

PAPER – 5 : ADVANCED MANAGEMENT ACCOUNTING

QUESTIONS

Decision Making - Profit Maximization

1. ABC Co Ltd which produces household electronic gadget HIFY had 90% capacity utilization (4.5 lakh units) current year of Department A.

- i) Cost Sheet for Department A is given below: Rs Lakhs

Sales	8100.00
Direct Material	2700.00
Direct wages @ Rs 200 per day	2100.00
Component "AB" (one per product)	810.00
Factory Overheads (50% Fixed)	1200.00
Selling & Dist Overheads (60% variable)	500.00
Admin Overheads (fixed)	300.00

- ii) Component 'AB' is manufactured internally by another department B and component is transferred to Department A at total cost which includes Fixed cost of Rs 90.00 lakhs.
- iii) The company proposes to acquire a new technology at a cost of Rs 100 lakhs one time royalty to add additional features in the product with introduction of two components "CD" and "EF" each in place of one component 'AB' in each product.. Variable costs of production of each component 'CD' and "EF" in department B are expected to be Rs 200 and Rs 250 respectively. Additional investment required for facilities to produce components 'CD' and "EF" will be Rs 400 lakhs at a capital cost of 15%, annual Maintenance cost of machine Rs 20 lakhs, other fixed cost in the department B is expected to remain same. Market Research department indicates that a rise of price by Rs 400 per unit of new product will be safe to ensure sale of its product in domestic market.
- iv) The company is expected to receive an export order for the new product at a price of Rs 1800 per unit. The export order can be executed by way of going for 100% capacity utilization. Special shipping cost for the export will be Rs 25 lakhs and fixed cost for both the departments will remain unaltered.

Understanding that the company's policy of charging royalty for technology as deferred Revenue expenses equally over 4 years, advise the management giving your calculation details on

- i) Whether to go for modification of the product
- ii) Whether the export order to be expected.

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Decision making – Make or Buy

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

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

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

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

3. **Decision Making – Buying a new machine**

XYZ Ltd. received an order from a valuable client of supplying 6,00,000 pieces of components @Rs. 900 unit a year at a rate of 50,000 pieces per month. Cost of manufacturing of the component is estimated as:

	Rs. /Unit
Material	600
Labour	120
Variable overhead 40% of labour cost	48

Fixed Production overheads is Rs 50 lakhs.

There is a penalty/ reward clause of Rs. 40.00 per unit for supplying less / more than 50,000 units per month. To adhere to the schedule of supply, company procured a special machine costing Rs. 40 lakhs, which is expected to fetch Rs. 10 lakh after the end of the contract of supply of components. After supply of machine, the supplier of the machine offered another advanced version of machine (new in the market) with 20% increase in Labour productivity but there will be material wastage 0.5% . The new

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machine cost is Rs. 60 lakhs but will have no resale value after the end of the job. If the new machine is purchased, the old machine supplied will be taken back at Rs 24 lakhs. With the new machine, maintenance cost will increase by Rs. 1,00,000 per month and the entire job is expected to be completed within 10 months. Advise whether the company should go for the improved version machine.

Decision Making – Make or Buy

4. A manufacturer of industrial pump buys 30,000 components annually from a supplier @ Rs.300 per set. Purchase Department has received request from vendor for an upward revision of price per set of component by 5% from the next financial year. Production manager is in favour of manufacturing the 40,000 components in the factory itself so that the same may be used to match its enhanced capacity of manufacturing pumps. He has submitted the following cost estimates

	For 40,000 units
Direct Material	Rs.80.00 lakh
Direct wages	Rs.30.00 lakh
Factory overheads	Rs.12.00 lakh

The Manager has proposed for procurement of required machines the cost estimate for which Rs 20 lakhs and life of the same is 10 years. Additional Maintenance cost per annum will be Rs 1.00 lakhs which is not included in variable factory overheads. Loan arrangement with the bank of Rs 25.00 lakhs against additional working capital requirement @ 12% per annum has been finalized. On critical analysis, it has been seen that 30% of the factory overheads included in the cost of component are fixed in nature.

You are required to place your views.

Pricing

5. ABC Company has three products A, B & C. The relevant current year's data are :

	A	B	C
No of units sold	5000	4000	5000
Sales price per unit (Rs)	30	42	45
Variable cost per unit (Rs)	21	30	30

- i) Fixed Cost per annum is Rs 88,000.
- ii) Product A is produced by a special purpose machine whereas B and C are produced by another.
- III) The company is having a proposal of buying a new machine for production of better quality C for export. The same will be installed next year and induce fixed cost of Rs 37,000 per annum. The better quality of material will increase the material cost of C by Rs 7.50 per unit. Export of C will provide added advantage of 15% on price in terms of duty draw back and others incentives.

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- iv) If the new machine is procured, the exclusive use of old machine will double the production of product B and gain in price for procurement of double volume of its raw material will be Rs 1.50 / unit. According to market study, price of B is to be reduced by Rs 3 to smoothen enhanced sale of B.

Keeping in mind the expected profitability improvement of the company by 30%, what export price of C do you suggest ?

Transfer Pricing

6. A company has two manufacturing divisions A and B. Division A has a capacity of 96,000 hours per annum. It manufactures two products X and Y as per the following details:

	X	Y
Direct materials	Rs.300	Rs 60
Variable costs @ 80 per hour	.320	80
Selling price	800	160
Maximum sales units	15,000	Unlimited

Division B produces product Z whose particulars are as under:

	Rs.
Imported component	800
Direct materials	120
Variable costs @ Rs.40 per hour	400
Selling price	1450

The fixed overheads amount to Rs.30 lacs and Rs.5 lacs per annum for Division A and B respectively. With a view to minimizing the dependence on imported component, the company explored the possibility of the Division B using the product X as substitute for imported component. This is possible provided Division B spends two machine hours entailing an additional expenditure of Rs.80 per component on modification of the product X to fit into the product Z. The production of Z in Division B is 5000 units per annum. Division B seeks a discount of Rs.80 so that the transfer price of product X can be set at Rs.720 each.

You are required to present division wise profitability and the profitability of the company as a whole on the basis of the following conditions:

- (i) Division B imports its requirement of components.
- (ii) Division B uses 5000 units of substitute material product X , transferred from Division A at market price of Rs.800 per unit.
- (iii) Division B uses 5000 units of substitute material product X , transferred from Division A at a transfer price of Rs.720 per unit.

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Transfer Pricing

7. A Company has two divisions whose activities and related cost are given below :

Division A:

Products	X	Y	Z
Capacity of production (units)	8000	5000	3000
Machine Hour/ unit	3	4	2
Selling Price/ Unit (Rs)	480	460	400
Variable Cost/ Unit (Rs)	330	240	280

Division B: has a capacity to produce 3000 units of FY taking input Product Y from division A. It has also option to buy the similar product as Y from the market. The cost and selling price per unit are as given below :

	Material cost	Direct Wages	Var Prod Overheads	Var Selling Overheads	Selling Price
If process with product Y from Division A	At Transfer price	200	Rs 150	Rs 100	Rs 1200
If processed with similar product from the market	Rs 400	180	Rs 150	Rs 110	Rs 1100

There is capacity constraints of Division A in terms of Machine hour of 38000 hours. Fixed Cost of Division A is Rs 10.0 lakhs and that of Division B is Rs 5.00 lakhs each.

You are required to

- calculate profitability of the company if the transfer price of Y from Div A to Div B is fixed at Rs 400 on the basis of market price of similar product.
- Give comments of fixing the transfer price based on market price
- Calculate the impact on profitability if capacity of Division B is enhanced to 5000 units by making capital expenditure of Rs 6.00 lakhs at 15% cost of capital and transfer price is true market price i.e Rs 460.

Transfer Pricing

8. L Ltd. and M Ltd. are subsidiaries of the same group of companies. L Ltd. produces a branded product sells 10,000 drums at a price of Rs. 2000 per drum.

Its direct product costs per drum are:

Raw material from M Ltd.: At a transfer price of Rs. 900 for 25 litres.

Other products and services from outside the group: At a cost of Rs. 300.

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

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

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

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

Its variable costs are Rs. 20 per Kilolitre and its fixed costs are Rs. 60 lakhs per month.

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

You are required to calculate

- (a) the monthly profit position for each of L Ltd. and M Ltd. if the sales of L Ltd. are
 - (i) at their present level, and
 - (ii) at the higher potential level indicated by the market research, subject to a cut in price of 20%.

Profit

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Service Cost

9. Hotel Galaxy analysed previous 5 years data for preparation of budget for current year.

Average occupancy during off-season i.e Nov to April remains below 60%.

Contribution of Three Profit Centres: Accommodation: 50%, Restaurant: 30%, Bar 20%

The three Profit Centres had the following pattern of contribution %:

	Accommodation	Restaurant	Bar
Revenue	100	100	100
Wages	25	20	15
Direct Cost	15	50	45
Contribution	60	30	40

Estimated Revenue for the current year: Rs 60 lakhs, and Fixed cost Rs 10.00 lakhs.

To improve Return on Capital Employed of 110 lakhs, two suggestions have been made:

Option A. An offer of two-nights reduced price @ Rs 1600 during off-season (Nov–April).

It is expected that occupants under this offer will spend 30% of accommodation charge in restaurant and 15% in the bar.

Option B. To increase restaurant & bar prices by 15% and also increase room rent (assuming that there will be no change in occupancy).

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You are required to calculate the following (before tax):

- i) Expected Return on Capital Employed under the budget
- ii) How many two-night offers to be sold as in proposal A to increase ROCE by 5%.
- iii) What increase in room rent to be under proposal B to get same ROCE as in (ii).

10. Activity Based Costing

IBM Ltd. Manufactures and sells computers peripherals to several retail outlets throughout the country. Amar is the manager of the printer division. Its two largest-selling printers are P1 & P2.

The manufacturing cost of each printer is calculated using IBM's activity based costing system. IBM has one direct manufacturing cost category (direct materials) and the following five indirect manufacturing cost pools.

<i>Indirect manufacturing cost pool</i>	<i>Allocation Base</i>	<i>Allocation Rate (Rs.)</i>
1. Materials handling	No. of parts	Rs. 1.20 per part
2. Assembly management	Hours of assembly time	Rs. 40 per hour of time
3. Machine insertion of parts	No. of machine inserted parts	Rs. 0.70 per machine inserted part
4. Manual insertion of parts	No. of manually inserted parts	Rs. 2.10 per manually inserted part
5. Quality testing	Hours of quality testing time	Rs. 25 per testing hour.

Product characteristics of P1 and P2 are as follows:

<i>Product</i>	<i>P1</i>	<i>P2</i>
Direct materials costs	Rs. 407.50	Rs. 292.10
Number of parts	85	46
Hours of assembly time	3.2	1.9
Number of machine – inserted parts	48	31
Number of manually inserted parts	36	15
Hours of quality testing time	1.4	1.1

A foreign competitor has introduced products very similar to P1 and P2. Given their announced selling prices and to maintain his company's market share and profits, Amar estimates the P1 to have manufacturing cost of approximately Rs. 680 and P2 to have a manufacturing cost of approximately Rs. 390. He calls a meeting of product designers and manufacturing personnel at the printer division. They all agree to have the Rs. 680

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and Rs. 390 figures become target costs for designed version of P1 and P2 respectively. Product designers examine alternative ways of designing printer with comparable performance but lower costs. They come up with the following revised designs for P1 and P2 (termed P1 – REV and P2 – REV, respectively)

<i>Particulars</i>	<i>P1 – REV</i>	<i>P2 – REV</i>
Direct materials cost	Rs. 381.20	Rs. 263.10
Number of parts	71	39
Hours of assembly time	2.1	1.6
Number of machine – inserted parts	59	29
Number of manually – inserted parts	12	10
Hours of quality testing time	1.2	0.9

- Compute the present costs of products P1 and P2 using ABC system.
- Compute the manufacturing costs of P1 – REV and P2 – REV. How do they compare with the Rs. 680 and Rs. 390 target costs?

11. Budgeting

Budget for previous two year 2008 and 2009 is given as under:

	year 2009	Year 2010
Units sold	5000	6000
	Rs lakhs	Rs lakhs
Sales	30	39.6
Material	12.5	15.75
Labour	6	7.92
Overheads (Variable & fixed)	7	8.7
Total Cost	25.5	32.37
Profit	4.3	7.23

- Price increase in 2010 was due to inflation and same was applicable to overheads.
- The Management of the company of the view that sales volume increase and labour cost increase in 2011 will be same as seen in 2010 compared to 2009.
- As far as increase in sales price, and other cost components are concerned, there are two views that a) same increase rate will prevail b) Increase will be less by 2%.
Prepare the budgeted profitability for the year 2010 taking both views (a) & (b) in (iii) above.

12. Budgeting

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Selected information concerning sales and production for ABC Ltd. for June, 2010 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, June 1, 2010:

		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	<u>94,500</u>
	Total	<u>1,45,500</u>

There were no work in process inventories estimated for June 1, 2010.

c. Desired inventories at June 30, 2010

		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	<u>70,000</u>
	Total	<u>1,12,500</u>

There were no work in process inventories desired for June 30, 2010.

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
Direct labour rate	Rs. 12.00 per hour	Rs. 16.00 per hour

g. Estimated factory overhead costs for June 2010:

	Rs.
Indirect factory wages	2,00,000

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Depreciation of plant and equipment	40,000
Power and light	25,000
Indirect materials	<u>34,000</u>
Total	<u>2,99,000</u>

You are required to prepare :

1. Sales budget for July.
2. Production budget for July.
3. Direct materials purchases budget for July.
4. Direct labour cost budget for July.
5. Cost of goods sold budget for July.

Standard Costing

13. ABC Ltd manufactures a product '123ABC' at its plant at Ahmedabad , the maximum capacity of which is 200 units per month. Details of raw material which go into the making of 1 unit of '123ABC ' 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)
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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 (Rs 30,000) and the actual overheads from what was projected in standards, compute actual profits.

Standard Costing and Variance Analysis

14. 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.

15. **Learning Curve Theory**

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

16. **Total Quality Management & Value Chain Analysis**

- (a) Define Total Quality Management (TQM). Explain in brief six Cs of T.Q.M. for its

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successful implementation.

- (b) How can Value Chain Analysis be used to assess competitive advantage. Give a diagram for value chain activities within the firm with suitable classifications under primary and support activities and also the industry value chain indicating what the end use consumer pays for.

17. Target Costing & Life Cycle Costing

- (a) What is Target Costing and what are the stages to the methodology ?
(b) What is total-life-cycle costing approach? Why is it important?

Just in Time (JIT) & Concept of Back Flushing in JIT

18. (a) Describe the concept of Back flushing as used in the JIT system. What problems need to be addressed before implementing such a concept? Briefly discuss.
(b) Littlefield Company uses a backflush costing system with three trigger points:
- Purchase of direct materials
 - Completion of good finished units of product
 - Sale of finished goods

There are no beginning inventories. Information for March, 2010 is:

	Rs.		Rs.
Direct materials purchased	4,40,000	Conversion costs allocated	2,00,000
Direct materials used	4,25,000	Cost transferred to finished goods	6,25,000
Conversion costs incurred	2,11,000	Cost of goods sold	5,95,000

Required:

1. Prepare journal entries for April (without disposing of underallocated or overallocated conversion costs). Assume there are no direct materials variances.
2. Under an ideal JIT production system, how would the amounts in your journal entries differ from the journal entries in requirement 1?

Inter-Firm Comparison & Balanced Score Card

19. (a) Describe the requisites to be considered while installing a system of inter-firm comparison by an industry.
(b) What do you understand by a Balanced Scorecard? Give reasons why Balanced Scorecards sometimes fail to provide for the desired results. Do you think that such a scorecard is useful for external reporting purposes?

Linear Programming

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20. A manufacturer produces two different models. X and Y of the same product. The raw materials r_1 and r_2 are required for production. At least 18 kg of r_1 and 12kg of r_2 must be used daily. Also at most 34 hours of labour are to be utilised. 2 kg of r_1 are needed for each model X and 1 kg. of r_1 for each model Y. For each model of X and Y, 1 kg of r_2 is required. It takes 3 hours to manufacture a model X and 2 hours to manufacture a model Y. The profit is Rs. 50 for each model X and Rs. 30 for each model Y. How many units of each model should be produced to maximize the profit.

Linear Programming

21. A household goods manufacturer produces and sells three products A, B and C . They have no difficulty in selling their items. However, limited availability of machine time, labour and floor space in factory restrict production. Data on usage of resources, supplies and profits on items are given below:

	A	B	C	Supply
Machine hrs/unit	8	4	5	1000 hrs
Labour hrs/unit	5	3	3	650 hrs
Floor space sq ft/unit	9	6	9	1260 sq ft
Contribution Rs./unit	270	144	225	

- (i) Formulate the above as a linear programming problem.
(ii) Using x_1, x_2, x_3 as the respective decision variables, simplex algorithm was initiated for the above problem. At one stage, the following table was reached.

Basic variables B	C_B	Solution values $b = x_B$	270 x_1	144 x_2	225 x_3	0 s_1	0 s_2	0 s_3
x_1	270	125	1	1/2	5/8	1/8	0	0
s_2	0	25	0	1/2	- 1/8	- 5/8	1	0
s_3	0	135	0	3/2	27/8	- 9/8	0	1
$C_j - Z_j$			0	9	225/4	- 135/4	0	0

From the above table, what is the current solution? Is it optimum?

- (iii) If the current solution above is not optimum, carry out the simplex algorithm till an optimum solution is reached. State the optimum solution.
(iv) The Personnel Manager of the company claims that by recruiting additional labour force, the profits can be increased. Assuming no changes, is the claim valid? Explain with reasons.

Assignment Problem

22. A Private firm employs typists on hourly piece rate basis for their daily work. Five typists A, B, C, D, E are working in that firm and their charges and speed are given below in Table A. Table B gives No of pages of different typing jobs in hand. Find the lease cost allocation of jobs.

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Table A

Typist	Rate per hour (Rs.)	Number of pages typed per hr.
A	5	12
B	6	14
C	3	8
D	4	10
E	4	11

Table B

Job	No. of pages
P	199
Q	175
R	145
S	298
T	178

Transportation Problem

23. Solve the following Transportation Problem.

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

PERT-CPM

24. A modern shop in order to maintain its inventory control through computer operation, likes to implement Inventory Control Systems. The time estimates in different stages of software development and implementation are given below:

Activity	Activity description	Immediate predecessor	Time (days)		
			Most optimistic	Most likely	Most pessimistic
A	Select the computer model	—	4	6	8
B	Design input/output system	A	5	7	15
C	Design monitoring system	A	4	8	12
D	Assemble computer hardware	B	15	20	25
E	Develop the main programmes	B	10	18	26
F	Develop input/output routines	C	8	9	16
G	Create data base	E	4	8	12
H	Instal the system	D,F	1	2	3
I	Test and implement	G,H	6	7	8

- Construct an arrow diagram for this problem.
- Determine the critical path and compute the expected completion time.
- Determine the probability of completing the project in 55 days.

25. XYZ scientific equipment manufacturing company is engaged in producing different

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types of high class equipment for use in science laboratories. The company has two different assembly lines to produce its product. The processing time for each of the assembly lines is regarded as a random variable and is described by the following distributions:

Processing time (minutes)	Assembly A ₁	Assembly A ₂
20	0.20	0.10
21	0.40	0.15
22	0.20	0.40
23	0.15	0.25
24	0.05	0.10

Using the following random numbers, generate data on the process times for 15 units of the item and compute the expected process time for the product:

3441	7674	4349	4383	8311	1519	0236	4594	1554
0575	8900	8008	2874	2434	0993			

For the purpose, read the numbers horizontally, taking the first two digits for the processing time on assembly A₁ and the last two digits for processing time on assembly A₂.

Time Series Analysis and Forecasting

26. The following table relates to the tourist arrivals during 1990 to 1996 in India:

Years	:	1990	1991	1992	1993	1994	1995	1996
Tourists arrivals	:	18	20	23	25	24	28	30

(in millions)

Fit a straight line trend by the method of least squares and estimates the number of tourists that would arrives in the year 2000.

Testing of hypothesis

27. A manufacturer claimed that at least 95% of the equipment which he supplied to a factory conformed to specifications. An examination of a sample of 200 pieces of equipment revealed that 18 were faulty. Test this claim at a significance level of (i) 0.05 (ii) 0.01.

SUGGESTED ANSWERS/HINTS

1

- i) Department B

A. Variable cost of 4.5 lakhs components 'AB' (Rs lakhs 810-90)	720
B. Variable cost per unit of component 'AB' (720/4.5)	Rs. 160
C. Variable cost of one unit of 'CD' and 'EF' each (200+250)	Rs. 450

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D. Price difference per unit of HIFY	Rs. 400
E. Additional Contribution (D - C + B) per unit of HIFY	Rs. 110
F. Total Addl Contribution (Rs lakhs) (E x 4.5)	495
G. Increase in fixed cost (* 25+ 20 + 400 x0.15) Rs lakhs	105
H. Net increase in profit (Rs lakhs)	390
Hence, Product modification proposal is to accepted.	

* Note: charge on deferred revenue expenses is taken as fixed exp for the concerned period.

ii) Old Product (4.5 lakh units)	Total Rs lakhs	Per Unit Rs
Sales Value	8100	1800
Direct Material	2700	
Direct Wages	1800	
Component 'AB' - variable cost	720	
Variable production overheads	600	
Variable Selling & distribution Overheads	300	
Total Variable cost of old product	6120	1360
Differential cost of component CD & EF in place of AB (450-160)		290
Total Variable cost of new Product		1650
Export Order size = 10% capacity = 0.5 lakhs		
Net price realization per unit of export order (price–shipment cost)		1750

Export order is to be accepted as it will have Rs 100 contribution per unit.

iii) Comparison of profitability	Cur Year Actual	Next year Budgeted
Domestic sale (units)	4.5 lakhs	4.5 lakhs
Price per unit (Rs)	1800	2200
Variable cost per unit (Rs)	1360	1650
Contribution per unit (Rs)	440	550
	(Rs. Lakhs)	

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Total Contribution (440 x 4.5)	1980	2475
Additional Contribution from export order (0.5 x Rs 100)		50
I. Total Contribution	1980	2525
J. Total Fixed Cost (dep A & B) (600 + 200 + 300 + 90)	1190	
Total Fixed Cost (600 + 200+ 300 + 90 + 105) *		1295
Net Profit (I -J)	790	1230
Profit increase		440

Profit Increase of Rs 440 lakhs is due to additional contribution of Rs 390 lakhs from domestic sale of 4.5 lakh units as shown under (i) and Rs 50 lakhs from export sale of 50,000 units.

2.

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

From the above table, it is suggested to procure component Z 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 in the second shift

Mmaterial cost	Rs. 60
Wage Cost	Rs. 36
Direct Exp.	Rs. 40
Total Variable	Rs 136

Fixed cost is excluded as it is sunk cost for the purpose of decision making here.

Cost of manufacturing 1625 units in 2nd shift @ Rs 136 = Rs. 2, 21,000

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Extra fixed cost for 3250 hrs = Rs. 12,000

= Rs. 2,33,000

Purchase price for 1625 unit @Rs. 150/- = Rs. 2,43,750

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

3.

	Special Machine	Advanced Machine
Direct material per unit	Rs. 600	Rs. 603
Labour Cost	120	100
Variable . overheads 40% of labour	48	40
Total variable cost	768	743
Relevant cost relating to production of 6,00,000 units	(Rs. Lakhs)	(Rs. Lakhs)
Total variable cost for 6,00,000 unit	4608	4458
Depreciation	30	60
Maintenance cost		12
Loss in return of old machine		16
Bonus earned for 1,00,000 unit @ Rs 40	-	- 40
Total	4638	4506

Working Note:

1. Taking into wastage, material cost per unit in new machine = Rs 600/1.005 = Rs 603
2. With efficiency improvement, labour cost per unit = Rs 120/1.2 = Rs 100
3. Fixed cost is not relevant for decision making here.
4. Average production per month = 60,000 unit. Average advanced supply per month 10,000 units. Total rewards for 10 months = 10,000 x 40 x 10 = Rs 40 lakhs
5. As the new machine is for special purpose and life is equal to project duration, machine cost is taken into account

As there will be gain of Rs. 132 lakhs, purchase of advanced version machine is suggested.

4.

Cost of manufacturing per set of component = Rs (200 + 75 + 30) = Rs 305

On analysis of data, 30% of Factory Overhead to be excluded.

Variable cost per set of component = Rs (200 + 75 + 21) = Rs 296

Price per set of component from next year = Rs 300 x 1.05 = Rs 315

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Saving per set = Rs 19.00

Annual saving = Rs 19 x 40,000 = Rs 7.60 lakhs.

Additional Cost (annual):	Rs lakhs
Depreciation of new machine:	2.0
Maintenance Cost	1.0
Interest on working capital	<u>3.0</u>
Total additional cost	6.0

The proposal of making components in the factory will have net saving of Rs 1.6 lakhs and hence should be accepted.

5.

	Rs '000
Contribution = (5000 x 9) + (4000 X 12) + (5000 x 15) =	168
Fixed Cost	88
Profit for Current year	80
Expected Profit for the next year (80 x 1.3)	104
Fixed Cost (next year) (88 + 37)	125
Contribution required	229
Contribution of B per unit will be (12 - 3 + 1.5) = Rs 10.5	
Thus, Contribution of A & B : (5000 x 9) + (8000 X 10.5)	129
Contribution required by C	100
Contribution required per unit of C (Rs) = 1,00,000/5000	20
Variable cost per unit of C (Rs) (30 + 7.50)	37.5
Effective price of C per unit (Rs)	57.5
Considering export advantage of 15%, export price of C = Rs 57.5/1.15	Rs 50

6.

	Products		
	X	Y	Z
Selling price per unit : (Rs)	800	160	1,450
Less: Variable costs: (Rs)	620	140	1,320
Contribution per unit: (Rs)	180	20	130
Hours required per unit	4	1	–

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Contribution per hour: (Rs.)	45	20	—
Demand in units	15,000	—	—
Hours required to meet the units demanded:	60,000	36,000	

(i) When division B imports its component requirements:

Division A		Division B	
	Rs.		Rs.
Contribution		Contribution	6,50,000
X — 15,000 units x Rs.180	27,00,000	(5,000 units x Rs.130)	
Y — 36,000 units x Rs. 20	<u>7,20,000</u>	Less: Fixed costs	5,00,000
Total contribution:	34,20,000		
Less: Fixed costs	<u>30,00,000</u>		
Profit	<u>4,20,000</u>	Profit	<u>1,50,000</u>

The profit of the Company as a whole is Rs.5,70,000

(ii) When division B buys 5,000 units of product X at Rs.800 per unit:

Division A		Division B	
	Rs.		Rs.
Contribution		Sales revenue (5,000 units x 1,450)	72,50,000
X — 20,000 units x Rs.180	36,00,000	Less: Variable cost (5,000 units x Rs.1,320)	66,00,000
Y — 16,000 units x Rs.20	<u>3,20,000</u>	Less: Additional cost (5000 units x Rs.80)	<u>4,00,000</u>
Total contribution	39,20,000		
Less: Fixed costs	<u>30,00,000</u>		
Profit	<u>9,20,000</u>	Contribution	2,50,000
		Less: Fixed costs	<u>5,00,000</u>
		Loss	<u>(2,50,000)</u>

Profit of the company as a whole in this case would be Rs. 6,70,000

(iii) Division B gets a product X at a transfer price Rs 720 from Division A.

Profit of Division A		Profit for Division B		Product Z
	Rs.			Cost per unit
Contribution				Rs.
X — 15,000 units x Rs.180	27,00,000	Variable cost of material X		720
X — 5,000 units x Rs.100	5,00,000	Direct materials		120

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(For Division B)

Y –16,000 units x Rs.20	<u>3,20,000</u>	Variable overheads	400
Total contribution	35,20,000	Additional cost	80
Less: Fixed costs	<u>30,00,000</u>	Total cost : (A)	1,320
Profit	<u>5,20,000</u>	Selling price : (B)	1,450
		Contribution (per unit) : {B-A}	<u>130</u>
		Total contribution (5,000 units x Rs.130)	6,50,000
		Less: Fixed costs	<u>5,00,000</u>
		Profit of Division B	<u>1,50,000</u>

Total profit of the company as a whole is Rs.6,70,000

7.

(a) Profitability of Division B : 3000 units production (Rs lakhs)

	Product Y transfer from Div A @ Rs. 400	Input procured from market
Material (Rs)	12.00	12.00
Direct Wages (Rs)	6.00	5.40
Variable Overheads (Rs)	4.50	4.50
Variable Selling Overheads	3.00	3.30
Total Variable Cost	25.50	25.20
Fixed Overheads	5.00	5.00
Total Cost	30.50	30.20
Sales Value	36.00	33.00
Profit	5.50	2.80

Profitability of Division A:

Products	X	Y		Z	Total
		Sell in market	Transfer to div B		
Selling Price/ Unit (Rs)	480	460	400	400	
Variable Cost/ Unit (Rs)	330	240	240	280	
Contribution per unit (Rs)	150	220	160	120	

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Machine Hour per unit	3	4	4	2	
Contribution per hour	50	55	40	60	
Rank in terms of limiting factor	III	II	IV	I	
In case of Transfer of Y to Div B					
Units to be manufactured	4000	2000	3000	3000	
Machine Hour used	12000	8000	12000	6000	38000
Contribution (Rs lakhs)	6.00	4.40	4.80	3.60	18.80
Fixed Cost (Rs lakhs)					10.00
Profit (Rs lakhs)					8.80
In case of No Transfer of Y to Div B					
Units to be manufactured	4000	5000		3000	
Machine Hour used	1200	2000		600	38000
Contribution (Rs lakhs)	6.00	11.00		3.60	20.60
Fixed Cost (Rs lakhs)					10.00
Profit (Rs lakhs)					10.60

In case of Transfer from Division A:

Total Profit of the company = Rs (5.50+ 8.80) lakhs = Rs 14.30 lakhs

In case of procurement of input for division B from outside market ,

Profit = Rs (2.80 + 10.60) lakhs = Rs 13.40 lakhs

- (b) Thus, the transfer price of Rs 400 based on market price is beneficial to the company.
- (c) In case of enhancement of capacity of Division B to 5000 units & transfer of 5000 units of Y from Division A at transfer price of Rs 460,

	Rs lakhs
Profitability of Division A	10.60
Profitability of Division B :	
Sales Value (5000 x 1200)	60.00
Variable Cost (2550 x 5000/3000) + 60 x 5000	45.50
Contribution	14.50
Fixed Cost + Capital Cost	5.90
Profit	8.60
Total profit of the company	19.20
Increase in profitability	4.90

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8.

(a) (i) **Monthly profits at present level of L & M Ltd.** (Rs. lakhs)

L Ltd.:	Sales (10,000 drums* @ Rs.2000 per drum)	200
Less :	Costs: Raw materials @ Rs. 900 per drum	90
	Other costs @ Rs.300 per drum	<u>30</u>
	Contribution	80
Less :	Fixed costs	<u>40</u>
Profit		<u>40</u>
M Ltd.:	Sales (7,50,000 kilolitres at Rs. 900 per 25 litres)	270
Less:	Costs: Variable (@Rs. 20 per Kilolitre)	<u>150</u>
	Contribution	120
Less :	Fixed costs	<u>60</u>
Profit		<u>60</u>
Total profit		100

Sale of M Ltd to outside market = $(7,50,000 - 2,50,000)/25 = 20,000$ drums

If price is reduced by 20%, sales for M Ltd = 18,000 drums

(ii) **Monthly profits at higher sales level** (Rs.' lakhs)

L Ltd.:	Sales (18,000 drums* at Rs.1600 per drum)	288
Less:	Costs: Raw materials (Rs. 900 per drum)	162
	Other expenses (Rs.300 per drum)	<u>54</u>
	Contribution	72
Less:	Fixed costs	<u>40</u>
	Profit	<u>32</u>
M Ltd.	Sales (9,50,000 kilolitres* at Rs. 900 per 25 litres)	342
	Costs: Variable (@ Rs.20 per kilolitre)	<u>190</u>
	Contribution	152
Less:	Fixed costs	60
	Profit	<u>92</u>

9. i) Analysis of Revenue and Contribution

Profit Centre	Estimated Revenue		Contribution	
	%	Amount	%	Amount

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		(Rs lakhs)		(Rs lakhs)
Accommodation	50	30.00	60	18.00
Restaurant	30	18.00	30	5.40
Bar	20	12.00	40	4.80
Total	100	60.00		28.20
			Fixed Cost	10.00
			Gross profit	18.20

ROCE (before Tax) under the budget = $18.2/110 = 16.55\%$

- ii) Extra Revenue to be earned from per occupancy of two-night offer :

	Revenue (Rs)	%	Contb. (Rs)
Accommodation	1600	60	960
Restaurant	480	30	144
Bar	240	40	96
Total	2320		1200

Required ROCE (before tax) = $(16.55 + 5)\% = 21.55\%$

Gross Profit required = Rs 110 x 0.2155 lakhs = Rs 23.70 lakhs

Additional contribution required = Rs (23.70 – 18.20) = Rs 5.50 lakhs

No of two-nights offer at reduced price to be sold = $5.50 \text{ lakhs} / 1200 = 458$

- iii) We assume that contribution % of revenue will remain same after increase in price.

Increase in revenue from restaurant & bar by 15% increase in price will be

Rs 2.70 akhs and Rs 1.80 lakhs respectively.

Increase in Contribution from restaurant and bar = $2.7 \times 0.30 + 1.8 \times 0.40 = \text{Rs } 1.53 \text{ lakhs}$

Additional contribution required from accommodation (5.50-1.53) = Rs 3.97 lakhs

Required increase in revenue = Rs lakhs $(3.97 / 0.60) = \text{Rs } 6.60 \text{ lakhs approx}$

Required percentage increase in rent = $6.60 / 30 = 22\%$

10.

	P1	P2
	Rs/unit	Rs./unit
Material	407.5	292.1
Overhead-Material handling	$85 \times 1.2 = 102$	$46 \times 1.2 = 55.2$

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Assembly Management	$40 \times 3.2 = 128$	$40 \times 1.9 = 76$
Machine insertion	$48 \times 0.7 = 33.6$	$31 \times 0.7 = 21.7$
Manual insertion	$36 \times 2.1 = 75.6$	$1.5 \times 2.10 = 31.5$
Quality testing	$1.4 \times 25 = 35$	$1.1 \times 25 = 27.5$
Present cost	781.70	504.00
Target cost	680.00	390.00

	Revised P1	Revised P2
	<i>Rs./unit</i>	<i>Rs./unit</i>
Direct material	381.20	263.10
Overhead - Material handling	$(71 \times 1.2) = 85.2$	$(39 \times 1.2) = 46.8$
Assembly hour	$(2.1 \times 40) = 84.0$	$(1.6 \times 40) = 64.0$
Machine insertion	$(59 \times 0.7) = 41.3$	$(29 \times 0.7) = 20.30$
Manual insertion	$(12 \times 2.10) = 25.2$	$(10 \times 2.10) = 21.00$
Quality testing	$(1.2 \times 25) = \underline{30.00}$	$(0.9 \times 25) = \underline{22.50}$
Estimated cost	646.90	437.70
Target cost	680.00	390.00

Achieved

Not achieved

11.

Compared to 2009, following are the changes in 2010 :

Increase in volume	20%
Increase in sales price = $39.6 / (30 \times 1.2) =$	10%
Increase in Material Price = $15.75 / (12.5 \times 1.2)$	5%
Increase in Labour cost = $7.92 / (6 \times 1.2)$	10%
Overheads for 2010 due to inflation (7×1.1)	7.7
Variable overhead increase due to volume increase in 2010	1.0
Total Variable overheads in 2010	6.0
Fixed Overheads for 2010	2.7

Thus, Budget for the year 2011 :

Sales unit	View (a)	view(b)
	7,200	7200
	Rs lakhs	Rs lakhs
Sales	52.27	51.32
Material	19.85	19.47
Labour	10.45	10.26
Variable Overheads	7.92	7.78

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Fixed Overheads	2.97	2.92
Total Cost	41.19	40.43
Profit	11.08	10.89

12.

1. Sales Budget for the Month ending June 30, 2010

<i>Product</i>	<i>Unit Sales</i>	<i>Unit Selling Price</i>	<i>Total Sales</i>
		<i>Rs.</i>	<i>Rs.</i>
Product K	40,000	30.00	12,00,000
Product L	20,000	65.00	<u>13,00,000</u>
Total revenue from sales			<u>25,00,000</u>

2. Production Budget for the Month ending June 30, 2010

	<i>Units</i>	
	<i>Product K</i>	<i>Product L</i>
Sales	40,000	20,000
Plus desired inventories at June30, 2010	<u>2,500</u>	<u>2,000</u>
Total	42,500	22,000
Less: Estimated inventories, June, 2010	<u>3,000</u>	<u>2,700</u>
Total production	<u>39,500</u>	<u>19,300</u>

3. Direct Materials Purchases Budget for the Month ending June30, 2010

	<i>Direct Materials</i>		
	<i>Material A</i>	<i>Material B</i>	<i>Total</i>
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			
June 30, 2010	<u>3,000</u>	<u>2,500</u>	
Total	98,200 kgs.	84,640 kgs,	
Less estimated units of inventory			
June 1, 2010	<u>4,000</u>	<u>3,500</u>	
Total units to be purchased	94,200 kgs.	81,140 kgs.	
Unit price	<u>..... ×</u> <u>.....Rs.4.00</u>	<u>..... ×</u> <u>.....Rs.2.00</u>	
Total direct materials purchases	<u>Rs. 3,76,800</u>	<u>Rs. 1,62,280</u>	<u>Rs. 5,39,080</u>

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$$*27,650 = 39,500 \times 0.7 \quad 47,400 = 39,500 \times 1.2$$

$$**67,550 = 19,300 \times 3.5 \quad 34,740 = 19,300 \times 1.8$$

4. Direct Labour Cost Budget for the Month ending June 30, 2010

	<i>Department 1</i>	<i>Department 2</i>	<i>Total</i>
Hours required for production:			
Product K (39,500 × hours per unit)	15,800*	5,925*	
Product L (19,300 × hours per unit)	<u>11,580**</u>	<u>4,825**</u>	
Total	27,380	10,750	
Hourly rate	<u>× Rs.12.00</u>	<u>× Rs.16.00</u>	
Total	Rs.3,28,560	Rs.1,72,000	<u>Rs. 5,00,560</u>
*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. Cost of Goods sold Budget for the Month ending June 30, 2010

	<i>Rs.</i>	<i>Rs.</i>
Finished goods inventory, June 1, 2010		1,45,500
<i>Direct materials:</i>		
Direct materials inventory, June 1, 2010 (Note A)	23,000	
Direct materials purchases	<u>5,39,080</u>	
Cost of direct materials available for use	5,62,080	
Less: Direct materials inventory, June 30, 2010 (Note B)	<u>17,000</u>	
Cost of direct materials placed in production	5,45,080	
Direct labour	5,00,560	
Factory overhead	<u>2,99,000</u>	
Cost of goods manufactured		<u>13,44,640</u>
Cost of finished goods available for sale		14,90,140
Less: Finished goods inventory, June 30, 2010		<u>1,12,500</u>
Cost of goods sold		<u>13,77,640</u>

<i>Note A:</i>			<i>Rs.</i>
Material A	4,000 kgs.	at Rs. 4.00 per kg.	16,000
Material B	3,500 kgs.	at Rs. 2.00 per kg.	<u>7,000</u>

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Direct materials inventory, June 1, 2010 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.	<u>5,000</u>
Direct materials inventory, June 30, 2010			<u>17,000</u>

13.

(a) Standard Cost Sheet

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

(b) Production Volume Variance

Unutilised capacity × Standard Fixed Cost per Finished Good

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

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

Raw Material	Std Qty/F G	Std Qty on actual prod	Actual Qty on actual prod	Act Price per Ut of RM(Rs)	Std Price per Ut of RM(Rs)	Usage Variance (Rs)	Price Variance (Rs)
A	1	100	102	700	600	(1,200)	(10,200)
B	2	200	201	600	500	(500)	(20,100)
C	3	300	310	500	400	(4,000)	(31,000)
D	4	400	415	400	300	(4,500)	(41,500)
E	5	500	540	300	200	(8,000)	(54,000)
F	6	600	610	200	100	(1,000)	(61,000)
						(19,200)	(2,17,800)

(d) Standard Profit (Rs 13,000 × 100) = Rs 13,00,000

Usage Variance	(19,200)
Price Variance	(2,17,800)
Production Volume Variance	(10,00,000)
Actual Profit	63,000

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Computation of material variances:

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

Material cost variance:

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

Material price variance:

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

Material usage variance:

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

Computation of labour variances:

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

Labour cost variance:

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

Labour rate variance:

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

Labour efficiency variance:

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

Idle time variance

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

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

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

Computation of Fixed overhead variances:

Budgeted / Standard data		Actual data	
Budgeted overheads (Rs)	25,000	Fixed overheads (Rs)	23,240
Budgeted output (units)	10,000	Actual output (units)	9,000
Budgeted (hours)	50,000	Actual production (hours)	40,500

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		Idle hours	1,500
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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 (A)

Expenditure variance:

= [Budgeted fixed overheads – Actual fixed overheads]

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

Volume variance:

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

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

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 (F)

Capacity variance:

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

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

Idle time variance:

= Idle time hours x Std rate per hour

= 1,500 hours x 0.50 = Rs.7.50 (A)

Computation of variable overhead variances:

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

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Total variable overhead cost variance:

$$\begin{aligned} &= (\text{Variable overhead recovered on actual output} - \text{Actual variable overhead incurred}) \\ &= (9,000 \text{ units} \times \text{Rs.1} - \text{Rs.9,250}) = \text{Rs.250 (A)} \end{aligned}$$

Expenditure variance:

$$\begin{aligned} &= [\text{Budgeted variable overheads} - \text{Actual variable overheads}] \\ &= [\text{Rs.8,100} - \text{Rs.9,250}] = \text{Rs.1,150 (A)} \end{aligned}$$

Efficiency variance:

$$\begin{aligned} &= [\text{Standard hours for actual output} - \text{Actual hours}] \text{ Std. rate per unit} \\ &= (45,000 - 40,000) 0.20 = \text{Rs.900 (F)} \end{aligned}$$

Computation of sales variances:

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

Total sales value variance:

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

Sales price variance:

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

Sales volume variance:

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

Standard gross margin volume variance:

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

Reconciliation of budgeted profit with actual profit:

	Rs.
Budgeted profit	90,000
Sales gross margin volume variance	<u>9,000 (A)</u>
Standard profit	81,000

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Sales price variance	<u>13,500</u> (F)
Total	94,500

Cost variances:

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

15.

Average labour cost for first 50 units = Rs 100.00

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

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

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

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

We know that learning curve equation :

$$Y = ax^b$$

Where y = average time for producing x units

a = time spent on first unit / batch

b = co-efficient of learning curve

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

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

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

$$\log y = \log(100) - 0.15206(\log 20) = 2 - 15206 \times 1.3010 = 1.802172$$

$$\text{Thus } y = \text{antilog}(1.802172) = 63.41$$

Thus, average labour cost for 1000 units = Rs 63.41

Thus the price to be quoted for :

	First 400 units (Rs)	First 800 units (Rs)	First 1000 unit (Rs)
Material @ Rs 150	60000	120000	150000
Labour Cost	29160	52488	63410
Overheads	20000	40000	50000

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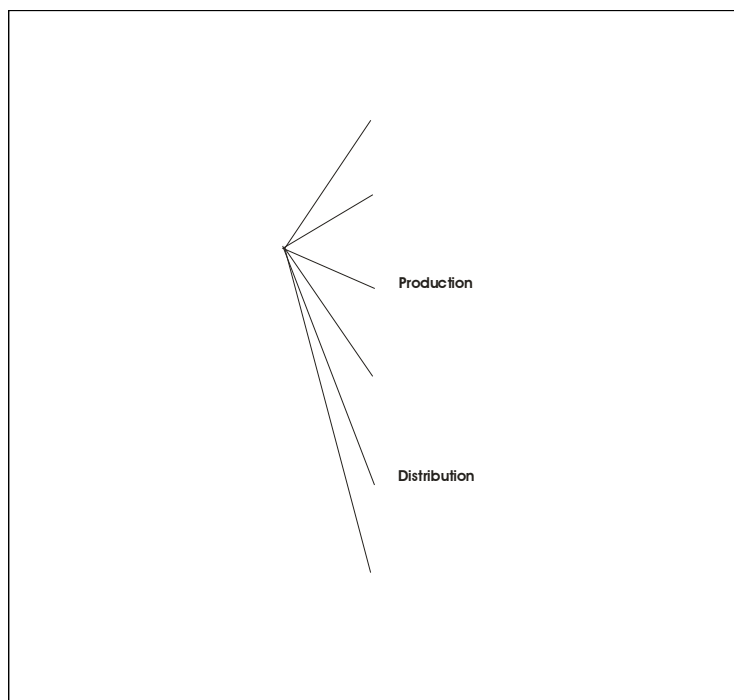
Total Cost	109160	212488	263410
Profit	27290	53122	65852
Price to be quoted	136450	265610	329262

16. (a) **Total Quality Management:** Traditional focus was primarily on the financial performance of an organisation. Now a days it is crucial for organisation to monitor performance in many non financial areas as well. For many companies, quality is at the forefront of the area in which non financial performance is critically important. Monitoring product quality coupled with measuring and reporting quality costs helps companies program of total quality management (TQM) . TQM refers to the broad set of management and control processes designed to focus the entire organisation and all of its employees on providing products or services that do the best possible job of satisfying the customers.

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) In order to gain a competitive advantage over its competitors , a company needs to profitably satisfy or even exceed the needs and expectations of its various customers. This can be done by the use of Value Chain Analysis . This analysis can be used to better understand which segments, distribution channels, price points, product differentiation , selling propositions and value chain configurations will yield the firm its greatest competitive advantage. The use of VCA to assess competitive advantage involves the following analyses'
- **Internal cost analysis**
 - **Internal differential analysis**

- **Vertical linkage analysis**



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

Stages of Target Costing:

1. **Conception (planning) Phase:** Under this stage of life cycle, competitors products are to be analysed, with regard to price, quality, service and support, delivery and technology. The features which consumers would like to have like consumer value etc. established. After preliminary testing, the company may be asked to pinpoint a market niche, it believes, is under supplied and which might have some competitive advantage.
2. **Development phase:** The design department should select the most competitive product in the market and study in detail the requirement of material, manufacturing process along with competitors cost structure. The firm should also develop estimates of internal cost structure based on internal cost of similar products being produced by the company. If possible the company

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should develop both the cost structures (competitors and own) in terms of cost drivers for better analysis and cost reduction.

3. **Production phase:** This phase concentrates its search for better and less expensive products, cost benefit analysis in different features of a product priority wise, more towards less expensive means of production, as well as production techniques etc.
- (b) **Total life cycle costing approach:** Life cycle costing estimates, tracks and accumulates the costs over a product's entire life cycle from its inception to abandonment or from the initial R & D stage till the final customer servicing and support of the product. It aims at tracing of costs and revenues on product by product basis over several calendar periods throughout their life cycle. Costs are incurred along the product's life cycle starting from product's design, development, manufacture, marketing, servicing and final disposal. The objective is to accumulate all the costs over a product life cycle to determine whether the profits earned during the manufacturing phase will cover the costs incurred during the pre and post manufacturing stages of product life cycle.

Product life cycle costing is important for the following reasons:

- (i) When non-production costs like costs associated with R & D, design, marketing, distribution and customer service are significant, it is essential to identify them for target pricing, value engineering and cost management. For example, a poorly designed software package may involve higher costs on marketing, distribution and after sales service.
 - (ii) There may be instances where the pre-manufacturing costs like R & D and design are expected to constitute a sizeable portion of life cycle costs. When a high percentage of total life cycle costs are likely to be so incurred before the commencement of production, the firm needs an accurate prediction of costs and revenues during the manufacturing stage to decide whether the costly R & D and design activities should be undertaken.
 - (iii) Many costs are locked in at R & D and design stages. Locked in or Committed costs are those costs that have not been incurred at the initial stages of R & D and design but that will be incurred in the future on the basis of the decisions that have already been taken. For example, the adoption of a certain design will determine the product's material and labour inputs to be incurred during the manufacturing stage. A complicated design may lead to greater expenditure on material and labour costs every time the product is produced. Life cycle budgeting highlights costs throughout the product life cycle and facilitates value engineering at the design stage before costs are locked in.
18. (a) Traditional accounting systems record the flow of inventory through elaborate accounting procedures. Such systems are required in those manufacturing

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environment where inventory/WIP values are large. However, since JIT systems operate in modern manufacturing environment characterized by low inventory and WIP values, usually also associated with low cost variances, the requirements of such elaborate accounting procedures does not exist.

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

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

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

(b) 1. Journal entries for April are:

	Rs.	Rs.
Entry (a) Inventory: Materials and In-Process Control	4,40,000	
Accounts Payable Control		4,40,000
(direct materials purchased)		
Entry (b) Conversion Costs Control	2,11,000	
Various Accounts (such as Wages Payable Control)		2,11,000
(Conversion costs incurred)		
Entry (c) Finished Goods Control	6,25,000	
Inventory: Materials and In-Process Control		4,25,000
Conversion Costs Allocated		2,00,000
(Standard cost of finished goods completed)		
Entry (d) Cost of Goods Sold	5,95,000	

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Finished Goods Control		5,95,000
(Standard costs of finished goods sold)		

2. Under an ideal JIT production system, if the manufacturing lead time per unit is very short, there could be zero inventories at the end of each day. Entry (c) would be Rs. 5,95,000 finished goods production [to match finished goods sold in entry (d)], not Rs. 6,25,000. If the marketing Department could only sell goods costing Rs. 5,95,000, the JIT production system would call for direct materials purchases and conversion costs of lower than Rs. 4,40,000 and Rs. 2,11,000, respectively, in entries (a) and (b).
- (b) (i) The use of a market price as the transfer price produces difficulties because L Ltd. is not motivated to reduce the selling price, in order to increase volume, because its profit declines from Rs. 40,000 to Rs. 32,000. However, the profits of M Ltd. increase from Rs. 60,000 to Rs. 92,000. Thus, the profits for the company as a whole increase by Rs. 24,000. Hence the transfer price does not encourage goal congruence in this particular situation.
- (ii) In order to overcome the above difficulties, there is a need to offer some inducement to L Ltd. such that its profits will increase as a result of lowering the selling price in order to increase volume. Factors to consider are the following:
1. The significance of the loss in profits arising from the difference between profits at the optimum output level and profits based on the output using the current transfer pricing system.
 2. Savings in selling and distribution costs arising from internal transfers compared with external sales. The savings per unit should be deducted from the market price.
19. (a) Requisites of inter-firm comparison system: The following requisites should be considered while installing a system of inter-firm comparison:—
1. Centre for Inter-Comparison — For collection and analysing data received from member units, for doing a comparative study and for dissemination of the results of study a Central body is necessary. The functions of such a body may be :—
 - (a) Collection of data and information from its members;
 - (b) Dissemination of results to its members;
 - (c) Undertaking research and development for common and individual benefit of its members;
 - (d) Organising training programmes and publishing magazines.
 2. Membership — Another requirement for the success of inter-firm comparison is that the firms of different sizes should become members of the Centre

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entrusted with the task of carrying out inter-firm comparison.

3. Nature of information to be collected — Although there is no limit to information, yet the following information useful to the management is in general collected by the Centre for inter-firm comparison.
 - (a) Information regarding costs and cost structures.
 - (b) Raw material consumption.
 - (c) Stock of raw material, wastage of materials, etc.
 - (d) Labour efficiency and labour utilisation.
 - (e) Machine utilisation and machine efficiency.
 - (f) Capital employed and Return on capital.
 - (g) Liquidity of the organisation.
 - (h) Reserve and appropriation of profit.
 - (i) Creditors and debtors.
 - (j) Methods of production and technical aspects.
 4. Method of Collection and presentation of information The Centre collects information at fixed intervals in a prescribed form from its members. Sometimes a questionnaire is sent to each member; the replies of the questionnaire received by the Centre constitute the information/data. The information is generally collected at the end of the year as it is mostly related with final accounts and Balance Sheet. The information supplied by firms is generally in the form of ratios and not in absolute figures. The information collected as above is stored and presented to its members in the form of a report. Such reports are not made available to non-members.
- (b) The Balanced Scorecard can be defined as 'an approach to the provision of information to management to assist strategic policy formulation and achievement. It emphasises 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'.

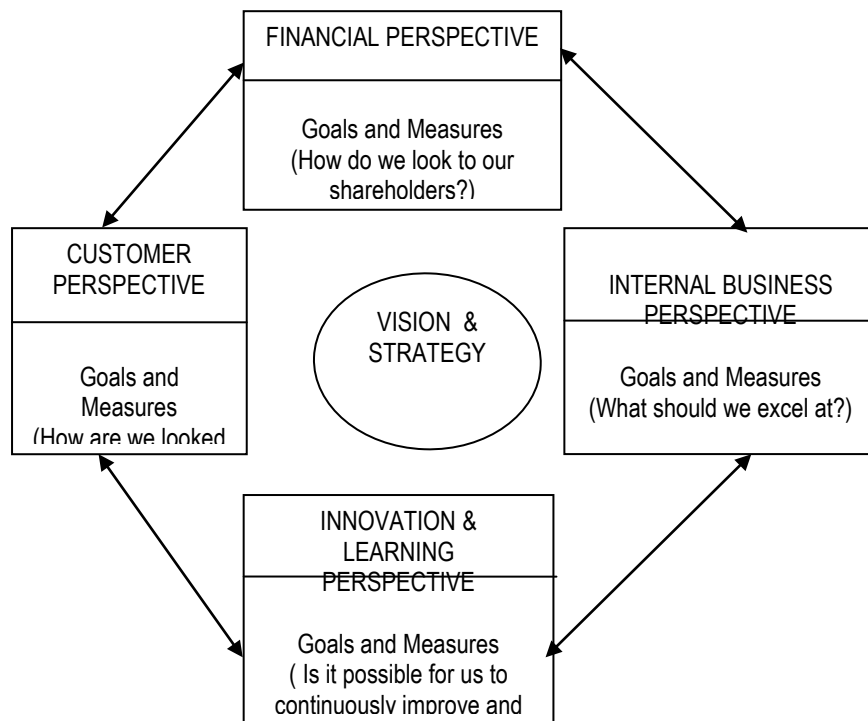
It is clear from the above definition that the central idea of the Balanced Scorecard is that managers should develop the measures on which they manage the business from four different perspectives:

1. customer satisfaction
2. internal business process e.g., operating cycle time.
3. kaizen approach (can we continue to improve and create value)

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4. financial e.g., operating income by segments.

The following figure summarises the ideas of a Balanced Scorecard:



According to Kaplan and Norton, 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;

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- The use of non financial measures leads managers to think that they have a Balanced Scorecard already working for strategic purposes.
- 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. It remains a matter of debate whether a Balanced Scorecard is applicable to external reporting. Critics argue that if the Scorecard is indeed a relevant driver of long term performance, shouldn't the information generated be of interest to the investment community? However, it has been noticed that the Scorecard does not translate easily to the investment community for the simple reason that it makes sense for individual business units and different individual projects rather than the company as a whole. Most companies have different divisions with their own mission and strategy and hence these individual scorecards cannot be aggregated into an overall corporate scorecard. However, in case the company somehow manages to overcome such a problem and indeed use its Scorecard for external reporting, it may end up passing sensitive information to its competitors which may end up being detrimental to the company in the long run. However, with changes in the thinking process of the investment community, such strategic reporting could well be accepted in the near future.

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

Maximize $Z = 50x_1 + 30x_2$ subject to the constraints $2x_1 + x_2 \geq 18$; $x_1 + x_2 \geq 12$; $3x_1 + 2x_2 \leq 34$; $x_1 \geq 0$, $x_2 \geq 0$, where x_1, x_2 represent the number of units of model X and Y.

Clearly, each point (x_1, x_2) satisfying the condition $x_1 \geq 0$, $x_2 \geq 0$ must lie in the first quadrant only. Also since $2x_1 + x_2 \geq 18$, $x_1 + x_2 \geq 12$ and $3x_1 + 2x_2 \leq 34$, the desired point (x_1, x_2) lies somewhere on the feasible region PQR.

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

P (6, 6), Q = (2, 14) and R = (10, 2)

Corner point	Co-ordinates (x_1, x_2)	Objective function value $Z = 50x_1 + 30x_2$
P	(6, 6)	$50(6) + 30(6) = 480$
Q	(2, 14)	$50(2) + 30(14) = 520$
R	(10, 2)	$50(10) + 30(2) = 560$

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Since the maximum value of Z is 560 which occurs at the point R = (10,2), the solution to the given LP problem is: $x_1 = 10$, $x_2 = 2$ and maximum $Z = 560$.

To maximize profit, the manufacturer should produce 10 units of model X and 2 units of Y.

21. (i) The mathematical formulation of the given problem is:

$$\text{Maximize } Z = 270x_1 + 144x_2 + 225x_3$$

subject to the constraints

$$8x_1 + 4x_2 + 5x_3 \leq 1000$$

$$5x_1 + 3x_2 + 3x_3 \leq 650$$

$$9x_1 + 6x_2 + 9x_3 \leq 1260$$

$x_1, x_2, x_3 \geq 0$, where x_1, x_2 and x_3 denote the number of products A, B, C respectively.

- (ii) From the given tableau, we obtain the current solution as:

x_1 : No. of A = 125

s_2 : slack labour hours = 25 hrs.

s_3 : slack floor space = 135 sq. ft.

Contribution = $125 \times 270 = \text{Rs. } 33,750$

Thus solution is not optimum as $C_j - Z_j$ has positive quantities in x_2, x_3 columns.

- (iii) We proceed at follows:

$C_j \rightarrow$ $C_B \downarrow$	Basic variables	Solution values	270	144	225	0	0	0	Minimum ratio
			x_1	x_2	x_3	s_1	s_2	s_3	
270	x_1	125	1	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{8}$	0	0	200
0	s_2	25	0	$\frac{1}{2}$	$-\frac{1}{8}$	$-\frac{5}{8}$	1	0	—
0	$\leftarrow s_3$	135	0	$\frac{3}{2}$	$\frac{27}{8}^*$	$-\frac{9}{8}$	0	1	40
	$C_j - Z_j$		0	9	$\frac{225}{4}$	$-\frac{135}{4}$	0	0	$\uparrow$
270	x_1	100	1	$\frac{2}{9}$	0	$\frac{1}{3}$	0	$-\frac{5}{27}$	
0	s_2	30	0	$\frac{5}{9}$	0	$-\frac{2}{3}$	1	$\frac{1}{27}$	
225	x_3	40	0	$\frac{4}{9}$	1	$-\frac{1}{3}$	0	$\frac{8}{27}$	
	$C_j - Z_j$		0	-16	0	-15	0	$-\frac{16}{3}$	

Since all the entries in $C_j - Z_j$ row are either zero or negative, the optimum solution is arrived at.

Solution: $x_1 = 100$, $x_2 = 0$, $x_3 = 40$ with maximum $Z = 36,000$.

- (iv) The solution shows that labour force is slack as seen from $s_2 = 30$ in the basis. Hence, addition of further labour force will not change the optimum solution. The personnel Manger's claim, therefore, is not valid.

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- 22.** Step 1: Cost Matrix generated for allocation of different jobs to different typists.

TABLE 1

Job Typist	P	Q	R	S	T
A	85	75	65	125	75
B	90	78	66	132	78
C	75	66	57	114	69
D	80	72	60	120	72
E	76	64	56	112	68

Step 2 : . Subtracting the minimum element of each row from all its elements

Job Typist	P	Q	R	S	T
A	20	10	0	60	10
B	24	12	0	66	12
C	18	9	0	57	12
D	20	12	0	60	12
E	20	8	0	56	12

Step 3 : Subtracting minimum element of each column from all its elements

Job Typist	P	Q	R	S	T
A	2	2	0	4	0 →
B	6	4	0	10	2
C	0	1	0	1	2 →
D	2	4	0	4	2
E	2	0	0	0	2 →

Step 4 : Since there are only 4 lines (<5) to cover all zeros, it is not optimum assignment. The minimum uncovered element is 2. We, therefore subtract uncovered element '2' from all uncovered elements, add this value to all junction values and leave the other elements undisturbed.

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Job Typist	P	Q	R	S	T
A	2	2	2	4	0
B	4	2	0	8	0
C	0	1	2	1	2
D	0	2	0	2	0
E	2	0	2	0	2

Step 5. Since the minimum number of lines required to cover all the zeros is only 4 (<5), optimum assignment cannot be made at this stage also. The minimum uncovered element is 1. Repeating the usual procedure again, we get the adjoining matrix:

Job Typist	P	Q	R	S	T
A	2	1	2	3	0
B	4	1	0	7	0
C	0	0	2	0	2
D	0	1	0	1	0
E	2	0	2	0	2

Step 6. Minimum number of lines to cover all zeros is equal to 5, this matrix gives optimum solution

Job Typist	P	Q	R	S	T
A	2	1	2	3	0
B	4	1	0	7	0
C	0	0	2	0	2
D	0	1	0	1	0
E	2	0	2	0	2

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The optimum assignment is made in the matrix given below:

Typist	Job	Cost (Rs.)
A →	T	75
B →	R	66
C →	Q	66
D →	P	80
E →	S	<u>112</u>
Total		Rs. 399

23. The given problem is un-balanced transportation problem

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

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

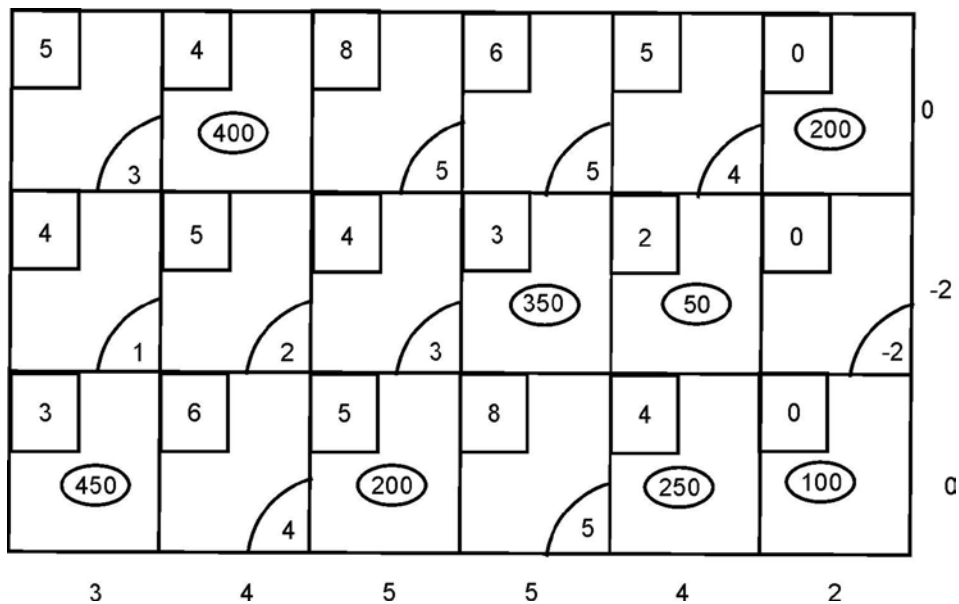
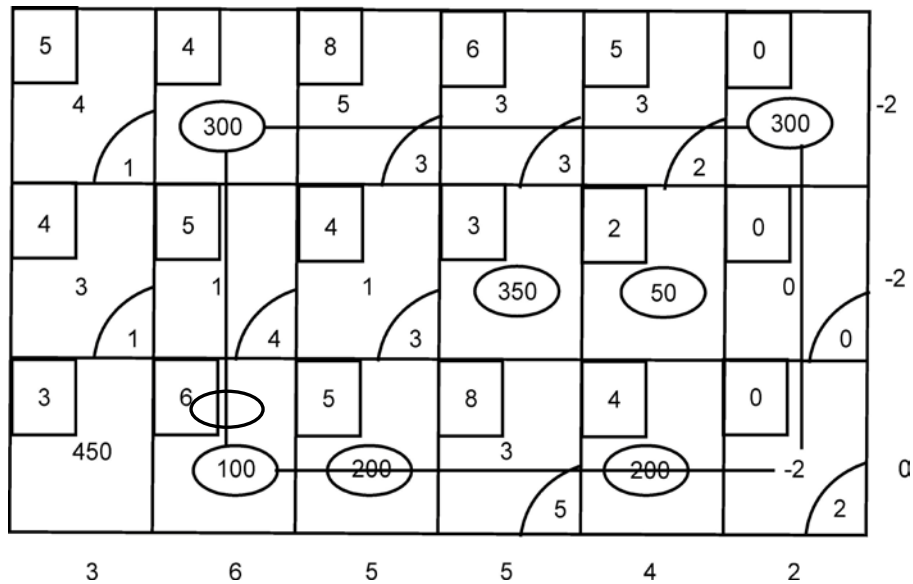
5	4	8	6	5	0	600 300	4	1	1	1	1	
	300				300							
4	5	4	3	2	0	400 50	2	1	2			
			300	50								
3	6	5	8	4	0	1000 300 700 450	3	1	1	1	1	3
450	100	200		250								
450	400 100	200	350									
1	1	1	3	2	0							
1	1	1	3↑	2								
1	1	1		2								
2	2	3↑		1								
2	2↑			1								
3	6↑			4								
3			4↑									
3												

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The transportation cost.

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

Optimum solution is



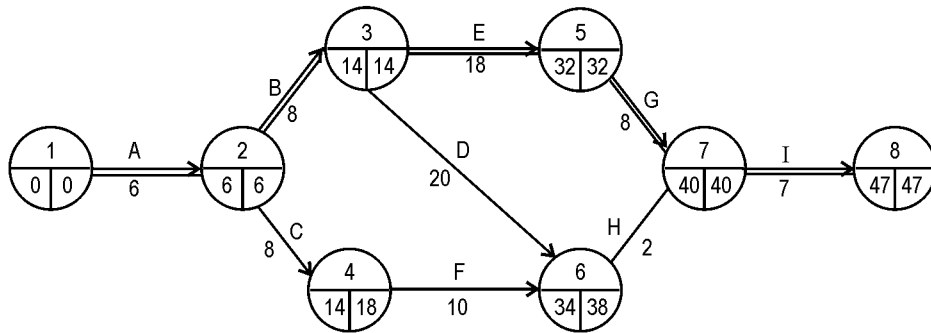
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Transportation cost

$$= 4 \times 400 + 0 \times 200 + 3 \times 350 + 2 \times 50 + 3 \times 450 + 5 \times 200 + 4 \times 250 + 0 \times 100$$

$$= 1,600 + 1,050 + 100 + 1,350 + 1,000 + 1,000 = 6,100$$

24. The network diagram for the given data is shown below



(i) The expected time t_e and variance σ^2 for activities is calculated by using the formulae:

$$t_e = \frac{1}{6} (t_o + 4t_m + t_p) \quad \text{and} \quad \sigma^2 = \left[\frac{1}{6} (t_p - t_o) \right]^2$$

Activity :	A (1,2)	B (2,3)	C (2,4)	D (3,6)	E (3,5)	F (4,6)	G (5,7)	H (6,7)	I (7,8)
t_o :	4	5	4	15	10	8	4	1	6
t_p :	6	7	8	20	18	9	8	2	7
t_m :	8	15	12	25	26	16	12	3	8
t_e :	6	8	8	20	18	10	8	2	7
σ^2 :	4/9	25/9	16/9	25/9	64/9	16/9	16/9	1/9	1/9

For the critical path, we compute earliest and latest time in respect of each job which is given in the following table:

Job	t_e	Earliest time		Latest time		Total float
		Start	Finish	Start	Finish	
A (1,2)	6	0	6	0	6	0
B (2,3)	8	6	14	6	14	0
C (2,4)	8	6	14	10	18	4
D (3,6)	20	14	34	18	38	4
E (3,5)	18	14	32	14	32	0
F (4,6)	10	14	24	28	38	14
G (5,7)	8	32	40	32	40	0

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H (6,7)	2	34	36	38	40	4
A (7,8)	7	40	47	40	47	0

The activities with zero total float are considered and thus the critical path has been identified as:

1 → 2 → 3 → 5 → 7 → 8, i.e., A → B → E → G → I

Now, expected project length, $T_e = 6 + 8 + 18 + 8 + 7 = 47$ days, and the variance of the project length,

$$\sigma^2 = \frac{4}{9} + \frac{25}{9} + \frac{64}{9} + \frac{16}{9} + \frac{1}{9} = \frac{110}{9} \Rightarrow \sigma = \sqrt{\frac{110}{9}} = 3.496$$

Thus the project duration being normally distributed with mean $T_e = 47$ days and standard deviation, $\sigma = 3.496$ days. The probability of the project being completed in 55 days would be equal to the area under the normal curve lying to the left of $X = 55$. We have

$$Z = \frac{55 - 47}{3.496} = 2.89$$

From the normal area table, the area between mean and $Z = 2.89$ under the normal curve is found to be equal to 0.4981.

$$P(X \leq 55) = P(Z \leq 2.89) = 0.5 + P(0 \leq Z \leq 2.89) = 0.9981.$$

25.

TABLE 1: RANDOM NUMBER CODING FOR PROCESS TIMES

Time (mts.)	Assembly A ₁			Assembly A ₂		
	Prob.	Cum. prob	RN Interval	Prob.	Cum. prob	RN Interval
20	0.20	0.20	00 – 19	0.10	0.10	00 – 09
21	0.40	0.60	20 – 59	0.15	0.25	10 – 21
22	0.20	0.80	60 – 79	0.40	0.65	25 – 64
23	0.15	0.95	80 – 94	0.25	0.90	65 – 89
24	0.05	1.00	95 – 99	0.10	1.00	90 – 99

The random numbers for the first unit are 34 and 41 respectively for the assemblies A₁ and A₂. From the table 2 we observe that the times corresponding to these are 22 and 21 minutes respectively. Thus the total time required for the unit is 43 minutes. In the same way, the times for the other 14 units are determined and shown in the last column of the table.

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TABLE 2: SIMULATION WORKSHEET

Unit	Assembly A ₁		Assembly A ₂		Total time (mts.)
	R. number	Time	R. number	Time	
1	41	22	34	21	43
2	74	23	76	22	45
3	49	22	43	21	43
4	83	23	43	21	44
5	11	21	83	23	44
6	19	21	15	20	41
7	36	22	02	20	42
8	94	24	45	21	45
9	54	22	15	20	42
10	75	23	05	20	43
11	00	20	89	23	43
12	08	20	80	23	43
13	74	23	28	21	44
14	34	22	24	21	43
15	93	24	09	20	44
			Expected time = $\frac{649}{15} = 43.27$		

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26. Fitting straight line Trend by the Method of Least square

Year	Tourist Arrivals (in millions) Y	X	XY	X ²
1990	18	-3	-54	9
1991	20	-2	-40	4
1992	23	-1	-23	1
1993	25	0	0	0
1994	24	1	24	1
1995	28	2	56	4
1996	30	3	90	9

N = 7 $\Sigma y = 168$ $\Sigma x = 0$ $\Sigma xy = 53$ $\Sigma x^2 = 28$

The equation of the straight line trend is :

$$Y = a + bx$$

$$\Sigma x = 0, a = \frac{\Sigma y}{N} = \frac{168}{7} = 24$$

$$b = \frac{\Sigma xy}{\Sigma x^2} = \frac{53}{28} = 1.893$$

Hence $Y = 24 + 1.893x$

Estimated Number of tourists that would arrive in 2000

$$Y = 24 + 1.893(7) = 24 + 13.251 = 37.251 \text{ million.}$$

27. In the usual notations, we are given $n = 200$. x = No. of pieces conforming to specifications in the sample = $200 - 18 = 182$.

$$\therefore P = \text{Proportion of pieces conforming to specifications in the sample} = \frac{182}{200} = 0.91.$$

Null hypothesis. $H_0 : P \geq 0.95$, i.e., the proportion of pieces conforming to specifications in the lot is at least 95%.

Alternative Hypothesis. $H_1 ; P < 0.95$ (Left-tailed alternative).

It will suffice to test $H_0 : P = 0.95 \Rightarrow Q = 1 - P = 0.05$

Level of significance (i) $\alpha = 0.05$, (ii) $\alpha = 0.01$

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Test statistic. Under H_0 , the test statistic is $Z = \frac{P - E(P)}{SE(P)} = \frac{P - \bar{P}}{\sqrt{PQ/n}} \sim N(0,1)$,

Since sample is large

$$= \frac{0.91 - 0.95}{\sqrt{0.95 \times 0.05/200}} = \frac{-0.04}{\sqrt{0.00237}} = \frac{-0.04}{0.0154} = -2.6.$$

- (i) Significance at 5% level of significance.

Since the alternative hypothesis is one-sided (left-tailed), we shall apply left-tailed test for testing significance of Z . The significant value of Z at 5% level significance for left-tail test is -1.645 .

Since computed value of $Z = -2.6$ is less than -1.645 (or since $|z| > 1.645$), we say Z is significant (as it lies in the critical region) and we reject the null hypothesis at 5% level of significances. Hence, the manufacturer's claim is rejected at 5% level of significance.

- (ii) Significance at 1% level of significance. The critical value of Z at 1% level of significance for single-tailed (left-tailed) test is -2.33 . Since the computed value $Z = -2.6$ is less than -2.33 (is $|z| > 2.33$),
 $\therefore H_0$ is rejected at 1% level of significance also.