PAPER – 5 : ADVANCED MANAGEMENT ACCOUNTING

QUESTIONS

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

Decision making – Make or Buy

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

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

(i) There are constrains in machine time is manufacturing all components. Total machine lours available is only 12,000.

(ii) Other alternative is to use machine time in a second shift which will attract 20% extra wages and other fixed overheads @Rs. 3,000 for 1000 hours or part threof.

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

Decision Making - Profit Optimization

2. ABC Ltd is producing following four products, sales and costs for last year is given below:

₹ *Lakhs*

Products ------ à	A	B	C	D
Sales	500	600	240	200
Direct Material	160	180	68	110
Direct Wages	100	120	64	56
Factory Overheads	80	70	54	30
Selling & Dist Overheads	40	50	20	35
Total cost	380	420	206	231
Profit	120	180	34	-31

Total Profit is ₹ 303 lakhs.

(i) Present production is much below the capacity. There is market demand of Products A and B and the management likes to enhance production of both A & B by 30%.

(ii) Management proposes to discontinue product D as it is loss making. However, sale of product C is in conjunction with D and D's discontinuance will affect sale of C by 25%.

(iii) 50% of Factory Overheads is variable and variable Selling & Dist. Overheads is 5% of sales. In case of Increase of Production of A & B as above in (i), Fixed Factory Overheads apportioned to A and B will rise by 25% and 20% respectively. On discontinuance of D, Fixed Factory Overhead for product D can be eliminated by 70% and its portion of Selling & Dist Overhead can be avoided totally.

(a) Suggest whether Product D is to be discontinued.

(b) What will be profitability after enhancement of production of A & B ?

Decision Making : Relevant Costing

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

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

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

(ii) Direct Labour –

Skilled Labour 0.25 hrs / unit @ ₹ 100 per hour

Unskilled Labour 2 hrs / unit @ ₹ 70 per hour

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

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

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

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

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

Estimate Cost of Product C based on relevant 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 2006 or 30 November, 2006. XYZ Ltd will receive ₹ 65,000 per month for a contract which will commence either at 30 June, 2006 or 30 November 2006.

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

	Publishing ₹ '000	Printing ₹ '000	Distribution ₹ '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 ₹ 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 ₹ 1,400 per month which is ₹ 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 ₹ 18,000 and which will be sold to XYZ Ltd. for ₹ 10,000 if closure takes place on 30 June, 2006. Otherwise the material will be used as part of the July 2006 printing requirements. The distribution department has a contract to purchase pallets at a cost of ₹ 5000 per month for July and August, 2006. A cancellation clause allows for

non-delivery of the pallets for July and August for a one-off payment of ₹ 300. Non-delivery for August only will require a payment of ₹ 100. If the pallets are taken from the supplier, XYZ Ltd has agreed to purchase them at a price of ₹ 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 ₹ 2,500 when space is available.

(v) Printing plant and machinery has an estimated net book value of ₹ 48,000 at 30 June, 2006. It is anticipated that it will be sold at a loss of ₹ 21,000 on 30 June, 2006. If sold on 30 November, 2006 the prospective buyer will pay ₹ 25,000.

(vi) The net book value of distribution vehicles at 30 June, 2006 is estimated as ₹ 80,000. They could be sold to the original supplier at ₹ 48,000 on 30 June, 2006. The original supplier would purchase the vehicles on 30 November, 2006 for a price of ₹ 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, 2006 or on 30 November, 2006. Explanatory notes and calculations should be shown. Ignore taxation.

Marginal Costing - Optimum Product Mix

5. A Company Produces three products, details of costs & sales Value per unit is given below

	Products (₹ / Unit)		
	A	B	C
Sales Value	2000	3000	2500
Direct Material	500	1000	800
Direct Wages Rs 100 per hour	500	700	400
Variable Overheads	300	600	700

(i) 80% of Direct Material is imported @ ₹ 500 per kg. Import is restricted to 5,000 kg.

(ii) Capacity avaiable for production of A and C is restricted to 6250 and 6000 hrs respectively.

(iii) Fixed Cost is ₹ 20 lakhs.

(a) Workout most profitable product mix and profit.

(iv) Company identifies a source of alternative material as replacement of imported material. Availability of material will not be restricted but carrying cost will be @ ₹ 2.75 per kg.

The company plans to modify its process to suit the new material and enhance its capacity for all products by 20% above the present one with an investment of ₹ 25 lakhs at an interest of cost of 15%. Company expects 30% rise in is profit.

(b) Find out the price the company can pay to alternative source.

Pricing of an Export Order.

6. A company is operating at 60% capacity with a turnover Rs. 86.40 lakhs.

(i) If the Company works at 100% capacity, the sales-cost relation is: Factory Cost is two-third of sales value.

(ii) Prime Cost is 75% of Factory Cost.

(iii) Administrative and selling expenses (75% variable) is 20 % of sales value.

(iv) Factory overhead will vary according to operating capacity as given below :

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

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

Product Pricing

7. AB Company has two departments producing several small electronic components. It has acquired a new technology to produce a electronic product X. Cost and other information for manufacturing X are given below :

Item	*Department A*	*Department B*
Direct Material	₹ 240	₹ 200
Direct Labour	2 hours @ ₹ 120	3 hours @ ₹ 100
Variable Overhead per hour	₹ 50	₹ 30
Fixed Overheads per hour (based on 100% capacity)	₹ 60	₹ 40
Value of Machinery on revaluation	₹ 40 lakhs	₹ 28 lakhs

(i) Technology cost ₹ 25 lakhs and working capital requirement ₹ 7 lakhs

(ii) Target Volume of production in the first year is 2000 units at 25% capacity

(iii) Variable Selling & Distribution is ₹ 3 lakhs

(iv) Expected net return on investment is 24%

Suggest on pricing product as (a) new one (b) established one - production at 80% capacity.

Service Cost

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

Annual fixed expenses	*(₹Lakh)*
Salary of the staff (excluding room attendant)	7.50
Repair & Maintenaance	2.60
Depreciation on Building & Furniture	2.40
Other fixed expenses like dusting, sweeping etc.	3.25
Total	15.75
Variable expenses (per guest per day)	
Linen, Laundry & security support	₹ 30.00
Electricity & Other facilities	₹ 20.00
Misc expenses like attendant etc	₹ 25.00

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

(a) Calculate the tariff rate per room.

(b) Calculate the Break Even Occupancy in normal season assuming 50% occupancy is off-season.

(c) Management is proposing 20% cut in tariff to improve occupancy at 100% and 70% in normal season and off-season respectively,. Give your views on it.

(d) What is the minimum rise in occupancy % to takes care of risk of fall in profit due to tariff-cut ?

Transfer Price

9. Division A produces three products X, Y and Z, cost per unit and other details are given below :

	X	Y	Z
Market Price (₹)	500	450	400
Max Demand (units)	800	500	300
Variable Cost (₹)	440	350	310
Labour hours required/ Unit	3	4	3

Division B requires 300 units of Y. Similar product is procured by it @ ₹ 430.

Division A operates as a profit centre. Work out a transfer price not affecting Division A, if labour hours available to division A are(i) 4400 hours (ii) 5900 hours

Transfer Pricing

10. AB Ltd. has two divisions A & Division B. Division A produces components, two units of which is required for one unit of final product produced by division B. Division A has a capacity to produce 20,000 units and entire quantity is supplied to Division B @ ₹ 200 per unit. Variable cost of component at Division A is ₹ 190 and fixed cost is ₹ 20 per unit. .For final product of Division B, per unit variable cost (excluding component) is ₹ 700 , fixed cost ₹ 200 and selling price is ₹ 1500.

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

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

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

    You have evaluate the following and give your views :

    (a) Division A facilities rented out and Division B buys components @ ₹ 210 from outside market.

    (b) Division A sells components to outside @ ₹ 220 and Division B buys components @ ₹ 210 from market.

    (c) Proposal of enhancement of capacity of Division A to 40,000 units. (assume capital cost @ 12%)

Target Costing

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

	₹ lakhs
Direct Material	60.00
Direct wages	45.00
Variable Factory Overheads	20.00
Fixed Overheads including sales & admin exp	35.00
Total Cost	160.00

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

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

(i) improving productivity of workers by 20%

(ii) cut down material wastage by 1.0 %

(iii) Elimination of services of supervisors because of auto facilities of the machine

(iv) Saving in packaging cost by ₹1.5 lakhs.

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

Budgeting

12. ABC Ltd has, over the past few years, has sales of ₹ 400 lakhs with 30% contribution. Last year's fixed cost was ₹ 45 lakhs. Company plans to venture into new contract service business and also in the process of introduction of a new product.

    (i) Proposal A : Value of ₹ 30 lakhs with variable cost 60%, fixed cost of ₹ 4 laks

    Proposal B : Value of ₹ 20 lakhs with variable cost 50%, fixed cost ₹ 3 lakhs

    (ii) New product : Expected Sales per month 6 lakh with 50% variable cost and fixed cost of ₹ 1.0 lakhs per month.

    (iii) Optimistic assumption : Offer for both Contract A & B will mature and be executed next year and new product will be launched from 2nd quarter of next year.

    (iv) Pessimistic assumption : Only Contract A will mature and be executed next year and new product will be launched from 4th quarters of next year and there will be rise in both variable and fixed cost by 10% without scope for rise in sales value.

    Prepare two budgets based on optimistic and pessimistic assumptions.

Standard Costing and variance Analysis

13. 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 ₹ 20,00,000 per month whereas the standard variable overhead rate has been estimated as equal to ₹ 1,400 per unit of finished good. You are required to compute the

(a) standard cost of the product

(b) compute the production volume variance in case the company produces and sells only 100 units of finished goods in the concerned month.

(c) 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(₹ 00)
A	102	7
B	201	6
C	310	5
D	415	4
E	540	3
F	610	2

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

Activity Based Cost Management

14. ABC Ltd plans to use activity-based costing to determine it 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 ₹
Production Support	12,25,000
Production (factory overhead only)	1,75,000
Total cost	14,00,000

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 ₹
Set up	4,28,750
Production control	2,45,000
Quality control	1,83,750
Materials management	3,67,500
Total	12,25,000

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	50,000	1,40,000	5	5	0	30
Total cost	62,000	1,75,000	125	125	75	750

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?

Variance Analysis

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

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

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

	Favourable (₹'000)	Adverse (₹ '000)
Direct Material		
Price		425
Usage	105	
Direct Labour		
Rate		400
Efficiency	320	
Factory Overhead		
Variable Expenditure	40	
Fixed Expenditure	40	
Fixed Volume		168
Administrative overhead		
Expenditure		40
Volume		168

Calculate actual cost and profit for the period.

Learning Curve Theory

16. In your company, production manager has observed that learning curve theory is very much applicable in the newly procured machine @ 90%. A batch of production is of 100 units. The average labour cost for the first batch is ₹ 200. Material Cost and Overheads are ₹ 150 and 50 per unit respectively. If profit margin is 25% on cost, estimate the price per unit if the order size is for (a) 800 units and (b) 1600 units (c) 2000 units

JIT & Service Costing

17. (a) What do you mean by back-flushing in JIT system? What are the problems that must be corrected before it will work properly?

    (b) What is Target Costing and list the steps involved in target costing process .

Life Cycle Costing : Introduction and Benefits

18. (a) What is life cycle costing? What are the benefits of the technique ?

    (b) What is theory of constraints? What are key measures suggested by it ?

Total Quality Management & Value Chain Analysis

19. (a) Define Total Quality Management? What are the six Cs for successful implementation of TQM?

(b) What is the concept of 'Value-chain' and what steps are involved in value chain analysis approach for assessing competitive advantages?

Linear Programming

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

Product mix.(xi)	x1	x2	s1	s2	Quantity (bi)
x2	1	1	1	0	10
s2	1	0	- 1	1	3
cj	4	5	0	0	
zj	5	5	5	0	50
zj- cj	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 s1 is slack in machine A (in hours/week) and s2 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 x1 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 s1, 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) 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 ₹
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 ₹ 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 ₹ 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 ₹ 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.

Transportation Problem

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

Table 1

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

Table 2

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

(i) Formulate this into a transportation problem to maximize profit.

(ii) Find the solution using VAM method.

(iii) Test for optimumity and find the optimum solution.

Assignment Problem

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

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

Simulation

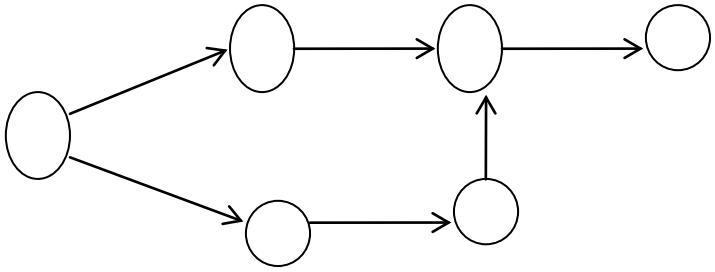
23. Occurrence of rain in a city on a day is dependent up whether if rained on the previous day.

If rained previous day		If not rained previous day	
Event	Probability	Event	Probability
No rain	0.50	No rain	0.75
1 cm rain	0.25	1 cm rain	0.15
2 cm rain	0.15	2 cm rain	0.06
3 cm rain	0.05	3 cm rain	0.04
4 cm rain	0.03		
5 cm rain	0.02		

Simulate the city's weather for 10 days and determine the rain fall during the period. Use the following random numbers: 67, 63, 39, 55, 29, 78, 70, 06, 78, and 76.

Critical Path analysis and PERT

24. 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 (₹)	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 for cost 36 days schedule.

25. 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:

(i) Draw a net work diagram.

(ii) Find the critical path after estimating the earliest and latest event times for all nodes.

(iii) Find the probability of completing the project before 35 weeks.

(iv) What is the chance of project duration exceeding 50 weeks?

SUGGESTED ANSWERS / HINTS

1.

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

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

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

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

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

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

Cost of manufacturing of W per unit

Material cost	₹ 60
Wage Cost (rs 30 x 1.2)	₹ 36
Direct Expenses	₹ 40
Total Variable cost	₹136

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

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

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

2. On Discontinuance of D, sale of C will be 75% and henceProfitability of C will be affected as follows :

For Product C	₹ *Lakhs*
Sale	180.0
Direct Material	51.0
Direct Wages	48.0
V Factory Overheads	20.3
Fixed Factory Overheads	27.0
V Selling & Dist Overheads	9.0
Fixed Selling & Dist Overheads	8.0
Total Cost	163.3
Profit for C	16.7
Less Fixed Fac Overheads for D	7.5
Profit on discontinuance of D	9.2

Earlier profitability of products of both C and D was ₹ 3 lakhs only which has been increased to ₹ 9.20 lakhs. Hence, D may be discontinued.

Profitability of A and B on enhancement of its production by 30% (₹ lakhs)

	A	B	Total
Sales	650	780	1430
Direct Material	208	234	
Direct Wages	130	156	
V Factory Overheads	52	45.5	
Fixed Overheads	50	42	
V. Selling & dist. Overheads	32.5	39	
Fixed Selling & Dist Overheads	15	20	

Total cost	477.5	536.5	1014
Profit			326

Total Profit including that of C = Rs 335.2 lakhs i.e increase by Rs 32.2 lakhs.

3.

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

4 The costs/benefits of closing on 30 November, 2006 instead of closing on 30 June, 2006 are:

	₹	₹
Payments to XYZ Ltd avoided (5 months @ ₹ 65,000)		3,25,000
*Salaries and wages cost		
(5 months @ (₹18,000 + Rs. 4,000 – ₹ 3,000 + ₹ 1,300)		(1,01,500)
**Printing materials		
(5 months @ ₹ 31,000) – ₹ 18,000 + ₹10,000)		(1,47,000)
***Distribution materials		(5,280)
Occupancy costs		
****Printing	17,212.50	
*****Distribution	2,175.00	
		(19,387.50)
Loss of sub-letting income (5 months @ ₹ 2,500)		(12,500)

******Additional loss on sale of plant		(2,000)
Additional loss on sale of vehicles (₹ 48,000 – ₹ 44,000)		(4,000)
Net benefit of closing on 30 November		33,332.50

The plant should remain open until 30 November.

* The total salaries equal ₹ 22,000 (₹ 18,000 + ₹ 4,000) but two staff will be retained so the net saving of closing on 30 June is reduced by their salaries (₹ 3,000 per month). If closure does not occur until November, the vacancy in the publishing department will need to be filled (at ₹ 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 ₹ 31,000 per month for five months less the ₹ 18,000 held in stock. However, the opportunity to sell the stock is lost, therefore, there is an additional cost of ₹ 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 ´ ₹ 500) – (2 ´ ₹ 380) = ₹ 240 net cost.

(ii) Accept the July delivery, pay for it, sell it to XYZ Ltd and pay the cancellation cost for August:

(₹ 500 – ₹ 380) + ₹ 100 = ₹ 220 net cost.

(iii) Cancel both deliveries at a net cost of ₹ 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 @ ₹ 1,100) – ₹ 220 = ₹ 5,280.

**** Attributable costs are [(₹ 8,500 ´ 30%) + (₹ 8,500 ´ 70% ´ 15%)] ´ 5 months = ₹ 17,212.50.

***** Attributable costs are [(₹ 1,200 ´ 25%) + (₹ 1,200 ´ 75% ´ 15%)] ´ 5 months = ₹ 2,175.

******

	₹
Net book value	48,000
June sale	21,000 loss
Therefore June proceeds	27,000
November proceeds	25,000
Additional loss	2,000

5. (a)

	A	*B*	*C*	*Total*
Sales price (₹)	2000	3000	2500	
Imported Material (₹)	400	800	640	
Domestic Material (₹)	100	200	160	
Direct Wages (₹)	500	700	400	
Variable Overheads (₹)	300	600	700	
Total VariableCost (₹)	1300	2300	1900	
Contribution per unit (₹)	700	700	600	
Imported Material in Kg	0.8	1.6	1.28	
Contribution per kg of imported mat (₹)	875	437.5	468.75	
Ranking based on contribution per kg imported material	1	3	2	
Labour Hours required	5	7	4	
Contribution per labour hours (₹)	140	100	150	
Ranking based on contribution per labour hour	2	3	1	
Units to be produced on basis Labour Hours available	1250		1500	
Imported Material required/ available in Kg	1000	2080	1920	
Optimum Product Mix	1250	1300	1500	
Contribution (₹)	875000	910000	900000	
Total Contribution				2685000
Fixed Cost				2000000
Profit				685000

(b) Profitability to be maintained after process modification & capacity enhancement

	A	B	C	Total
Units to be produced	1500	1560	1800	
Sales Value	3000000	4680000	4500000	12180000
Substitute Material required (kg)	1200	2496	2304	6000
Total Variable cost per unit (excluding import material)	900	1500	1260	
Total Variable cost (excluding cost of subs material)	1350000	2340000	2268000	5958000
Contribution required + Sub Material Cost				6222000

Profit required at enhanced rate				890500
Fixed Cost (including interest on invest.)				2375000
Contribution Required				3265500
Substitute Material Cost of 6000 kg				2956500
Cost Per kg of Substitute Material				492.75
Transport Cost per kg				2.75
Price may be offered per kg for substitute material				490

6. At 100% capacity.

Sale = 86.40 x 100/60 = ₹ 144 lakhs

Factory Cost = 1.44 x 2/3 = ₹ 96 lakhs

Prime Cost = 96 x .75 = ₹ 72 lakhs

Factory overheads = ₹ 24 lakhs

Selling & Distribution Exp = ₹ 28.8 lakhs

Variable S/D Exp = ₹ 21.6 lakhs

Fixed S/D Exp = ₹ 7.2 lakhs

	Operation 80% capacity (₹ Lakhs)	Export order 40% capacity (₹ lakhs)
Prime Cost	57.60	12.00
Factory overhead (given)	21.60	8.40
Selling & Dist. Cost-variable	17.28	-
Selling & Dist. Cost – fixed	7.20	2.00
Total Cost of Sales	103.68	22.40
Sales Value (at 80% capacity) 144 x 0.80	115.20	
Profit	11.52	2.49
Profit %	10% on sales	10% of export sales value
Export Price to be quoted		24.89

Let , Sales value = x , then profit = 0.1x

Then 0.9 x = 22.40

Hence x = 24.89

7. Variable Cost per unit of X

Item	Dept A (₹)	Dept B (₹)	Total (₹)
Direct Material	240	200	440
Direct Labour	240	300	540
Variable Overhead	100	90	190
Variable S/D Overheads			150
Total Variable Cost			1320

Fixed Cost = ₹ 8000 (60 x 2 + 40 x 3) = ₹ 19. 20 lakhs

Fixed Capital Employed = ₹ (40+28+25+7) lakhs = 100 lakhs

Return Expected @ 24 % on capital = 24 lakhs

(a) For New Product, minimum price may be at variable cost i.e ₹ 1320.

(b) When the product will be established one, unit sold will be 6400 units.

Return on Capital per unit = ₹ (24 + 19.2) lakhs/ 6400 = ₹ 675.

It is assumed that S/D cost will be at the same rate.

Price to be charged = ₹ (1320 + 675) = ₹ 1995.

8. (a) Variable cost per room-day = ₹ 75

Total occupancy = (50 x 30 x 8 x 0.8) + (50 x 30 x 4 x 0.5)
= 12,600 room-days

Total variable cost = ₹ 9.45 lakhs
(12,600 x 75)

Fixed Cost = ₹ 15.75 lakhs

Total Cost ₹ 25.20 lakhs

Profit ₹ 6.30 lakhs

₹ 31.50 lakhs

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

(b) Contribution per day = ₹ (250 – 75)= ₹ 175.00

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

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

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

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

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

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

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

Fixed Cost (unchanged) = ₹ 15.75 lakhs

Profit = ₹ 8.55 lakhs

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

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

With new tariff, contribution per day = ₹ 150

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

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

9.

	X	Y	Z
Contribution Per Unit (₹)	60	100	90
Labour Hours per unit units)	3	4	3
Contribution per L. hour (₹)	20	25	30
Ranking on Contribution	3	2	1

(i) If only 4400 hours available, production of Division A will be :

Product	When sold in outside market			Transfer to Div B		
	Units	Lobour Hours	Contribution (₹)	Units	Lobour Hours	Contribution (₹)
Z	300	900	27000	300	900	27000
Y	500	2000	50000	800	3200	74000
X	500	1500	30000	100	300	6000
Total		4400	107000		4400	107000

On 300 units transfer of Y, loss on production of X by 400 units will cause loss of contribution of ₹ 24,000. Thus, 300 units transfer should make up loss @ ₹ 80 per unit. Thus, transfer price of ₹ 430 satisfies the same.

(ii) If only 5900 hours available, production of Division A will be :

Product	When sold in outside market			Transfer to Div B		
	Units	Lobour Hours	Contribution (₹)	Units	Lobour Hours	Contribution required (₹)
Z	300	900	27000	300	900	27000
Y	500	2000	50000	800	3200	62000

X	800	2400	48000	600	1800	36000
Total		5300	125000		5900	125000

In this case, on 300 units transfer of Y, loss on production of X by 200 units will cause loss of contribution of ₹ 12,000. Thus, 300 units transfer should make up loss @ ₹ 40 per unit.

In this case, transfer price may be fixed at ₹ 390.

Division A will earn higher contribution of ₹ 18,000 for its extra effort.

And a transfer price of ₹ 430 will give Division A ₹ 30,000 higher contribution.

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

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

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

	A division (₹)	B division (₹)	AB Ltd (₹ lakhs)
No of Units		10,000	
Variable Cost per unit		1120	
Contribution per unit		380	
Total Contribution		38,00,000	38.00
Fixed Cost		20,00,000	20.00
Profit		28,00,000	18.00
Income from Rent	3,00,000		3.00
Total Profit			21.00

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

	A division (₹)	B division (₹)	AB Ltd (₹ lakhs)
No of Units	20,000	10,000	
Variable Cost per unit	190	1120	
Contribution per unit	30	380	
Total Contribution	6,00,000	38,00,000	44.00

Fixed Cost	4,00,000	20,00,000	24.00
Profit	2,00,000	18,00,000	20.00

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

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

11. Due to cut is price of product, sales value will decrease by ₹ 10.00 lakhs.

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

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

Hence, number of supervisors to be eliminated = 4

12. Budget for the next year based on optimistic assumptions (Figures in ₹ Lakhs)

Activities	*Revenue*	*Variable Cost*	*Fixed Cost*	*Profit*
Normal Activity	400	280	45	75
Contract service	50	28	7	15
New Product	54	27	9	18
Total	504	335	61	108

Budget based on pessimistic assumptions (Figures in ₹ Lakhs)

Activities	*Revenue*	*Variable Cost*	*Fixed Cost*	*Profit*
Normal Activity	400	280	45	75
Contract service	30	19.8	4.4	5.8
New Product	18	9.9	3.3	4.8
Total	448	309.7	52.7	85.6

13. (a) Standard Cost Sheet

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

(b) Production Volume Variance

Unutilised capacity × Standard Fixed Cost per Finished Good

100 × ₹ 10,000 = ₹ 10,00,000 Adverse

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

Raw Mat.	Std Qty/FG	Std Qty on actual prod	Actual Qty on actual prod	Act Price per Ut of RM(₹)	Std Price per Ut of RM(₹)	Usage Variance(₹)	Price Variance(₹)
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 (₹ 13,000 × 100)	₹ 13,00,000
Usage Variance	(19,200)
Price Variance	(2,17,800)
Production Volume Variance	(10,00,000)
Actual Profit	63,000

14. 1. plant wide factory overhead rate $= \frac{₹\ 14,00,000}{1,75,000 \text{ direct labour hours}}$

= ₹ 8 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	´ ₹ 8/dlh	´ ₹ 8/dlh	´ ₹ 8/dlh
Total factory overhead	₹ 2,00,000	₹ 80,000	₹ 11,20,000
Number of units	÷ 10,000	÷ 2,000	÷ 50,000
Cost per unit	₹ 20.00	₹ 40.00	₹ 22.40

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	₹ 4,28,750	÷	125 set ups	=	₹ 3,430 per setup
Production control	₹ 2,45,000	÷	125 production orders	=	₹ 1,960 per production order

Activity	Activity Cost Pool Budget	÷	Estimated Activity Base	=	Activity Rate
Quality control	₹ 1,83,750	÷	75 inspections	=	₹ 2,450 per inspection
Materials management	₹ 3,67,500	÷	750 requisitions	=	₹ 490 per requisition
Production	₹ 1,75,000	÷	1,75,000 direct labour hours	=	₹ 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	´	₹ 3,430	=	₹ 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	=	25,000
Total factory overhead					₹ 6,98,750
Unit volume					÷ 10,000
Factory overhead cost per unit					₹ 69.88

Product L

Activity	Activity –Base Usage	´	Activity Rate	=	Activity Cost
Set up	40 setups	´	₹ 3,430	=	₹ 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	=	10,000
Total factory overhead					₹ 5,19,600
Unit volume					÷ 2,000
Factory overhead cost per unit					₹ 259.80

Product M

Activity	Activity –Base Usage	´	Activity Rate	=	Activity Cost
Set up	5 setups	´	₹ 3,430	=	₹ 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	=	1,40,000
Total factory overhead					₹ 1,81,650

Unit volume					÷ 50,000
Factory overhead cost per unit					₹ 3.63

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

15. (₹'000)

	Standard Cost	Adjustment Variance	Actual Cost
Direct Material Cost (14,000 × 450)	6480		
Material Price Variance (A)		+ 425	
Material Usage Variance (F)		- 105	
Actual Material Cost			6800
Direct Labour Cost (14,400 × 300)	4320		
Labour Rate Variance (A)		+ 400	
Labour Efficiency Variance (F)		- 320	
Actual Labour Cost			4400
Direct Expenses (14,400 × 50)	720		720
Actual Prime Cost			11920
Variable factory overhead (14,400 × 25)	360		
Variable Expenditure Variance		- 40	
Actual Variable Overheads			320
Fixed Factory Overhead (14,400 × 30)	432		
Fixed Volume Variance (A)		+ 168	
Fixed Expenditure Variance (F)		- 40	
Actual Fixed overhead			560

Administrative overhead (14,400 × 30)	432		
Adm. Expenditure Variance (A)		+ 40	
Adm. Volume Variance (A)		+ 168	
Actual Administrative Overhead			640
Total Actual Cost			13440
Sales (14,400 × Rs.1,000)			14400
Actual Profit			9600

16. Average cost for first 200 units = 0.90 x 200 = Rs 180

Average cost for first 400 units = 0.90 x 180 = Rs 162

Average cost for first 800 units = 0.90 x 162 = Rs 145.80

Average cost for first 1600 units = 0.90 x 145.80 = Rs 131.22

We know that learning curve equation :

Y= ax ^b

Where y = average time for producing x units

a = time spent on first unit / batch
b = co-efficient of learning curve

b= - log (1 - % decrease) / Log 2 = log (1 – 0.10) / log 2 = - 0.0458/0.3010 =- 0.15206

Thus, for 2000 units, batch = 2000/ 100 = 20

Y= 200 x 20 ^ -0.15206

Log y= log (200) - 0.15206(log 20) = 2.3010 - 0.15206 x 1.3010 = 2.103172

Thus y = antilog (2.103172) = 126.81

Thus, average labour cost for 2000 units = Rs 126.81

Thus, price to be quoted for different units are :

	First 800 units (₹)	*First 1600 units (₹)*	*First 2000 units (₹)*
Material @ ₹ 150	120000	240000	300000
Labour Cost	116640	209952	253620
Overheads	40000	80000	100000
Total Cost	276640	529952	653620
Profit	69160	132488	163405
Price to be quoted	345800	662440	817025

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

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

(i) Production reporting

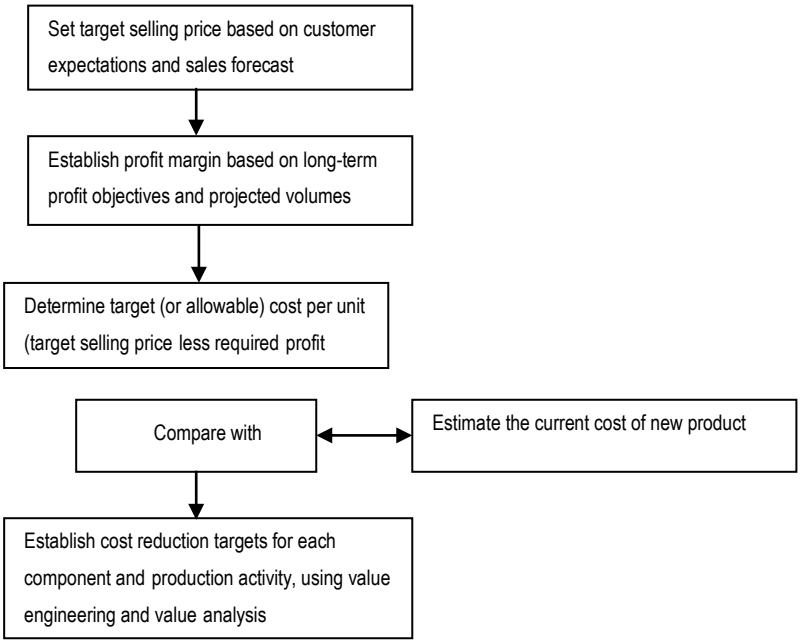
(ii) Scrap reporting

(iii) Lot tracing

(iv) Inventory accuracy.

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

Target Costing Process



18. (a) 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 accumutation 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 the 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.

(b) The theory of constraints focuses its attention on constraints and bottlenecks within organisation which hinder speedy production. The main concept is to maximize the rate of manufacturing output is the throughput of the organisation. This requires to examine the bottlenecks and constraints. A bottleneck is an activity within the organization where the demand for that resource is more than its capacity to supply.

A constraint is a situational factor which makes the achievement of objectives / throughput more difficult than it would otherwise, for example of constraint may be lack of skilled labour, lack of customer orders, or the need to achieve high quality in product output.

For example let meeting the customers' delivery schedule be a major constraint in an organisation. The bottleneck may be a certain machine in the factory. Thus bottlenecks and constraints are closely examined to increase throughput.

Key measures of theory of constraints:

(i) Throughput contribution: It is the rate at which the system generates profits through sales. It is defined as, sales less completely variable cost, sales – direct are excluded. Labour costs tend to be partially fixed and conferred are excluded normally.

(ii) Investments: This is the sum of material costs of direct materials, inventory, WIP, finished goods inventory, R & D costs and costs of equipment and buildings.

(iii) Other operating costs: This equals all operating costs (other than direct materials) incurred to earn throughput contribution. Other operating costs include salaries and wages, rent, utilities and depreciation.

19 (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.

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 ₹ 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 ₹ 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.

Maximise $C = 15x_1 + 12x_2 + 16x_3 + 12x_4 + 7x_5$

subject to the following constraints:

x_1 £ 1,500
x_2 £ 1,200
x_3 £ 900
x_4 £ 600
x_5 £ 600

(expected maximum demand constraints)

$x_1 + x_2 + 3x_3 + 4x_4 + 5x_5$ £ 5,800 (special component constraint)

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

$15x_1+14x_2+16x_3+15x_4+16x_5$ £ 30,000 (material expenditure constraint)

x_1, x_2, x_3, x_4, x_5 ³ 0 (non- negativity conditions)

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

Profit = Sales price – production cost – raw material cost – transportation cost

Warehouse	Profit (Rs. Per unit)					Demand
	1	2	3	4	Dummy	
A	6	6	11	15	0	80
B	4	6	10	12	0	120
C	6	4	7	6	0	150

D	4	10	14	14	0	70
E	8	8	7	9	0	90
Supply	100	200	120	80	10	510

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

TABLE 3: INITIAL BASIC FEASIBLE SOLUTION – VAM

Warehouse	Plants					Demand
	1	2	3	4	Dummy	
A				80		80
B		70	!			120
C		40			10	150
D			70	e		70
E		90				90
Supply	100	200	120	80	10	510

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

TABLE 4: INITIAL SOLUTION – NON-OPTIMUM

Warehouse	Plants					Demand	u_1
	1	2	3	4	Dummy		
A						80	$u_1 = -7$
B			(-)	(+)		120	$u_2 = -2$
C	100					150	$u_3 = 0$
D			(+)	(-)		70	$u_3 = -6$
E						90	$u_3 = -4$
Supply	100	200	120	80	10	510	
v_1	$v_1 = 9$	$V_2 = 11$	$v_3 = 7$	$v_4 = -7$	$v_5 = 15$		

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

TABLE 5: REVUSED SOLUTION - IPTIMUM

Warehouse	Plants					Demand	u_1
	1	2	3	4	Dummy		
A						80	$u_1 = 6$
B						120	$u_2 = 9$
C	100					150	$u_3 = 11$
D						70	$u_3 = 5$
E						90	$u_3 = 7$
Supply	100	200	120	80	10	510	
v_1	$v_1 = -2$	$V_2 = 0$	$v_3 = -4$	$v_4 = -6$	$v_5 = 4$		

Table 5 gives optimum solution.

Total Maximum Profit = 15 x 80 + 6 x 70 = 10X 50 + 6 x 100 + 4 x 40 + 14 x 70 + 8 x 90 = ₹ 4580

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

	Regions				
Salesman	R1	R2	R3	R4	R5
S1	5	17	21	19	22

S2	0	4	1	17	15
S3	16	13	15	6	1
S4	14	19	10	1	6
S5	11	12	6	15	21

Step 2: Run Subtraction.

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

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

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

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

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

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

23. Assume that one the 1st day of simulation, there was no rain on the previous day.

Table 1 Rain on previous day.

Event	Probability	Cum Prob.	Range for random no.
No rain	0.50	0.50	00 – 49
1 cm rain	0.25	0.75	50 – 74
2 cm rain	0.15	0.90	75 – 89
3 cm rain	0.05	0.95	90 – 94
4 cm rain	0.03	0.98	95 – 97
5 cm rain	0.02	1.00	98 – 99

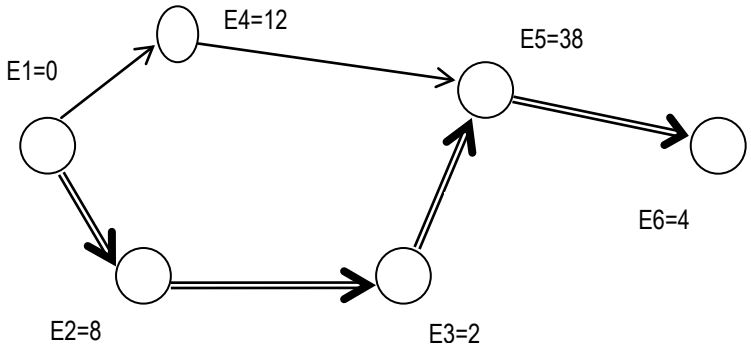
Table 2: No rain previous day

Event	Probability	Cum Prob.	Range for random no.
No rain	0.75	0.75	00 – 74
1 cm rain	0.15	0.90	75 – 89
2 cm rain	0.06	0.96	90 – 95
3 cm rain	0.04	1.00	96 – 99

Table 3: Simulation Sheet

Day	Random No.	Event	From Table	Cum Rain
1	67	No rain	2	
2	63	No rain	2	
3	39	No rain	2	
4	55	No rain	2	
5	29	No rain	2	
6	78	1 cm rain	1	1 cm
7	70	1 cm rain	1	2 cm
8	06	No rain	1	3 cm
9	78	1 cm rain	2	4 cm
10	76	2 cm rain	1	5 cm

24.



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 = ₹ (1800+1500+1800+2400+800+2000) = ₹ 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:

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

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 ₹ 5 × 120 = ₹ 600. Therefore, new schedule corresponds to 43 days with accost of ₹(10,300+600) = ₹ 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 ₹ 5 ×140=₹ 700.Thus the new project duration becomes 38 days with a cost of ₹ (10900+700)= ₹ 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 → 4 → 5 → 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 ₹ 11600+200) = ₹ 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 ₹ 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 ₹ (200+200)= ₹ 400.

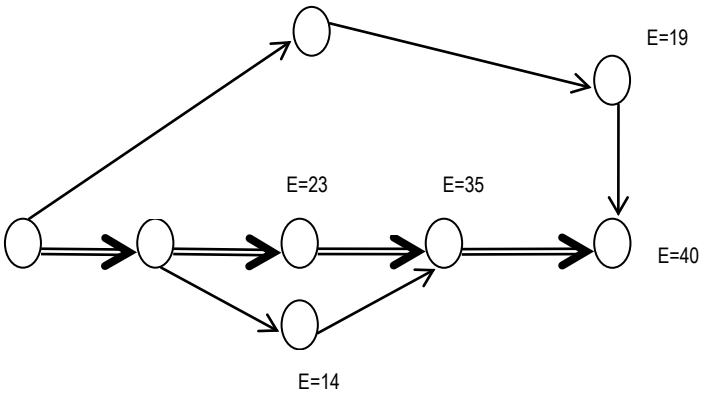
(iii) Activities A and E can be compressed by one day each at total cost of ₹ (200+1200)= ₹ 1400

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

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

Activity	Duration (days)	Cost (₹)
A	6	2200
B	11	2200
C	9	2400
D	11	2600
E	15	800
F	10	2000

25. (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 $= \frac{a+4m+b}{6}$	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= s^2 = (4+16+4+1) =25 weeks

Standard deviation of all critical paths s = 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:

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

So, $Z = \frac{36 - 40}{5} = -1$

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

Therefore the probability of completing the project before 36 weeks is 05 - 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%