PAPER – 5 : ADVANCED MANAGEMENT ACCOUNTING

QUESTIONS

Marginal Costing Vs. Absorption Costing

1. During the current period, ABC Ltd sold 60,000 units of product at Rs. 30 per unit. At the beginning for the period, there were 10,000 units in inventory and ABC Ltd manufactured 50,000 units during the period. The manufacturing costs and selling and administrative expenses were as follows:

	Total cost	*Number of units*	*Unit cost*
	Rs.		*Rs.*
Beginning inventory:			
Direct materials	67,000	10,000	6.70
Direct labour	1,55,000	10,000	15.50
Variable factory overhead	18,000	10,000	1.80
Fixed factory overhead	20,000	10,000	2.00
Total	2,60,000		26.00
Current period costs:			
Direct materials	3,50,000	50,000	7.00
Direct labour	8,10,000	50,000	16.20
Variable factory overhead	90,000	50,000	1.80
Fixed factory overhead	1,00,000	50,000	2.00
Total	13,50,000		27.00
Selling and administrative expenses:			
Variable	65,000		
Fixed	45,000		
Total	1,10,000		

Instructions:

1. Prepare an income statement based on the variable costing concept.
2. Prepare an income statement based on the absorption costing concept.
3. Give the reason for the difference in the amount of income from operations in 1 and 2.

Profitability Analysis, Flexible Budget and Marginal Costing

2. A budgeted profit statement of a company working at 75% capacity is provided to you

below,

Sales	9,000 units at Rs. 32		Rs. 2,88,000
Less:	Direct materials	Rs. 54,000	
	Direct wages	72,000	
	Production overhead:		
	–fixed	42,000	
	–variable	18,000	
			1,86,000
	Gross profit		1,02,000
Less:	Administration, selling and distribution costs:		
	–fixed	36,000	
	–varying with sales volume	27,000	
			63,000
	Net profit		39,000

You are required to:

(a) Calculate the breakeven point in units and in value.

(b) It has been estimated that:

(i) if the selling price per unit were reduced to Rs. 28, the increased demand would utilise 90% of the company's capacity without any additional advertising expenditure, and

(ii) to attract sufficient demand to utilise full capacity would require a 15% reduction in the current selling price and a Rs. 5,000 special advertising campaign.

You are required to present a statement showing the effect of the two alternatives compared with the original budget and to advise management which of the three possible plans ought to be adopted, i.e., the original budget plan or (i) above or (ii) above.

(c) An independent market research study shows that by spending Rs. 15,000 on a special advertising campaign, the company could operate at full capacity and maintain the selling price at Rs. 32 per unit.

You are required to:

(i) Advise management whether this proposal should be adopted.

CVP Analysis

3. (a) ABC Ltd. expects to maintain the same inventories at the end of the year as at the beginning of the year. The estimated fixed costs for the year are Rs. 2,88,000, and

the estimated variable costs per unit are Rs. 14. It is expected that 60,000 units will be sold at a price of Rs. 20 per unit. Maximum sales within the relevant range are 70,000 units.

Instructions:

1. What is (a) the contribution margin ratio and (b) the unit contribution margin?
2. Determine the break-even point in units.
3. What is the margin of safety?

Standard Costing

(b) Garland Company uses a standard cost system. The standard for each finished unit of product allows for 3 kgs of plastic at Rs. 0.72 per kg. During December, Garland bought 4,500 kgs of plastic at Rs. 075 per kg, and used 4,100 kgs in the production of 1,300 finished units of product. What is the material purchase price variance for the month of December ?

Budget: Functional Budgets

4. Selected information concerning sales and production for ABC Ltd. for July, 2006 are summarised as follows:

a. Estimated sales:

Product K: 40,000 units at Rs. 30.00 per unit

Product L: 20,000 units at Rs. 65.00 per unit

b. Estimated inventories, July 1, 2006:

		Rs.
Material A: 4,000 kgs.	Product K: 3,000 units at Rs. 17 per unit	51,000
Material B: 3,500 kgs.	Product L: 2,700 units at Rs. 35 per unit	94,500
	Total	1,45,500

There were no work in process inventories estimated for July 1, 2006.

c. Desired inventories at July 31, 2006:

		Rs.
Material A: 3,000 kgs.	Product K: 2,500 units at Rs. 17 per unit	42,500
Material B: 2,500 kgs.	Product L: 2,000 units at Rs. 35 per unit	70,000
	Total	1,12,500

There were no work in process inventories desired for July 31, 2006.

d. Direct materials used in production:

	Product K	**Product L**
Material A:	0.7 kgs. per unit	3.5 kgs. per unit
Material B:	1.2 kgs. per unit	1.8 kgs. per unit

e. Unit costs for direct materials:

Material A:	Rs. 4.00 per kg.
Material B:	Rs. 2.00 per kg.

f. Direct labour requirements:

	Department 1	Department 2
Product K	0.4 hour per unit	0.15 hour per unit
Product L	0.6 hour per unit	0.25 hour per unit

g.

	Department 1	Department 2
Direct labour rate	Rs. 12.00 per hour	Rs. 16.00 per hour

h. Estimated factory overhead costs for July:

	Rs.
Indirect factory wages	2,00,000
Depreciation of plant and equipment	40,000
Power and light	25,000
Indirect materials	34,000
Total	2,99,000

Instructions:

1. Prepare a sales budget for July.
2. Prepare a production budget for July.
3. Prepare a direct materials purchases budget for July.
4. Prepare a direct labour cost budget for July.
5. Prepare a cost of goods sold budget for July.

Standard Costing: Material, Labour and Factory Overhead Variance

5. ABC Ltd. manufactures Product S for national distribution in India. The standard costs for the manufacture of Product S were as follows:

	Standard Costs	Actual Costs
Direct materials	1,500 kgs at Rs. 35	1,600 kgs at Rs. 32
Direct labour	4,800 hours at Rs. 11	4,500 hours at Rs. 11.80
Factory overhead	Rates per labour hour, based on 100% of normal capacity of 5,500 labour hours:	
	Variable cost, Rs. 2.40	Rs. 12,300 variable cost
	Fixed cost, Rs. 3.50	Rs. 19,250 fixed cost

Instructions:

1. Determine the quantity variance, price variance, and total direct materials cost variance for Product S.
2. Determine the time variance, rate variance, and total direct labour cost variance for Product S.
3. Determine the controllable variance, volume variance, and total factory overhead cost variance for Product S.

Standard Costing and Reconciliation

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

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

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

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

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

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

You are required to calculate the appropriate variances for material, labour and overhead;

Target Costing

7. 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.

Differential Costing

8. ABC Ltd recently began production of a new product, M, which required the investment of Rs. 16,00,000 in assets. The costs of producing and selling 80,000 units of Product M are estimated as follows:

	Rs.	
Variable costs:		
Direct materials	10.00	per unit
Direct labour	6.00	
Factory overhead	4.00	
Selling and administrative expenses	5.00	
Total	25.00	per unit
Fixed costs:		
Factory overhead	8,00,000	
Selling and administrative expenses	4,00,000	

ABC Ltd is currently considering establishing a selling price for Product M. The President of ABC Ltd has decided to use the cost-plus approach to product pricing and has indicated that Product M must earn a 10% rate of return on invested assets.

Instructions:

1. Determine the amount of desired profit from the production and sale of Product M.
2. Assuming that the total cost concept is used, determine (a) the cost amount per

unit, (b) the markup percentage, and (c) the selling price of Product M.

3. Assuming that the product cost concept is used, determine (a) the cost amount per unit, (b) the mark up percentage, and (c) the selling price of Product M.

4. Assuming that the variable cost concept is used, determine (a) the cost amount per unit, (b) the markup percentage, and (c) the selling price of Product M.

5. Assume that for the current year, the selling price of Product M was Rs. 42 per unit. To date, 60,000 units have been produced and sold, and analysis of the domestic market indicates that 15,000 additional units are expected to be sold during the remainder of the year. Recently, ABC Ltd received an offer from XYZ Ltd for 4,000 units of product M at Rs. 28 each. XYZ Ltd. will market the units in Korea under its own brand name, and no additional selling and administrative expenses associated with the sale will be incurred by ABC Ltd. The additional business is not expected to affect the domestic sales of Product M, and the additional units could be produced during the current year, using existing capacity. (a) Prepare a differential analysis report of the proposed sale to XYZ Ltd (b) Based upon the differential analysis report in (a), should the proposal be accepted?

CVP Analysis and Decision Making

9. ABC Ltd. manufactures three prototype toy furniture products – chairs, benches and tables. The budgeted unit cost and resource requirements of each item is detailed below:

	Chair	*Bench*	*Table*
	Rs.	*Rs.*	*Rs.*
Timber cost	5.00	15.00	10.00
Direct labour cost	4.00	10.00	8.00
Variable overhead cost	3.00	7.50	6.00
Fixed overhead cost	4.50	11.25	9.00
	16.50	43.75	33.00
Budgeted volumes per annum	4,000	2,000	1,500

These volumes are believed to equal the market demand for these products.

The fixed overhead costs are attributed to the three products on the basis of direct labour hours.

The labour rate is Rs. 4.00 per hour.

The cost of the timber is Rs. 2.00 per square metre.

The products are made from a specialist timber. A memo from the purchasing manager advises you that because of a problem with the supplier, it is to be assumed that this specialist timber is limited in supply to 20,000 square metres per annum.

The sales manager has already accepted an order for 500 chairs, 100 benches and 150 tables which if not supplied would incur a financial penalty of Rs. 2,000. These quantities

are included in the market demand estimates above.

The selling prices of the three products are:

	Rs.
Chair	20.00
Bench	50.00
Table	40.00

Requirements:

(a) Determine the optimum production plan and state the net profit that this should yield per annum.

(b) Calculate and explain the maximum prices which should be paid per square metre in order to obtain extra supplies of the timber.

Pricing Decisions

10. 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 2007 or 30 November, 2007. XYZ Ltd will receive Rs. 65,000 per month for a contract which will commence either at 30 June, 2007 or 30 November 2007.

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, 2007. Otherwise the material will be used as part of the July 2007 printing

requirements. The distribution department has a contract to purchase pallets at a cost of Rs. 5000 per month for July and August, 2007. 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, 2007. It is anticipated that it will be sold at a loss of Rs. 21,000 on 30 June, 2007. If sold on 30 November, 2007 the prospective buyer will pay Rs. 25,000.

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

11. (a) Describe the concept of Back flushing as used in a JIT system. What problems need to be addressed before implementing such a concept? Briefly discuss.

(b) "Skimming pricing is a policy where the prices are kept high during the early period of a product's existence". Discuss briefly the reasons for following such a policy.

12. Discuss briefly your understanding of a Balanced Scorecard? What are its advantages ?

13. (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.

14. (a) Indicate the possible disadvantages of treating divisions as profit centres

(b) Explain the role of bench marking in continuous improvement in an organisation.

Cost Sheet and Standard Costing

15. 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

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

16. (a) Explain the concept 'Learning curve'. How can it be applied for Cost management?

Profitability Analysis and Learning Curve

(b) An electronics firm which has developed a new type of fire-alarm system has been asked to quote for a prospective contract. The customer requires separate price

quotations for each of the following possible orders:

Order	Number of fire-alarm systems
First	100
Second	60
Third	40

The firm estimates the following cost per unit for the first order:

Direct materials	Rs. 500
Direct labour	
Deptt. A (Highly automatic) 20 hours at Rs. 10 per hour	
Deptt. B (Skilled labour) 40 hours at Rs. 15 per hour	
Variable overheads	20% of direct labour
Fixed overheads absorbed:	
Deptt. A	Rs. 8 per hour
Deptt. B	Rs. 5 per hour

Determine a price per unit for each of the three orders, assuming the firm uses a mark up of 25% on total costs and allows for an 80% learning curve. Extract from 80% Learning curve table:

X	1.0	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
Y%	100.0	91.7	89.5	87.6	86.1	84.4	83.0	81.5	80.0

X represents the cumulative total volume produced to date expressed as a multiple of the initial order.

Y is the learning curve factor, for a given X value, expressed as a percentage of the cost of the initial order.

Cost Sheet and Reporting

17. Jimmedar Works ltd has at the factory three Production Departments, Machine Shop, Fabrication and Assembly which are the responsibility of the shop Superintendent. The Shop Superintendent along with Materials Manger, Planning Superintendent and Maintenance Engineer Report to the Works Manager at the factory. The office administration, sales and publicity come under the Sales Manager who along with the Works Manger report to the Managing Director of the company. The following data relating to a month's performance are called out from the books of the company.

	Budget (Rs.)	*Variance from Budget*
Sales commission	800	Rs. 50 A
Raw Material and Components – Machine shop	900	20 A
Publicity Expenses	1100	100 A

Printing and Stationery	3200	200 F
Travelling expenses	4000	200 A
Wages – Machine shop	800	10 F
– Fabrication	600	20 A
– Assembly	720	10 A
Material – Assembly	760	40 A
– Fabrication	460	10 A
Utilities – Assembly Shop	320	10 A
– Assembly	470	60 F
– Fabrication	560	30 F
– Maintenance	400	20 A
– Stores	210	40 F
– Planning	180	20 A
Shop Superintendent's Office		
– Salaries and Expenses	1100	22 F
Depreciation – Factory	3880	40 A
Works Manager's Office Expenses	3810	40 A
General Office Salaries and Administration	4270	30 A
Managing Director's Salary and Administration	2800	20 F

(A = Adverse, F = Favourable)

(i) Treating the Machine Shop, Fabrication and Assembly as Cost Centres, prepare Cost Sheets for each centre with the help of the this additional information:

The Shop Superintendent devotes his time amongst Machine Shop, Fabrication and Assembly in the ratio 4:3: 4. Other Factory Overheads are absorbed on the basis of Direct Labour in each Cost Centre. Office, Administration, Selling and Distribution Overheads are, borne equally by the Cost Centres.

(ii) Treating the Machine Shop, Fabrication and Assembly as Responsibility Centres, prepare a Responsibility Accounting report for the Shop Superintendent.

Standard Costing

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

	Budget	*Actual*
Product and sales volume in units	10000	9000
Selling price per unit	Rs.60.00	61.50

Costs for the month:		
Direct materials	Rs.2,50,000	2,57,400
Direct wages	Rs.2,25,000	2,20,500
Variable overheads	Rs.10,000	9,250
Fixed overheads	Rs.25,000	23,240
Direct labour hours	50,000	42,000
Per unit data:		
Direct materials kg/unit	25	26
Direct materials price/ kg	Rs.1.00	1.10
Direct labour hours / unit	5	4.5
Direct labour rate / hour	Rs.4.50	5.25

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

Relevant Costing

19. ABC Ltd has been approached by a customer who would like a special job to be done for him, and who is willing to pay Rs. 22,000 for it. The job would require the following materials.

Material	*Total units required*	*Units already in stock*	*Book value of units in stock Rs./unit*	*Realisable value Rs. /unit*	*Replacement cost Rs./unit*
A	1,000	0	–	–	6
B	1,000	600	2	2.50	5
C	1,000	700	3	2.50	4
D	200	200	4	6.00	9

Material B is used regularly by ABC Ltd, and if units of B are required for this job, they would need to be replaced to meet other production demand.

Material C and D are in stock as the result of previous over-buying, and they have a restricted use. No other use could be found for material C, but the units of material D could be used in another job as substitute for 300 units of material E, which currently costs Rs. 5 per unit (of which the company has no units in stock at the moment).

Calculate the relevant costs of material for deciding whether or not to accept the order.

Application of Cost Concept

20. 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*
	Rs.
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*
	Rs.
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?

Linear Programming

21. A firm manufactures two types of products A and B and sells them at a profit of Rs.2 on type A and Rs. 3 on type B. Each product is processed on 2 machines G and H. Type A requires 1 minute of processing time on G and 2 minutes on H. Type B requires 1 minute

on G and 1 minute on H. The machine G is available for not more than 6 hours 40 minutes, while machine H is available for 10 hours during any working day. Formulate the problem as a L.P.P. and solve by using graphical method.

Linear Programming

22. Using simplex method to solve the following L.P.P.

Max $Z = x_1 + 2x_2 + 3x_3 - x_4$

Subject to

$x_1 + 2x_2 + 3x_3 = 15$

$2x_1 + x_2 + 5x_3 = 20$

$x_1 + 2x_2 + x_3 + x_4 = 10$

$x_1, x_2, x_3, x_4 \geq 0.$

Transportation Problem

23. Solve the following transportation problem.

	1	2	3	4	5	Stock available
1	73	40	9	79	20	8
2	62	93	96	8	13	7
3	96	65	80	50	65	9
4	57	58	29	12	87	3
5	56	23	87	18	12	5
Demand	6	8	10	4	4	

The Assignment Problem

24. A company is faced with the problem of assigning six different machine to 5 different jobs. The cost are estimated as follows (hundred of rupees).

		Jobs				
Machine		1	2	3	4	5
	1	2.5	5	1	6	1
	2	2	5	1.5	7	3
	3	3	6.5	2	8	3
	4	3.5	7	2	9	4.5
	5	4	7	3	9	6
	6	6	9	5	10	6

Solve the problem assuming that the objective is to minimize total cost.

Critical Path Analysis and PERT

25. The project has the following characteristics.

Activity	Preceding Activity	Expected Completion Time (in weeks)
A	None	5
B	A	2
C	A	6
D	B	12
E	D	10
F	D	9
G	D	5
H	B	9
I	C, E	1
J	G	2
K	F, I, J	3
L	K	9
M	H, G	7
N	M	8

(a) Draw a PERT network for this project.

(b) Find the critical path and the project completion time.

(c) Prepare on activity schedule showing ES, EF, LS, LF, and slack for each activity.

(d) Will the critical path change if activity G takes 10 weeks instead of 5 weeks? If so, what will be the new critical path?

Critical Path Analysis and PERT

26. A project consists of nine activities whose time estimates (in weeks) and other characteristics are given below.

Activity	Preceding activity(ies)	Time estimates (weeks)		
		Most optimistic	Most likely	Most pessimistic
A	–	2	4	6
B	–	6	6	6
C	–	6	12	24
D	A	2	5	8
E	A	11	14	23
F	B, D	8	10	12

G	B, D	3	6	9
H	C, F	9	15	27
I	E	4	10	16

(i) Show the PERT network for the project.

(ii) Identify the critical activities.

(iii) What is the expected project completion time and its variance?

Simulation

27. An investment company wants to study the investment projects based on market demand, profit and the investment required, which are independent of each other. Following probability distributions are estimated for each of these three factors:

Annual demand (Units in thousands)	25	30	35	40	45	50	55
Probability	0.05	0.10	0.20	0.30	0.20	0.10	0.05
Profit per Unit	3.00	5.00	7.00	9.00	10.00		
Probability	0.10	0.20	0.40	0.20	0.10		
Investment required (in thousands of Rupees)	2750	3000	3500				
Probability	0.25	0.50	0.25				

Using simulation process, repeat the trial 10 times, compute the investment on each trial taking these factors into trial what is the most likely return?

Use the following random numbers:

(30, 12, 16); (59, 09, 69); (63, 94, 26); (27, 08, 74);

(64, 60, 61); (28, 28, 72); (31, 23, 57); (54, 85, 20);

(64, 68, 18); (32, 31, 87).

In the bracket above, the first random number is for annual demand, the second one is for profit and the last one is for the investment required.

Time Series Analysis and Forecasting

28. Below are given the figures of production (in thousand quintals) of a sugar factory.

Year	Production (thousand quintals)
1993	77
1995	88
1996	94

1997	85
1998	91
1999	98
2002	90

(i) Fit a straight line by the 'least squares' method and tabulate the trend values.

(ii) Eliminate the trend. What components of the series are thus left over?

(iii) What is monthly increase in the production of sugar?

Time Series Analysis and Forecasting

29. Calculate 5 yearly and 7 yearly moving averages for the following data of the numbers of commercial and industrial failure in a country during 1987 to 2002.

Year	No. of failures
1987	23
1988	26
1989	28
1990	32
1991	20
1992	12
1993	12
1994	10
1995	9
1996	13
1997	11
1998	14
1999	12
2000	9
2001	3
2002	1

Also plot the actual and trend values on a graph.

Testing of Hypothesis (chi – square – test)

30. The contingency table below summarize the results obtained in a study conducted by a research organization with respect to the performance of four competing brands of tooth paste among the users

	Brand A	Brand B	Brand C	Brand D	Total
No. of Cavities	9	13	17	11	50
One of five	63	70	85	82	300
More than five	28	37	48	37	150
Total	100	120	150	130	500

Test the hypothesis that incidence of cavities is independent of the brand of the tooth paste used. Use level of significance 1% and 5%.

Testing of Hypothesis (ANOVA)

31. Below are given the yield (in kg.) per acre for 5 trial plots of 4 varieties of treatment. Carry out an analysis of variance and state conclusion

	Treatment			
Plot no.	1	2	3	4
1	42	48	68	80
2	50	66	52	94
3	62	68	76	78
4	34	78	64	82
5	52	70	70	66

Testing of Hypothesis (t – test)

32. The sales data of an item in six shops before and after a special promotional compaign are as under

Shops	A	B	C	D	E	F
Before Compaign	53	28	31	48	50	42
After Compaign	58	29	30	55	56	45

Can the compaign be judged to be a success?

Test at 5% level of significance using t-test.

SUGGESTED ANSWERS/HINTS

1. Variable Costing Income Statement

	Rs.	*Rs.*
Sales (60,000 × Rs. 30)		18,00,000
Variable cost of goods sold:		
Beginning inventory (10,000 × Rs. 24)	2,40,000	

Variable cost of goods manufactured (50,000 × Rs. 25)	12,50,000	
Variable cost of goods sold		14,90,000
Manufacturing margin		3,10,000
Variable selling and administrative expenses		65,000
Contribution margin		2,45,000
Fixed Costs:		
Fixed manufacturing costs	1,00,000	
Fixed selling and administrative expenses	45,000	1,45,000
Income from operations		1,00,000

Absorption Costing Income Statement

	Rs.	*Rs.*
Sales (60,000 × Rs. 30)		18,00,000
Cost of goods sold:		
Beginning inventory (10,000 × Rs. 26)	2,60,000	
Cost of goods manufactured (50,000 × Rs. 27)	13,50,000	
Cost of goods sold		16,10,000
Gross profit		1,90,000
Selling and administrative expenses (Rs. 65,000 + Rs. 45,000)		1,10,000
Income from operations		80,000

2. (a) Contribution and Profitability Analysis

			Total	*Per unit*
Sales*			Rs. 2,88,000	Rs. 32
Less:	Variable costs			
	Direct material	54,000		6
	Direct wages	72,000		8
	Production Overheads	18,000		2
	Admn, S & D OH	27,000		3
			1,71,000	19
Contribution			1,17,000	13
Less:	Fixed Overheads			
	Production	42,000		
	Admn, S & D	36,000		
			78,000	
	Net Profit		39,000	

*Capacity utilisation: 75%

P/V Ratio = $(S - V)/S \times 100 = 40.625\%$

BE Sales = Fixed costs ÷ P/V Ratio

= 78,000 ÷ 40.625%

= Rs. 1,92,000

or 1,92,000 ÷ Rs. 32 = 6,000 Units

(b)

Production	*90% Capacity (10,800 Units)*	*100% Capacity (12,000 Units)*
Selling price per unit	Rs. 28	Rs. 27.20
Variable cost per unit	19	19.00
Contribution per unit	9	8.20
P/V Ratio	32.143%	30.147%
Total contribution	97,200	98,400
Less Fixed Overheads	78,000	83,000
	19,200	15,400

The P/V Ratio has gone down to 32.143% in the case of alternative b(i) and to 30.147% in alternative b(ii). Therefore the company should follow the original plan as at (a) above

(c) (i)

Selling price per unit	Rs. 32
Less Variable costs	19
Contribution per unit	13
Total contribution (12,000 × Rs 13)	1,56,000
Less: fixed costs	93,000
Profit	63,000

This proposal may be expected as there is a considerable increase in the profits.

3. (a) 1. (a) $\text{Contribution margin ratio} = \dfrac{\text{Sales} - \text{Variable costs}}{\text{Sales}}$

$$\text{Contribution margin ratio} = \frac{(60{,}000 \text{ units} \times \text{Rs. } 20) - (60{,}000 \text{ units} \times \text{Rs. } 14)}{(60{,}000 \text{ units} \times \text{Rs. } 20)}$$

$$\text{Contribution margin ratio} = \frac{\text{Rs. } 1{,}20{,}000 - \text{Rs. } 8{,}40{,}000}{\text{Rs. } 12{,}00{,}000} = \frac{\text{Rs. } 3{,}60{,}000}{\text{Rs. } 12{,}00{,}000}$$

Contribution margin ratio = 30%

(b) Unit contribution margin = Unit selling price – Unit variable costs

Unit contribution margin = Rs. 20 – Rs. 14 = Rs. 6

2. $$\text{Break - even sales (units)} = \frac{\text{Fixed costs}}{\text{Unit contribution margin}}$$

$$\text{Break - even sales (units)} = \frac{\text{Rs. 2,88,000}}{\text{Rs. 6}} = 48{,}000 \text{ units}$$

3. Margin of safety:

	Rs.
Expected sales (60,000 units × Rs. 20)	12,00,000
Break-even point (48,000 units × Rs. 20)	9,60,000
Margin of safety	2,40,000

Or

$$\text{Margin of safety} = \frac{\text{Sales} - \text{Sales at break - even point}}{\text{Sales}}$$

$$\text{Margin of safety} = \frac{\text{Rs. 2,40,000}}{\text{Rs. 12,00,000}} = 20\%$$

(b) (Standard price – actual price) × number of kgs purchased

(Rs 0.72 – 0.75) × 4,500 kgs = Rs 135 unfavourable

4. 1.

ABC Ltd

Sales Budget
for the Month ending July 31, 2006

Product	*Unit Sales Volume*	*Unit Selling Price*	*Total Sales*
		Rs.	*Rs.*
Product K	40,000	30.00	12,00,000
Product L	20,000	65.00	13,00,000
Total revenue from sales			25,00,000

2.

ABC Ltd.
Production Budget for
the Month ending July 31, 2006

	Units	
	Product K	*Product L*
Sales	40,000	20,000
Plus desired inventories at July 31, 2006	2,500	2,000

Total	42,500	22,000
Less: Estimated inventories, July 1, 2006	3,000	2,700
Total production	39,500	19,300

3.

ABC Ltd

Direct Materials Purchases Budget
for the Month ending July 31, 2006

	Direct Materials		
	Material A	*Material B*	*Total*
Units required for production:			
Product K (39,500 × lbs. per unit)	27,650 kgs*	47,400 *	
Product L (19,300 × lbs. per unit)	67,550 kgs**	34,740 **	
Plus desired units of inventory			
July 31, 2006	3,000	2,500	
Total	98,200 kgs.	84,640 kgs,	
Less estimated units of inventory			
July 1, 2006	4,000	3,500	
Total units to be purchased	94,200 kgs.	81,140 kgs.	
Unit price	.... × Rs.4.00	.....× Rs.2.00	
Total direct materials purchases	Rs. 3,76,800	Rs. 1,62,280	Rs. 5,39,080

*27,650 = 39,500 × 0.7 47,400 = 39,500 × 1.2

**67,550 = 19,300 × 3.5 34,740 = 19,300 × 1.8

4.

ABC Ltd
Direct Labour Cost Budget
for the Month ending July 31, 2006

	Department 1	*Department 2*	*Total*
Hours required for production:			
Product K (39,500 × hours per unit)	15,800*	5,925*	
Product L (19,300 × hours per unit)	11,580**	4,825**	
Total	27,380	10,750	
Hourly rate	× Rs.12.00	× Rs.16.00	
Total	Rs.3,28,560	Rs.1,72,000	Rs. 5,00,560

*15,800 = 39,500 × 0.4 5,925 = 39,500 × 0.15

**11,580 = 19,300 × 0.6 4,825 = 19,300 × 0.25

5.

ABC Ltd
Cost of Goods sold Budget
for the Month ending July 31, 2006

		Rs.
Finished goods inventory, July 1, 2006		1,45,500
Direct materials:		
Direct materials inventory, July 1, 2006 (Note A)	23,000	
Direct materials purchases	5,39,080	
Cost of direct materials available for use	5,62,080	
Less: Direct materials inventory, July 31, 2006 (Note B)	17,000	
Cost of direct materials placed in production	5,45,080	
Direct labour	5,00,560	
Factory overhead	2,99,000	
Cost of goods manufactured		13,44,640
Cost of finished goods available for sale		14,90,140
Less: Finished goods inventory, July 31, 2006		1,12,500
Cost of goods sold		13,77,640

Note A:			*Rs.*
Material A	4,000 kgs.	at Rs. 4.00 per kg.	16,000
Material B	3,500 kgs.	at Rs. 2.00 per kg.	7,000
Direct materials inventory, July 1, 2006			23,000

Note B:			*Rs.*
Material A	3,000 kgs.	at Rs. 4.00 per kg.	12,000
Material B	2,500 kgs.	at Rs. 2.00 per kg.	5,000
Direct materials inventory, July 31, 2006			17,000

5. 1. **Direct Materials Cost Variance**

Quantity Variance:		
Actual quantity	1,600 kgs	
Standard quantity	1500 kgs	
Variance – unfavourable	100 kgs × Std price, Rs 35	Rs. 3,500
Price Variance:		
Actual price	Rs. 32.00 per kg	

Standard price	35	
Variance – favourable	Rs(300) per kg × Actual Qty, 1600	(4,800)
Total direct materials cost variance - favourable		Rs. (1,300)

2. Direct Labour Cost Variance

Time Variance:		
Actual time	4,500 hours	
Standard time	4,800 hours	
Variance – favourable	(300 hours) × Std rate, Rs 11	Rs. (3,300)
Rate Variance:		
Actual rate	Rs. 11.80	
Standard rate	11.00	
Variance – unfavourable	Rs 0.80 per hr × Actual time, 4500 hours	3,600
Total direct labour cost variance - unfavourable		Rs. 300

3. Factory Overhead Cost Variance

Variable factory overhead – controllable variance:		
Actual variable factory overhead cost incurred	Rs. 12,300	
Budgeted variable factory overhead for 4,800 hours	11,520*	
Variance – unfavourable		Rs. 780
Fixed factory overhead – volume variance:		
Budgeted hours at 100% of normal capacity	5,500 hours	
Standard hours for actual production	4,800	
Productive capacity not used	700 hours	
Standard fixed factory overhead cost rate	× Rs. 3.50 hours	
Variance – unfavourable		2,450
Total factory overhead cost variance – unfavourable		Rs. 3,230

*4,800 hours × Rs. 2.40 = Rs. 11,520

6. Standard Variable O.H. rate = Rs. 1,80,000÷15,000 = Rs. 12 per hr.

Standard Fixed OH rate = 2,70,000 ÷ 15,000 = Rs.1 8 per hr.

Material Variances (Actual Production : 25,000 Units)

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

Labour Variances

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

Variable Overhead Variances

Actual variable overhead	= Rs. 1,60,000 (a)
Budgeted variable overhead	= Rs. 1,68,000 (b)
(28,000×0.5 hr×Rs. 12)	
Standard Variable O.H. for actual production	= Rs. 1,50,000 (c)
(25,000 units × 0.5 hr × Rs. 12)	
Variable O.H. Expenditure variance	= (a) – (b)
	= Rs. 1,60,000 –Rs. 1,68,000
	= Rs. 8,000 (F)
Variable O.H. Efficiency variance	= (b) – (c)
= Rs. 1,68,000 –Rs. 1,50,000	= Rs. 18,000 (A)

Fixed Overhead Variances

Actual fixed overhead incurred	= Rs. 2,70,000
Budgeted Fixed Overhead	= Rs. 2,70,000
Expenditure Variance	= Nil
Budgeted production	= 28,000 Units
Actual production	= 25,000 Units
Unutilised capacity	= 3,000 Units or 1,500 Hrs
Production volume variance	= 1,500 Hrs × Rs 18 per hr
	= (Rs 27,000)

Note : For calculating production volume variance, normal operating capacity of 15,000 hours can also be used. In that case, budgeted production will be 30,000 units.

7. 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

8. 1. Rs. 1,60,000 (Rs. 16,00,000 × 10%)

2. a. *Total costs:*

	Rs.
Variable (Rs. 25 × 80,000 units)	20,00,000
Fixed (Rs. 8,00,000 + Rs. 4,00,000)	12,00,000
Total	32,00,000

Cost amount per unit: Rs. 32,00,000 ÷ 80,000 units = Rs. 40.00

b. $$\text{Markup percentage} = \frac{\text{Desired profit}}{\text{Total costs}}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 1,60,000}{\text{Rs. } 32,00,000} = 5\%$$

c.

	Rs.
Cost amount per unit	40.00
Markup (Rs. 40 × 5%)	2.00
Selling price	42.00

3. a. Total manufacturing costs:

	Rs.
Variable (Rs. 20 × 80,000 units)	16,00,000
Fixed factory overhead	8,00,000
Total	24,00,000

Cost amount per unit: Rs. 24,00,000 ÷ 80,000 units = Rs. 30.00

b. $$\text{Markup percentage} = \frac{\text{Desired profit} + \text{Total selling and administrative expenses}}{\text{Total manufacturing costs}}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 1,60,000 + \text{Rs. } 4,00,000 + (\text{Rs. } 5 \times 80,000 \text{ units})}{\text{Rs. } 24,00,000}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 1,60,000 + \text{Rs. } 4,00,000 + \text{Rs. } 4,00,000}{\text{Rs. } 24,00,000}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 9,60,000}{\text{Rs. } 24,00,000} = 40\%$$

c.

	Rs.
Cost amount per unit	30.00
Markup (Rs. 30 × 40%)	12.00
Selling price	42.00

4. a. Variable cost amount per unit : Rs. 25

Total variable costs: Rs. 25 × 80,000 units = Rs. 20,00,000

b. $$\text{Markup percentage} = \frac{\text{Desired profit} + \text{Total fixed costs}}{\text{Total variable costs}}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 1,60,000 + \text{Rs. } 8,00,000 + \text{Rs. } 4,00,000}{\text{Rs. } 20,00,000}$$

$$\text{Markup percentage} = \frac{\text{Rs. } 13,60,000}{\text{Rs. } 20,00,000} = 68\%$$

c.

	Rs.
Cost amount per unit	25.00
Markup (Rs. 25 × 68%)	17.00
Selling price	42.00

5. a. Proposal to Sell to XYZ Ltd.

	Rs.
Differential revenue from accepting offer:	
Revenue from sale of 4,000 additional units at Rs. 28	1,12,000
Differential cost from accepting offer:	
Variable production costs of 4,000 additional units at Rs. 20	80,000
Differential income from accepting offer	32,000

b. The proposal should be accepted.

9. (a) Production plan and net profit

Timber required

	Square metres	*Budgeted volume*	*Requirement (square metres)*
	(a)	(b)	(a × b)
Chair	Rs. (5 ÷ 2) = 2.5	4,000	10,000
Bench	Rs. (15 ÷ 2) = 7.5	2,000	15,000
Table	Rs. (10 ÷ 2) = 5.0	1,500	7,500
			32,500

Therefore, there is a shortfall of 12,500 square metres.

	Chair	Bench	Table
Unit contribution	Rs. 8.00	Rs. 17.50	Rs. 16.00
Timber requirement (square metres)	2.5	7.5	5.0
Contribution per square metre	Rs. 3.20	Rs. 2.33	Rs. 3.20
Ranking	1st =	3rd =	1st =

Production plan

	Square metres	*Contribution*
		Rs
4,000 chairs (inclusive of 500 firm orders)	10,000.0	32,000.00
1,500 tables (inclusive of 150 firm orders)	7,500.0	24,000.00
333 benches (inclusive of 100 firm orders)	2,500.0	5,825.00
	20,000.0	61,825.00
Fixed overhead (Rs18,000 + Rs22,500 + Rs13,500)		54,000.00
Profit		7,825.00

(b) Since the optimum production plan in part (a) indicates that demand for chairs and tables is satisfied by production, any additional timber would be utilized to manufacture benches.

Each square metre used on a bench contributes Rs2.33 (see part (a) after charging the present cost of timber (Rs. 2 per square metre).

Therefore the maximum price to be paid is Rs2.33 + Rs2 = Rs 4.33 per square metre.

Unsatisfied demand = (2,000 − 333) 1,667 benches.

∴ Timber required is 1,667 × 7.5 square metres = 12,502.5 square metres, less the 2.5 square metres still available from the original supplier = 12,500 square metres.

10. The costs/benefits of closing on 30 November, 2006 instead of closing on 30 June, 2006 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	2,175.00	
		(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)		(4,000)
Net benefit of closing on 30 November		33,332.50

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 × Rs. 500) – (2 × Rs. 380) = Rs. 240 net cost.

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

(Rs. 500 – Rs. 380) + Rs. 100 = 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 [(Rs. 8,500 × 30%) + (Rs. 8,500 × 70% × 15%)] × 5 months = Rs. 17,212.50.

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

******

	Rs.
Net book value	48,000
June sale (loss)	21,000
Therefore June proceeds	27,000
November proceeds	25,000
Additional loss	2,000

11. (a) Back flushing in a JIT system

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 black 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.

(b) Reasons for following skimming pricing policy

It is a policy where the prices are kept high during the early period of a product's existence. This can be synchronised with high promotional expenditure and in the latter years the prices can be gradually reduced. The reasons for following such a policy are as follows:

(i) The demand is likely to be inelastic in the earlier stages till the product is established in the market.

(ii) The gradual reduction in price in the latter years will tend to increase the sales.

(iii) This method is preferred in the beginning because in the initial periods when the demand for the product is not known the price covers the initial cost of production.

(iv) High initial capital outlays needed for manufacture, results in high cost of production. In addition to this, the producer has to incur huge promotional activities resulting in increased costs. High initial prices will be able to finance the cost of production particularly when uncertainties block the usual sources of capital.

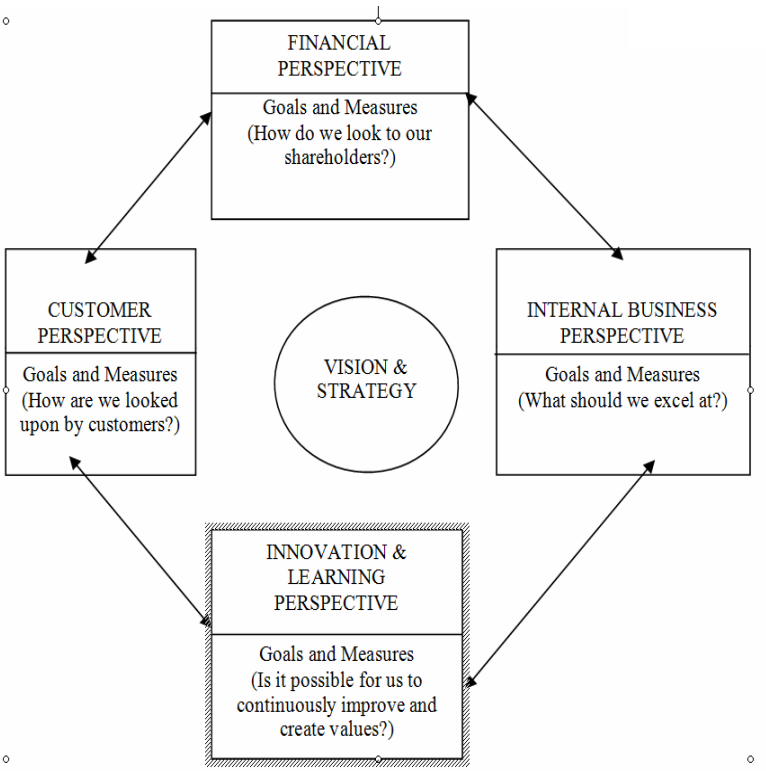
12. The Balanced Scorecard can be defined as 'an approach to the provision of information to management to assist strategic policy formulation and achievement'. It emphasizes the need to provide the user with a set of information, which addresses all relevant areas of performance in an objective and unbiased fashion. The information provided may include both financial and non financial elements, and cover areas such as profitability, customer satisfaction, internal efficiency and innovation'.

It shall be clear from the above definition that the central idea of the Balanced Scorecard is that managers should develop the measures on which they manage the business from

four different perspectives:

1. Customer satisfaction
2. Internal business process e.g., operating cycle time.
3. Kaizen approach (can we continue to improve and create value)
4. Financial e.g., operating income by segments.

The following figure summarises the ideas of a Balanced Scorecard:



The ultimate result of using the Balanced Scorecard approach should be an improved long-term financial performance. Since the scorecard gives equal importance to the relevant non – financial measures, it should discourage the short termism that leads to cuts in spending on new product development, human resource development etc which are ultimately detrimental for the future prospects of the company.

The responsibility to devise and implement a Balanced Scorecard should be that of the

managers working with the business. Since every company is different, it shall need to work out for itself the various financial and non – financial measures, which need to be focussed upon for its own development. Since the Balanced Scorecard is recommended as a management tool used both for internal and external reporting purposes, it is again the manager's responsibility to decide as to what information needs to be disclosed and how any problems of confidentiality can best be overcome.

The following are some reasons why Balanced Scorecards sometimes fail to provide for the desired results:

- Managers mistakenly think that since they already use non – financial measures, they already have a Balanced Scorecard.
- Senior executives misguidedly delegate the responsibility of the Scorecard implementation to middle level managers.
- Company's try to copy measures and strategies used by the best companies rather than developing their own measures suited for the environment under which they function.
- There are times when Balanced Scorecards are thought to be meant for reporting purposes only. This notion does not allow a Business to use the Scorecard to manage Business in a new and more effective way.
- It may be noted that the above-mentioned difficulties refer to the internal use of the Scorecard, unless it is used internally successfully, it should not be used as a basis for external reporting.

13. (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 costs 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, one time, ad-hoc problems. The following are the most common short-term problems and areas where differential cost 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 decision, 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 decision. These costs are different between alternatives being considered. Only costs that differ among decision alternatives are relevant to a decision.

14. (a) The possible disadvantages of treating divisions as profit centres are as follows:

1. Divisions may compete with each other and may take decisions to increase profits at the expense of other divisions thereby overemphasizing short term results.
2. It may adversely affect co-operation between the divisions and lead to lack of harmony in achieving organisational goals of the company. Thus it is hard to achieve the objective of goal congruence.
3. It may lead to reduction in the company's overall total profits.
4. The cost of activities which are common to all divisions may be greater for decentralised structure than for centralised structure. It may thus result in duplication of staff activities.
5. Top management 10 sesc' Control by delegating decision making to divisional managers. There are risks of mistakes committed by the divisional managers which the top management, may avoid.
6. Series of control reports prepared for several departments may not be effective from the point of view of top management.
7. It may under utilise corporate competence.
8. It leads to complications associated with transfer pricing problems.
9. It becomes difficult to identity and define precisely suitable profit centres.
10. It confuses division's results with manager's performance.

(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.

15. (a) **Standard Cost Sheet**

Max. capacity = 200 units.

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 × Standard Fixed Cost per Finished Good

100 × Rs 10,000 = Rs 10,00,000 Adverse.

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

Raw Material	*Std Qty/FG*	*Std. Qty on actual prod*	*Actual Qty on actual prod*	*Act Price per unit of RM (Rs.)*	*Std Price per unit 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)

16. (a) The first time when a new operation is performed, both the workers and the operating procedures are untried. As the operation is repeated and the workers become more familiar with work, labour efficiency increases and the labour cost per unit declines. This process continues for some time and a regular rate of decline in cost per unit can be established. This rate can be used to predict future labour costs. The learning process starts from the point when the first unit comes out of the production line. In other words 'Learning curve' is a function that measures how

labour hours per unit decline as units of production increase because workers are learning and becoming better at their jobs.

Cost Management Application:

1. Learning curve is useful in analysing cost volume profit relationship. The company can set low price of its product to generate high demand. As the production increases, cost per unit drops.
2. It helps in budgeting and profit planning.
3. It enables the company in price fixation. In particular, the company can fix a lower price for repeat orders.
4. It helps the design engineers to take suitable decisions based on expected rates of improvement.
5. It helps in price negotiations.
6. It is useful in setting standards and in performance evaluation.

(b) (i) Price per unit for first order of 100 units

		Rs.	*Rs.*
Direct material			500.00
Direct labour	Dept A 20 Hrs @ 10 = 200 Dept B 40 Hrs @ 15 = 600		800.00
Variable Overhead	20% of Rs 800		160.00
Fixed Overhead	Dept A 20 Hrs @ 8 = 160 Dept B 40 Hrs @ 5 = 200		360.00
Total cost			1,820.00
Profit 25%			455.00
Selling price per unit			2,275.00

(ii) Price per unit for second order of 60 units

Learning will be applicable only in department B.

Cumulative output becomes 100 units + 60 units = 160 units i.e 1.6 times for which learning is 86.1 % from the tables.

Therefore Total Hrs for 160 units = 160 units $\times 40 \times .861$ = 5,510.4 Hrs

Therefore Hrs for 60 units = Hrs for 160 units less Hrs for 100 units

Or 5510.4 less 40×100 = 1510.4 Hrs

Therefore Hrs per unit = $\frac{1510.4}{60}$ = 25.17.

Calculation of selling price per unit

		Rs.
Direct materials		500.00
Direct labour	Dept A 20 Hrs @ 10 = 200 Dept B 25.17 Hrs @ 15 = 377.55	577.55
Variable Overhead	20% of 577.55	115.51
Fixed Overhead	Dept A 20 Hrs @8= 160 Dept B 25.17 Hrs @5=125.85	285.85
Total cost		1,478.91
Profit 25%		369.73
Selling price per unit		1,848.64

(iii) Price per unit for third order of 40 units

Cumulative output becomes 100 + 60 + 40 = 200 units i.e. 2 times for which learning is 80% from the table

Total Hrs for 200 units = 200 $\times$40 $\times$.80 = 6,400 Hrs

Hrs for 40 units = Hrs for 200 units less Hrs for 160 units

Or 6,400 less 5510.4 = 889.6 Hrs

Therefore Hrs per unit = $\frac{889.6}{40}$ = 22.24

Calculation of selling price per unit

		Rs.
Direct materials		500.00
Direct labour	Dept A 20 Hrs @ 10 = 200.00 Dept B 22.24 @ 15 = 333.60	533.60
Variable Overhead	20% of 533.60	106.72
Fixed Overhead	Dept A 20 Hrs @ 8 = 160 Dept B 22.24 Hrs @ 5 = 111.20	271.20
Total cost		1,411.52
Profit 25%		352.88
Selling price per unit		1,764.40

17. (i) Cost Sheets for Machine Shop, Fabrication and Assembly treating them as Cost Centres

	Machine Shop		**Fabrication**		**Assembly**	
	Budget	Actual	Budget	Actual	Budget	Actual
Raw Material and components	900	920	460	470	760	800
Wages	800	790	600	620	720	730
Utilities	320	330	560	530	470	410
Prime Cost	2020	2040	1620	1620	1950	1940
Shop Supdt's Office Salaries and Expenses (Ratio 4:3:4)	400	392	300	294	400	392
Other factory overheads	3200	3160	2400	2480	2880	2920
Factory cost	5620	5592	4320	4394	5230	5252
@ Adm. Selling & Distribution Overheads (one-third each)	5390	5443	5390	5443	5390	5444
Total cost	11010	11035	9710	9837	10620	10696

*Factory overheads

	Budget	*Actual*
Utilities		
Maintenance	Rs. 400	Rs. 420
Stores	210	170
Planning	180	200
Depreciation	3880	3920
Works manager's office expense	3810	3850
Total factory overheads	8480	8560
Direct Wages (Rs. 800 + 600 + 720)	2120	2140
Factory overhead as a % of direct wages	400%	400%

@ Administration, Selling and Distribution Overheads

	Budget	Actual
Sales commission	Rs. 800	Rs. 850
Publicity expenses	1100	1200
Printing and Stationery	3200	3000
Travelling Expenses	4000	4200
General office salaries administartion	4270	4300
M. D. salary and administration	2800	2780
Total	16170	16330

These overheads are to be divided equally among the production departments.

(ii) Responsibility Accounting Report for the Shop Superintendent treating the Machine Shop, fabrication and Assembly as responsibility centres.

Sl. No.		*Budget*	*Actual*	*Variance*
1.	Machine Shop			
	Material	900	920	20 (A)
	Labour	800	790	10 (F)
	Utilities	320	330	10 (F)
		2020	2040	20 (A)
2.	Fabrication			
	Material	460	470	10 (A)
	Labour	600	620	20 (A)
	Utilities	560	530	30 (F)
		1620	1620	—
3.	Assembly			
	Material	760	800	40 (A)
	Labour	720	730	10 (A)
	Utilities	470	410	60 (F)
		1950	1940	10 (F)
	Total (1 + 2 + 3)	5590	5600	10 (A)

Note: Since Shop Superintendent's office salaries and expenses include his salary also, it has been assumed that these are not controlled by him and hence not included.

18. 1. Computation of material variances:

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

Material cost variance :

= (S.C – A.C) = Rs.2,25,000 – Rs.2,57,400 = Rs.32,400 (Adv.)

Material price variance:

= (S.P – A.P) A.Q = (1–1.10) 2,34,000 = Rs.23,400 (Adv.)

Material usage variance:

= *(S.Q* – A.Q) S.P = (2,25,000 – 2,34,000) Re.1 = Rs.9,000 (Adv.)

2. Computation of labour variances:

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

Labour cost variance :

= (S.C – A.C) = (Rs.2, 02,500 – Rs.2, 20,500) = Rs.18,000 (Adv.)

Labour rate variance:

= (S.R – A.R) A.H = (4.50 – 5.25) 42,000 = Rs.31,500 (Adv.)

Labour efficiency variance:

= (S.H – Actual production hrs) S.R = (45,000 – 40,500) 4.50 = Rs.20,250 (Fav)

Idle time variance

= Idle time hours x standard rate per hour = 1,500 hours x Rs.4.50

= Rs. 6,750(Adv)

3. Computation of Fixed overhead variances:

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

Total fixed overhead cost variance:

= {Fixed overhead recovered on actual output – Actual fixed overhead incurred}

= { 9,000 x Rs.2.50 – Rs.23,240} = Rs.740 (Adv)

Expenditure variance:

= [Budgeted fixed overheads – Actual fixed overheads]

= [Rs.25,000 – Rs.23,240) = Rs.1,760 (fav.)

Volume variance:

= [Budgeted volume – Actual volume) Std. rate per unit

= (10,000 – 9,000) Rs.2.50 = Rs.2,500 (Adv.)

Efficiency variance:

= (Standard hours for actual output – Actual production hours) Std rate per hour

= (45,000 hours – 40,500 hours) 0.50 = Rs.2,250 (Fav.)

Capacity variance:

= (Budgeted hours – Actual hours) Std rate per hour

= (50,000 hours – 42,000 hours) 0.50 = Rs.4,000 (adv)

Idle time variance:

= Idle time hours x Std rate per hour

= 1,500 hours x 0.50 = Rs.750 (Adv.)

4. Computation of variable overhead variances:

Budgeted / Standard data		*Actual data*	
Budgeted variable overheads for actual production hours (Rs.)	8,100	Actual variable overheads (Rs.)	9,250
		Actual output (units)	9,000
		Actual production (hours)	40,500

Standard hours per unit	5
Standard variable overhead rate per hour (Rs.)	0.20
Standard variable overhead rate per unit	Re.1

Total variable overhead cost variance:

= (Variable overhead recovered on actual output - Actual variable overhead incurred)

= (9,000 units x Re.1 – Rs.9,250) = Rs.250 (Adv.)

Expenditure variance:

= [Budgeted variable overheads – Actual variable overheads]

= [Rs.8,100 – Rs.9,250) = Rs.1,150 (Adv.)

Efficiency variance:

= [Standard hours for actual output – Actual hours) Std. rate per unit

= (45,000 – 40,500) 0.20 =Rs.900 (Fav.)

5. Computation of sales variances:

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

Total sales value variance:

= [Budgeted sales value – Actual sales value]

= (Rs.6,00,000 – Rs.5, 53,500) = Rs.46, 500 (Adv.)

Sales price variance:

= [Budgeted selling price – Actual selling price] AQ

= (60 - 61.50) 9,000 = Rs.13,500 (Fav.)

Sales volume variance:

= [Budgeted volume – Actual volume] Budgeted S.P per unit

= (10,000 – 9,000) 60 = Rs.60,000 (Adv.)

Standard gross margin volume variance:

= (Budgeted volume – Actual volume) Std. gross margin per unit

= (10,000 – 9,000) (Rs. 60 – Rs. 51) = Rs. 9,000 (Adv.)

Reconciliation of budgeted profit with actual profit:

		Rs.
Budgeted profit		90,000
Sales gross margin volume variance		9,000 (Adv)
Standard profit		81,000
Sales price variance		13,500 (Fav)
Total		94,500
Cost variances:		
Direct material	32,400 (Adv.)	
Direct labour	18,000 (Adv.)	
Variable overhead	250 (Adv)	
Fixed overhead	740 (Adv)	51,390 (Adv.)
Actual profit		43,110

19. Material A is not yet owned. It would have to be bought in full at the replacement cost of Rs. 6 per unit.

Material B is used regularly by the company. There are existing stocks (600 units) but if these are used on the contract under review a further 600 units would be bought to replace them. Relevant costs are therefore 1,000 units at the replacement cost of Rs. 5 per unit.

1,000 units of material C are needed and 700 are already in stock. If used for the contract, a further 300 units must be bought at Rs. 4 each. The existing stock of 700 will not be replaced. If they are used for the contract, they could not be sold at Rs. 2.50 each. The realisable value of these 700 units is an opportunity cost of sales revenue forgone.

The required units of material D are already in stock and will not be replaced. There is an opportunity cost of using D in the contract because there are alternative opportunities either to sell the existing stocks for Rs. 6 per unit (Rs. 1,200 in total) or avoid other purchases (of material E), which would cost 300 $\times$ Rs. 5 = Rs. 1,500. Since substitution for E is more beneficial, Rs.1,500 is the opportunity cost.

Summary of relevant costs

	Rs.
Material A (1,000×Rs. 6)	6,000
Material B (1,000×Rs. 5)	5,000
Material C (300×Rs. 4) plus (700×Rs. 2.50)	2,950
Material D	1,500
Total	15,450

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

= Rs. 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	× Rs.8/dlh	× Rs.8/dlh	× Rs.8/dlh
Total factory overhead	Rs.2,00,000	Rs.80,000	Rs.11,20,000
Number of units	÷ 10,000	÷ 2,000	÷ 50,000
Cost per unit	Rs. 20.00	Rs. 40.00	Rs. 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	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
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	=	25,000
Total factory overhead					Rs.6,98,750
Unit volume					÷ 10,000
Factory overhead cost per unit					Rs. 69.88

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	=	10,000
Total factory overhead					Rs.5,19,600
Unit volume					÷ 2,000
Factory overhead cost per unit					Rs. 259.80

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	=	1,40,000
Total factory overhead					Rs.1,81,650
Unit volume					÷ 50,000
Factory overhead cost per unit					Rs. 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.

21. Let us assume the number of A products produced be x_1 and the number of B products produced be x_2

Profit function is $Z = 2x_1 + 3x_2$

The in–equation due to G is $x_1 + x_2 \leq 400$

The in–equation due to H is $2x_1 + x_2 \leq 600$

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

$\therefore$ The required L.P.P. is

Maximize $Z = 2x_1 + 3x_2$ (Objective Function)

Subject to $x_1 + x_2 \leq 400$

$2x_1 + x_2 \leq 600$ constraints.

$x_1, x_2 \geq 0$ – Non–negative constraints.

To solve by Graphical Method

We shall converts the in–equation given in L.P.P. as equation

$x_1 + x_2 = 400 \rightarrow (1)$

$2x_1 + x_2 = 600 \rightarrow (2)$

Consider the line – (1), $x_1 + x_2 = 400$

When $x_2 = 0$, $x_1 = 400$

$\therefore$ line (1) cuts x_1 – axis at (400,0)

When $x_1 = 0$, $x_1 + x_2 = 400$, $x_2 = 400$

Line (1) cuts x_2 axis at (0,400)

Consider the line (2).

When $x_2 = 0$, $2x_1 + x_2 = 600$

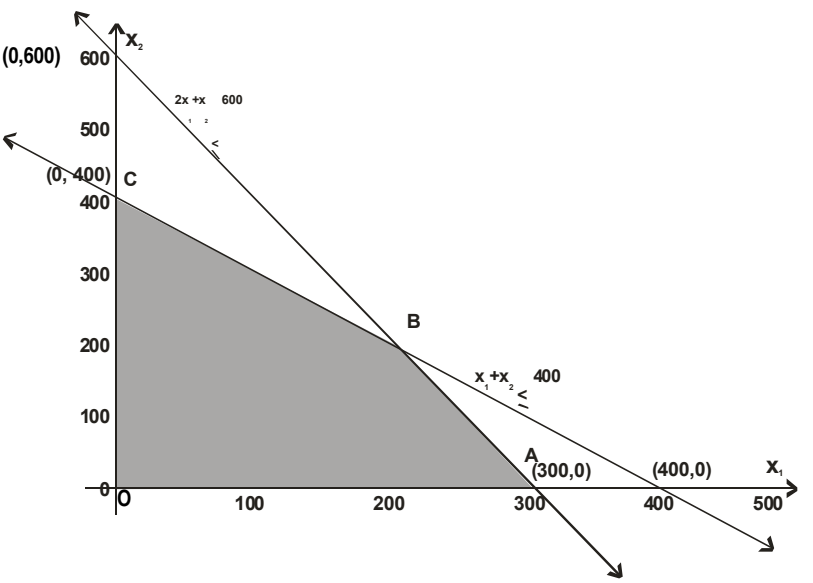
$2x_1 = 600$

$x_1 = 300$

$\therefore$ line (2) cuts x_1 axis at (300,0)

When $x_1 = 0$, $x_2 = 600$

line (2) cuts x_2 axis at (0, 600)



From the figure the region OABC is called space.

The point C = (0, 400)

The point A = (300,0)

The point O = (0, 0).

We shall find point B

$\therefore$ we shall solve equation (1) and (2).

(2) – (1) $\Rightarrow$

$$2x_1 + x_2 = 600$$

$$\underline{x_1 + x_2 = 400}$$

$$x_1 = 200$$

$x_1 + x_2 = 400$

$200 + x_2 = 400$

$x_2 = 400 - 200$

$x_2 = 200$

The point B = (200, 200)

Now $Z = 2x_1 + 3x_2$

At 'O', Z = 0

at 'C' = (0, 400), $Z = 2(0) + 3(400) = 1200$

at A = (300,0), $Z = 2(300) + 3(0) = 600$

at B = (200, 200), $Z = 2(200) + 3(200)$

$= 400 + 600 = 1000$

$\therefore$ The solution is

$\therefore$ Maximize $Z = 1200$

at $x_1 = 0$, $x_2 = 400$

22. The given L.P.P. is

$Z = x_1 + 2x_2 + 3x_3 - x_4$

Subject to

$x_1 + 2x_2 + 3x_3 = 15$

$2x_1 + x_2 + 5x_3 = 20$

$x_1 + 2x_2 + x_3 + x_4 = 10$

We shall add artificial variable

$x_1 + 2x_2 + x_3 + x_4 = 10$

$x_1 + 2x_2 + 3x_3 + x_5 = 15$

$2x_1 + x_2 + 5x_3 + x_6 = 20$

$x_1, x_2, x_3, x_4, x_5, x_6 \geq 0$

Here x_5, x_6 are called artificial variable.

The no. of variable n = 6

The no. of constraints m = 3

$n - m = 6 - 3 = 3$

$\therefore$ The objective function is

$Z = x_1 + 2x_2 + 3x_3 - x_4 - Mx_5 - Mx_6$

Let us assume that

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

$\therefore$ The Starting Basic feasible solution is

$x_4 = 10$, $x_5 = 15$, $x_6 = 20$

Table : 1

		C	[1	2	3	–1	–M	–M]	
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Minimum Ratio
–1	Y_4	10	1	2	1	1	0	0	$\frac{10}{1}=10$
–M	Y_5	15	1	2	3	0	1	0	$\frac{15}{3}=5$
–M	Y_6	20	2	1	[5]	0	0	1	$\frac{20}{5}=4$
	Z	–35M –10	–3M –2	–3M –4	–8M –4	0	0	0	

Y_3 is the entering variable.

Y_6 is the leaving variable.

and 5 is the leading Common element.

Table : 2

		C	[1	2	3	–1	–M]	
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_4	Y_5	Minimum Ratio
–1	Y_4	6	3/5	9/5	0	1	0	$\frac{30}{9}=3$
–M	Y_5	3	–1/5	[7/5]	0	0	1	$\frac{15}{7}=2.1$ ←
3	Y_3	4	2/5	1/5	1	0	0	20
	Z	–3M +6	$\frac{M-2}{5}$	$\frac{-7M-16}{5}$	0	0	0	

Here Y_2 is the entering variable.

Y_5 is the leaving variable

7/5 is the leading common element

Table : 3

		C	[1	2	3	–1]	
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_4	Minimum Ratio
–1	Y_4	15/7	6/7	0	0	1	$\frac{15}{6}=2.5$ ←
2	Y_2	15/7	–1/7	1	0	0	
3	Y_3	25/7	3/7	0	1	0	$\frac{25}{3}=8$
		$Z=\frac{90}{7}$	–6/7	0	0	0	

Y_1 is the entering variable.

Y_4 is the leaving variable

and 6/7 is the leading common element.

Table : 4

		C	[1	2	3	–1]
C_B	Y_B	X_B	Y_1	Y_2	Y_3	Y_4
1	Y_1	15/6	1	0	0	7/6
2	Y_2	35/14	0	1	0	1/6
3	Y_3	35/14	0	0	1	-1/2
		$Z=\frac{30}{2}$	0	0	0	1

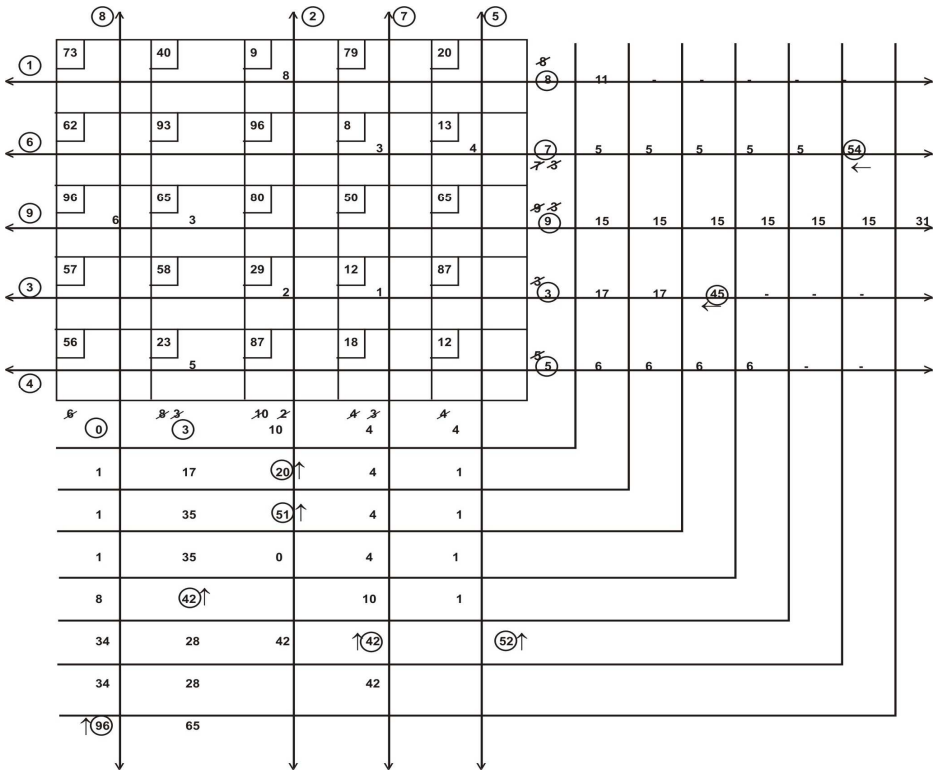
Since all the element Zj – Cj non–negative. The above table gives optimum solution.

$\therefore$ The solution is

$x_1 = \frac{15}{6} = 5/2,\ x_2 = 35/14 = 5/2,\ x_3 = 35/14 = 5/2$

$x_4 = 0$ and $Z = 15$

23. The initial solution is found by VAM below:



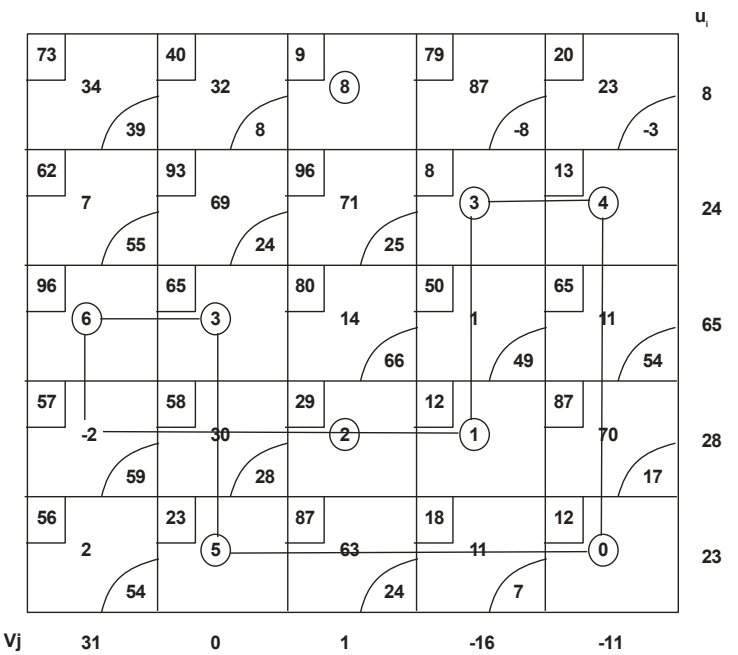
The transportation cost = $9 \times 8 + 8 \times 3 + 13 \times 4 + 96 \times 6$

$+ 65 \times 3 + 29 \times 2 + 23 \times 5 + 12 \times 1$

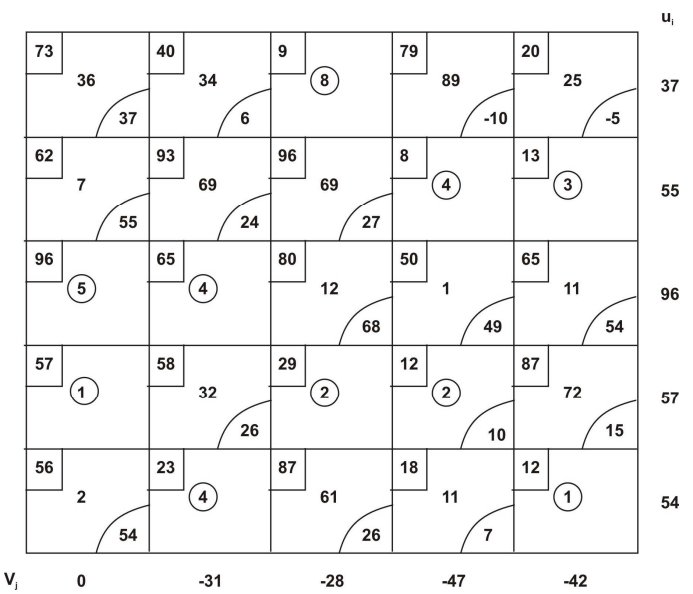
$= 72 + 24 + 52 + 576 + 195 + 58 + 115 + 12$

$= 1104$

The above initial solution is tested for optimality. Since there are only 8 allocations and we require 9 ($m + n - 1 = 9$) allocations, we put a small quantity in the least cost independent cell (5, 5) and apply the optimality test. Let $u_5 = 0$ and then we calculate remaining u_i and v_j.



Since some of the Aij's are negative, the above initial solution is not optimal. Introducing in the cell (Dummy) with most negative Aij an assignment e. The value of e and the new solution as obtained from above is shown below. The values of u_i's, v_j's are also calculated. The solution satisfies the conditions of optimality. The condition $A_{ij} = C_{ij} - (u_i + v_j) \geq 0$ for non allocated cells is also fulfilled.



The above table gives the minimum cost.

$\therefore$ The cost is

$= 9 \times 8 + 8 \times 4 + 13 \times 3 + 65 \times 4 + 96 \times 5 + 57 \times 1 + 29 \times 2 + 23 \times 4 + 12 \times 1$

$= 72 + 32 + 39 + 260 + 480 + 57 + 58 + 92 + 12$

$=$ **1102**

24. The problem given is an unbalanced problem, hence we add a dummy column (job 6)

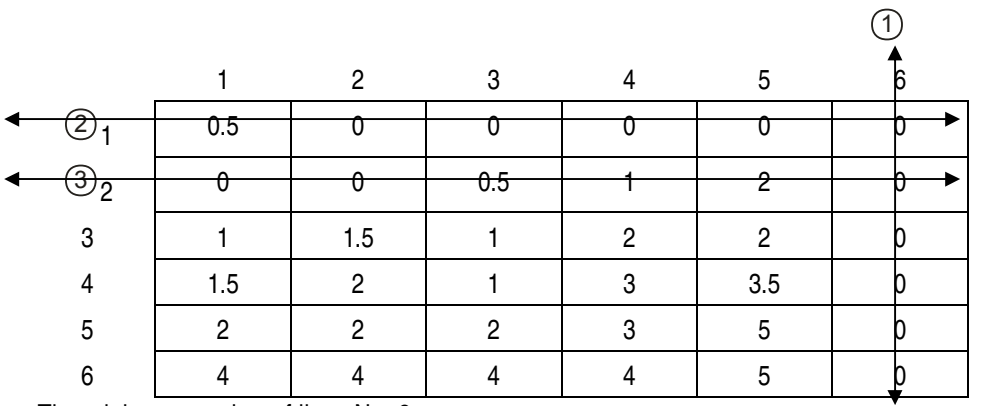
	1	2	3	4	5	6
1	2.5	5	1	6	1	0
2	2	5	1.5	7	3	0
3	3	6.5	2	8	3	0
4	3.5	7	2	9	4.5	0
5	4	7	3	9	6	0
6	6	9	5	10	6	0

Now we get the balanced assignment problem and hence we proceed as follows:

Table : 1 (Row wise)

	1	2	3	4	5	6
1	2.5	5	1	6	1	0
2	2	5	1.5	7	3	0
3	3	6.5	2	8	3	0
4	3.5	7	2	9	4.5	0
5	4	7	3	9	6	0
6	6	9	5	10	6	0

Table : 2 (Columnwise)

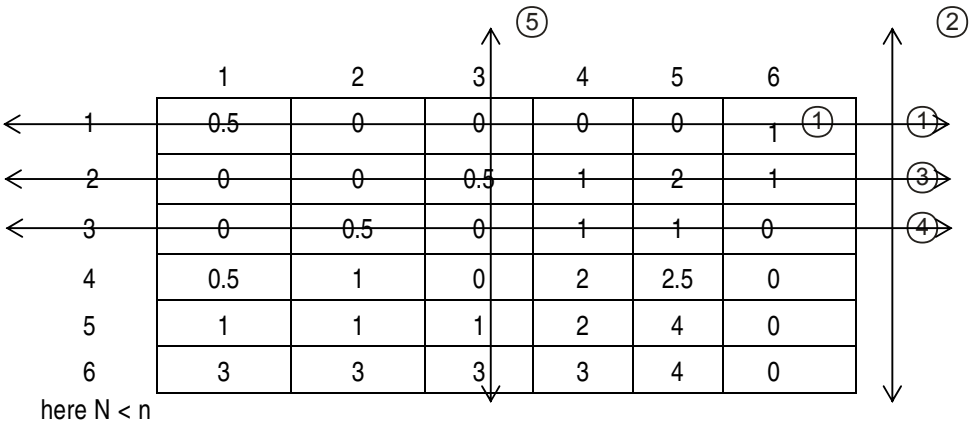


The minimum number of lines N = 3

The order of matrix n = 6

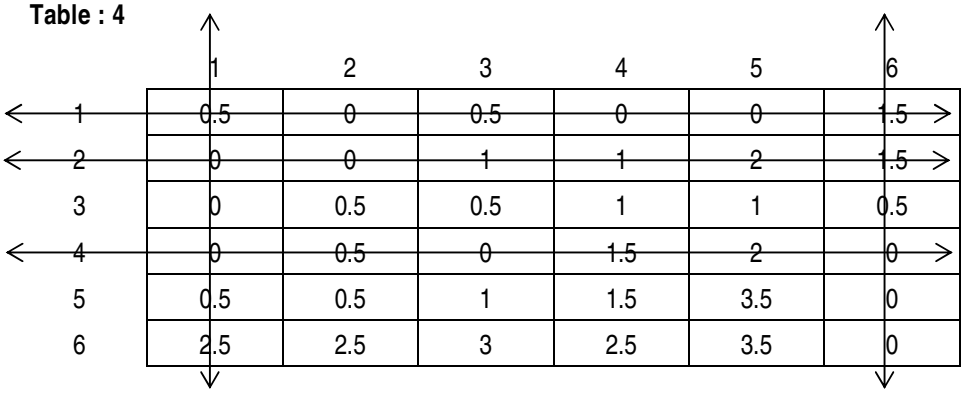
$\therefore$ N < n

Table : 3



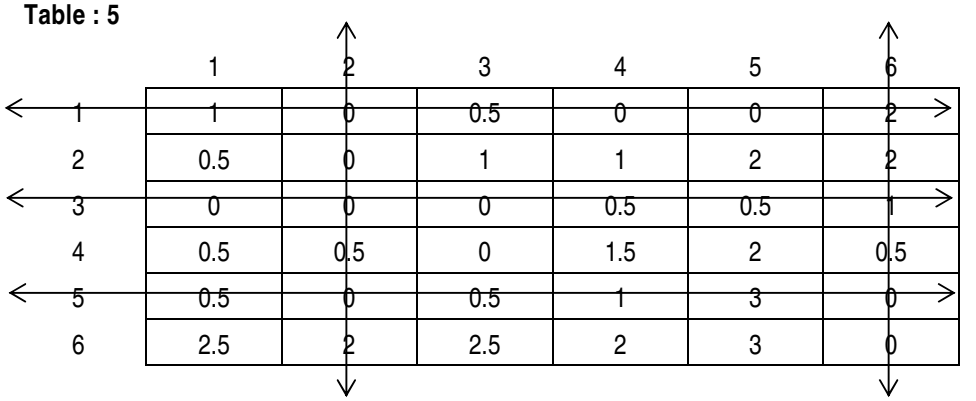
here N < n

Table : 4



here N < n

Table : 5



$\therefore$ N < n.

Table : 6

	1	2	3	4	5	6
1	1	0.5	0.5	0	0	2.5
2	0	0	0.5	0.5	1.5	2
3	0	0.5	0	0.5	0.5	1.5
4	0.5	1	0	1.5	2	1
5	0	0	0	0.5	2.5	0
6	2	2	2	1.5	2.5	0

Here N < n

Table : 7

	1	2	3	4	5	6
1	1.5	1	1	0	0	3
2	0	0	0	0	1	2
3	0	0.5	0	0	0	1.5
4	0.5	1	0	1	1.5	1
5	0	0	0	0	2	0
6	2	2	2	1	2	0

Here N = n.

∴ The optimum Schedule Table is

	1	2	3	4	5	6
1				[0]	⊗	
2	[0]	⊗	⊗	⊗		
3	⊗		⊗	⊗	[0]	
4			[0]			
5	⊗	[0]	⊗	⊗		⊗
6						[0]

$\therefore$ The schedule is

(1) $\rightarrow$ 4

(2) $\rightarrow$ 1

(3) $\rightarrow$ 5

(4) $\rightarrow$ 3

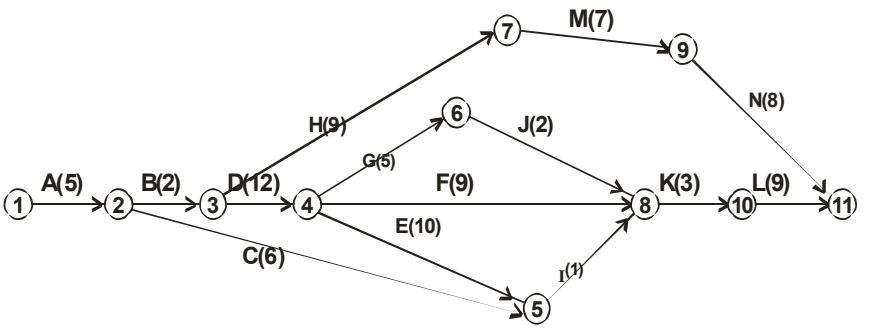
(5) $\rightarrow$ 2

(6) $\rightarrow$ 6

$\therefore$ The minimal total cost = 6 + 2 + 3 + 2 + 7 = 20

i.e. 20 × 100 = 200

25. (a) The network for the given project is shown in the following. Network Diagram.



(b) The various path and their lengths are as follows:

	Path	Length (weeks)
(i)	1 – 2 – 5 – 8 – 10 – 11	24
(ii)	1 – 2 – 3 – 7 – 9 – 11	31
(iii)	1 – 2 – 3 – 4 – 6 – 7 – 9 – 11	39
(iv)	1 – 2 – 3 – 4 – 6 – 8 – 10 – 11	38
(v)	1 – 2 – 3 – 4 – 8 – 10 – 11	40
(vi)	1 – 2 – 3 – 4 – 5 – 8 – 10 – 11	42*

Thus, the critical path is 1 – 2 – 3 – 4 – 5 – 8 – 10 – 11 and the direction of the project is 42 weeks.

(c) The required information is given in the following table.

Activity	Duration	ES	EF	LS	LF	Slack
A	5	0	5	0	5	0
B	2	5	7	5	7	0

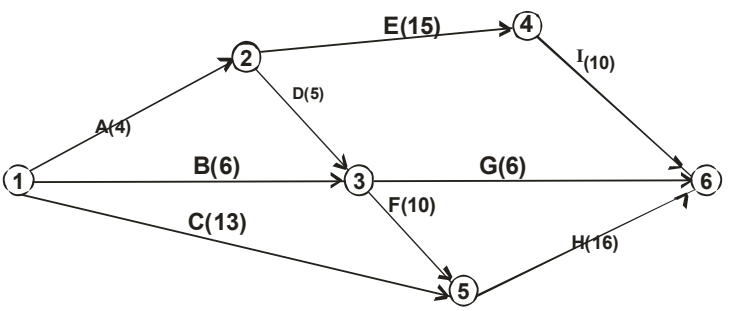
C	6	5	11	23	29	18
D	12	7	19	7	19	0
E	10	19	29	19	29	0
F	9	19	28	21	30	2
G	5	19	24	22	27	3
H	9	7	16	18	27	11
I	1	29	30	29	30	0
J	2	24	26	28	30	4
K	3	30	33	30	33	0
L	9	33	42	33	42	0
M	7	24	31	27	34	3
N	8	31	39	34	42	3

(d) If activity G (4–6) takes 10 weeks instead of 5, the of the paths (iii) and (iv) would become 44 and 43 weeks respectively. In that case path 1 – 2 – 3 – 4 – 6 – 7 – 9 – 11 would become critical.

26. Based on the given data, we first obtain the expected duration and variance for each of the activities as follows:

Activity	a	m	b	t_e	σ^2
A	2	4	6	4	4/9
B	6	6	6	6	0
C	6	12	24	13	9
D	2	5	8	5	1
E	11	14	23	15	4
F	8	10	12	10	4/9
G	3	6	9	6	1
H	9	15	27	16	9
I	4	10	16	10	4

(i) The project network is shown as follows.



(ii) and (iii) the various paths and their lengths are given below:

Path	Length
1 – 2 – 4 – 6	29
1 – 2 – 3 – 6	15
1 – 2 – 3 – 5 – 6	35*
1 – 3 – 6	12
1 – 3 – 5 – 6	32
1 – 5 – 6	29

Thus, the expected project completion time = 35 weeks.

The critical path is 1 – 2 – 3 – 5 – 6 and critical activities are: 1 – 2 (A), 2 – 3 (D), 3 – 5 (F) and 5 – 6 (H).

The variance of the project completion time = 4/9 + 1 + 4/9 + 9 = $\frac{98}{9}$ weeks^2

and the standard deviation = $\sqrt{98/9}$ = 3.23 weeks.

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

$$\text{Return (\%)} = \frac{\text{Profit} \times \text{Number of units demanded}}{\text{Investment}} \times 100$$

First of all, random number 00 – 99 are allocated in proportion to the probabilities associated with each of the three variables as given under:

Annual demand

Units in thousands	*Probability*	*Cumulative Probabilities*	*Random Numbers assigned*
25	0.05	0.05	00–04
30	0.10	0.15	05–14
35	0.20	0.35	15–34
40	0.30	0.65	35–64
45	0.20	0.85	65–84
50	0.10	0.95	85–94
55	0.05	1.00	95–99

Profit per unit

Profit	Probability	Cumulative Probabilities	Random Numbers assigned
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

Investment required (in thousand of rupees).

Units	Probability	Cumulative Probabilities	Random Numbers assigned
2750	0.25	0.25	00–24
3000	0.50	0.75	25–74
3500	0.25	1.00	75–99

Let us now simulate the process for 10 trials. The result of the simulation is shown in the tables given below:

Trials	Random number of Demand	Simulated demand ('000) units	Random no. to profit per unit	Simulated profit per unit	Random Number for investment	simulated investment ('000) Rs.	Simulated return (demand profit per *'000 investment)
1	30	35	12	5.00	16	2750	6.36
2	59	40	09	3.00	69	3000	4.00

3	63	40	94	10.00	26	3000	13.33
4	27	35	08	3.00	74	3000	3.50
5	64	40	60	7.00	61	3000	9.33
6	28	35	28	5.00	72	3000	5.83
7	31	35	23	5.00	57	3000	5.83
8	54	40	85	9.00	20	2750	13.09
9	64	40	68	7.00	18	2750	10.18
10	32	35	31	7.00	87	3500	7.00

The above table shows that the highest likely return is 13.33% which is corresponding to the annual demand of 40,000 units resulting a profit of Rs. 10/– per unit and the required investment will be Rs. 30,00,000.

28. The equation of the straight line trend is

$Y_c = a + bx$

Since Σx is not zero the value of a and b will be obtained directly by solving the following two normal equations:

$\Sigma y = Na + b \Sigma x$

$\Sigma xy = a \Sigma x + b \Sigma x^2$

Year	Production ('000 qt) Y	Taking 1997 as origin X	XY	X^2	Trend Values	(Y – Yc)
1993	77	–4	–308	16	83.283	–6.283
1995	88	–2	–176	4	86.043	+1.957
1996	94	–1	–94	1	87.423	6.577
1997	85	0	0	0	88.803	–3.803
1998	91	1	91	1	90.183	0.817
1999	98	2	196	4	91.563	6.437
2002	90	5	450	25	95.703	–5.703
N = 7	$\Sigma y=623$	$\Sigma x=1$	$\Sigma xy=159$	$\Sigma x^2=51$	Σ Yc=623	$\Sigma(Y–Yc) = 0$

$623 = 7a + b \rightarrow$ (i)

$159 = a + 51b \rightarrow$ (ii)

Multiplying the second equation by 7, we get $1113 = 7a + 357b \rightarrow$ (iii)

Deducting equation (iii) from (i) – 490 = –356 b or b = $\frac{490}{356}$ = 1.38

Substituting the value of b in equation (i)

623 = 7a + 1.38

7a = 623 – 1.38 = 621.62 (or) a = 88.803

So the equation of straight line trend is Y = 88.803 + 1.38 X

When x = –4, Y = 88.803 + 1.38 (–4) = 88.803 – 5.52 = 83.283

When x = –2, Y = 88.803 + 1.38 (–2) = 88 – 803 – 2.76 = 88.043

When x = –1, Y = 88.803 – 1.38 = 87.423

When x = 0, Y = 88.803

When x = + 1, Y = 88.803 + 1.38 = 90.183

When x = +2, Y = 88.803 (1.38 x 2) = 91.563

When x = +5, Y = 88.803 + (1.38 x 5) = 95.703

(ii) After eliminating the trend we are left with cyclical and irregular variations.

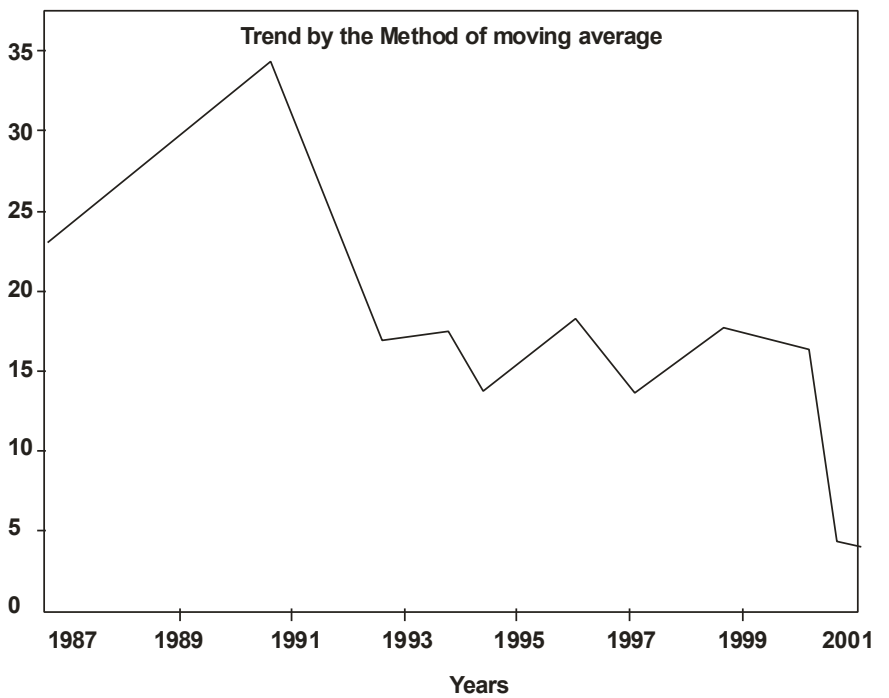
(iii) The monthly increase in the production of sugar is

b/12, i.e. 1.38 / 12 = 0.115 thousand quintal.

29. Calculation of 5 – yearly and 7 – yearly moving Averages

Year	No. of failure	5 – yearly moving totals	5 – yearly moving average	7 – yearly moving total	7 – yearly moving average
1987	23	–	–	–	–
1988	26	–	–	–	–
1989	28	129	25.8	–	–
1990	32	118	23.6	153	21.9
1991	20	104	20.8	140	20.0
1992	12	86	17.2	123	17.6
1993	12	63	12.6	108	15.4
1994	10	56	11.2	87	12.4
1995	9	55	11.0	81	11.6
1996	13	57	11.4	81	11.6
1997	11	59	11.8	78	11.1
1998	14	59	11.8	71	10.1

1999	12	69	13.8	63	9.0
2000	9	39	7.8	–	–
2001	3	–	–	–	–
2002	1	–	–	–	–



30. Let H_0 : Incident of cavities is independent of the brand of the tooth paste used.

Here, $E_{11} = \frac{50x100}{500} = 10$

$E_{21} = \frac{300x100}{500} = 60$

O	E	(O–E)	$(O–E)^2$	$(O–E)^2/E$
9	10	–1	1	0.100
63	60	3	9	0.150
28	30	–2	4	0.133
13	12	1	1	0.083
70	72	–2	4	0.056
37	36	1	1	0.028
17	15	2	4	0.267

85	90	–5	25	0.278
48	45	3	9	0.200
11	13	–2	4	0.308
82	78	4	16	0.205
37	39	–2	4	0.103

$\therefore \Psi^2 = 1.911$

D.f. = V = (r–1) (c – 1) = (3–1) (4–1) = 6

$\Psi^2 (6,0.05) = 12.59$

The calculated value of Ψ^2 is less than the table value.

$\therefore$ On hypothesis holds true.

Hence, incidence of cavities is independent of the brand of the tooth paste used.

31.

Plot No.	I	II	III	IV
	X_1	X_2	X_3	X_4
1	42	48	68	80
2	50	66	52	94
3	62	68	76	78
4	34	78	64	82
5	52	70	70	66
Total	240	330	330	400

T = sum of all the observation = 1300

$$\frac{T^2}{N} = \frac{(1300)^2}{20} = 84500$$

SST = Sum of the squares of all the observation – T^2/N

$= (42^2 + 50^2 + 62^2 + \ldots\ldots\ldots\ldots 82^2 + 66^2) - 84500 = 4236$

$$SSC = \frac{(\text{sum } x_1)^2}{n_1} + \frac{(\text{sum } x_2)^2}{n_2} + \frac{(\text{sum } x_3)^2}{n_3} + \frac{(\text{sum } x_4)^2}{n_4} - \frac{T^2}{N}$$

$$= \frac{240^2}{5} + \frac{330^2}{5} + \frac{330^2}{5} + \frac{400^2}{5} - 84500$$

= 2580

SSE = SST – SSC = 4236 – 2580 = 1656

$$MSC = SSC / (K-1) = \frac{2580}{3} = 860$$

$$MSE = \frac{SSE}{N-K} = \frac{1656}{20-4} = 103.5$$

The degree of freedom = (K–1, N–K) = (3, 16)

(Since K is the number of columns and N is the total number of observation)

The analysis of variance (ANOVA) table is

Source of Variance	Sum of squares	D.F.	Mean Square
Between sample	SSC = 2580	K-1 = 3	MSC = 860
Within sample	SSE = 1656	N-K = 16	MSE = 103.5
Total	SST = 4236	N–1 = 19	

$$\therefore F = \frac{MSC}{MSE} = \frac{860}{103.5} = 8.3$$

The table values of F at 5% level of significance for (3, 16) degrees of freedom is 3.24. The calculated value of F is more than the table value of F

$\therefore$ The null hypotheses is rejected

$\therefore$ The treatment does not have same effect.

32. Here the sales data before campaign (x) and after campaign (y) are not independent but paired together for 6 shops A to F. Hence we shall apply paired t-test

Null hypotheses $H_0 : \mu_x = \mu_y$, u, that is the average sales before campaign and after campaign are same. In other words, there is no significant chance in sales after the special promotional campaign.

Alternative hypotheses $H_1 : \mu_x < \mu_y$ (Left tailed), i.e. the special promotional campaign increases the sales. Test statistics value H_0, the test statistics is

$$t = \frac{\bar{d}}{s/\sqrt{n}} = \frac{\bar{d}}{\sqrt{\frac{s^2}{n}}} \sim t_{n-1} = t_5 \quad \ldots\ldots\ldots\ldots(1)$$

Shop	A	B	C	D	E	F	Total
x	53	28	31	48	50	42	
y	58	29	30	55	56	45	
d=x–y	–5	–1	1	–7	–6	–3	$\Sigma d = -21$
d^2	25	1	1	49	36	9	$\Sigma d^2 = 121$

$$\therefore \bar{d} = \frac{\sum d}{n} = \frac{-21}{6} = -3.5$$

$$S^2 = \frac{1}{n-1}\left[\sum d^2 - \frac{(\sum d)^2}{n}\right] = \frac{1}{5}\left[121 - \frac{441}{6}\right] = 9.5$$

$$\therefore t = \frac{-3.5}{\sqrt{\frac{9.5}{6}}} = \frac{-3.5}{\sqrt{1.5833}} = \frac{-3.5}{1.2583} = -2.78 \qquad \text{[using (i)]}$$

The tabulated value of t for 5 d.f. at 5% level of significance for a single tailed test is 2.02

i.e. $t_5(0.05) = 2.02$ (from table)

Since $|t| = 2.78$ is greater than 2.02, it is significant

Hence, H_0 is rejected at 5% level of significance and we conclude that the special promotional campaign has been effective in increasing the sales.