FINAL EXAMINATION — SET 1

MODEL ANSWER — TERM – JUNE 2023

PAPER - 16

STRATEGIC COST MANAGEMENT

Time Allowed: 3 Hours **Full Marks: 100**

The figures in the margin on the right side indicate full marks.

Where considered necessary, suitable assumptions may be made and clearly indicated in the answer.

SECTION – A : STRATEGIC COST MANAGEMENT FOR DECISION MAKING

Answer to Question No. 1 & 6 in Section A, are compulsory.

Further, answer **any 3** from Question nos. 2, 3, 4 & 5**.**

1. (a)

Sl. No.	Answer	Justification
(i)	c	Cost to ensure that failure does not happen is for ensuring that in future failure is prevented.
(ii)	c	Service organizations produce a product that is intangible. Usually, the complete product cannot be seen or touched. Rather, it is experienced. Examples include delivery of health care, experience of staying at a vacation resort, and learning at a university. Thus durability cannot be a parameter of quality of Service organization.
(iii)	d	(i) Today, there is no single universal definition of quality. Some people view quality as "performance to standards." Others view it as "meeting the customer's needs" or "satisfying the customer." Some of the more common definitions of quality are; a. Conformance to Specifications: b. Fitness for Use c. Value for Price Paid d. Support Services e. Psychological Criteria Thus Physiological Criteria is certainly not one of the standard definitions of Quality.
(iv)	d	The first category of quality cost consists of costs necessary for achieving high quality, which are also called quality control costs. These are either prevention cost or appraisal cost. While prevention costs are all costs incurred in the process of preventing poor quality from occurring appraisal costs are incurred in the process of uncovering defects. They include the cost of quality inspections,

		product testing, and performing audits to make sure that quality standards are being met. Thus it is quite evident that WIP testing and inspecting is appraisal cost and not prevention cost.
(v)	d	(i) Three principles guide Lean Accounting and form the foundation for all of accounting's work and interaction with the organization: a. Customer value: Delivering the relevant and reliable information in a timely manner to all users of the information inside the organization. b. Continuous improvement: Improving accounting processes, cross-functional business processes and the information used inside the business for analysis and decision making. c. Respect for people: Adopting a learning attitude by seeking to understand root causes of business problems and issues in a cross-functional, collaborative manner. Thus the best way of defining the principles of Lean Accounting are all of the above.
(vi)	a	(i) The relevant cost in this example is the lower of the relevant cost for each option Recruitment Four employees @ ₹ 40,000 each = £160,000 (Super vision is sunk as it is already incurred) Retrain and replace Training ₹ 15,000 Replacement ₹1,00,000 ₹ 1,15,000 So answer is ₹ 1,15,000
(vii)	b	B (incremental approach) Option 1 Sell for scrap ₹ 12,500 Option 2 Extra cost 7,500 Extra revenue 5,000 Loss 2,500

(viii)	c	Target ROI at 15% of total investment of ₹ 15 lakhs = ₹ 15,00,000 × 0.15 = ₹ 2,25,000 Expected output = 500 units Target Profit per unit of output = ₹ 2,25,000 ÷500 = ₹ 450 per unit Target cost per unit = Selling Price – Profit per unit = ₹ 1,500 – ₹ 450 = ₹ 1,050 per unit

2. (a) (i) Developed by Michael Porter in 1985 and used throughout the world, the value chain is a powerful tool for disaggregating a company into its strategically relevant activities in order to focus on the sources of competitive advantage, that is, the specific activities that result in lower costs or higher prices. A company's value chain is typically part of a larger value system that includes companies either upstream (suppliers) or downstream (distribution channels), or both. This perspective about how value is created forces managers to consider and see each activity not just as a cost, but as a step that has to add some increment of value to the finished product or service. Manufacturing companies create value by acquiring raw materials and using them to produce something useful. Retailers bring together a range of products and present them in a way that is convenient to customers, sometimes supported by services such as trial rooms or personal shopper advice and insurance companies offer policies to customers that are underwritten by larger re-insurance policies. Here, they are packaging these larger policies in a customer-friendly way, and distributing them to a mass audience. In other words, the value that is created and captured by a company as reduced by the costs incurred is the profit margin. Expressed as a formula the equation would read as:

Value Created and Captured – Cost of Creating that Value = Profit Margin

The more value an organisation creates, the more profitable it is likely to be. As more and more value is provided to the customers, competitive advantage creeps in. Understanding how a company creates value, and looking for ways to add more value, are critical elements in developing a competitive strategy. Thus, the value chain is a set of activities that an organisation carries out to create value for its customers. Porter proposed a general-purpose value chain that companies can use to examine all of their activities, and see how they are connected. The way in which value chain activities are performed determines costs and affects profits.

Elements in Porter's Value Chain

Rather than looking at departments or accounting cost types, Porter's Value Chain focuses on systems, and how inputs are changed into the outputs purchased by consumers. Using this viewpoint, Porter described a chain of activities common to all businesses, and he divided them into primary and support activities, as shown below.

Primary Activities: Primary activities relate directly to the physical creation, sale, maintenance and support of a product or service. They consist of the following:

- Inbound Logistics: These are all the processes related to receiving, storing, and distributing the inputs internally. The supplier relationships are a key factor in creating value here.
- Operations: These are the transformation activities that change inputs into outputs that are sold to customers. Here, operational systems create value.
- Outbound Logistics: These activities deliver the product or service to the customer. These are the things like collection, storage, and distributing the outputs. They may be internal or external to the organisation.
- Marketing and Sales: These are the processes that are used to persuade clients to purchase from the firm instead of its competitors. The benefits being offered, and how well they are communicated to the customers, are sources of value here.
- Service: These are the activities related to maintaining the value of the product or service to customers, once it has been purchased.

Support Activities:

Support activities support the primary functions stated above. Each support, or secondary, activity can play a role in each primary activity. For example, procurement supports operations with certain activities, but it also supports marketing and sales with other activities.

- Procurement (Purchasing): This is what the organisation does to get the resources it needs to operate. This includes finding vendors and negotiating best prices.
- Human Resource Management: This is how well a company recruits, hires, trains, motivates, rewards, and retains its workers. People are a significant source of value, so businesses can create a clear advantage with good HR practices.
- Technological Development: These activities relate to managing and processing information, as well as protecting a company's knowledge base. Minimizing information technology costs, staying current with

technological advances, and maintaining technical excellence are sources of value creation.

- Infrastructure: These are a company's support systems, and the functions that allow it to maintain daily operations. Accounting, legal, administrative, and general management are examples of necessary infrastructure that businesses can use to their advantage

(ii) Value chain analysis (VCA) is a process where a firm identifies its primary and support activities that add value to its final product and then analyse these activities to reduce costs or increase differentiation. Value chain analysis relies on the basic economic principle of advantage - companies are best served by operating in sectors where they have a relative productive advantage compared to their competitors. Simultaneously, companies should ask themselves where they can deliver the best value to their customers. Conducting a value chain analysis prompts a firm to consider how each step adds or subtracts value from its final product or service. This, in turn, can help it realize some form of competitive advantage, such as:

- Cost reduction, by making each activity in the value chain more efficient and, therefore, less expensive
- Product differentiation, by investing more time and resources into activities like research and development, design, or marketing that can help the product stand out

Typically, increasing the performance of one of the four secondary activities can benefit at least one of the primary activities.

There are as such five steps in developing the value chain analysis

Step 1: Identify all value chain activities

Step 2: Calculate the cost of each activity

Step 3: Look at what your customers perceive as value

Step 4: Look at your competitors' value chains

Step 5: Decide on a competitive advantage

(b) (i) In order to identify how and to what extent TQM differs from the traditional model of quality management, the philosophy behind the TQM is to be identified, which are;

a) Failure and poor quality are unacceptable. It is inappropriate to think of an optimal level of quality at which some failures will occur, and the inevitability of errors is not something that an organisation should accept. The target should be zero defects.

b) Quality costs are difficult to measure, and failure costs in particular are often seriously underestimated. The real costs of failure include not just the cost of scrapped items and reworking faulty items, but also the management time spent sorting out problems and the loss of confidence between different parts of the organisation whenever faults occur.

c) A TQM approach does not accept that the prevention costs of achieving zero defects becomes unacceptably high as the quality standard improves and goes above a certain level. In other words, diminishing returns do not necessarily set in. If everyone in the organisation is involved in improving quality, the cost of continuous improvement need not be high.

d) If an organisation accepts an optimal quality level that it believes will minimize total quality costs, there will be no further challenge to management to improve quality further.

(ii) According to Colin Drury Continuous Improvement (CI) is an 'ongoing process that involves a continuous search to reduce costs, eliminate waste, and improve the quality and performance of activities that increase customer value or satisfaction'.

The implementation of continuous improvement does not necessarily call for significant investment, but it does require a great deal of commitment and continuous effort. Continuous improvement is often associated with incremental changes in the day-to-day process of work suggested by employees themselves. This is not to say that continuous improvement organisations do not engage in radical change. Quantum leaps in performance can occur when cumulative improvements synergize, the sum of a number of small improvements causing a profound net effect greater than the sum of all the small improvements. The process must be ongoing, and sustained success is more likely in organisations that regularly review their business methods and processes in the drive for improvement.

Cornerstones of continuous improvement (CI)

- Quality – the creation of key performance indicators (KPIs) with a focus on meeting customer needs was an important step in improving these processes. Previous measures had focused on output.
- Process improvements – a process of benchmarking its KPIs means that Tata is always reviewing its activities, and by sharing relevant information within Tata, it maintains the drive necessary to keep the system working.

- Teamwork – CI requires everyone to work differently. Every employee needs to feel that they can and should spot areas of weakness and make suggestions about how to make improvements. To help employees make this shift in attitude, a phased approach was used whereby initially CI coaches were responsible for CI, then CI champions, managers, team leaders and finally the team.

3. (a) (i) **Make or Buy**

Total Cost per tube of EMO:

		Per Tube
Direct Material	= (108 ÷ 24)	= ₹ 4.50
Direct Wages	= (72 ÷ 24)	= ₹ 3.00

Variable Overheads = {(54 ÷ 24) – (4,50,000 ÷ 3,00,000) = ₹ 0.75

Particulars	Total Cost (₹)	Tube Cost (₹)	Product Cost (₹)
Material	4.50	20% of total cost = 0.90	3.60
Wages	3.00	10% of total cost = 0.30	2.70
Variable Overhead	0.75	10% of total cost = 0.075	0.675
Total	8.25	1.275	6.975

Cost of Making = (3,00,000 × 1.275) = ₹ 3,82,500

Cost of Buying = (3,00,000 × 1.35) = ₹ 4,05,000

Therefore, it is better to make the tubes at 3,00,000 level of output, as it is cheaper than Buying.

Computation of Cost for additional tubes at the level of 3,50,000 and 4,50,000:

Particulars	3,50,000	4,50,000
Additional tubes needed over 3,00,000	50,000	1,50,000
Cost of Making (₹)	93,750 [(50,000×1.275)+30,000]	2,21,750 [(1,50,000×1.275)+ 30,000]
Cost of Buying (₹)	67,500 (50,000 × 1.35)	2,02,500 (1,50,000 × 1.35)

From the above, it is better to Buy the empty tubes at the level of 3,50,000 and 4,50,000, as it is deeper than making at both levels.

(ii) **The level at which it is beneficial to make the tubes over and above 300000 units**

Additional Fixed Overheads = ₹ 30,000

Excess of buying cost over variable cost = (1.35 - 1.275) = ₹ 0.075

Indifference Point = (Additional Fixed Overheads ÷ Excess Buying Cost)

= 30,000 ÷ 0.075

= 4,00,000 units

Therefore, the Company will be justified to install the additional Equipment for the manufacture of Empty tubes at a sales volume of 400000 units.

(iii) Evaluation of Profitability at the three levels of output

Sl. No.	Particulars	3,00,000	3,50,000	4,00,000
(i)	Sales @ ₹ 10 p.u.	30,00,000	35,00,000	45,00,000
(ii)	Product Cost @ ₹ 6.975 p.u.	20,92,500 (3,00,000×6.975)	24,41,250 (3,50,000×6.975)	31,38,750 (4,50,000×6.975)
(iii)	Tube Cost (₹) [As per (i)]	3,82,500 (3,00,000×1.275)	4,72,500 (3,50,000 × 1.35)	6,07,500 (4,50,000×1.35)
(iv)	Fixed cost (₹)	4,50,000	4,50,000	4,50,000
(v)	Total Cost (₹)	29,25,000	33,63,750	41,96,250
(vi)	Profit (I–V) (₹)	75,000	1,36,250	3,03,750

(b) Contribution per labour hour of X = ₹ 25 ÷ 5 = ₹ 5 (2^{nd})

Contribution per labour hour of Y = ₹ 40 ÷ 6 = ₹ 6.67 (1^{st})

Contribution per labour hour of Z = ₹ 32 ÷ 8 = ₹ 4 (3^{rd})

Quantities produced

	Hours	
100 units of Y	600	
50 units of X	250	
18.75 unit of Z	150	(balance)
	1,000	

Since it would not be practical to produce 0.75 of a unit, we would produce 18 units of product Z with 6 spare hours.

4. **(a)** (i) The opportunity costs of producing cassettes are the salary forgone of ₹ 1,000 per month and the rental forgone of ₹ 400 per month.

(ii) The consultant’s fees and development costs represent sunk costs.

(b) The following information can be obtained from the report.

	₹ Selling price	₹ 9 selling price
Sales quantity	7500 – 10000 units	12000 – 18000 units
Fixed costs[a]	₹ 13,525	₹ 17,525
Profit at maximum sales[b]	₹ 3,975	₹ 4,975
Profit/(Loss) at minimum sales[c]	(₹ 400)	(₹ 2,525)
Break-even point[d]	7729 units	14020 units
Margin of safety:		
Below maximum	2271 units	3,980 units
Above minimum	229 units	2020 units

Notes:

[a] Fixed production cost + ₹ 1,400 opportunity cost

[b] (10000 units × ₹ 1.75 contribution) – ₹ 13,525 fixed costs = ₹ 3,975 profit
(18000 units × ₹ 1.25 contribution) – ₹ 17,525 fixed costs = ₹ 4,975 profit

[c] (7500 units × ₹ 1.75 contribution) – ₹ 13,525 fixed costs = ₹ 400 loss
(12000 units × ₹ 1.25 contribution) – ₹ 17,525 fixed costs = ₹ 2,525 loss

[d] Fixed costs / contribution per unit

Conclusions

(i) The ₹ 10 selling price is less risky than the ₹ 9 selling price. With the ₹ 10 selling price, the maximum loss is lower and the break-even point is only 3% above minimum sales (compared with 17% for a ₹ 9 selling price).

(ii) The ₹ 9 selling price will yield the higher profits if maximum sales quantity is achieved.

(iii) In order to earn ₹ 3975 profits at a ₹ 9 selling price, we must sell 17,200 units (required contribution of 17,525 fixed costs plus ₹ 3,975 divided by a contribution per unit of ₹ 1.25).

Additional information required: These are the assumptions

(i) Details of capital employed for each selling price.

(ii) Details of additional finance required to finance the working capital and the relevant interest cost so as to determine the cost of financing the working capital.

(iii) Estimated probability of units sold at different selling prices.

(iv) How long will the project remain viable?

(v) Details of range of possible costs. Are the cost figures given in the question certain?

(b)

Compounded present value of 3 years @ 10%		2.486
P.V. of Annual running cost of Machine A for 3 years	₹40,000×2.486	₹ 99,440
Compounded present value of 2 years @ 10%		1.735
P.V. of annual running cost of Machine B for 2 years	₹60,000×1.735	₹ 1,04,100

Statement Showing Evaluation of machine A and B

Particulars	Machine A	Machine B
Cost of purchase	1,50,000	1,00,000
Add: P.V. of running cost	99,440	1,04,100
P.V. of Cash outflow	2,49,440	2,04,100
Equivalent present value of annual cash outflow/EAC	2,49,440÷2,486=1,00,338	2,04,100÷1,735=1,17,637

Suggestion: Since the annual cash outflow of Machine B is higher, purchase of Machine A is recommended.

5. (a) a. **(i) Sales margin variance (Marginal costing):**

(Actual Volume – Budgeted Volume) × Standard Contribution Margin

= (9500 – 10000) × Standard Contribution Margin (SCM) = ₹7,500 (A)

500 SCM = 1500

Therefore, SCM (Standard Contribution Margin) = ₹ 15

(ii) Sales margin volume variance (Absorption Costing)

(Actual Volume – Budgeted Volume) × Standard profit margin per unit

= (9500 – 10000) × Standard Profit Margin (SPM) = ₹ 4,500 (A)

500 SPM = ₹4,500 (A)

SPM (Standard Profit Margin) = ₹ 9

(iii) Fixed Overhead Volume Variance

(Actual Production – Budgeted Production) × Standard Rate

= (9700 – 10000) × Standard Rate = ₹ 1,800 (A)

Standard Fixed Overhead rate per unit = ₹ 6

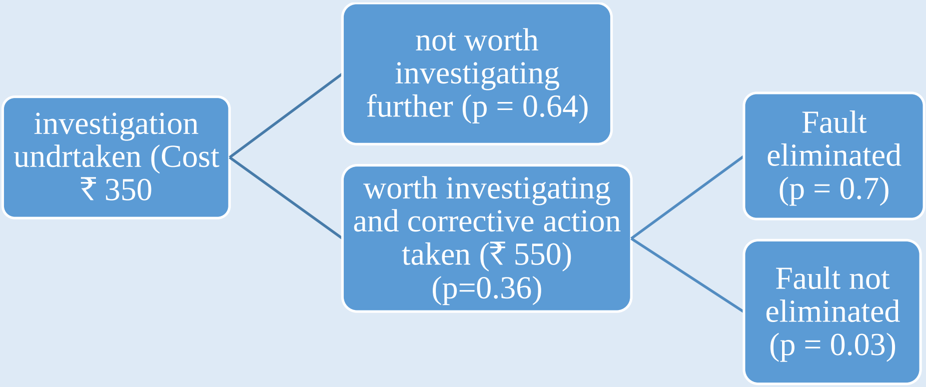
Budgeted Fixed Overheads = 10000 units × ₹ 6 = ₹ 60,000

Fixed Overhead expenditure variance = ₹ 2,500 (F)

Actual Fixed Overheads (₹ 60,000 – ₹ 2,500) = ₹ 57,500.

b. Absorption costing unitises fixed overheads and treats them as product costs whereas marginal costing does not charge fixed overheads to products. Instead, the total amount of fixed overheads is charged as an expense (period cost) for the period. A fixed overhead volume variance only occurs with an absorption costing system. Because marginal costing does not unitise fixed costs product margins are expressed as contribution margins whereas absorption costing expresses margins as profit margins.

(b) Decision Tree if an investigation is carried out

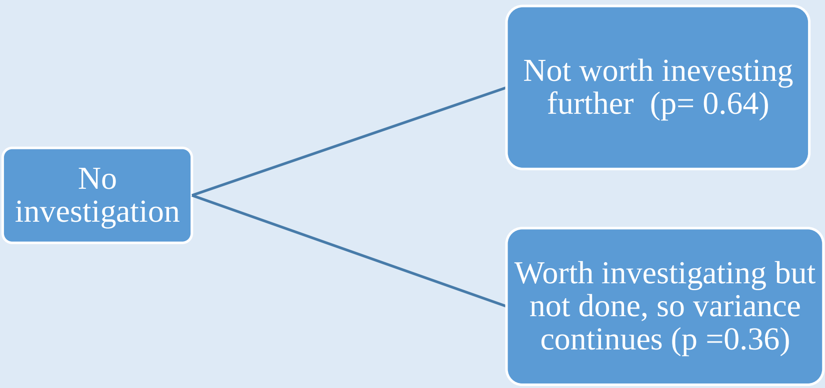


It is assumed that the ₹ 550 correction cost applies to all variances that the initial investigation indicates are worthy of further investigation. The expected cost if the investigation is carried out is

₹350 + ₹550 (corrective action) + 0.36 × 0.3 × ₹246 (conituning variance) = ₹815

[note: ₹ 246 represents the PV of ₹ 525 for 5 month at 2% (₹ 525 × 4.7135) for cariancs that are not eliminated]

Decision Tree if an investigation is not carried out



The expected cost if no investigation is undertaken is

0.36 × ₹ 525 × 4.7135 = ₹ 891.

6. (1) If Division B buys all of its components from division S (80000) then division S will sell its remaining capacity (95000) on the external market. This will result in unfulfilled demand of 55000 components (total demand of 150000 295000) in the external market. In terms of the transfer price 55000 of the components transferred will have an opportunity cost equal to the lost sales revenue of ₹ 50. This could be restated as variable cost (₹ 44) + lost contribution (₹ 6) giving a transfer price of ₹ 50. The remaining 25 000 units transferred to division B do not have an opportunity cost so the relevant cost is the marginal cost of ₹ 44. The profit statements will be as follows:

	S (₹)	B (₹)	Working
Sales			
Internal	38,50,000		1
External	47,50,000	72,00,000	2
	86,00,000	72,00,000	
Variable costs			
Components			
Internal	0		3
External	77,00,000		4
Other Variable	0	18,88,000	5
Fixed Costs	5,60,000	14,60,000	
Profit	3,40,000	2,000	

Workings:

[1] (55,000 × ₹ 50) + (25,000 × ₹ 44) = ₹ 38,50,000

[2] 95,000 × ₹ 50) + ₹ 47,50,000 Division S, 16,000 × ₹ 450 = ₹ 72,00,000

[3] Same as division S internal sales revenue

[4] 1,75,000 × ₹ 44 = ₹ 77,00,000

[5] 16,000 × ₹ 118 = ₹ 18,88,000

(2)

	S (₹)	B (₹)	SBA (₹)	Working
Sales				
Internal	0	0	0	
External	75,00,000	72,00,000	1,47,00,000	1
	75,00,000	72,00,000	1,47,00,000	
Variable costs				
Components				
Internal	0	0	0	

External	66,00,000	33,60,000	99,60,000	2
Other Variable	0	18,88,000	18,88,000	3
Fixed Costs	5,60,000	14,60,000	20,20,000	
Profit	3,40,000	4,92,000	8,32,000	

Workings:

[1] Division S = 1,50,000 maximum external demand × ₹ 50; division B = 16,000 × ₹ 450 = ₹ 72,00,000

[2] Division S = 1,50,000 × ₹ 44 variable cost = ₹ 66,00,000, division B = 80,000 × ₹ 42 = ₹ 33,60,000

[3] 16,000 × ₹ 118 = ₹ 18,88,000.

(3) The motivation for outsourcing is that the external supplier may be able provides the component at a lower cost than SBA is currently incurring internally. Specialist component manufacturers may be more efficient arising from utilizing the latest manufacturing technology. The major disadvantage of outsourcing is that there is a potential loss of control and a danger that SBA will be at the mercy of the supplier when negotiating a new contract. This danger will be minimized if there are many other suppliers that can provide the component at a competitive price. A close relationship will be required between the two organizations requiring knowledge of lead times and the demand cycle at SBA. Outsourcing the manufacture of components may also result in spare capacity at SBA. Can this be utilized or can cost savings be achieved from reducing capacity?

	S (₹)	B (₹)	SBA (₹)	Working
Sales				
Internal	0	0	0	
External	75,00,000	72,00,000	1,47,00,000	1
	75,00,000	72,00,000	1,47,00,000	
Variable costs				
Components				
Internal	0	0	0	
External	66,00,000	33,60,000	99,60,000	2
Other Variable	0	18,88,000	18,88,000	3
Fixed Costs	5,60,000	14,60,000	20,20,000	
Profit	3,40,000	4,92,000	8,32,000	

SECTION – B : QUANTITATIVE TECHNIQUES IN DECISION MAKING

Answer to Question No. 7 & 11 in Section B, are compulsory.

Further, answer **any 2** from Question nos. 8, 9 & 10**.**

7.

Sl. No.	Answer	Justification
(i)	a	Optimistic time (to) and Pessimistic (tp) time – 4 days 16 days. Variance of duration = $\left(\frac{tp - to}{6}\right)^2 = \left(\frac{16-4}{6}\right)^2 = \left(\frac{12}{6}\right)^2 = (2)^2 = 4.$
(ii)	d	The purpose of dummy row or column in an assignment problem is to obtain balance between total number of activities and total number of resources. Dummy row (or columns) are added in the matrix so as to complete it to perform a square matrix. The dummy rows or columns will contain all costs elements as zeroes.

8. **(a)** The appropriate mathematical formulation of the given problem as LP model is as follows:

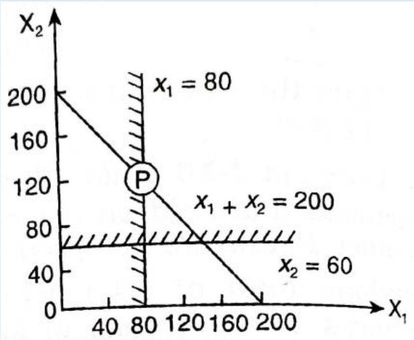
Minimize (total cost) = $3x_1 + 5x_2$

Subject to the constraints

$x_1 + x_2 = 200$, $x_1 \leq 80$, $x_2 \geq 60$,

$x_1 \geq 0$ and $x_2 \geq 0$

Drawing the lines $x_1 + x_2 = 200$, $x_1 = 80$ and $x_2 = 60$ on a graph sheet, we get the adjoining figure.



It may be observed from the adjoining figure that the given problem has no feasible solution space (shaded area) but has only one feasible point with its co-ordinates $x_1 = 80$ and $x_2 = 120$.

Hence the optimum solution is to mix 80 kgs. of ingredients X_1 and 120 kgs. of ingredients X_2 to have a minimum cost of ₹ 840.

(b) Step 1: Assign a high cost, denoted by M, to the paif (A, 2) and (B, 3).

ROW SUBSTRACTION

Officer \ Task	A	B	C	D
1	0	3	1	2
2	M	4	3	0
3	0	M	2	0
4	4	4	2	0

COLUMN SUBTRACTION

Officer \ Task	A	B	C	D
1	0	0	0	2
2	M	1	2	0
3	0	M	1	0
4	4	1	1	0

Step 2 : Draw minimum number of straight lines to cover all zeros.

Officer \ Task	A	B	C	D
1	0	0	0	2
2	M	1	2	0
3	0	M	1	0
4	4	1	1	0

Step 3 : Smallest uncovered number subtracted from uncovered numbers, added to numbers at intersection of two lines.

Officer \ Task	A	B	C	D
1	1	0	0	3
2	M	0	1	0
3	0	M	0	0
4	4	0	0	0

Step 4 : Return to step 2. Cover all zeros. Since the number of lines is 4, the optimum solution is reached

Officer \ Task	A	B	C	D
1	1	[0]	~~0~~	3
2	M	~~0~~	1	[0]
3	[0]	M	~~0~~	~~0~~
4	4	~~0~~	[0]	~~0~~

Assign:

Officer		Job	Time
1	to	B	7 hrs
2	to	D	4 hrs
3	to	A	3 hrs
4	to	C	4 hrs
		Total	18 hrs

9. (a) Let the given Game is played by the players A and B with A (the maximizing player) having strategies A_1, A_2 and A_3, represented along the rows and B (the minimizing player) having strategies B_1, B_2 and B_3 represented along the columns. So the given payoff Matrix can be written as follows –

	Strategies of B		
Strategies of A	**B_1**	**B_2**	**B_3**
A_1	15	2	3
A_2	6	5	7
A_3	-7	4	0

All the elements of Row A_3 are less than the corresponding elements of Row A_2. So A_3 is dominated by A_2. Henceit is ignored and deleted. The new matrix is given below.

Strategies of A	Strategies of B		
	B_1	B_2	B_3
A_1	15	2	3
A_2	6	5	7

Here all the elements of B_3 are more than the corresponding elements of B_2. Hence B_3 is dominated by B_2 and ignored to get the new matrix below.

Strategies of A	Strategies of B		
	B_1	B_2	Row Min.
A_1	15	2	2
A_2	6	5	**5**
Column Max.	15	**5**	

Maximum among the Row minimums = 5 = Maximin value and Minimum among the Column maximums = 5
= Minimax value. As, Maximin and Minimax values are equal, there exists a Saddle Point. It occurs at the cell A_2B_2.
Hence optimal strategies of A and B are respectively A_2 and B_2. Also value of the Game = 5

(b) (i) Data Mining

This is the activity of "Data Discovery" because here the patterns and inconsistencies of data unveiled through automated or semi-automated data analysis. Common correlations drawn from Data Mining include grouping specific sets of data, finding outliers in data and drawing connections and dependencies from disparate datasets.

Data Mining often uncovers the patterns used in more complex analyses, like Predictive modelling which makes it an essential part of the BI Process whose growth is correlated directly with the rise of Big Data in businesses of all sizes.

Of the standard processes performed by Data Mining, association rule learning presents the greatest benefit. By examining data to draw dependencies and construct correlations, the association rule can help businesses better understand the way customers interact with their website or even what factors influence their purchasing behavior.

Association rule learning was originally introduced to uncover connections between purchase data recordedin point of sale systems at supermarkets. For example, if a customer purchased Tomato Sauce and Cheese, theassociation rules would likely uncover that the customer purchased Hamburger Meat as well. Though thisis a very simple example but it works well to understand the type of analysis that now connects incredibly complex chains of events in all sorts of industries and helps users find correlations that would have remainedhidden otherwise.

(ii) Applications of R Programming in the real world

1. **Data Science** – With the advent of "Internet of things" (IoT) devices creating terabytes and terabytesof data that can be used to make better decisions, Data Science is a field that has no other way but togo up. Simply explained, a data scientist is a statistician with an extra asset – computer programmingskills. Programming languages like R give a data scientist superpowers that allow them to collect data in real time, perform statistical and predictive analysis, create visualisation and communicate actionable results to the stakeholders.
2. **Statistical Computing** – R is the most popular programming language among statisticians. In fact, it was initially built by statisticians for carry work related to statistical data. It has a rich package repository with over 9000 packages having every statistical function one can think of. R₹s expressivesyntax allows researchers – even those from non-computer science backgrounds to quickly import,clean and analyse data from various data sources. R also has charting capabilities which means onecan plot the data and create interesting visualisations from any dataset.
3. **Machine Learning** – R has found a lot of use in predictive analytics and machine learning. Ithas various packages for common ML tasks like linear and nonlinear regression, decision trees, linear and non-linear classification and many more. Everyone from machine learning enthusiasts to researchers use R to implement machine learning algorithms in fields like finance, genetics research,retail, marketing and health care.

10. (a) Total time taken to produce 14 units

$Y = ax^b$

$Y = 40\ (14)^{-0.322}$

log Y = log 40 – (0.322) log 14

= 1.60221 – (0.322) × 1.1461

= 1.60221 – 0.3690 = 1.233

Y = Antilog (1.233) = 17.14

Total time = 17.14 × 14 = 239.96

= 240 hours (which is same as the hours recorded)

So the assumption that learning ratio 80% is reasonable.

(i) 30 units

$Y = 40\ (30)^{-0.322}$ = 13.380 hours (Average time)

50 units

$Y = 40\ (50)^{-0.322}$ = 11.35 hours (Average time)

Total time for 30 units = 13.38 × 30 = 401.4 hours

Total time for 50 units = 11.35 × 50 = 567.5 hours

Time taken for 20 units from 31 to 50 units (567.5 – 401.4) = 166.1 hours

(ii)

Man hours = 10 × 8 × 5 × 4	=	1600
(–) down time (25% × 1600)	=	400
		1200

Fixed Cost per hour = 6000/1200 = ₹ 5

Computation of total cost for the initial order

Material (30 × 30)	= ₹ 900.0
Labour (401.4 ×6)	= ₹ 2408.4
Variable Overheads (0.5 × 401.4)	= ₹ 200.7
Fixed Overheads (5 ×401.4)	= ₹ 2007.0
Total Cost	= ₹ 5516.1

(b) Cost function is given to be $C(x) = 14400 + 550x + 0.01x^2$

So Average Cost function = C(x) / x

Or, $AC(x) = (14400 + 550x + 0.01x^2) /x$

Or, AC(x) = 14400/x + 550 + 0.01x

This is the Objective function which has to be minimized.

Differentiating both sides of the above function with respect to 'x' we get

$\frac{d}{dx}$ [AC(x)] = $14400/x^2 + 0.01$ ---------- (i)

As per the necessary condition of optimization, $\frac{d}{dx}$ [AC(x)] = 0

or, $-14400/x^2 + 0.01$

or, $0.01x^2 = 14400$

or, $x^2 = 14400/ 0.01$

Or, $x = \pm \sqrt{1440000}$

Or, x = ± 1200

But x being the quantity cannot be negative. Hence x = 1200

To ascertain whether this value of x corresponds to minima, we have to take help of the sufficient condition mentioned above.

Again differentiating both sides of 9i) with respect to 'x' we get, $\frac{d^2}{dx^2}$ [AC(x)]

= 28800/x3

For x = 1200, the value of 2nd order Derivative is $\frac{d^2}{dx^2}$ [AC(1200)] = $28800/(1200)^3$

$= 1.67 \times 10^{-5} > 0$

So there exist a Minima to the Objective Function at x = 1200

Hence 1200 units should be produced per day to minimize the Average Cost.

At this level of production,

Average Cost = $[AC(X)]_{at\ x = 1200}$

= 14400/1200 + 550 + 0.01 × 1200

= ₹574 per unit

Also at this level of production,

Total Cost = $[C(x)]_{at\ x = 1200}$

$= 14400 + 550 \times 1200 + 0.01 \times 1200^2$

= ₹ 6,88,800/-

Case study

11. (1) As per the given information, Total demand of eggs = 10 Lakh pieces and Total supply is 16 Lakh pieces. Thus the problem is unbalanced one with Supply > Demand

So, the very first step should be to make it balanced by introducing a DUMMY destination having a demand of 16 – 10 = 6 Lakh pieces.

(2) When the vehicle speed is 30 Kmph then the total percentage of broken eggs is (2.54+4.77+2.42+3.61) = 13.34.

So, the average percentage of broken eggs = 13.34 ÷ 4 = 3.335.

Hence the figure of average breakage percentage for a speed of 30 Kmph is correct.

(3) Total Cost of transportation = ₹ 280000/-,

Total No. of eggs to be supplied = 1000000

Minimum total distance to be travelled = 1464 Kms.

So, Cost of Transportation per egg per Km =280000 ÷ (1000000 x 1464) = ₹ 0.00019.

(4) Time (Hours) Matrix for Vehicle Speed 35 Kmph

From Source	To Destination		
	I	II	III
A	15.74	8.97	8.00
B	14.89	7.63	9.74
C	11.31	4.06	5.51

Note:- Time in hours = Distance in Km ÷ Speed in Kmph.