PAPER – 5: ADVANCED MANAGEMENT ACCOUNTING

QUESTIONS

Kaizen Costing System

1. FZ India Ltd. (FZIL) is an automobile manufacturer in India and a subsidiary of Japanese automobile and motorcycle manufacturer Fuji. It manufactures and sells a complete range of cars from the entry level to the hatchback to sedans and has a present market share of 27% of the Indian passenger car markets. FZIL uses a system of standard costing to set its budgets. Budgets are set semi-annually by the Finance department after the approval of the Board of Directors at FZIL. The Finance department prepares variance reports each month for review in the Board of Directors meeting, where actual performance is compared with the budgeted figures. Ms. Kiyoshi, group CEO of the Fuji is of the opinion that Kaizen costing method should be implemented as a system of planning and control in the FZIL.

Required

Recommend key changes vital to FZIL's planning and control system to support the adoption of Kaizen Costing Concepts.

Value Added Activity

2. AF Furniture manufactures high-quality wooden doors. Management is having emphasize on creativity, engineering, innovation and experience to provide customers with the door they desire, whether it is a standard design or a one-of-a-kind custom door. The following information pertains to operations during April:

Processing time	9.0 hrs.*	Waiting time	6.0 hrs.*
Inspection time	1.5 hr.*	Move time	7.5 hrs.*
Units per batch	60 units		

(*) average time per batch

Required

Compute the following operational measures:

(i) Average non-value-added time per batch

(ii) Average value added time per batch

(iii) Manufacturing cycle efficiency

(iv) Manufacturing cycle time

Just in Time

3. Haigh Ltd. is a leading manufacturing company. Under increasing pressure to reduce costs, to contain inventory and to improve service, Haigh's Costing Department has recently undertaken a decision to *implement a JIT System*.

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The management of Haigh is convinced of the benefits of their changes. But Supplies Manager Mr. Smith fears with the Costing Department's decision. He said:

"We've been driven by suppliers for years ... they would insist that we could only purchase in thousands, that we would have to wait weeks, or that they would only deliver on Mondays!"

Required

Is Mr. Smith's view point correct and why?

Limiting Factor

4. List out the basis for deciding the priority of selecting the best product in the different circumstances stated below:

(i) When maximum sales (in value) is a limiting factor.

(ii) When raw-material is a limiting factor.

(iii) When labour hour is a limiting factor.

(iv) When there is a heavy demand for the product.

Cost Indifference Point

5. X Ltd. wants to replace one of its old machines. Three alternative machines namely A_1, A_2 and A_3 are under its consideration. The costs associated with these machines are as under:

	A_1	A_2	A_3
	₹	₹	₹
Direct material cost p.u.....	50	100	150
Direct labour cost p.u.....	40	70	200
Variable overhead p.u.....	10	30	50
Fixed cost p.a.....	2,50,000	1,50,000	70,000

Required

(i) Compute the cost indifference points for these alternatives.

(ii) Based on these points suggest a most economical alternative machine to replace the old one when the expected level of annual production is 1,200 units.

Flexible Budget

6. WDG Ltd. Had prepared fixed and flexible budget for the financial year 2015-16 as under:

	Fixed Budget *for full capacity* **(₹)**	**Flexible Budget *for 75% level*** **(₹)**
Sales	13,50,000	10,12,500
Direct Material	4,25,000	3,18,750

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Direct Labour	1,85,000	1,38,750
Variable Overheads	2,15,000	1,61,250
Semi-Variable Overheads	3,65,000	3,23,750
Profit	1,60,000	70,000

After the closing of the financial year 2015-16, total actual sales stood at ₹11,07,000 and there was a favourable sales price variance of ₹17,000 (F).

Required

Prepare a flexible budget for the actual level of sales.

Pareto Analysis

7. Nine Plus Technology Ltd. develops cutting-edge innovations that are powering the next revolution in mobility and has nine tablet smart phone models currently in the market whose previous year financial data is given below:

Model	Sales (₹'000)	Profit-Volume (PV) Ratio
Tab - A001	5,100	3.53%
Tab - B002	3,000	23.00%
Tab - C003	2,100	14.29%
Tab - D004	1,800	14.17%
Tab - E005	1,050	41.43%
Tab - F006	750	26.00%
Tab - G007	450	26.67%
Tab - H008	225	6.67%
Tab - I009	75	60.00%

Required

Using the financial data, carry out a Pareto analysis (80/20 rule) of Sales and Contribution. Discuss your findings with appropriate recommendations.

Standard Costing

8. Sapporo Manufacturing Co. (SMC) is a leading consumer goods company. The budgeted and actual data of SMC for the year 2018-19 are as follows:-

Particulars	Budget	Actual	Variance
Sales / Production (units)	2,00,000	1,65,000	(35,000)
Sales (₹)	21,00,000	16,92,900	(4,07,100)
Less: Variable Costs (₹)	12,66,000	10,74,150	1,91,850
Less: Fixed Costs (₹)	3,15,000	3,30,000	(15,000)
Profit	5,19,000	2,88,750	(2,30,250)

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The budgeted data shown in the table is based on the assumption that total market size would be 4,00,000 units but it turned out to be 3,75,000 units.

Required

Prepare a statement showing reconciliation of budget profit to actual profit through marginal costing approach for the year 2018-19 in as much detail as possible.

Relevant Cost Concept

9. A company has to decide whether to accept a special order or not for a certain product J in respect of which the following information is given:

Material M required	5,000 kg	Available in stock. It was purchased 5 years ago at ₹ 35 per kg. If not used for J, it can be sold as scrap @ ₹ 15 per kg.
Material N required	8,000 kg	This has to be purchased at ₹ 25 per kg from the market.
Other hardware items	₹ 10,000	To be incurred
Dept P - Labour oriented	5 men for 1 month @ ₹ 7,000 per month per man	Labour to be freshly hired. No spare capacity available.
Dept Q - Machine oriented	3,000 machine hours @ ₹ 5 per machine hour	Existing spare capacity may be used.
Patten and Specification	₹ 15,000	To be incurred for J, but after the order, it can be sold for ₹ 2,000

Required

Considering relevant costs, find out the minimum value above which the company may accept the order.

Transfer Pricing

10. Star Ltd. has two divisions Division W and Division B. Division W produces product N, which it sells to external market and also to Division B. Divisions in the Star Ltd. are treated as profit centres and divisions are given autonomy to set transfer prices and to choose their supplier. Performance of each division measured on the basis of target profit given for each period.

Division W can produce 1,00,000 units of product N at full capacity. Demand for product N in the external market is for 70,000 units only at selling price of ₹2,500 per unit. To produce product N Division W incurs ₹1,600 as variable cost per unit and total fixed overhead of ₹4,00,00,000. Division W has employed ₹12,00,00,000 as working capital, working capital

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is financed by cash credit facility provided by its lender bank @ 11.50% p.a. Division W has been given a profit target of ₹2,50,00,000 for the year.

Division B has found two other suppliers C Ltd and H Ltd. who are agreed to supply product N.

Division B has requested a quotation for 40,000 units of product N from Division W.

Required

(i) Calculate the transfer price per unit of product N that Division W should quote in order to meet target profit for the year.

(ii) Calculate the two prices Division W would have to quote to Division B, if it became Star Ltd. policy to quote transfer prices based on opportunity costs.

Linear Programming

11. The manufacturing company has 100 kg of X, 180 kg of Y and 120 kg of Z ingredients available per month. Company can use these materials to make three basic products namely 5-10-5, 5-5-10 and 20-5-10, where the numbers in each case represent the percentage of weight of X, Y and Z respectively in each of products. The cost of these raw materials are as follows:

Ingredient	Cost per Kg. (₹)
X	64
Y	16
Z	40
Inert Ingredients	16

Selling price of these products are ₹32.60, ₹34.80, and ₹36.00 per Kg, respectively. There is capacity restriction of the company product 5-10-5, so that company cannot produce more than 30 Kg per month.

Required

Formulate this problem as an LP model to determine the productions (in Kg.) of each product which will maximise its monthly profit.

Note: Formulate Only

Transportation Problem

12. Coupers Partners a leading CA firm has three managers. Each manager can work up to 176 hours during the next month, during which time three assignments must be completed. Tax Accounting (TA) Assignment will take 143 hours, Tax Performance Advisory (TPA) will take 154 hours, and Global Compliance & Reporting (GCR) will take 176 hours. The amount per hour that can be billed for assigning each manager to each assignment is given below:

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Manager	Assignment		
	TA (₹)	TPA (₹)	GCR (₹)
C_1	1,800	2,250	2,850
C_2	2,100	1,950	1,800
C_3	2,400	2,100	2,250

Required

Formulate this as a transportation problem and find the optimal solution. Also find out the maximum total billings during the next month.

Note: A manager may be involved in more than one assignment.

PERT and CPM

13. State the Validity of following statements along with the reasons:

(i) Two activities have common predecessor and successor activities. So, they can have common initial and final nodes.

(ii) In respect of any activity whether real or dummy, the terminal node should bear a number higher than the initial node number.

(iii) The difference between the latest event time and the earliest event time is termed as free float.

(iv) For every critical activity in a network, the earliest start and the earliest finish time as well as the latest finish time and the latest start time are the same.

(v) The optimal duration of a project is the minimum time in which it can be completed.

(vi) Resource leveling aims at smoothening of the resource usage rate without changing the project duration.

Simulation

14. Finance Controller of Dunk Limited has drawn the following projections with probability distribution:

Raw Material		Wages & Other Variable Overheads		Sales	
₹ in 000	Probability	₹ in 000	Probability	₹ in 000	Probability
08 – 10	0.2	11 – 13	0.3	34 – 38	0.1
10 – 12	0.3	13 – 15	0.5	38 – 42	0.3
12 – 14	0.3	15 – 17	0.2	42 – 46	0.4
14 – 16	0.2			46 – 50	0.2

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Opening cash balance is ₹40,000 and fixed cost is estimated at ₹15,000 per month.

Required

Simulate cash flow projection and expected cash balance at the end of the sixth month. Use the following single digit random numbers.

Raw Material	4 3 1 0 4 6
Wages & Other Variable Overheads	2 7 9 1 8 9
Sales	0 6 6 0 2 8

Learning Curve

15. Marketing manager of X Ltd. has conducted a market research on the price-demand relationship for its consumer durable product 'K-2'. K-2 is a recently launched product. The price-demand pattern will be as follows:

Price per unit (₹)	Demand (units)
11,100	1,000
10,700	2,000
9,600	3,000
8,700	4,000

K-2 is produced in batches of 1,000 units. Production manager of X Ltd. has also researched and studied the production pattern and has believe that 50% of the variable manufacturing cost would have learning and experience curve effect. This learning & experience curve effect will be continued upto 4,000 units of production at a constant rate. But after 4,000 units of production, unit variable manufacturing cost would be equal to the unit cost at the 4th batch. The manufacturing unit cost of the first batch will be ₹4,400 of which only 50% is subjected to learning and experience curve effect. The average unit variable cost of all 4 batches will be ₹4,120.

Required

(i) Calculate the rate of learning that has been expected by the Production manager.

(ii) Calculate the price at which X Ltd. should sell the K-2 in order to maximise its contribution.

Note

log0.93 = -0.0315, log2 = 0.3010, $2^{-0.1047} = 0.9299$, $3^{-0.1047} = 0.8913$, $4^{-0.1047} = 0.8649$

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SUGGESTED ANSWERS/ HINTS

1. **Kaizen Costing** emphasizes on *small but continuous improvement*. Targets once set at the beginning of the year or activities are *updated continuously* to reflect the improvement that has already been achieved and that are yet to be achieved.

The suggestive changes which are required to be adopted Kaizen Costing concepts in FZIL are as follows:

Standard Cost Control System to Cost Reduction System: Traditionally Standard Costing system assumes stability in the current manufacturing process and standards are set keeping the normal manufacturing process into account thus the whole effort is on to meet performance cost standard. On the other hand Kaizen Costing believes in continuous improvements in manufacturing processes and hence, the goal is to achieve cost reduction target. The first change required is the standard setting methodology i.e. from earlier Cost Control System to Cost Reduction System.

Reduction in the periodicity of setting Standards and Variance Analysis: Under the existing planning and control system followed by the FZIL, standards are set semi-annually and based on these standards monthly variance reports are generated for analysis. But under Kaizen Costing system cost reduction targets are set for small periods say for a week or a month. So the period covered under a standard should be reduced from semi-annually to monthly and the current practice of generating variance reports may be continued or may be reduced to a week.

Participation of Executives or Workers in standard setting: Under the Kaizen Costing system participation of workers or executives who are actually involved in the manufacturing process are highly appreciated while setting standards. So the current system of setting budgets and standards by the Finance department with the mere consent of Board of Directors required to be changed.

2. **Value Added Activities**

(i) Average Non- Value Added Time *per batch*

= Inspection Time + Waiting Time + Move Time

= 1.5 hr. + 6.0 hrs. + 7.5 hrs.

= 15 hrs.

(ii) Average Value Added Time per batch

= Processing Time

= 9 hrs.

(iii) Manufacturing Cycle Efficiency

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$$= \frac{\text{Processing Time}}{\text{Processing Time + Inspection Time + Waiting Time + Move Time}}$$

$$= \frac{9.0 \text{ hrs.}}{9.0 \text{ hrs.} + 1.5 \text{ hr.} + 6.0 \text{ hrs.} + 7.5 \text{ hrs.}}$$

$$= 37.5\%$$

(iv) Manufacturing Cycle Time

$$= \frac{\text{Total Production Time}}{\text{Units per Batch}}$$

$$= \frac{24 \text{ hrs.}}{60 \text{ units}}$$

$$= 0.40 \text{ hrs. } \textit{per unit}$$

3. JIT Inventory System

"For successful operation of JIT inventory system, the suppliers chosen must be willing to make frequent deliveries in small lots. Rather than deliver a week's or a month's material at one time, suppliers must be willing to make deliveries several times a day and in the exact quantities specified by the buyer."

It is described in the problem that suppliers are not willing to

- make frequent deliveries and
- make supplies in the exact quantities as required

Accordingly, Mr. Smith's doubt is correct on successful implementation of JIT System.

4. Limiting Factor

Case	Basis for Selecting Priority of Product
If maximum sales (in value) is a limiting factor	Profit Volume Ratio
If raw material is a limiting factor	Contribution per unit of raw material required to produce one unit of a product
If labour hour is a limiting factor	Contribution per unit of labour hour required to produce one unit of a product
If there is a heavy demand for the product	Profit Volume Ratio

5. Computation of Cost Indifference Points *for three alternatives*

$$\text{Cost Indifference Point of } \textit{two machines} = \frac{\text{Difference in Fixed Cost}}{\text{Difference in Variable Cost per unit}}$$

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Machine A_1 & A_2 $= \dfrac{₹\,2,50,000 - ₹\,1,50,000}{(₹100 + ₹\,70 + ₹\,30) - (₹\,50 + ₹\,40 + ₹10)}$

$= \dfrac{₹1,00,000}{₹\,100}$

= 1,000 units

Machine A_2 & A_3 $= \dfrac{₹\,1,50,000 - ₹\,70,000}{(₹\,150 + ₹\,200 + ₹\,50) - (₹\,100 + ₹\,70 + ₹\,30)}$

$= \dfrac{₹\,80,000}{₹\,200}$

= 400 units

Machine A_1 & A_3 $= \dfrac{₹\,2,50,000 - ₹\,70,000}{(₹\,150 + ₹\,200 + ₹\,50) - (₹\,50 + ₹\,40 + ₹\,10)}$

$= \dfrac{₹\,1,80,000}{₹\,300}$

= 600 units

From the above computations, it is clear that at activity level below the indifference point the alternative (machine) with lower fixed cost and higher variable costs should be used. In case the activity level exceeds the indifference point, a machine with lower variable cost per unit (or higher contribution per unit) and higher fixed cost, is more profitable to operate.

At the activity level equal to the indifference point both machines are on equal footing. Hence from the above we conclude as follows:

Activity Level	**Machine Preference**
Less than 400 units	A_3
Exactly 400 units	Either A_2 or A_3
Above 400 units but *less than* 1,000 units	A_2
Exactly 1,000 units	Either A_1 or A_2
Above 1,000 units	A_1

When expected level of activity is 1,200 units i.e. more than 1,000 units, Machine A_1 should be used.

6. Working Notes

(1) Calculation of Actual Sales at Budgeted Prices

	(₹)
Actual Sales at Actual Price	11,07,000

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Less: Sales Price Variance (F)	17,000
Actual Sales at Budgeted Prices	10,90,000

$$\text{Activity Level} = \frac{\text{Actual Sales at Budgeted Prices}}{\text{Budgeted Sales at Full Capacity}} \times 100$$

$$= \frac{₹10,90,000}{₹13,50,000} \times 100$$

$$= 80.74\ldots\%$$

(2) Segregation of Fixed & Variable Cost Element from Semi-Variable Overheads

$$\text{Variable Overhead} = \frac{\text{Overhead at Full Capacity - Overhead at 75\% Capacity}}{\text{Difference in Activity Level}}$$

$$= \frac{₹3,65,000 - ₹3,23,750}{25}$$

$$= ₹1,650$$

Fixed Overhead = Total SV Overheads at 100% Level – Variable Overheads at 100% level

= ₹3,65,000 – (₹1,650 × 100)

= ₹2,00,000

Flexible Budget at 80.74..% Activity Level

	(Amount in ₹)
Sales	10,90,000
Less:	
Direct Material (₹4,25,000 × 80.74..%)	3,43,148
Direct Labour (₹1,85,000 × 80.74..%)	1,49,370
Variable Overheads (₹2,15,000 × 80.74..%)	1,73,593
Semi-Variable Overheads	
Variable Cost (₹1,650 × 80.74..) [W.N.-2]	1,33,222
Fixed Cost [W.N.-2]	2,00,000
Profit	90,667

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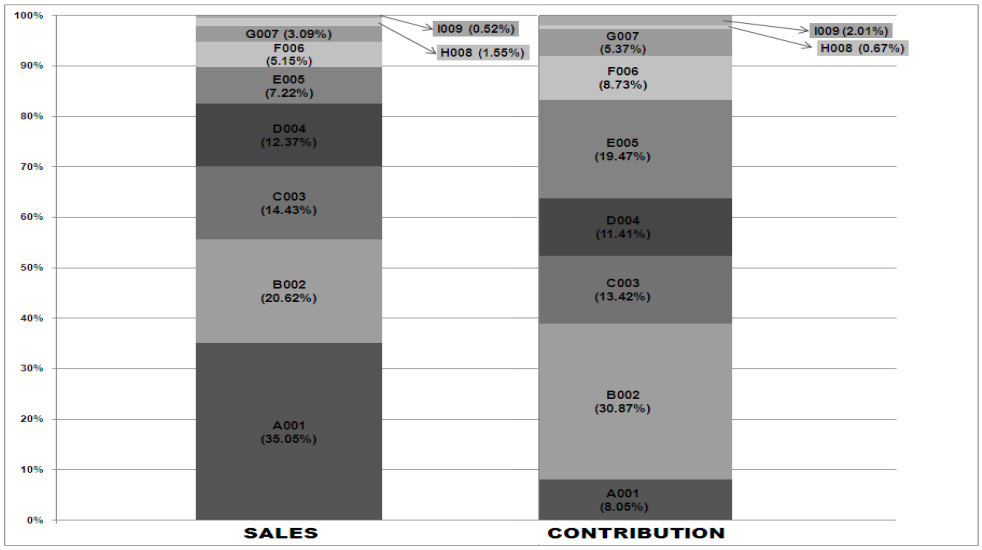
7. Statement Showing 'Pareto Analysis'

Model	Sales (₹'000)	% of Total Sales	Cumulative Total	Model	Cont. (₹'000)	% of Total Cont.	Cumulative Total %
Pareto Analysis Sales				Pareto Analysis Contribution			
A001	5,100	35.05%	35.05%	B002	690	30.87%	30.87%
B002	3,000	20.62%	55.67%	E005	435	19.47%*	50.34%
C003	2,100	14.43%	70.10%	C003	300	13.42%	63.76%
D004	1,800	12.37%	82.47%	D004	255	11.41%	75.17%
E005	1,050	7.22%	89.69%	F006	195	8.73%*	83.90%
F006	750	5.15%	94.84%	A001	180	8.05%	91.95%
G007	450	3.09%	97.93%	G007	120	5.37%	97.32%
H008	225	1.55%	99.48%	I009	45	2.01%	99.33%
I009	75	0.52%	100.00%	H008	15	0.67%	100.00%
	14,550	100.00%			2,235	100.00%	

(*) *Rounding - off difference adjusted.*

Diagram Showing 'Sales and Contribution' (NOT COMPULSORY)



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This Diagram is shown for **better understanding** of the concept.

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Recommendations

Pareto Analysis is a rule that recommends focus on most important aspects of the decision making in order to simplify the process of decision making. The very purpose of this analysis is to direct attention and efforts of management to the product or area where best returns can be achieved by taking appropriate actions.

Pareto Analysis is based on the 80/20 rule which implies that 20% of the products account for 80% of the revenue. But this is not the fixed percentage rule; in general business sense it means that a few of the products, goods or customers may make up most of the value for the firm.

In present case, five models namely A001, B002, C003, D004 account for 80% of total sales where as 80% of the company's contribution is derived from models B002, E005, C003, D004 and F006.

Models B002 and E005 together account for 50.34% of total contribution but having only 27.84% share in total sales. So, these two models are the key models and should be the top priority of management. Boths C003 and D004 are among the models giving 80% of total contribution as well as 80% of total sales so; they can also be clubbed with B002 and E005 as key models. Management of the company should allocate maximum resources to these four models.

Model F006 features among the models giving 80%of total contribution with relatively lower share in total sales. Management should focus on its promotional activities.

Model A001 accounts for 35.05% of total sales with only 8.05% share in total contribution. Company should review its pricing structure to enhance its contribution.

Models G007, H008 and I009 have lower share in both total sales as well as contribution. Company can delegate the pricing decision of these models to the lower levels of management, thus freeing themselves to focus on the pricing decisions for key models.

8. Statement of Reconciliation - Budgeted Vs Actual Profit

Particulars	₹
Budgeted Profit	5,19,000
Less: Sales Volume Contribution Planning Variance (Adverse)	52,125
Less: Sales Volume Contribution Operational Variance (Adverse)	93,825
Less: Sales Price Variance (Adverse)	39,600
Less: Variable Cost Variance (Adverse)	29,700
Less: Fixed Cost Variance (Adverse)	15,000
Actual Profit	2,88,750

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Workings

Basic Workings

Budgeted Market Share (in %) = $\frac{2,00,000 \text{units}}{4,00,000 \text{units}}$

= 50%

Actual Market Share (in %) = $\frac{1,65,000 \text{units}}{3,75,000 \text{units}}$

= 44%

Budgeted Contribution = ₹21,00,000 – ₹12,66,000

= ₹8,34,000

Average Budgeted Contribution (*per unit)* = $\frac{₹8,34,000}{₹2,00,000}$

= ₹4.17

Budgeted Sales Price *per unit* = $\frac{₹21,00,000}{₹2,00,000}$

= ₹10.50

Actual Sales Price *per unit* = $\frac{₹16,92,900}{₹1,65,000}$

= ₹10.26

Standard Variable Cost *per unit* = $\frac{₹12,66,000}{₹2,00,000}$

= ₹6.33

Actual Variable Cost *per unit* = $\frac{₹10,74,150}{₹1,65,000}$

= ₹6.51

Calculation of Variances

Sales Variances:.....

Volume Contribution Planning* = Budgeted Market Share % × (Actual Industry Sales Quantity *in units* – Budgeted Industry Sales Quantity

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		in units) × (Average Budgeted Contribution *per unit*)
	=	50% × (3,75,000 units – 4,00,000 units) × ₹4.17
	=	52,125 (A)

(*) *Market Size Variance*

Volume Contribution Operational**	=	(Actual Market Share % – Budgeted Market Share %) × (Actual Industry Sales Quantity *in units*) × (Average Budgeted Contribution *per unit*)
	=	(44% – 50 %) × 3,75,000 units × ₹4.17
	=	93,825 (A)

(**) *Market Share Variance*

Price	=	Actual Sales – Standard Sales
	=	Actual Sales Quantity × (Actual Price – Budgeted Price)
	=	1,65,000 units × (₹10.26 – ₹10.50) = 39,600 (A)

Variable Cost Variances:.....

Cost	=	Standard Cost for Production – Actual Cost
	=	Actual Production × (Standard Cost *per unit* – Actual Cost *per unit*)
	=	1,65,000 units × (₹6.33 – ₹6.51)
	=	₹29,700(A)

Fixed Cost Variances:.....

Expenditure	=	Budgeted Fixed Cost – Actual Fixed Cost
	=	₹3,15,000 – ₹3,30,000
	=	₹15,000 (A)

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Fixed Overhead Volume Variance does not arise in a Marginal Costing system

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9. Determination of Minimum Value of Special Order

Cost Element	Relevant / Irrelevant	Calculation	Amt. (₹)
Material – M	Realisable value is relevant.	5,000 Kg. × ₹15	75,000
Material – N	Relevant as it has to be purchased.	8,000 Kg. × ₹25	2,00,000
Other hardware items	Relevant as it is to be incurred.	----	10,000
Dept P – Labour oriented	Relevant as fresh labours are to be hired.	5 men × 1 month × ₹7,000	35,000
Dept Q – Machine oriented	Irrelevant, as spare capacity is available.	----	----
Pattern and Specification	Relevant, Net cost after considering its resale value.	₹ 15,000 − ₹ 2,000	13,000
Minimum Value of Special Order			**3,33,000**

10. (i) Transfer Price *per unit* of Product N that Division W Should Quote *in order to meet* Target Profit

Quotation for the 40,000 units of product N should be such that meet Division W's target profit and interest cost on working capital. Therefore, the minimum quote for product N will be calculated as follows:

Particulars	Amount (₹)
Target Profit (given for the year)	2,50,00,000
Add: Interest Cost on Working Capital (₹12,00,00,000 @11.5%)	1,38,00,000
Required Profit	3,88,00,000
Add: Fixed Overhead	4,00,00,000
Target Contribution	7,88,00,000
Less: Contribution Earned --- External Sales {60,000 units × (₹2,500 – ₹1,600)}	5,40,00,000
Contribution Required – Internal Sales	2,48,00,000
Contribution *per unit* of Product N (₹2,48,00,000 ÷ 40,000 units)	620
Transfer Price of Product N to Division B (Variable Cost *per unit* + Contribution *per unit*)	2,220

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(ii) The Two Transfer Prices Based on Opportunity Costs

For the 30,000 units (i.e. maximum capacity – maximum external market demand) at variable cost of production i.e. ₹1,600 per unit.

For the next 10,000 units (i.e. external market demand – maximum possible sale) at market selling price i.e. ₹2,500 per unit.

11. Let the P_1, P_2 and P_3 be the three products to be manufactured. Then the data are as follows:

Products	Product ingredients			
	X	Y	Z	Inert Ingredients
P_1	5 %	10%	5%	80%
P_2	5%	5%	10%	80%
P_3	20%	5%	10%	65%
Cost per kg (₹)	64	16	40	16

Cost of Product P_1

= 5% × ₹64 + 10% × ₹16 + 5% × ₹40 + 80% × ₹16

= ₹19.60 per kg

Cost of Product P2

= 5% × ₹64 + 5% × ₹16 + 10% × ₹40 + 80% × ₹16

= ₹20.80 per kg.

Cost of Product P3

= 20% × ₹64 + 5% × ₹16 + 10% × ₹40 + 65% × ₹16

= ₹28.00 per kg.

Let k_1, k_2, and k_3 be the quantity (in kg) of P_1, P_2, and P3 respectively to be manufactured. The LP problem can be formulated:

Objective function:

Maximise Z = (Selling Price - Cost Price) × Quantity of Product

= (₹32.60 − ₹19.60) k_1 + (₹34.80 − ₹20.80) k_2 + (₹36.00 − ₹28) k_3

= $13k_1 + 14k_2 + 8k_3$

Subject to Constraints:

$1/20k_1 + 1/20k_2 + 1/5k_3 \leq 100$

Or $k_1 + k_2 + 4k_3 \leq 2{,}000$

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$1/10k_1 + 1/20k_2 + 1/20k_3 \leq 180$

Or $2k_1 + k_2 + k_3 \leq 3,600$

$1/20k_1 + 1/10k_2 + 1/10k_3 \leq 120$

Or $k_1 + 2k_2 + 2k_3 \leq 2,400$

$k_1 \leq 30$

and $k_1, k_2, k_3 \geq 0$

12. The given information can be tabulated in following transportation problem-

Manager	Assignment			Time Available (Hours)
	TA (₹)	TPA (₹)	GCR (₹)	
C_1	1,800	2,250	2,850	176
C_2	2,100	1,950	1,800	176
C_3	2,400	2,100	2,250	176
Time Required (Hours)	143	154	176	

The given problem is an unbalanced transportation problem. Introducing a dummy assignment to balance it, we get-

Manager	Assignment				Time Available (Hours)
	TA (₹)	TPA (₹)	GCR (₹)	Dummy (₹)	
C_1	1,800	2,250	2,850	0	176
C_2	2,100	1,950	1,800	0	176
C_3	2,400	2,100	2,250	0	176
Time Required (Hours)	143	154	176	55	528

The objective here is to maximize total billing amount of the auditors. For achieving this objective, let us convert this maximization problem into a minimization problem by subtracting all the elements of the above payoff matrix from the highest payoff i.e. ₹2,850.

Manager	Assignment				Time Available (Hours)
	TA (₹)	TPA (₹)	GCR (₹)	Dummy (₹)	
C_1	1,050	600	0	2,850	176
C_2	750	900	1,050	2,850	176

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C_3	450	750	600	2,850	176
Time Required (Hours)	143	154	176	55	528

Now, let us apply VAM method to the above matrix for finding the initial feasible solution.

Manager	**Assignment**				Time Avail. (Hours)	Difference
	TA (₹)	**TPA (₹)**	**GCR (₹)**	**Dummy (₹)**		
C_1	1,050	600	0 [176]	2,850	176/0	600 - -
C_2	750	900 [121]	1,050	2,850 [55]	176/55/0	150, 150 1,950
C_3	450 [143]	750 [33]	600	2,850	176/33/0	150, 300, 2,100
Time Required	143/0	154/121/0	176/0	55/0	528	
Difference	300 300 -	150 150 150	600 -- -	0 0 0		

The initial solution is given below. It can be seen that it is a degenerate solution since the number of allocation is 5. In order to apply optimality test, the total number of allocations should be 6 (m + n -1). To make the initial solution a non-degenerate, we introduce a very small quantity in the least cost independent cell which is cell of C_3, GCR.

Manager	**Assignment**			
	TA (₹)	**TPA (₹)**	**GCR (₹)**	**Dummy (₹)**
C_1	1,050	600	0 [176]	2,850
C_2	750	900 [121]	1,050	2,850 [55]
C_3	450 [143]	750 [33]	600 [e]	2,850

Let us test the above solution for optimality-

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($u_i + v_j$) Matrix for Allocated / Unallocated Cells

				u_i
-150	150	0	2,100	-600
600	900	750	2,850	150
450	750	600	2,700	0
450	750	600	2,700	
v_j				

Now we calculate $\Delta_{ij} = C_{ij} - (u_i + v_j)$ for non basic cells which are given in the table below-

Δ_{ij} Matrix

1,200	450		750
150		300	
			150

Since, all allocations in $\Delta_{ij} = C_{ij} - (u_i + v_j)$ are non negative, the allocation is optimal. The allocation of assignments to managers and their billing amount is given below:

Manager	Assignment	Billing Amount
C_1	Global Compliance & Reporting (GCR)	₹5,01,600 (176 hrs. × ₹2,850)
C_2	Tax Performance Advisory (TPA)	₹2,35,950 (121 hrs. × ₹1,950)
C_3	Tax Accounting (TA)	₹3,43,200 (143 hrs. × ₹2,400)
C_3	Tax Performance Advisory (TPA)	₹69,300 (33 hrs. × ₹2,100)
	Total Billing	₹11,50,050

13. (i) Invalid

Reason: As per the rules of network construction, parallel activities between two events, without intervening events, are prohibited. Dummy activities are needed when two or more activities have same initial and terminal events. Dummy activities do not consume time or resources.

(ii) Valid

Reason: As per the conventions adopted in drawing networks, the head event or terminal node always has a number higher than that of initial node or tail event.

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(iii) Invalid

Reason: The difference between the latest event time and the earliest event time is termed as slack of an event. Free float is determined by subtracting head event slack from the total float of an activity.

(iv) Invalid

Reason: For every critical activity in a network, the earliest start time and the latest start time is same and also the earliest finish time and the latest finish time is same.

(v) Invalid

Reason: The optimum duration is the time period in which the total cost of the project is minimum.

(vi) Valid

Reason: Resource leveling is a network technique used for reducing the requirement of a particular resource due to its paucity or insufficiency within a constraint on the project duration. The process of resource leveling utilize the large floats available on non-critical activities of the project and cuts down the demand of the resource.

14. Allocation of Random Numbers

Raw Material			Wages & Other Variable Overheads			Sales		
Mid Point	Cum. Prob.	Random Nos.	Mid Point	Cum. Prob.	Random Nos.	Mid Point	Cum. Prob.	Random Nos.
9	0.2	0 – 1	12	0.3	0 – 2	36	0.1	0
11	0.5	2 – 4	14	0.8	3 – 7	40	0.4	1 – 3
13	0.8	5 – 7	16	1.0	8 – 9	44	0.8	4 – 7
15	1.0	8 – 9				48	1.0	8 – 9

Simulation Table

(₹ in 000)

Month	Raw Material	Wages & Other V.O	Sales	Fixed Cost	Net Cash Flow	Cash Balancing (Opening ₹40 thousand)
1	11	12	36	15	-2	38
2	11	14	44	15	+ 4	42
3	9	16	44	15	+4	46
4	9	12	36	15	0	46
5	11	16	40	15	-2	44
6	13	16	48	15	+4	48

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15. (i) Variable cost per unit that will be effected by learning and experience curve is ₹2,200 (₹4,400 – 50% of ₹ 4,400).

Let, 'r' be the learning curve rate.

No. of Batch (x)	Cumulative Average Cost *per unit* (y)
1	2,200
2	2,200 r
4	2,200 r^2

If 2,200 r^2 = ₹1,920 (₹4,120 – 50% of ₹ 4,400)

r^2 = 0.8727

r = 0.934

Therefore, Learning Curve Effect = 93% (rounded off)

(ii) Calculation of Optimum Price

Price *per unit* (₹)	Demand (units)	Variable Cost *per unit* * [W.N.] (₹)	Variable Cost *per unit* ** (₹)	Total Variable Cost *per unit* (₹)	Contribution *per unit* (₹)	Total Contribution (₹)
11,100.00	1,000	2,200.00	2,200.00	4,400.00	6,700.00	67,00,000
10,700.00	2,000	2,046.00	2,200.00	4,246.00	6,454.00	1,29,08,000
9,600.00	3,000	1960.86	2,200.00	4,160.86	5,439.14	1,63,17,420
8,700.00	4,000	1,902.78	2,200.00	4,102.78	4,597.22	1,83,88,880

(*) This represents variable cost part which is affected by the learning and experience curve effect.

(**) This represents variable cost part which is not affected by the learning and experience curve effect.

Working Note [W.N.]

Variable Cost *per unit*

Output in Batches (x)	Average Cost of the First Unit (a)	$x^{-0.1047}$	Cumulative Average Cost *per unit* (y)
1	2,200	1.0000	2,200.00
2	2,200	0.9299	2,046.00
3	2,200	0.8913	1,960.86
4	2,200	0.8649	1,902.78

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$y = ax^b$

Where,

y = Cumulative average unit costs

a = Average cost of the first unit

x = Cumulative number of batches

b = Log of learning ratio ÷ Log of 2

= log 0.93 ÷ log 2

= −0.0315 ÷ 0.3010

= −0.1047

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