FINAL EXAMINATION **SET - 2**

MODEL ANSWERS **TERM – DECEMBER 2024**

PAPER – 16 **SYLLABUS 2022**

STRATEGIC COST MANAGEMENT

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

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

SECTION – A (Compulsory)

1. Choose the correct option: **[15 x 2=30]**

(i) **A company has forecast sales and cost of goods sold for the coming year as ₹25 lakhs and ₹18 lakhs respectively. The inventory turnover has been taken as 9 times per year. In case the inventory turnover increases to 12 times and the short-term interest rate on working capital is taken as 10%, what will be the saving in cost?**

a) ₹10,000
b) ₹20,000
c) ₹15,000
d) ₹5,000

(ii) **The break-even point of a manufacturing company is ₹1,60,000. Fixed cost is ₹48,000. Variable cost is ₹12 per unit. The PV ratio will be:**

a) 20%
b) 40%
c) 30%
d) 25%

(iii) **The higher the actual hours worked:**

a) The lower the capacity usage ratio
b) The higher the capacity usage ratio
c) The lower the capacity utilization ratio
d) The higher the capacity utilization ratio

(iv) **Ankit Ltd., operates throughput accounting system. The details of product A per unit are as under: Selling Price: ₹75**
Material Cost: ₹30
Conversion Cost:₹ 20
Time to bottleneck resources: 10 minutes
What is the throughput contribution per bottleneck resource per hour?

a) ₹270
b) ₹150
c) ₹120
d) ₹90

(v) Which of the following is not a primary activity of Value Chain?
a) Inbound Logistics
b) Operations
c) Services
d) Infrastructure

(vi) Kanban Japanese System under JIT approach ensures that
a) Continuous supply of inventory or product
b) Minimum and Maximum level of stock to be maintained
c) Inventory valuation
d) All of the above

(vii) Aderholt uses activity-based costing to allocate its overheads. The budgeted cost expected for the Supervisor cost pool was:
Budgeted units: 5,000
Number of employees: 75
Budgeted Cost: ₹7,500
The actual costs incurred were:
Actual Units: 5,500
Actual Employees: 77
Actual cost: ₹8,085
What was the total variance for the pool?
a) ₹585 Adverse
b) ₹165 Favourable
c) ₹555 Favourable
d) ₹385 Adverse

(viii) Pareto analysis recognizes:
a) 80:20 Rule
b) 50:50 Rule
c) 20:80 Rule
d) None of the above

(ix) Cost of Rework is a cost related to:
a) Internal failure
b) Appraisal
c) Prevention
d) None of the above

(x) Which of the following is not a term normally used in value analysis?
a) Resale value

b) Use value
c) Esteem value
d) Cost value

(xi) The Objective Function of a LPP is $Z = 3x_1 + 2x_2$. If $x_1 = 10$ and $x_2 = 5$ then the value of Z is –
a) 35
b) 40
c) 45
d) 50

(xii) When the total allocation of a Transportation Problem match with supply and demand values, the solution is –
a) Non- degenerate
b) Feasible
c) Degenerate
d) None of the above

(xiii) Which of the following considers difference between least cost and the cost just before least for each row and column while finding Basic Feasible Solution in Transportation?
a) North West Corner Method
b) Least Cost Method
c) Vogel's Approximation Method
d) Both (b) and (c) above

(xiv) Script Ends – is related to which type of programming language?
a) R Programming
b) SAS
c) Python
d) SPSS

(xv) Which of the following is related to Financial Data Analytics?
a) Value driver analytics
b) Financial ratio analytics
c) Predictive sales analysis
d) All of the above

Answers:

i	ii	iii	iv	v	vi	vii	viii	ix	x
d	c	d	a	d	a	b	a	a	a
xi	**xii**	**xiii**	**xiv**	**xv**					
b	b	b	c	d					

SECTION – B

(Answer any 5 questions out of 7 questions given. Each question carries 14 marks.)

[5 x 14 = 70]

2. A review, made by the top management of Sweat and Struggle Ltd. which makes only one product, of the result of the first quarter of the year revealed the following:

Sales in units	**10,000**
Loss	**₹ 10,000**
Fixed cost (for the year ₹1,20,000)	**₹ 30,000**
Variable cost per unit	**₹8.00**

The Finance Manager who feels perturbed suggests that the company should at least break-even in the second quarter with a drive for increased sales. Towards this, the company should introduce better packing which will increase the cost by ₹0.50 per unit.

The Sales Manager has an alternative proposal. For the second quarter additional sales promotion expenses can be increased to the extent of ₹5,000 and a profit of ₹5,000 can be aimed at during the period with increased sales.

The Production Manager feels otherwise. To improve the demand, the selling price per unit has to be reduced by 3%. As a result, the sales volume can be increased to attain a profit level of ₹4,000 for the quarter.

The Manager Director asks you as a Cost Accountant to evaluate the three proposals and calculate the additional sales volume that would be required in each case, in order to help him to take a decision. [14]

Answer:

Calculation of selling price

Particulars		(₹)
Variable cost	(8 × 10,000)	80,000.00
Add : Fixed cost		30,000.00
Total cost		1,10,000.00
Profit		(10,000.00)
Sales		1,00,000.00
Selling price	(100000/10000)	₹ 10

Statement showing evaluation of alternatives and the number of units required to attain the targets of respective managers.

Particulars	Finance Manager	Sales Manager	Production Manager
i) Selling price (₹)	10.00	10.00	9.70
ii) Variable cost (₹)	8.50	8.00	8.00
iii) Contribution per unit (₹)	1.50	2.00	1.70
iv) Fixed cost (₹)	30,000.00	35,000.00	30,000.00
v)Target (₹)	B.E.P	Profit of ₹5000	Profit of ₹4000
	(30000/1.5)	(40000/2)	(34000/1.7)
	20,000.00	20,000.00	20,000.00
Additional units required	10,000.00	10,000.00	10,000.00

3. (a) XYZ Ltd which has a system of assessment of Divisional Performance on the basis of residual income has two Divisions, Alpha and Beta. Alpha has annual capacity to manufacture 15,00,000 numbers of a special component that it sells to outside customers, but has idle capacity. The budgeted residual income of Beta is ₹1,20,00,000 while that of Alpha is ₹1,00,00,000.

Other relevant details extracted from the budget of Alpha for the current year were as follows

Particulars	
Sale (outside customers)	**12,00,000 units @ ₹180 per unit**
Variable cost per unit	**₹160**
Divisional fixed cost	**₹80,00,000**
Capital employed	**₹7,50,00,000**
Cost of Capital	**12%**

Beta has just received a special order for which it requires components similar to the ones made by Alpha. Fully aware of the idle capacity of Alpha, beta has asked Alpha to quote for manufacture and supply of 3,00,000 numbers of the components with a slight modification during final processing. Alpha and Beta agree that this will involve an extra variable cost of ₹5 per unit. Calculate the transfer price which Alpha should quote to Beta to achieve its budgeted residual income. **[7]**

Answer:

Contribution required at Budgeted Residual Income for Alpha

Fixed cost		80,00,000
Return on Capital Employed (7,50,00,000 × 12 %)		90,00,000
Residual Income of Alpha		1,00,00,000
Total Contribution required (Fixed Cost + Return on Cap. Emp. + Residual Income)		2,70,00,000
Contribution derived from existing units= 12,00,000 × 20	=	₹2,40,00,000
Contribution (Residual) required on 3,00,000 units =2,70,00,000 – 2,40,00,000	=	₹ 30,00,000
Contribution per unit = 30,00,000 ÷ 3,00,000	=	₹10
Increase in Variable cost	=	₹ 5
Transfer price = V.C + Desired Residual Contribution + Increase in VC = 160 + 10 + 5	=	₹175

(b) A2Z plc. supports the concept of tero technology or life cycle costing for new investment decisions covering its engineering activities. The financial side of this philosophy is now well established, and its principles extended to all other areas of decision making. The company is to replace a number of its machines and the Production Manager is torn between the Exe Machine, a more expensive machine with a life of 12 years, and the Wye machine with an estimated life of 6 years. If the Wye machine is chosen it is likely that it would be replaced at the end of 6 years by another Wye machine. The pattern of maintenance and running costs differs between the two types of machine and relevant data are shown below:

Particulars	Exe (₹)	Wye (₹)
Purchase Price	**19,000**	**13,000**
Trade-in value/breakup/scrap	**3,000**	**3,000**
Annual repair costs	**2,000**	**2,600**
Overhaul costs	**(at year 8) 4,000**	**(at year 4) 2,000**

Estimated financing costs averaged over machine life 10% p.a - Exe; 10% p.a. – Wye.

You are required to: recommend with supporting figures, which machine to purchase, stating any assumptions made. [7]

Answer:

Computation of present value of outflows and equivalent annual costs

Particulars	Working (₹)	Exe machine (₹)	Working (₹)	Wye machine (₹)
Initial cost		19,000.00		13,000.00
Less: Present Value of Scrap at the end of the life	(3000 × 0.319)	957.00	(3000 × 0.564)	1,692.00
Net Cost		18,043.00		11,308.00
Add: Present value of total annual repair costs	(2000 × 6.812)	13,624.00	(2600 × 4.354)	11,320.00
Add: Overhaul costs	(4000 × 0.466)	1,864.00	(2000 × 0.683)	1,366.00
P.V. of Total Cost		33,531.00		23,994.00
Capital recovery factor	(1 ÷ 6.812)	0.1468	(1 ÷ 4.354)	0.2297
Equivalent annual cost		4,922.35		5,511.42

Recommendation: As the equivalent annual cost is less for Exe machine, it is better to purchase the same.

Working Note

1. Present Value Factors @ 10%: Year4 =0.683; Year6 =0.564; Year8=0.466; Year12=0.319
2. Compounded Present Value (PVAF) @ 10%: 8 years = 4.354; 12 years = 6.812

4. (a) H Ltd. manufactures three products. The material cost, selling price and bottleneck resource details per unit are as follows:

Particulars	Product X	Product Y	Product Z
Selling Price (₹)	**66**	**75**	**90**
Material and other variable cost (₹)	**24**	**30**	**40**
Bottleneck resource timeline (minutes)	**15**	**15**	**20**

Budgeted factory costs for the period are ₹2,21,600. The bottleneck resources time available is 75,120 minutes per period.

Required:

(i) Company adopted throughput accounting and products are ranked according to 'product return per minute'. Select the highest rank product.

(ii) Calculate throughput accounting ratio (TA Ratio) and comment on it. [7]

Answer:

(i) Calculation of Rank according to product return per minute

Particulars	X	Y	Z
Selling Price	66	75	90
Less: Variable cost	24	30	40
Throughput contribution (a)	42	45	50
Minutes per unit (b)	15	15	20
Contribution per minute [(a) ÷ (b)]	2.8	3	2.5
Ranking	II	I	III

Comments: Product Y with a contribution of 3 per minute ranks the highest.

(ii) Calculation of throughput accounting ratio

Particulars	X	Y	Z
Factory cost per minute (₹) (₹2,21,600 ÷ 75,120 minutes)	2.95	2.95	2.95
TA ratio (Contribution per minute ÷ Cost per minute)	0.95	1.02	0.85
Ranking based on TA ratio	II	I	III

Comments: TA Ratio of Product Y is greater than 1 whereas TA Ratios of Product X and Product Z are less than 1. It is beneficial to maximise the production of Y and minimise the production of Z and X.

(b) Discuss the significance of lean accounting. **[7]**

Answer:

Lean accounting uses a method that categorizes costs by value stream rather than by department. This approach "provides the basis for sound management decisions". The researchers define value stream accounting as "tracking revenue and the associated variable costs required to generate those sales." It is experienced that value stream costing includes a simpler cost collection method and reduces the number of cost centers. They also list features of value stream accounting as:

- Costs calculated weekly
- No distinction made between direct or indirect costs – all costs of the value stream are considered direct costs
- Value stream costs include labour, materials, production support, machines and equipment, operation support, facilities and maintenance
- Value stream costing provides a more accurate picture by elimination of unnecessary costs outside control of value stream managers

Lean accounting groups together costs that fall outside of the value stream as "business sustaining costs" that do not get included in value stream costs. This, in turn, helps the businesses to find better price points for products and do further research into high-cost areas. The bottom line is that Lean accounting

can help business leaders quickly know if they are heading in the right direction or need to make a change.

Three principles guide Lean Accounting and form the foundation for all of accounting's work and interaction

with the organization:

i. Customer value: Delivering the relevant and reliable information in a timely manner to all users of the information inside the organization.

ii.Continuous improvement: Improving accounting processes, cross-functional business processes and the information used inside the business for analysis and decision making.

iii.Respect for people: Adopting a learning attitude by seeking to understand root causes of business problems and issues in a cross-functional, collaborative manner.

Lean Accounting facilitates the changes that are required to a company's accounting, control, measurement, and management processes to support lean manufacturing and lean thinking.

5. The summarized results of a company for the two years ended 31st December 2022 and 2023 are given below: -

Year	2023	2022
Particulars	**₹ lacs**	**₹ lacs**
Sales	**770**	**600**
Direct Materials	**324**	**300**
Direct Wages	**137**	**120**
Variable Overheads	**69**	**60**
Fixed Overheads	**150**	**80**
Profit	**90**	**40**

As a result of re-organisation of production methods and extensive advertisement campaign use, the company was able to secure an increase in the selling prices by 10% during the year 2023 as compared to the previous year. In the year 2022, the company consumed 1,20,000 Kgs. of raw materials and used 24,00,000 hours of direct labour. In the year 2023, the corresponding figures were 1,35,000 kgs of raw materials and 26,00,000 hours of direct labour.

You are required to:

Use information given for the year 2022 as the base year information to analyze the results of the year 2023 and to show in a form suitable to the management the amount each factor has contributed by way of price, usage and volume to the change in profit in 2023.

[14]

Answer:

Statement of Variances

Sl	Description	Workings	₹ lacs
1	**Sales Variances**		
a	Sales price variance	770 – {770 × (100/110)} = 70(F)	70 (F)
b	Sales volume variance	{770 × (100/110)} - 600 = 100(F)	100(F)
	Sales value variance	770 – 600 = 170(F)	170(F)
d	% of increase in Volume = (100÷600) × 100 = 16.67%		

2	**Material Variances**		
a	Key computations Material price in 2022 = (30000000)/120000 = ₹250 Material expected to be used in 2023 = (120000/600) × 700 = 140000 Kgs Standard Material Cost for 2023 = 140000 × ₹250 = ₹350 Lacs Material price in 2023 = (32400000)/135000 = ₹ 240		
b	Material cost variance	350 – 324 = 26 (F)	26(F)
c	Material volume variance	16.67% of Consumption for 2014 = 300 × 16.67% = 50(A)	50(A)
d	Material usage variance	SP (SQ-AQ) 250(140000-135000) = 12,50,000	12.50(F)
e	Material price variance	AQ(SP-AP) 135000(250-240) = 1350000	13.50(F)
3	**Labour Variances**		
a	Key computations Labour hours expected to be used in 2023 = (2400000/600) × 700 = 2800000 Labour rate of 2022 = (12000000)/(2400000) = ₹5 per hour Standard labour cost for 2015 = 2800000 × 5 = ₹140 lacs Labour rate of 2023 = (13700000)/(2600000) = ₹5.269 per hour		
b	Labour cost variance	140 -137 = 3 (F)	3(F)

Sl	Description	Workings	₹lacs
c	Labour volume variance	16.67% of Consumption for 2022 = 120 × 16.67% = 20(A)	20(A)
d	Labour efficiency variance	SR (SH-AH) 5*(2800000-2600000) = 10,00,000	10.00(F)
e	Labour rate variance	AH(SR-AR) 2600000(5 - 5.269) = 6,99,400(A) i.e. say 7 lacs(A)	7.00(A)
4	**Variable Overhead Variances**		
a	Key computations Standard variable overheads = ₹60 + (₹60 × 16.67%) = ₹70 Standard variable overheads rate per labour hour = ₹ 60 /24 = ₹2.5 VOH rate of 2023 = (6900000)/(2600000) = ₹2.65 per hour		
b	VOH cost variance	70 - 69 = 1(F)	1(F)
c	VOH volume variance	16.67% of Consumption for 2014 = 60 × 16.67% = 20(A)	10(A)
d	VOH efficiency variance	SR (SH-AH) 2.5(2800000 - 2600000) = 5,00,000	5(F)

e	VOH expenditure variance	AH(SR-AR) 2600000(2.50 – 2.65) = 3,90,000(A) i.e. say 4 lacs(A)	4(A)
5	**FOH cost variance**	**150 – 80 = 70(A)**	**70(A)**

(ii) Reconciliation Statement

Serial	Description	Favourable	Adverse	Rupees
1	**Profit for 2022**			**40.00**
2	**Variances**			
A	Sales			
	Price	70.00		
	Volume	100.00		
	Sub Total	170.00		170.00(F)

Serial	Description	Favourable	Adverse	Rupees
1	**Profit for 2022**			**40.00**
2	**Variances**			
B	Material			
	Volume		50.00	
	Usage	12.50		
	Price	13.50		
	Sub Total	26.00	50.00	24.00(A)
C	Labour			
	Volume		20.00	
	Efficiency	10.00		
	Price		7.00	
	Sub Total	10.00	27.00	17.00(A)
D	Variable Overheads			
	Volume		10.00	
	Efficiency	5.00		
	Expenditure		4.00	
	Sub Total	5.00	14.00	
				9.00(A)
E	Fixed Overheads		70.00	70.00(A)
F	Total	211.00	161.00	50.00(F)
3	**Profit for 2023**			**90.00**

6. (a) An equipment under breakdown has five repair jobs to make it operative again. The Maintenance Manager of the organisation has assigned five mechanics of his department to do the jobs. The estimated time (hours) for each of the mechanics to carry out the jobs are given in the following table:

	Time required (Hours) to complete the Repair jobs				
Mechanic	**A**	**B**	**C**	**D**	**E**
I	**7**	**5**	**9**	**8**	**11**
II	**9**	**12**	**7**	**11**	**10**
III	**8**	**5**	**4**	**6**	**9**
IV	**7**	**3**	**6**	**9**	**5**
V	**4**	**6**	**7**	**5**	**11**

Assuming that each mechanic can be assigned to only one job, determine the minimum time assignment. [7]

Answer:

Table showing supplied data

	Time required (Hours) to complete the Repair jobs				
Mechanic	A	B	C	D	E
I	7	5	9	8	11
II	9	12	7	11	10
III	8	5	4	6	9
IV	7	3	6	9	5
V	4	6	7	5	11

Minimum element of a row of the above table is subtracted from every element of that row and it is done for each row. The result is shown in the Table below.

Table – 1 showing reduced matrix after Row operation

	Time required (Hours) to complete the Repair jobs				
Mechanic	**A**	**B**	**C**	**D**	**E**
I	2	0	4	3	6
II	2	5	0	4	3
III	4	1	0	2	5
IV	4	0	3	6	2
V	0	2	3	1	7

Now the minimum element of a column of the above table is subtracted from every element of that column and it is done for each column. The result is shown in the Table below.

Table – 2 showing reduced matrix after Column operation

	Time required (Hours) to complete the repair jobs				
Mechanic	A	B	C	D	E
I	2	0	4	2	4
II	2	5	0	3	1
III	4	1	0	1	3
IV	4	0	3	5	0
V	0	2	3	0	5

Here we find that the minimum number of horizontal and vertical straight lines required to cover all the zero elements of the matrix = 4 ≠ Order (5) of the matrix. Hence the solution is non-optimal.

Thus, a new matrix table is formed as described in the following lines.

Minimum of all the elements which are not covered by the horizontal and vertical lines, drawn already, is found to be 1. This is subtracted from all the uncovered elements and added to the elements at the junction cells where a horizontal and a vertical line have intersected. Such cells are (V – B), (V – C) & (V – E). The result is shown in the next Table.

Table – 3 showing improved matrix (Optimal)

	Time required (Hours) to complete the repair jobs				
Mechanic	**A**	**B**	**C**	**D**	**E**
I	1	0	4	1	4
II	1	5	0	2	1
III	3	1	0	0	3
IV	3	0	3	4	0
V	0	3	4	0	6

Here we find that the minimum number of horizontal or vertical straight lines required to cover all the zero elements of the matrix = 5 = Order (5) of the matrix. Hence the solution is optimal

Now to make the assignments we start examining the rows one by one to see if there is any row with a single zero. Here the 1st row is having single zero at the cell (I – B). So we make an assignment here by putting a square boundary around the numerical figure zero at this cell. Correspondingly we check the column of this assigned cell to find if there is any other zero in it. We find a zero at the cell (IV – B) and we cross it out indicating no further assignment against B is possible. Similar activity is performed for the remaining rows, too and we get assignment at the cells (II – C), (III – D), (IV – E). and (V – A) The resultant matrix with assignments is shown in the Table below:

Table – 4 showing Optimal Assignments

	Time required (Hours) to complete the Repair jobs				
Mechanic	A	B	C	D	E
I	1	[0]	4	1	4
II	1	5	[0]	2	1
III	4	1	~~0~~	[0]	3
IV	4	~~0~~	3	4	[0]
V	[0]	3	4	~~0~~	6

Thus, the optimal solution is –

Repair job	Assigned to Mechanic	Time required (Hours)
A	V	4
B	I	5
C	II	7
D	III	6
E	IV	5
Total	-	27

So the minimum time required to complete all the Repair Jobs = 27 hours.

(b) Patients arriving at a village dispensary are treated by a doctor on a first-come-first-served basis. The inter-arrival time of the patients is known to be uniformly distributed between 0 and 80 minutes, while their service time is known to be uniformly distributed between 15 and 40 minutes. It is desired to simulate the system and determine the average time a patient has to be in the queue for getting service and the proportion of time the doctor would be idle.

Carry out the simulation using the following sequences of random numbers. The numbers have been selected between 00 and 80 to estimate inter-arrival times and between 15 and 40 to estimate the service times required by the patients.

Series 1	**07**	**21**	**12**	**80**	**08**	**03**	**32**	**65**	**43**	**74**
Series 2	**23**	**37**	**16**	**28**	**30**	**18**	**25**	**34**	**19**	**21**

[7]

Answer:

Simulated Inter-arrival & Service Times and Calculation of Patient's Waiting time & Doctor's Idle time

Patient No.	Inter arrival time Random No. (minutes)	Entry time in to the queue	Service Time Random No. (minutes)	Service Start time	Service End time	Waiting time of patient (minutes)	Idle time of doctor (minute)
1	07	8.07 A.M	23	8.07 A.M	8.30 A.M	-	7
2	21	8.28 A.M	37	8.30 A.M	9.07 A.M	2	-
3	12	8.40 A.M	16	9.07 A.M	9.23 A.M	27	-
4	80	10.00 A.M	28	10.00 A.M	10.28 A.M	-	37
5	08	10.08 A.M	30	10.28 A.M	10.58 A.M	20	-
6	03	10.11 A.M	18	10.58 A.M	11.16 A.M	47	-
7	32	10.43 A.M	25	11.16 A.M	11.41 A.M	33	-
8	65	11.48 A.M	34	11.48 A.M	12.22 P.M	-	7
9	43	12.31 P.M	19	12.31 P.M	12.50 P.M	-	9
10	74	1.45 P.M	21	1.45 P.M	2.06 P.M	-	55
					Total	**129**	**115**

[N.B – The above table is prepared on the basis of the assumption that the dispensary opened at 8.00 A.M]
Average time a patient has to be in the queue for getting service = 129/10 = 12.9 minutes
Doctor is there in the dispensary from 8.00 A.M to 2.06 P.M i.e. for 6 hours & 6 minutes = 366 minutes.

During this period, he is idle for 115 minutes. So proportion of time the doctor is idle = 115/366 = 0.314.

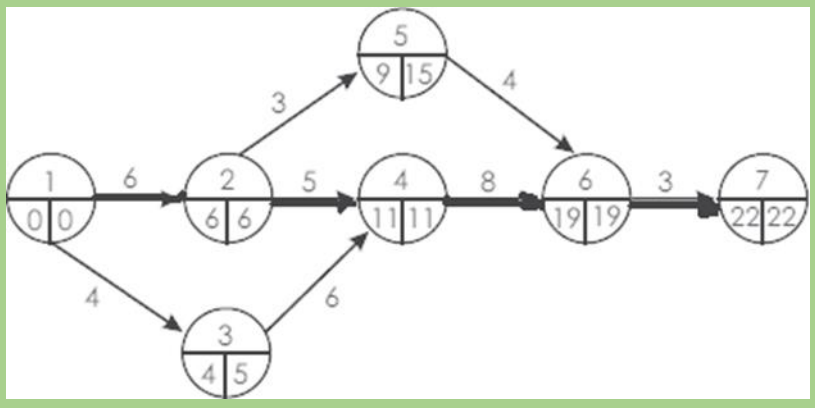
7. The following table gives data on normal time & cost as well as crash time & cost for a project. You need to draw the Network diagram and identify the Critical Path.
Also find out the Normal duration of the project and the corresponding Total Cost associated with it.
Crash the relevant activities systematically and determine the optimum completion time of the project. Also determine the corresponding cost when it is given that the Indirect Cost is ₹100 per day.

Activity	Normal		Crash	
	Time (days)	Cost (₹)	Time (days)	Cost (₹)
1—2	6	600	4	1,000
1—3	4	600	2	2,000
2—4	5	500	3	1,500
2—5	3	450	1	650
3—4	6	900	4	2,000
4—6	8	800	4	3,000
5—6	4	400	2	1,000
6—7	3	450	2	800

[14]

Answer:

The network for normal activity times indicates project duration of 22 days with critical path 1-2-4-6-7. It is shown below

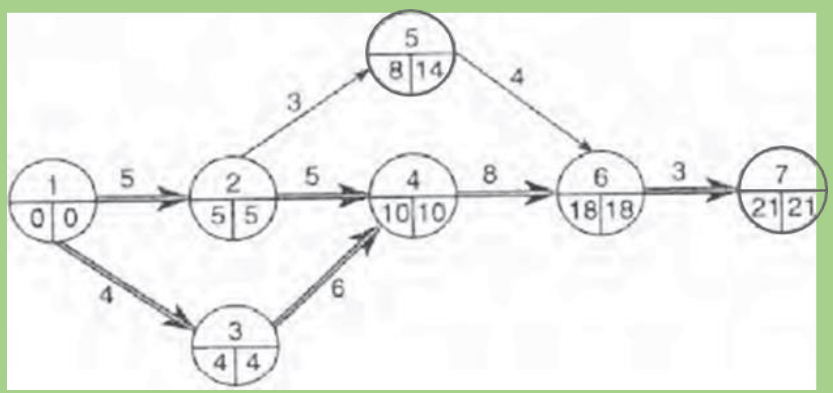


Total Cost associated with it is given as (Normal Direct Cost + Indirect Cost for 22 Days @ ₹100 per Day) Normal Direct Cost = (600 + 600 + 500 + 450 + 900 + 800 + 400 + 450) = ₹4700
Indirect Cost = 22 × 100 = ₹2200
Required Total Cost = 4700 + 2200 = ₹6900

1st Stage of Crashing
Cost slope of each of the Critical Activities of the Network diagram is calculated and ranked as below.

Critical Activity	Cost Slope =	Rank as per ascending order of Cost Slope
1 - 2	(1000 – 600)/ (6 – 4) = ₹200 per day	1
2 – 4	(1500 – 500)/ (5 – 3) = ₹500 per day	3
4 – 6	(3000 – 800)/ (8 – 4) = ₹550 per day	4
6 – 7	(800 – 450)/ (3 – 2) = ₹350 per day	2

As Cost Slope of Activity 1 – 2 is minimum, crashing is to be started from this Activity. Maintaining criticality of the existing Critical Path, Activity 1 – 2 is crashed by 1 Day.



New Network Diagram is shown above. It is having Duration of 21 Days and the associated Total Cost is given as TC = Normal Direct Cost + Indirect Cost (for 21 Days @ ₹100 per Day) + Cost of Crashing Activity 1-2 by 1 Day
= 4700 + 21 × 100 + 1 × 200 = ₹7000
It is seen that other activities too have become Critical. Now there are two Critical Paths given by 1 – 2 – 4 – 6 – 7 as well as 1 – 3 – 4 – 6 – 7

2nd Stage of Crashing
Cost Slopes of each of the new Critical Activities are calculated as below.
Cost Slope of Activity 1 – 3 = (2000 – 600)/ (4 – 2) = ₹700 per Day & that of 3 – 4 = (2000 – 900)/ (6-4) =₹550/- per Day.

As there are more than one Critical Path, parallel Crashing is necessary for some of the activities to maintain criticality of the existing Critical Paths. Various options of Crashing and their corresponding Cost Slopes are shown below.

Options	Possible Crash (Days)	Cost Slope (₹/ Day)	Rank
Activities (1 - 2) & (1 - 3)	1*	200 + 700 = 900	4
Activities (1 - 2) & (3 - 4)	1*	200 + 550 = 750	3
Activities (2 - 4) & (1 - 3)	2	500 + 700 = 1200	6
Activities (2 - 4) & (3 - 4)	2	500 + 550 = 1050	5
Activity (4 – 6)	4	550	2
Activity (6 – 7)	1	350	1

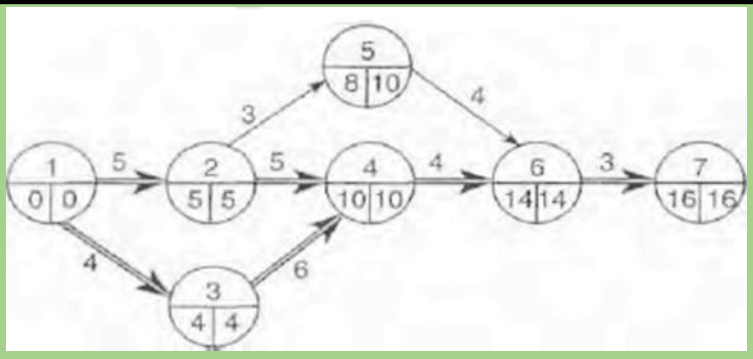
* Though as per the supplied data activities (1-3) & (3-4) can be crashed by 2 days each, but (1 – 2) cannot be crashed more than 1 Day after 1st stage of Crashing.

From the above ranking Crashing of (6-7) by 1 Day is suggested. Due to this project duration will be 20 Days and associated Total Cost = Normal Direct Cost + Indirect Cost for 20 Days @ ₹100 per Day+ Crashing Cost of Activity (1 – 2) by 1 Day @ ₹200 per Day + Crashing Cost of Activity (6 – 7) by 1 Day @ ₹350 per Day = 4700 + 20 × 100 + 1 × 200 + 1 × 350 = ₹7250

3rd Stage of Crashing

After 2nd Stage of Crashing, no new Critical Path emerged. So the options remain same as in the 2nd Stage with the exception of Activity (6 – 7) which is totally crashed in the 2nd Stage.

From the above list of Ranking, Activity (4 – 6) is having lowest Cost Slope. Thus it is crashed by 4 days now. New Network having project duration of 16 Days is shown below.

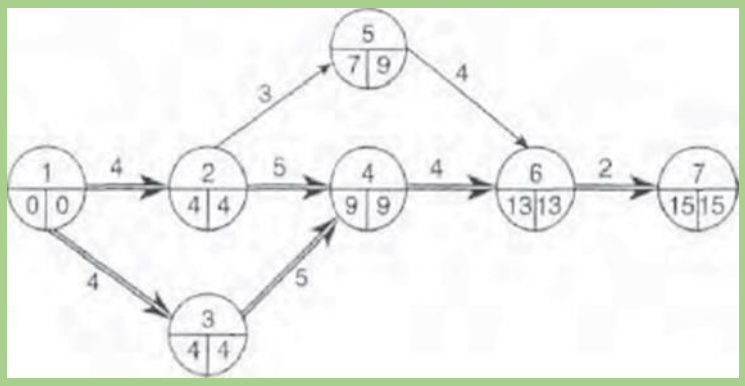


Total Cost of the Project = Normal Direct Cost + Indirect Cost (for 16 Days @ ₹100/ Day) + Crashing Cost [for Activity (1 – 2) by 1 Day @ ₹200/ Day + for Activity (6 – 7) by 1 Day @ ₹350/ Day + for Activity (4 – 6) by 4 Days @ ₹550/ Day] = 4700 + 1600 + 200 + 350 + 550 × 4 = ₹9050

4th Stage of Crashing

After 3rd Stage of Crashing, no new Critical Path emerged. So the options remain same as in the 2nd Stage with the exception of Activities (6 – 7) and (4 – 6) which are fully crashed in the 2nd and 3rd Stages.

From the above list of Ranking, Activity (1 – 2) and (3 – 4) together is having lowest Cost Slope. Thus both are crashed by 1 day now. New Network having project duration of 15 Days is shown below.



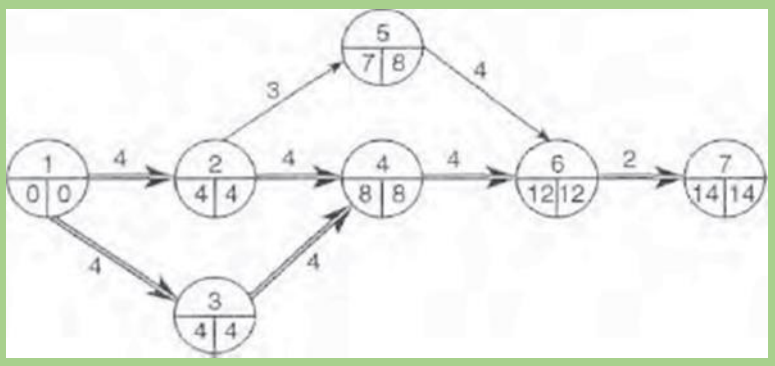
Total Cost of the Project = Normal Direct Cost + Indirect Cost (for 15 Days @ ₹100/ Day) + Crashing Cost [for Activity (1 – 2) by 1 Day @ ₹200/ Day + for Activity (6 – 7) by 1 Day @ ₹350/ Day + for Activity (4 – 6) by 4 Days @ ₹550 per Day + for Activities (1 – 2) & (3 – 4) together by 1 Day @₹ 750/Day] = 4700 + 1500 + 200 + 350 + 550 × 4 + 750 = ₹9700

5th Stage of Crashing

Though after 4th Stage of Crashing no new Critical Paths emerged, but the Activity (1 – 2) has been crashed fully.
Thus the options remaining are as follows.

Options	Possible Crash (Days)	Cost Slope (`/ Day)	Rank
Activities (2 - 4) & (1 - 3)	2	500 + 700 = 1200	2
Activities (2 - 4) & (3 - 4)	1*	500 + 550 = 1050	1

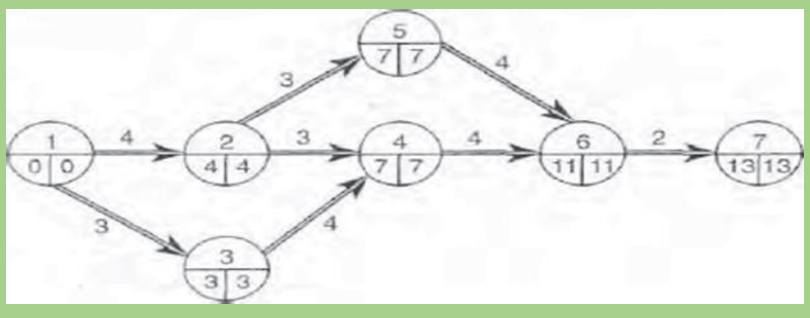
* Though Activity (2 - 4) can be crashed by 2 Days but after 4th Stage, (3 – 4) has only 1 Day of Crashing left. As Cost Slope of Activities (2 – 4) & (3 – 4) taken together is least, both are crashed by 1 Day and the new network diagram is shown below. It shows project duration of 14 Days.



Total Cost of the Project = Normal Direct Cost + Indirect Cost (for 14 Days @ ₹100/ Day) + Crashing Cost [for Activity (1 – 2) by 1 Day @ ₹200/ Day + for Activity (6 – 7) by 1 Day @ ₹350/ Day + for Activity (4 – 6) by 4 Days @ ₹550/ Day + for Activities (1 – 2) & (3 – 4) together by 1 Day @₹ 750/Day + for Activities (2 – 4) & (3 – 4) together by 1 Day @ ₹1050/ Day]
= 4700 + 1400 + 200 + 350 + 550 X 4 + 750 + 1050 = ₹10650

6th Stage of Crashing

After 5th Stage of Crashing no new Critical Paths emerged. So the available option as per the table above is to crash (2 – 4) and (1 – 3) together and they can be crashed by 1 Day because after 5th Stage only 1 Day of crashing is available for Activity (2 – 4). The new Network diagram having project duration of 13 Days is shown below



Total Cost of the Project = Normal Direct Cost + Indirect Cost (for 13 Days @ ₹100/ Day) + Crashing Cost [for Activity (1 – 2) by 1 Day @ ₹200/ Day + for Activity (6 – 7) by 1 Day @ ₹350/ Day + for Activity (4 – 6) by 4 Days @ ₹550 per Day + for Activities (1 – 2) & (3 – 4) together by 1 Day @₹ 750/Day + for Activities (2 – 4) & (3 – 4) together by 1 Day @
₹1050/ Day + for Activities + for Activities (2 – 4) & (1 – 3) by 1 Day @ ₹1200/ Day]

= 4700 + 1300 + 200 + 350 + 550 X 4 + 750 + 1050 + 1200 = ₹11750

From the diagram it is clear that all the paths of the Network Are Critical. Also activities of the path 1 – 2 – 4 – 6- 7 are each fully crashed. Thus no further crashing of the Network is possible.

It is noticed that the Total Cost of the Project kept on increasing all along. This has happened due to the fact that the rate of decrease of Indirect Cost is much lower than the rate of increase of Direct Cost for Crashing. Hence optimum duration of the project cannot be obtained and rather minimum possible duration is obtained and that value is 13 Days. Associated Total Cost of project is ₹11750.

8. (a) Joy Givers and Milan Toys are the two toy manufacturers who always compete with each other to increase their respective market shares. For both the companies the Marketing team work with close coordination with the Design team and always come out with attractive toys which are normally in great demand. To meet the demand, they have various strategic options like working for 8 hours a day, 12 hours a day, 16 hours a day, 24 hours a day, subcontracting etc. which will ultimately increase the market share. Joy Givers have decided not to go for all the above mentioned options and set up the following payoff matrix in which the percentage increase in market share is given against different strategies of Milan Toys

STRATEGIES of	**Milan Toys**			
Joy Givers	**Working 8 hrs/day**	**Working 12 hrs/day**	**Working 16 hrs/day**	**Subcontracting**
Working 12 hrs/day	**8**	**10**	**9**	**14**
Working 16 hrs/day	**10**	**11**	**8**	**12**
Working 24 hrs/day	**13**	**12**	**14**	**13**

Use Principle of Dominance to find the Optimal Strategies of the two manufacturers and the value of the Game. [7]

Answer:

Joy Givers is the Maximising player with strategies represented along the rows and Milan Toys is the Minimising Player with strategies represented along the columns. For ease of representation we consider the respective strategies of Joy Givers as J1, J2 & J3 and those of Milan Toys as M_1, M_2 & M_3.

STRATEGIES of	Milan Toys			
Joy Givers	M_1	M_2	M_3	M_4
J_1	8	10	9	14
J_2	10	11	8	12
J_3	13	12	14	13

All the elements of 4th Column are either greater than or equal to the corresponding elements of the 1st Column. So 4th Column's strategy (M_4) is dominated by the 1st Column's strategy (M_1). Hence M_4 is ignored. The new matrix is given below.

STRATEGIES	Milan Toys		
Joy Givers	M_1	M_2	M_3
J_1	8	10	9
J_2	10	11	8
J_3	13	12	14

All the elements of 1st Row are less than the corresponding elements of the 3rd Row. Thus, strategy of 1st Row
i.e. J_1 is dominated by the strategy of the 3rd Row i.e. J_3 and ignored. The reduced matrix becomes: -

STRATEGIES	Milan Toys		
Joy Givers	M_1	M_2	M_3
J_2	10	11	8
J_3	13	12	14

Apparently first two rules of dominance cannot be applied to either of the rows or columns of the above matrix, but if the average of the elements of the strategies M_2 and M_3 be taken then we get a matrix shown below.

STRATEGIES	Milan Toys	
Joy Givers	M_1	$[M_2 + M_3]/2$
J_2	10	(11 + 8)/2 = 9.5
J_3	13	(12 + 14)/2 = 13

So the elements of the strategy M_1 are either more or equal to the average of the corresponding elements of M_2 and M_3. Hence M_1 is dominated by M_2 and M_3. Thus, M_1 is deleted and the reduced matrix is as below

STRATEGIES of	Milan Toys		Row Minimum
Joy Givers	M_2	M_3	
J_2	11	8	8
J_3	12*	14	12=Maximin
Column Maximum	12=Minimax	14	

So Maximin value = 12 = Minimax value. Hence there exists a Saddle Point at the junction J_3M_2 Thus, optimal strategy of Joy Giver is J_3 that is "Working 24 hours /day" and that for Milan Toys is M_2 that is "Working 12 hours/day". Value of the Game = 12 (which means a 12% increase in market share for Joy Givers)

(b) Calculate the Seasonal Indices for the following quarterly data in certain units. Appropriate method for finding the Indices has to be decided by you with due explanation

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2020	**39**	**21**	**52**	**81**
2021	**45**	**23**	**63**	**76**
2022	**44**	**26**	**69**	**75**
2023	**53**	**23**	**64**	**84**

[7]

Answer:

The values in any quarter do not reveal any definite tendency to change. Thus there is no appreciable trend in the given dataset. So it is decided to use Method of Simple Average (Quarterly) to find out the Seasonal Indices. Also a Multiplicative Model is assumed for the data.

Calculations for Seasonal Index

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
2020	39	21	52	81	-
2021	45	23	63	76	-
2022	44	26	69	75	-
2023	53	23	64	84	-
Total	181	93	248	316	838
Arithmetic Mean	45.25	23.25	62	79	209.5
Seasonal Index	**86.4**	**44.4**	**118.4**	**150.8**	400

Calculations

Arithmetic Mean for any Quarter = Total for that quarter /4, Grand Average = Total of the Arithmetic Means /4.

Seasonal Index for any Quarter = (Arithmetic Mean of that Quarter / Grand Average) x100