Rs.	Chemist Shops Rs.
Customer purchase order processing	15,400 (Rs. 40 x 385 orders)	39,600 (Rs. 40 x 990 orders)	1,65,000 (Rs. 40 x 4125 orders)
Line item ordering	16,170 (Rs. 3 x 14 x 385)	35,640 (Rs. 3 x 12 x 990)	1,23,750 (Rs. 3 x 10 x 4125)
Store delivery	16,500 (Rs. 50 x 330 deliveries)	41,250 (Rs. 50 x 825 deliveries)	1,37,500 (Rs. 50 x 2750 deliveries)
Cartons dispatched	99,000 (Re. 1 x 300 cartons x 300 deliveries)	66,000 (Re. 1 x 80 cartons x 825 deliveries)	44,000 (Re. 1 x 16 cartons x 2,750 deliveries)
Shelf stocking	15,840 (Rs. 16 x 330 deliveries x 3 Av. hrs.)	7,920 (Rs. 16 x 825 deliveries x 0.6 Av. hrs)	4,400 (Rs. 16 x 2,750 deliveries x 0.1 Av. hrs)
Operating cost	1,62,910	1,90,410	4,74,650

- (iv) Challenges faced in assigning total operating cost of Rs. 8,27,970 :
- Choosing an appropriate cost driver for activity area.
 - Developing a reliable data base for the chosen cost driver.
 - Deciding, how to handle costs that may be common across several activities.
 - Choice of the time period to compute cost rates per cost driver.
 - Behavioural factors.

Business Environment & Life Cycle Costing

17. (a) 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.

MRP is designed to answer three questions: what is needed, how much is needed, and when is it needed. The primary inputs of MRP are a bill of materials, which tells what goes into a finished product; a master schedule, which tells how much finished product is desired and when; and an inventory-records file, which tells how much inventory is on hand or on order. This information is processed, using various computer programs to determine the net requirements for each period of the planning horizon. Outputs from the process include planned-order schedules, order releases, changes, performance-control reports, planning reports, and exception reports.

An MRP system is intended to simultaneously meet the following 3 objectives:

1. Ensure materials and products are available for production and delivery to customers.
2. Maintain the lowest possible level of inventory.
3. Plan manufacturing activities, delivery schedules and purchasing activities.

For further details please refer to chapter 10 of the Institute's Cost Management book.

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

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

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

- (i) The total production quantity entered into the system must be absolutely correct, if not, then wrong components and quantities will be subtracted from the stock.
 - (ii) All abnormal scrap must be diligently tracked and recorded. Otherwise materials will fall outside the back flushing system and will not be charged to inventory.
 - (iii) Lot tracing is impossible under the back flushing system. This is required when a manufacturer needs to keep records of which production lots were used to create a product in case all the items in a lot need be recalled.
 - (iv) The inventory balance may be too high at all times because the back flushing transactions that relieves inventory usually does so only once a day, during which time other inventory is sent to the production process. This makes it difficult to maintain an accurate set of inventory records in the warehouse.
- (c) Product life cycle costing traces costs and revenues of each product over several calendar periods throughout their entire life cycle.

The costs are included in different stages of the product life cycle.

Development phase – R & D cost / Design cost.

Introduction phase – Promotional cost / Capacity costs.

Growth phase/Maturity–Manufacturing cost/Distribution costs/Product support cost.

Decline/Replacement phase - Plants reused/sold/scrapped/related costs.

Total Quality Management & Value Chain Analysis

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 prepositions 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.

Budgeting Control and Performance Measurement

19. (a) Distinction between fixed budget and flexible budget:

- Fixed budget does not change with the change in the volume of activity attained whereas the flexible budget changes in accordance with the activity attained.
- Fixed budget operates at one level of activity and under one set of conditions flexible budget consists of a series of budgets at different levels of activity.
- In fixed budget both fixed and variable costs are related to only one level of activity and hence the variance analysis does not serve any useful purpose. In flexible budgeting since budgets are flexed to the level of activity attained, control is facilitated.
- In fixed budgeting, if the actual activity attained differs significantly cost ascertainment and price fixation are rendered difficult. Flexible budgeting facilitates correct ascertainment of costs and facilitates price quotations.
- Comparison of actual performance with the budgeted targets is meaningless in fixed budgets whereas such comparisons in flexible budgets provide a meaningful basis of performance measurement.

(b) Bench marking is a technique which is being adopted as a mechanism for achieving continuous improvement. It is a continuous process of measuring a company's products, services or activities against the other best performing organizations either internal or external to the company. The objective is to ascertain how the processes and activities can be improved. The latest developments, best practices and model examples can be incorporated within various operations of the business of the company. It represents an ideal way of achieving high competitive standards.

(c) Year 2008-2009

At 60% production 12,000 units

At 50% production 10,000 units

Production overheads:

	Rs.		
12,000 units	6,50,000	Total cost of 12,000 units	6,50,000
<u>10,000 units</u>	<u>6,00,000</u>	Variable cost @ Rs. 25/- per unit	<u>3,00,000</u>
2,000 units	50,000	Fixed costs	3,50,000

Selling overheads:

Units	Rs.		
12,000	2,40,000	Total cost of 12,000 units	2,40,000
<u>10,000</u>	<u>2,20,000</u>	Variable cost @ Rs.10/- per unit	<u>1,20,000</u>
2,000	20,000	Fixed costs	1,20,000

Flexible budget for 2009-10:

Account	Cost @ 60%	Increase	Revised @ 60%	75%	90%
Units				15,000	18,000
Materials	1,20,000	5%	1,26,000	1,57,500	1,89,000
Labour	1,92,000	3%	1,97,760	1,97,760	
	Efficiency fall	4%	2,06,000	2,57,500	3,09,000
Production					
Overheads V	3,00,000	6%	3,18,000	3,97,000	4,77,000
F	3,50,000	10%	3,85,000	3,85,000	4,27,000
Admn.Overheads	1,20,000	15%	1,38,000	1,38,000	1,38,000
F					
Selling	1,20,000	10%	1,32,000	1,65,000	198,000
overheads V					
F	1,20,000	8%	1,29,600	<u>1,29,600</u>	<u>1,29,600</u>
Total				16,30,100	18,67,600
				108.67	103.67

Cost per unit

At 75% capacity : Profit 20%

$$\therefore \text{Sales} = \frac{16,30,100 \times 100}{80} = 20,37,625$$

$$\text{Profit} = 20,37,625 - 16,30,100 = \text{Rs.}4,07,525$$

$$\text{Incremental cost of 3,000 units} = (16,30,100 - 18,67,600) = \text{Rs.}2,37,500$$

$$\text{Incremental cost per unit} = 79.17 \text{ S.P offered is Rs.92}$$

Hence the export order is acceptable

Linear Programming

20. (a) (i) The solution is optimal, since all the elements in the last row are non-negative.
- (ii) No, because the elements in the last row under non-basic variables x_1 and s_1 are strictly positive.
- (iii) No, because none of the basic variables x_2 or s_2 is zero.
- (iv) Yes, because the values of basic variable x_2 and s_2 are non-negative.
- (v) Machine A is being used to the full capacity because the value of slack variable s_1 is zero in the optimum simplex table. This indicates that the entire time (in hours/week) is consumed by the activities of the model.

(vi) From the given table, the element in the last row under x_1 is 1; therefore, an increase of x_1 from its current zero level to a positive level will mean the reduction in the total profit at the rate of unity per week. Hence in order to ensure that there should not be any reduction, price of x_1 should be increased by Re. one.

(vii) There will be no effect on the profits as s_1 is not in the final basis.

(viii) $x_1=0$ and $x_2 = 10$ with total profit of Rs.50.

- (b) To formulate a linear programming model based on the given data, an objective function in contribution terms is required. (The “net profit” figures per unit of product include an arbitrary absorption of fixed overheads. This will lead to a distortion of the appropriate product mix.)

Let the decision variable x_1, x_2, x_3, x_4 and x_5 represent the units of products A, B, C, D and E to be produced.

Then, the objective function is to maximise the contribution i.e.

$$\text{Maximise } C = 15x_1 + 12x_2 + 16x_3 + 12x_4 + 7x_5$$

subject to the following constraints:

$$\begin{array}{rcl} x_1 & \leq & 1,500 \\ x_2 & \leq & 1,200 \\ x_3 & \leq & 900 \\ x_4 & \leq & 600 \\ x_5 & \leq & 600 \end{array} \quad \left. \vphantom{\begin{array}{rcl} x_1 & \leq & 1,500 \\ x_2 & \leq & 1,200 \\ x_3 & \leq & 900 \\ x_4 & \leq & 600 \\ x_5 & \leq & 600 \end{array}} \right\} \text{ (expected maximum demand constraints)}$$

$$x_1 + x_2 + 3x_3 + 4x_4 + 5x_5 \leq 5,800 \quad \text{(special component constraint)}$$

$$12x_1 + 10\frac{2}{3}x_2 + 4x_3 + 2\frac{2}{3}x_4 + 2\frac{2}{3}x_5 \leq 20,000 \quad \text{(labour hours constraint)}$$

$$15x_1 + 14x_2 + 16x_3 + 15x_4 + 16x_5 \leq 30,000 \quad \text{(material expenditure constraint)}$$

$$x_1, x_2, x_3, x_4, x_5 \geq 0 \quad \text{(non-negativity conditions)}$$

The Transportation Problem

21. (a) .The total requirements of shops are = 100 + 200 + 450 + 150 = 900 dresses. But, the availability is only 150 + 450 + 250 = 850 dresses. Accordingly a dummy manufacturer capable of providing 50 dresses must be included so that the table balances. The dummy will be given zero profit per dress. The initial allocations as made in the loss matrix to give maximum profit are as follows:

Table 1

Manufacturer	Size				Quantity Available
	I	II	III	IV	
A	100 3.00	1.50	0.50	50 3.50	150
B	2.50	2.00	450 0.00	4.00	450
C	3.50	200 1.00	1.00	50 3.00	250
Dummy	5.50	5.50	5.50	50 5.50	50
Quantity Required by shops	100	200	450	150	900 900

The number of allocations is six. Whereas $m + n - 1 = 7$. It means a degenerate situation exists. Accordingly a small allocation ' ϵ ' must be made, so that the shadow profits can be calculated. Cell A/III will be deemed to occupy the said allocation. We introduce $u_i, v_j, i = (1, 2, 3, 4) \quad j = (1, 2, 3, 4)$ such that $(u_i + v_j) = C_{ij}$ for allocated cells. We assume $u_1 = 0$, and remaining u_i 's and v_j 's are calculated as below and are shown in the Table 2.

Table 2

Manufacturer	Size				Quantity Available	u_i 's
	I	II	III	IV		
A	100 3.00	1.50	ϵ 0.50	50 3.50	150	$u_1 = 0$
B	2.50	2.00	450 0.00	4.00	450	$u_2 = (-0.5)$
C	3.50	200 1.00	1.00	50 3.00	250	$u_3 = (-0.5)$
Dummy	5.50	5.50	5.50	50 5.50	50	$u_4 = 2$
Quantity Required by shops	100	200	450	150	900 900	
v_j 's	$v_1 = 3.00$	$v_2 = 1.50$	$v_3 = 0.50$	$v_4 = 3.50$		

Compute $C_{ij} - (u_i + v_j)$ for all of the non-allocated cells. Since it is positive for all of the non-allocated cells, hence the initial solution is an optimal one. The maximum profit of the concern in this case is computed as below:

The following table shows the allocations, which will yield the optimal profit.

Manufacturer	Size	Quantity	Profit / Unit Rs.	Total Profit Rs.
A	I	100	2.50	250
	IV	50	2.00	100
B	III	450	5.50	2,475
C	II	200	4.50	900
	IV	50	2.50	<u>125</u>
Total Profit				3,850

- (b) No improvement to this profit is possible because of actual/shadow profit comparison given in Table 2. Where there is zero difference, it means alternative solution is possible. For example, some dresses could be ordered from manufacturer A in Sizes II, III and from manufacturer B in size I.

Working Notes:

Values relating to Table 2

Occupied Cells, $C_{ij} = u_i + v_j$

Cell A, I $\Rightarrow u_1 + v_1 = 3.00$

Since $u_1 = 0$, therefore $v_1 = 3.00$

Cell A, III $\Rightarrow u_1 + v_3 = 0.50$

Since $u_1 = 0$, therefore $v_3 = 0.50$

Cell A, IV $\Rightarrow u_1 + v_4 = 3.50$

Since $u_1 = 0$, therefore $v_4 = 3.50$

Cell B, III $\Rightarrow u_2 + v_3 = 0$

Since $v_3 = 0.50$, therefore $u_2 = (-0.50)$

Cell C, IV $\Rightarrow u_3 + v_4 = 3$

Since $v_4 = 3.5$ therefore $u_3 = (-0.5)$

Cell C, II $\Rightarrow u_3 + v_2 = 1$

Since $u_3 = (-0.5)$; therefore $v_2 = 1.50$

Consider Dummy, IV $\Rightarrow u_4 + v_4 = 5.50$

Since $v_4 = 3.50$ therefore $u_4 = 2.00$

Unoccupied cells:

Compute $\Delta_{ij} = C_{ij} - (u_i + v_j)$

Cell A, II $\Rightarrow 1.50 - (0 + 1.50) = 0$

Cell B, I $\Rightarrow 2.50 - (-0.5 + 3.00) = 0$

Cell B, II $\Rightarrow 2.00 - (-0.5 + 1.50) = 1$

Cell B, IV $\Rightarrow 4.00 - (-0.5 + 3.50) = 1$

Cell C, I $\Rightarrow 3.50 - (-0.5 + 3.00) = 1$

Cell C III $\Rightarrow 1 - (-0.5 + 0.5) = 0$

Cell Dummy, I $\Rightarrow 5.50 - (2 + 3) = 0.50$

Cell Dummy, II $\Rightarrow 5.50 - (2 + 1.5) = 2$

Cell Dummy, III $\Rightarrow 5.50 - (2 + 0.5) = 3$

The Assignment Problem

22. (a) This problem is of maximization and is also unbalanced. Introducing one more column for a fictitious work center (say D) in order to get balanced assignment problem.

Work Center ↓ Methods →	A	B	C	D
1	10	7	8	0
2	8	9	7	0
3	7	12	6	0
4	10	10	8	0

For converting it into the minimization problem subtract every element from the maximum element i.e. 12.

Work Center ↓ Methods →	A	B	C	D
1	2	5	4	2
2	4	3	5	2
3	5	0	6	2
4	2	2	4	2

Apply Hungarian rule for obtaining the solution.

Work Center ↓ Methods →	A	B	C	D
1	0	3	0	1
2	1	0	0	0
3	5	0	4	3
4	0	0	0	1

Since the minimum number of lines drawn are equal to four. Hence we arrive at the solution as follows.

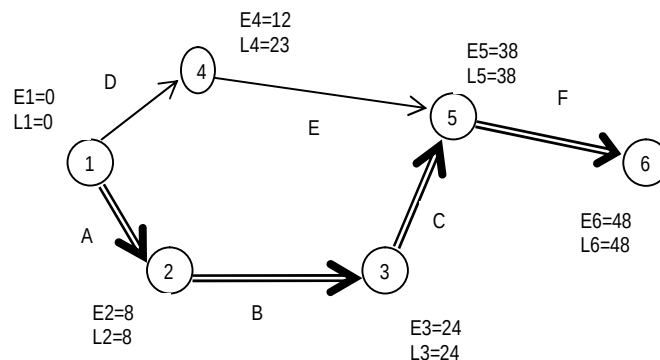
Work Center ↓ Methods →	A	B	C	D
1	0	3	0	1
2	1	0	0	0
3	5	0	4	3
4	0	0	0	1

Hence the optimal solution is:

Methods		Work centres		Units
1		C		8
2		D		0
3		B		12
4		A		10
				30

Critical Path Analysis

23.



First assume that all activities occur at normal times. Then the following net work shows the critical path computations under normal conditions. The critical path is A → B → C → F. The schedule of project is 48 days and its associated normal cost becomes = Rs.(1800+1500+1800+2400+800+2000) = Rs.10,300.

The different minimum cost schedule that can occur between normal and crash times, which are mainly depend on the cost time slopes for different activities. The cost times slopes can be computed by the formula:

$$\text{Cost-time slope} = \frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$

These slopes for the activities of the above net work are obtained as follows:

Activity :	A	B	C	D	E	F
Slope :	200	140	120	200	1200	1000

Now proceed step-by step as follows:

Step 1: Since the present schedule consumers more time, the schedule can be reduced by crashing some of the activities. Since the project duration controlled by

the activities lying on the critical path, the duration of some activities on the critical path is reduced.

First reduce the duration of that activity which involves minimum cost. Activity C with minimum slopes given in the minimum cost. So the duration of activity C is compressed from 14 days to 9 days with an additional cost $\text{Rs.} 5 \times 120 = \text{Rs.} 600$. Therefore, new schedule corresponds to 43 days with accost of $\text{Rs.} (10,300 + 600) = \text{Rs.} 10,900$

Step 2: Now it can be observed that the present schedule still consumers more time and also not all the activities on the critical path are at their crash durations. Hence the project duration can be reduced by crashing some other activity .Out of the remaining activities on the critical path, the activity B has the least slpoe. So reduce the duration of activity from B from 16 days to 11 days at a cost of $\text{Rs.} 5 \times 140 = \text{Rs.} 700$. Thus the new project duration becomes 38 days with a cost of $\text{Rs.} (10900 + 700) = \text{Rs.} 11600$.

Step 3: This project duration is still more than required duration of 36 days. So select some other activity lying on the critical path for crashing .Obviously only the activities A and F on the critical path can be considered for crashing .Since activity A has smaller slope, the duration of A can by only one day although it can be compressed by 2 days (from 8 to 6 days). Because, the path $1 \rightarrow 4 \rightarrow 5 \rightarrow 6$ becomes a parallel critical path as soon as A is compressed by one day. Thus new schedule corresponds to 37 days with accost of $\text{Rs.} (11600 + 200) = \text{Rs.} 11800$.

Step 4: Since only 36 days schedule is required, compress some activity by one day. To do so compress one day in each of the two parallel critical paths. So there are three choices:

- (i) Activity F can be compressed by one day at accost of $\text{Rs.} 1000$.
- (ii) Activities A and D can be compressed by one day each (Since B and C are already at their crash points) .This gives the total cost of $\text{Rs.} (200 + 200) = \text{Rs.} 400$.
- (iii) Activities A and E can be compressed by one day each at total cost of $\text{Rs.} (200 + 1200) = \text{Rs.} 1400$

But, the second choice gives the least cost schedule and it should be selected .This involves a 36 days schedule with a cost of $\text{Rs.} (11800 + 400) = \text{Rs.} 12200$.

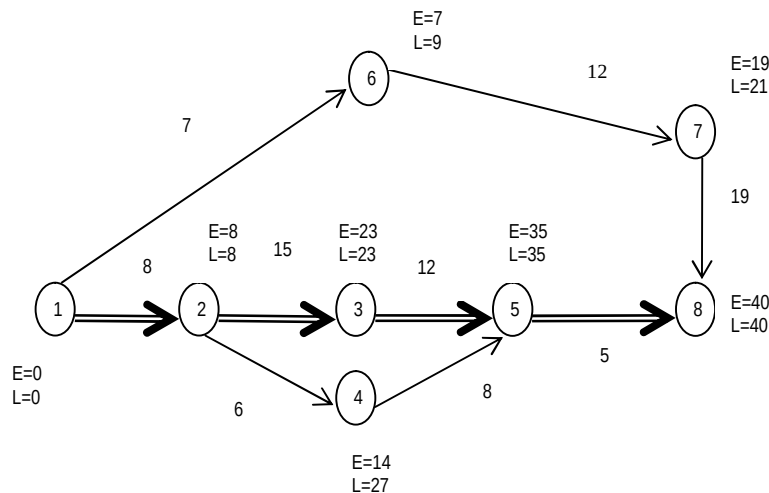
After effective crashing for a schedule of 36 days, the duration of activities and the cost involved are :

Activity	Duration (days)	Cost (Rs)
A	6	2200
B	11	2200
C	9	2400

D	11	2600
E	15	800
F	10	2000

Critical Path Analysis and PERT

24. (i) The required net work is given below



Various path	Duration paths
1-2-3-5-8	8+15+12+5= 40
1-2-4-5-8	8+6+8+5 = 27
1-6-7-8	7+12+19 = 38

Hence the critical path is 1-2-3-5-8 with duration of 40 weeks

(ii) Expected duration of various activities is calculated in the following table;

Job	Duration			Expected duration = $\left(\frac{a + 4m + b}{6}\right)$	Variance = $\left(\frac{b - a}{6}\right)^2$
	(a)	(m)	(b)		
1-2	4	7	16	8	4
2-3	7	13	31	15	16
3-5	6	12	18	12	4
7-8	5	20	29	19	16
5-8	2	5	8	5	1
6-7	4	10	28	12	16
4-5	4	7	16	8	4

1-6	3	6	15	7	4
2-4	3	6	9	6	1

The earliest and latest event times for all the nodes are shown in the above diagram.

From this time estimates, it is evident that the critical path for project is 1-2-3-5-8 and the project duration is 40 weeks.

- (iii) Variance for various activities which constitute the critical path is calculated and shown in the last column of the table.

Variance overall project duration = $\sigma^2 = (4+16+4+1) = 25$ weeks

Standard deviation of all critical paths $\sigma = 5$ weeks

Now, we want to find probability of completing the project before 35 weeks.

Then we have to find the value from normal variate:

$$Z = \frac{X - \bar{X}}{\sigma} \text{ here } \bar{X} = 35 \text{ weeks}$$

$$\text{So, } Z = \frac{35 - 40}{5} = -1$$

Area under normal curve corresponds to $Z = -1$ is 0.3413

Therefore the probability of completing the project before 36 weeks is $0.5 - 0.3413 = 0.16$ or 16% approximately.

- (iv) To calculate the chance of project duration exceeds 50 weeks, then first find

$$Z = \frac{50 - 40}{5} = 2.0$$

Area under normal curve corresponds $Z = 2.0$ is 0.4772

Hence the probability of project duration before 50 weeks is given by $0.5 + 0.4772 = 0.9772$ or 97.72%.

Probability of project duration exceeding 50 weeks = $100\% - 97.72\% = 2.28\%$

25. The yearly return can be determined by the formula:

$$\text{Return (R)} = \frac{(\text{price} - \text{cost})}{\text{Investment}} \times \text{number of units demanded}$$

To determine accumulative probability distribution corresponding to each of three factors, we assign appropriate set of random numbers corresponding each of three factors as shown in table 1, 2 and 3.

Table: 1

Annual Demand	Probability	Cumulative probability	Random Number
20000	0.05	0.05	00-04
25000	0.10	0.15	05-14
30000	0.20	0.65	15-34
35000	0.30	0.65	35-64
40000	0.20	0.85	65-84
45000	0.10	0.95	85-94
50000	0.05	1.00	95-99

Table: 2

(Price - Cost) per unit	Probability	Cumulative probability	Random Number
3.00	0.10	0.10	00-09
5.00	0.20	0.30	10-29
7.00	0.40	0.70	30-69
9.00	0.20	0.90	70-89
10.00	0.10	1.00	90-99

Table: 3

Investment Required	Probability	Cumulative probability	Random Number
17,50,000	0.25	0.25	00-24
20,00,000	0.50	0.75	25-74
25,00,000	0.25	1.00	75-99

We prepare the simulation work-sheet for 10 trials. The simulated return (R) is also calculated by using formula R, the results are shown table-4

Table-4

Trials	Random Numbers of Demand	Simulated Demand ('000)	Random number for profit (price-cost) per unit	Simulated profit	Random Numbers for investment	Simulated Investment ('000's)	Simulated return(%)
							$= \frac{\text{Demand} \times \text{Profit per unit}}{\text{Investment}}$
1	28	30	19	5.00	18	1750	8.57
2	57	35	07	3.00	67	2000	5.25
3	60	35	90	10.00	16	1750	20.00
4	17	30	02	3.00	71	2000	4.5
5	64	35	57	7.00	43	2000	12.25
6	20	30	28	5.00	68	2000	7.50
7	27	30	29	5.00	47	2000	7.50
8	58	35	83	9.00	24	1750	18.00
9	61	35	58	7.00	19	1750	14.00
10	30	30	41	7.00	97	2500	8.40

Result: Table: 4 shows, the highest likely return is 20% which is corresponding to the annual demand of Rs.35,000 units resulting a (profit of Rs.10 per unit and the required investment will be Rs.17, 50,000.