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)   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

(ii)   DMIADV is a methodology associated with
   a.   Pareto Analysis
   b.   PRAISE
   c.   Six Sigma
   d.   None of the above

(iii)   XYZ Ltd. has the following alternative planned activity levels.

Level	E	F	G
Total cost (₹)	1,00,000	1,50,000	2,00,000
No. of units produced	5000	10000	15000

If fixed overhead remains constant, then fixed overhead cost per unit at Level E is:
   a.   ₹ 20
   b.   ₹ 15
   c.   ₹13.33
   d.   ₹ 10

(iv)   A company has a breakeven point when sales are ₹ 3,20,000 and variable cost at that level of sales are ₹ 2,00,000. How much would contribution margin increase or decrease if variable expenses are dropped by ₹30,000?
   a.   Increase by 27.5%
   b.   Increase by 9.375%
   c.   Decrease by 9.375%
   d.   Increase by 37.5%

(v)   H Group has two divisions, Division P and Division Q. Division P manufactures an item that is transferred to Division Q. The item has no external market and 6000 units produced are transferred internally each year. The costs of each division are as follows:

	Division P	Division Q
Variable Cost (₹)	100 per unit	120 per unit
Fixed cost each year (₹)	1,20,000	90,000

Head Office management decided that a transfer price should be set that provides a profit of ₹30,000 to Division P. What should be the transfer price per unit?

a. ₹145

b. ₹125

c. ₹120

d. ₹135

(vi) A company has the capacity of producing 80000 units and presently sells 20000 units at ₹ 100 each. The demand is sensitive to selling price and it has been observed that with every reduction of ₹ 10 in selling price the demand is doubled. What should be the target cost if the demand is doubled at full capacity and profit margin on sale is taken at 25%?

a. ₹75

b. ₹90

c. ₹25

d. ₹60

(vii) A factory can make only one of the three products X, Y or Z in a given production period. The following information is given:

Per Unit ₹	X	Y	Z
Selling Price	1500	1800	2000
Variable Cost	700	950	1000

Assume that there is no constraint on resource utilization or demand and similar resources are consumed by X, Y and Z. The opportunity cost of making one unit of Z is:

a. ₹850

b. ₹800

c. ₹1,800

d. ₹1,500

(viii) Twin Ltd. uses JIT and back flush accounting. It does not use a raw material stock control account. During September 2021, 10000 units were produced and sold. The standard cost per unit is ₹ 150 which includes materials of ₹ 60. During September 2021, ₹ 9,90,000 of conversion costs were incurred. The debit balance in cost of goods sold account for September 2021 is:

a. ₹ 14,00,000

b. ₹ 14,80,000

c. ₹ 15,90,000

d. ₹ 16,20,000

(ix) The following figures are extracted from the books of a company:

Budgeted O/H ₹ 10,000 (Fixed ₹ 6,000, Variable ₹ 4,000)

Budgeted Hours 2000

Actual O/H ₹ 10,400 (Fixed ₹ 6,100, Variable ₹ 4,300)

Actual Hours 2100

Variable O/H cost variance and Fixed O/H cost variance will be:

a. 100 (A) and 200 (A)

b. 100 (F) and 200 (F)

c. 100 (A) and 200 (F)

d. 200 (A) and 100 (F)

(x)   Tableau is a –
    a.   Business Intelligence Tool
    b.   Visualisation Tool
    c.   Both (a) and (b)
    d.   None of the above

(xi)   Which one of the following is a Key feature of SAS language?
    a.   Capability of handling data analysis related to Operations Research and Project Management.
    b.   Capability of report formation with perfect graphs.
    c.   Capability to interact with multiple host systems
    d.   All the above

(xii)   A feasible solution of LPP –
    a.   Must satisfy all the constraints simultaneously.
    b.   Need not satisfy all the constraints, only some of them.
    c.   Must be a corner point of the feasible region
    d.   All the above

(xiii) A PERT activity has an optimistic time of 3 days, pessimistic time of 15 days and an expected time of 7 days. What is the most likely time of the activity?
    a.   10 days
    b.   6 days
    c.   5 days
    d.   None of the above

(xiv)   MR is
    a.   First order derivative of TC
    b.   Second order derivative of TR
    c.   First order derivative of TR
    d.   Second order derivative of TC

(xv)   The equations of the two lines of Regression are $4x + 3y + 7 = 0$ and $3x + 4y + 8 = 0$. The Coefficient of Correlation between x and y is –
    a.   1.25
    b.   0.25
    c.   – 0.75
    d.   0.92

Answer:

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

SECTION – B

Answer any "5" Questions from Question No. 2 to Question No. 8 in Section "B". Each Question Carries 14 marks.   **[5 x 14 = 70]**

2. Forward and Foundry Ltd. is feeling the effects of a general recession in the industry. Its budget for the coming half year is based on an output of only 500 tons of casting a month which is less than half of its capacity. The prices of casting vary with the composition of the metal and the shape of the mould, but they average ₹ 175 a ton. The following details are from the Monthly Production Cost Budget at 500 tone levels:

	Core Making	Melting and Pouring	Moulding	Cleaning and Grinding
	₹	₹	₹	₹
Labour	10,000	16,000	6,000	4,500
Variable overheads	3,000	1,000	1,000	1,000
Fixed overhead	5,000	9,000	2,000	1,000
	18,000	26,000	9,000	6,500
Labour and O.H rate per direct labour hour	9.00	6.50	6.00	5.2

Operation at this level has brought the company to the brink of break-even. It is feared that if the lack of work continues, the company may have to lay off some of the most highly skilled workers whom it would be difficult to get back when the volume picks up later on. No wonder, the work's Manager at this Juncture, welcomes an order for 90,000 casting, each weighing about 40 lbs., to be delivered on a regular schedule during the next six months. As the immediate concern of the Works Manager is to keep his work force occupied, he does not want to lose the order and is ready to recommended a quotation on a no-profit and no-loss basis.

Materials required would cost ₹ 1 per casting after deducting scrap credits. The direct labour hour per casting required for each department would be:

Core Making	0.09
Melting and pouring	0.15
Moulding	0.06
Cleaning and Grinding	0.06

Variable overheads would bear a normal relationship to labour cost in the melting and pouring department and in the moulding department. In core making, cleaning and grinding however, the extra labour requirements would not be accompanied by proportionate increases in variable overhead. Variable overhead would increase by ₹1.20 for every additional labour hour in core making and by 30 paise for every additional labour hour in cleaning and grinding. Standard wage rates are in operation in each department and no labour variances are anticipated. To handle an order as large as this, certain increases in factory overheads would be necessary amounting to ₹ 1,000 a month for all departments put together. Production for this order would be spread evenly over the six months period.

You are required to:

(a) Prepare a revised monthly labour and overhead cost budget, reflecting the addition of this order.

(b) Determine the lowest price at which quotation can be given for 90,000 castings without incurring a loss. [14]

Answer:

Computation of labour and overhead rate.

	Core making	Melting & pouring	Moulding	Cleaning & grinding
Labour & overheads (₹)	18,000.00	26,000.00	9,000.00	6,500.00
Labour & overheads per hour (₹)	9.00	6.50	6.00	5.20
No. of hours	2,000.00	4,000.00	1,500.00	1,250.00
Variable overhead per hour (₹)	1.50	0.25	0.67	0.80
Labour rate per hour (₹)	5.00	4.00	4.00	3.60
Hours required for new order	1,350.00	2,250.00	900.00	900.00
Labour cost required for order (₹)	6,750.00	9,000.00	3,600.00	3,240.00
Variable overhead cost for order (₹)	1,620.00	563.00	600.00	270.00

Revised monthly labour and overheads cost budget reflecting the additions of the order

	Core making	Melting & pouring	Moulding	Cleaning & grinding	Total
	₹	₹	₹	₹	₹
Labour	10,000.00	16,000.00	6,000.00	4,500.00	
Labour for the order	6,750.00	9,000.00	3,600.00	3,240.00	
	16,750.00	**25,000.00**	**9,600.00**	**7,740.00**	
Variable overheads	3,000.00	1,000.00	1,000.00	1,000.00	
Variable overheads for the order	1,620.00	563.00	600.00	270.00	
	4,620.00	**1,563.00**	**1,600.00**	**1,270.00**	
Fixed cost	**5,000.00**	**9,000.00**	**2,000.00**	**1,000.00**	
Total	**26,370.00**	**35,563.00**	**13,200.00**	**10,010.00**	**85,143.00**
Add : additional fixed cost					1,000.00
				Total:	**86,143.00**

Computation of total price for the order

	₹	₹
Material	(15,000 × 1)	15,000.00
Labour & overheads	(86,143 – 59,500)	26,643.00
		41,643.00
Total price for the order	(41,643 × 6)	2,49,858.00

3. (a) A Company with two manufacturing divisions is organised on profit centre basis. Division 'A' is the only source for the supply of a component that is used in Division B in the manufacture

of a product KLIM. One such part is used in each unit of the product KLIM. As the demand for the product is not steady, Division B can obtain orders for increased quantities only by spending more on sales promotion and by reducing the selling prices. The Manager of Division B has accordingly prepared the following forecast of sales quantities and selling prices. [7]

Sales units per day	Average Selling price per unit of KLIM (₹)
1,000	5.25
2,000	3.98
3,000	3.30
4,000	2.78
5,000	2.40
6,000	2.01

The manufacturing cost of KLIM in Division B is ₹3,750 for first 1,000 units and ₹750 per 1,000 units in excess of 1,000 units. Division A incurs a total cost of ₹1,500 per day for an output to 1,000 components and the total costs will increase by ₹900 per day for every additional 1,000 components manufactured. The Manager of Division A states that the operating results of his Division will be optimised if the transfer price of the component is set at ₹1.20 per unit and he has accordingly set the aforesaid transfer price for his supplies of the component to Division A.

You are required to:
(a) Prepare a schedule showing the profit at each level of output for Division A and Division B.
(b) Find the profit of the company as a whole at the output level which
    (i) Division A's net profit is maximum.
    (ii) Division B's net profit is maximum.
(c) If the Company is not organised on profit centre basis, what level of output will be chosen to yield the maximum profit.

(b) A company has estimated the following demand level of its product: [7]

Sales Volume (units)	10000	12000	14000	16000	18000
Probability	0.10	0.15	0.25	0.30	0.20

It has assumed that the sales price of ₹ 6 per unit, marginal cost of ₹ 3.50 per unit, and fixed costs of ₹ 34,000. What is the probability that:
(a) The company will break-even in the period?
(b) The company will make a profit of at least ₹ 10,000?

Answer:

(a) (a) Profit at each level of output
        (i) Statement showing profit of division A

Sale per day (units)	Sale value Units × ₹1.20 (₹)	Cost (₹)	Profit/(loss) (₹)
1000	1200	1500	(300)
2000	2400	2400	-
3000	3600	3300	300
4000	4800	4200	600
5000	6000	5100	900
6000	7200	6000	1200

(ii) **Statement showing profit of division B**

No of units	Selling Price per Unit (₹)	Sales (₹)	Transfer Price (₹)	Other Manufacturing Cost (₹)	Total Cost (₹)	Profit / (Loss) (₹)
1	2	3	4	5	6	7
Derivation		(1 × 2)			(4 + 5)	(3 − 6)
1000	5.25	5250	1200	3750	4950	300
2000	3.98	7960	2400	4500	6900	1060
3000	3.30	9900	3600	5250	8850	1050
4000	2.78	11120	4800	6000	10800	320
5000	2.40	12000	6000	6750	12750	(750)
6000	2.01	12060	7200	7500	14700	(2640)

(b) **(i)** Profit of the company at the output level where division A's net profit is maximum

Profit of Division A is maximum, i.e. ₹1,200/- at the output level of 6,000 units

At the level of 6,000 units:

Profit of Division A = ₹1,200

Profit of Division B = (-) ₹2,640

Profit of the Company = (-) ₹1,440

(ii) Profit of the company at the output level where division B's net profit is maximum

Profit of Division B is maximum, i.e. ₹ 1,060 at the output level of 2,000 units

At the level of 2,000 units:

Profit of Division A = ₹ Nil

Profit of Division B = ₹1,060

Profit of the Company = ₹1,060

(c) Profit when the company is not organized on profit centre basis

Units	Division A (₹)	Division B (₹)	Total (₹)
1000	(300)	300	—
2000	—	1060	1060
3000	300	1050	1350
4000	600	320	920
5000	900	(750)	150
6000	1200	(2640)	(1440)

Maximum profit of ₹1,350 accrues at the output level of 3000 units which may be chosen.

(Explanatory Comment: The problem throws light as to how to make use of the principles of transfer pricing for profit planning, both internally as also externally)

(b)   (a)   Probability of Break-even for the period

In order to break-even, the company must earn enough total contribution to cover its fixed costs. The contribution is ₹ 2.50 per unit (i.e. 6 - 3.5).

Break-even Sales = (Fixed Cost ÷ Contribution per Unit) =

= (34,000 ÷ 2.50) = 13,600 units

Contribution required/Contribution per unit = ₹ 34,000/₹2.50 = 13600 units

The probability that sales will equal or exceed 13,600 units is the probability that sales will be 14,000, 16,000 or 18,000 units which is (0.25 + 0.30 + 0.20) = 0.75 or 75%.

(b)   Probability of earning Profit of ₹10,000

Contribution Needed = (Profit Needed + Fixed Cost) = (10,000 + 34,000) = ₹44,000

Desired Sales = (Contribution Needed ÷ Contribution per Unit) = (44,000 ÷ 2.50) = 17,600 units

The probability that sales will equal or exceed 17,600 units is the probability that sales will be 18,000 units which is 0.20 or 20%

4.   (a)   Modern Co produces 3 products, A, B and C, details of which are shown below: [7]

Particulars	A	B	C
Selling price per unit (₹)	120	110	130
Direct material cost per unit (₹)	60	70	85
Variable overhead (₹)	30	20	15
Maximum demand (units)	30,000	25,000	40,000
Time required on the bottleneck resource (hours per unit)	5	4	3
Resources (hours per unit)	12	10	15

There are 3,20,000 bottleneck hours available each month.

Required:

Calculate the optimum product mix based on the throughput concept.

(b)   Narrate the principles, practices, and tools of lean accounting.   [7]

Answer:

(a)   **Step1: Computation of Rate per Factory Hour**

Serial	Particulars	A	B	C
1	Selling price per unit (₹)	120	110	130
2	Direct material cost per unit (₹)	60	70	85
3	Throughput per unit (₹) (1 – 2)	60	40	45
4	Time required on the bottleneck resource (hours per unit)	5	4	3
5	Return per Factory Hour (₹) (3 ÷ 4)	12	10	15
6	Ranking (on the basis of 5)	II	III	I

Step 2: Allocation of Hours according to Ranking

Description	Hours Allocated	Balance
Total of Bottleneck Hours Available		3,20,000
Hours allocated for C (40,000 units × 3 hours per unit) [Rank I]	1,20,000	
Hours allocated for A (30,000 units × 5 hours per unit) [Rank II]	1,50,000	2,70,000

Hours allocated for B (Being the balance) [Rank III]		50,000

Step 3: Optimum Product MIX

No. of units of B that can be made in balance hours = (50,000 hours ÷ 4 hours per unit) = 12,500 units.

Therefore, Optimum Product MIX:

A = 30,000 units

B = 12,500 units

C = 40,000 units

(b)

Sl.	Principles	Practices	Tools of lean accounting
1	Lean & simple business accounting	Continuously eliminates waste from the transactions, processes, reports, and other accounting methods	• Value stream mapping; current & future state • Kaizen (lean continuous improvement). • PDCA (Planning, Doing, Checking and Acting) problem solving
2	Accounting processes that support lean transformation	Management control & continuous improvement	• Performance Measurement Linkage Chart; linking metrics for cell/process, value streams, plant & corporate reporting to the business strategy, target costs, and lean improvement • Value stream performance boards containing break- through and continuous improvement projects • Box scores showing value stream performance
		Cost management	• Value stream costing • Value stream income statements
		Customer & supplier value and cost management	• Target costing
3	Clear & timely communication of information	Financial reporting	• "Plain English" financial statements Simple, largely cash-based accounting
		Visual reporting of financial & non- financial performance measurements	Primary reporting using visual performance boards; division, plant, value stream, cell/ process in production, product design, sales/marketing, administration, etc.
		Decision-making	Incremental cost & profitability analysis using value stream costing and box scores
4	Planning from a lean perspective	Planning & budgeting	• Hoshin policy deployment. (Hosin Kanri (also called Policy Deployment is a method for ensuring that a company's strategic goals drive progress and action at every level within that company. This method eliminates the waste that comes from inconsistent direction and poor communication). Sales, operations, & financial planning (SOFP)
		Impact of lean	• Value stream cost and capacity analysis

FINAL EXAMINATION
MODEL ANSWERS
PAPER – 16
STRATEGIC COST MANAGEMENT

SET - 1
TERM – DECEMBER 2023
SYLLABUS 2022

		improvement	• Current state & future state value stream maps
			• Box scores showing operational, financial, and capacity changes from lean improvement.
			• Plan for financial benefit from the lean changes
		Capital planning	• Incremental impact of capital expenditure on value stream box-score. Often used with 3P approaches. (Production Preparation Process)
		Invest in people	• Performance measurements tracking continuous improvement participation, employee satisfaction & cross- training Profit sharing
5	Strengthen internal accounting control	Internal control based on lean operational controls	• Transaction elimination matrix
			• Process maps showing controls and SOX risks. (A SOX control is a rule that prevents and detects error within a process cycle of financial reporting. These controls fall under the Sarbanes-Oxley Act of 2002 (SOX). SOX is a U.S. federal law requiring all public companies doing business in the United States to comply with the regulation).
		Inventory valuation	• Simple methods to value inventory without the requirement for perpetual inventory records and product costs can be used when the inventory is low and under visual control.

5. (a) **S.V. Ltd. manufactures BXE by mixing three raw materials. For every batch of 100Kg. of BXE, 125 Kg. of raw materials are used. In April 2021, 60 batches were prepared to produce an output of 5,600 Kg. of BXE. The standard and actual particulars for April 2021 are as under:** [7]

	Standard		Actual		
Raw material	**Mix %**	**Price per kg**	**Mix %**	**Price per kg**	**Quantity of raw materials purchased kg**
A	50	20	60	21	5,000
B	30	10	20	8	2,000
C	20	5	20	6	1,200

Calculate relevant material variances.

(b) **Vinak Ltd. has furnished you the following information for the month of February, 2017.**

	Budget	Actual
Output (Units)	30,000	32,500
Hours	30,000	33,000
Fixed Overhead	₹45,000	₹ 50,000
Variable overhead	60,000	68,000
Working days	25	26

Calculate Variances.   [7]

Answer:

(a) Standard Production = (60 batches ×100 units per batch) = 6,000 units

Standard Raw Material for 6,000 units = (60 batches ×125 kg) = 7,500 kg

Standard Loss = (7,500 - 6,000) = 1,500 kg

Actual Production = 5,600 units

Standard Mix for 60 batches (i.e., 6,000 units)

Raw Material	Mix (%)	Quantity (Kg)	Price (₹)	Value (₹)
A	50	3,750	20	75,000
B	30	2,250	10	22,500
C	20	1,500	5	7,500
Total		7,500		1,05,000
Standard Loss @ 25 kg per batch		60 × 25 = 1,500		
Production		6,000		1,05,000

Standard Mix for Actual Production of 5,600 units

Raw Material	Mix (%)	Quantity (Kg)	Standard Price (₹)	Value (₹)
A	50	3,500	20	70,000
B	30	2,100	10	21,000
C	20	1,400	5	7,000
Total		7,000		98,000

Actual Mix for 5,600 units

Raw Material	Mix (%)	Quantity (Kg)	Standard Price (₹)	Actual Price (₹)	Standard Value (₹)	Actual Value (₹)
A	60	4,500	20	21	90,000	94,500
B	20	1,500	10	8	15,000	12,000
C	20	1,500	5	6	7,500	9,000
Total		7,500			1,12,500	1,15,500
Actual Loss = 7,500 – 5600		1,900				
Production		5,600			1,12,500	1,15,500

Note:

Purchased quantity is 8,200 kg; but consumed quantity is only 7,500 kg.

Material Cost Variance = Standard Cost – Actual Cost = 98,000 – 1,15,500 = ₹ 17,500 (A)

Material Price Variance = AQ (SP-AP) = (1,12,500 - 1,15,500) = ₹ 3,000 (A)

Material Yield Variance = (Standard Price of Standard Mix for Actual Production – Standard Price

of Standard Mix for Standard Production)

$= (98,000 – 1,05,000) = ₹ 7,000$ (A)

Material Mix Variance = Standard Price of Standard Mix for Standard Production – Standard Price of Actual Mix for Actual Production

$= (1,05,000 – 1,12,500) = ₹ 7,500$ (A)

(b)   Calculation of Fixed OH Variances using hourly rate:

SRSH (1)	SRAH (2)	SRRBH (3)	SRBH (4)	ARAH (5)
1.5 × 32500	1.5 × 33000	1.5 × 31200		
48750	49500	46800	45000	50000

$SR = \dfrac{BFO}{BH} = \dfrac{45000}{30000} = 1.5$

RBH   25 -------------- 30000

        26 ------------- ?

SH   30000 --------------- 30000

        32500 ------------- ?

Fixed Overhead Efficiency Variance : 1 – 2 = 750 (A)

Fixed Overhead Capacity Variance : 2 – 3 = 2700

Fixed Overhead Calendar Variance : 3 – 4 = 1800

Fixed Overhead Volume Variance : 1 – 4 = 3750

Fixed Overhead Budget Exp. Variance: 4 – 5 = 5000 (A)

Fixed Overhead Cost Variance: 1 – 5 = 1250(A)

Calculation of Variable OH's Variance:

SRSH (1)	SRAH (2)	ARAH (3)
2 × 32500	2 × 33000	
65000	66000	68000

$SR = \dfrac{BVOHd}{BH's} = \dfrac{60000}{30000} = 2$

SRSH = Std. Cost of Std. Variable Overhead's

SRAH = Atd Cost of Actual Variable Overhead's

ARAH = Actual Cost of actual Variable Overhead's

A) Variable Overhead Efficiency Variance 1 – 2 =1000 (A)

B) Variable Overhead Budget/Exp Variance 2 – 3 = 2000 (A)

C) Variable Overhead Cost Variance 1 – 3 = 3000(A)

6.   **(a)**   **Mr. Lal is on a low cholesterol diet. During lunch at the office canteen he always chooses between two particular types of meal – Type A and Type B. the table below lists the amount of protein, carbohydrates and vitamins each meal provides along with the amount of cholesterol (which he is trying to minimize). He needs at least 200 grams of protein, 960 grams of carbohydrates and 40 grams of vitamins for lunch each month. Over this time period, how many days should he have Type A meal and how many days the Type B meal so that he gets adequate amount of protein, carbohydrates and vitamins and at the same time minimizes his cholesterol intake. Formulate LPP.**

[7]

	Type A meal	Type B meal
Protein (Grams)	8	16
Carbohydrates (Grams)	60	40
Vitamins (Grams)	2	2
Cholesterol (Milli grams)	60	50

(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. [7]

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

Answer:

(a) Let x_1 be the no. of units of type A meal

Let x_2 be the no. of units of type B meal

Objective function minimize $Z = 60x_1 + 50x_2$

Subject to the constraints

$8x_1 + 16x_2 \geq 200$:

$60x_1 + 40x_2 \geq 960$:

$2x_1 + 2x_2 \geq 40$.

$x_1 \geq 0, x_2 \geq 0$

(b) 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 (minutes)
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. (a) The following table gives the activities and other relevant information related to "Making of a loaf".

Activity	Preceded by	Elapsed Time (Minutes)
A - Weigh ingredients	-	1
B - Mix ingredients	A	3
C - Dough rising time	B	60
D - Prepare tins	-	1
E - Pre-heat oven	-	10
F - Knock back dough and place in tins	C&D	2
G - 2nd dough rising time	F	15
H - Cooking time	E&G	45

Draw a Network diagram. Also find the Earliest and Latest Times of each Event of the Network. Identify the different paths of the Network and their corresponding durations. Which path is critical? Find the time required to complete the job. [7]

(b) The usual Learning Curve model is $Y = ax^b$ where

Y is the average time per unit for x units and 'a' is the time for first unit

x is the cumulative number of units

b is the learning coefficient and is equal to (log 0.8)/(log 2) = –0.322 for a learning rate of 80%

Given that a = 10 hours, you are required to Calculate:

(i) The average time for 20 units.

(ii) The total time for 30 units.

(iii) The time for units 31 to 40.

Given that log 2 = 0.301, Antilog of 0.5811 = 3.812

log 3 = 0.4771, Antilog of 0.5244 = 3.345.
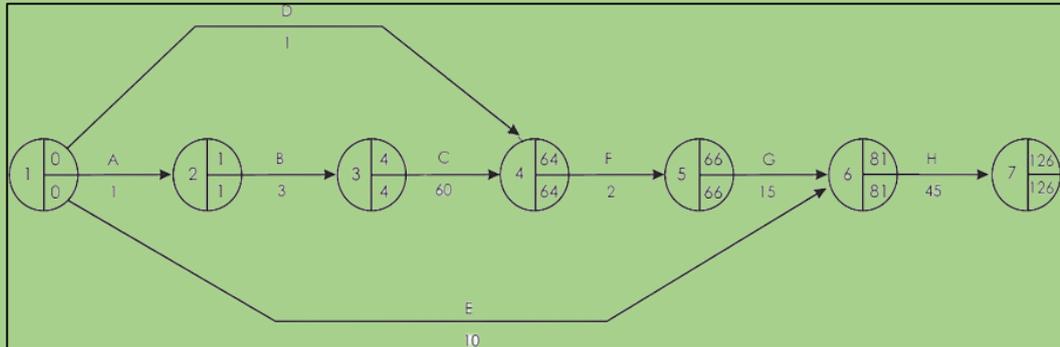
log 4 = 0.6021, Antilog of 0.4841 = 3.049. [7]

Answer:

(a)

FINAL EXAMINATION

MODEL ANSWERS

PAPER – 16

STRATEGIC COST MANAGEMENT

SET – 1

TERM – DECEMBER 2023

SYLLABUS 2022

The Earliest expected Time and the Latest allowable Time of each event is determined by using the methods of Forward Pass and Backward Pass respectively.

The formula used in the calculation of Earliest expected Event Time is $E_j = E_i + t_{ij}$ & for Merge Events $E_j = Max (E_i + t_{ij})$

As per the standard procedure of Forward Pass $E_1 = 0$

$E_2 = E_1 + t_{12} = 0+1 = 1$, $E_3 = E_2 + t_{23} = 1+3 = 4$, $E_4 = Max. [(E_3 + t_{34}), (E_1 + t_{14})] = Max. [(4+60), (0+1)] = 64$ $E_5 = E_4 + t_{45} = 64+2 = 66$, $E_6 = Max. [(E_5 + t_{56}), (E_1 + t_{16})] = Max. [(66+15), (0+10)] = Max. [81, 10] = 81$ $E_7 = E_6 + t_{67} = 81+45 = 126$

These values are shown in the upper one of the two quadrants drawn in each circle to represent events.

The formula used in the calculation of Latest allowable. Event Time is $L_i = L_j − t_{ij}$ & for Burst Events $L_i = Min. (L_j − t_{ij})$

As per the standard procedure of Backward Pass L = E for the last event. Thus $L_7 = E_7 = 126$

$L_6 = L_7 − t_{67} = 126 − 45 = 81$, $L_5 = L_6 − t_{56} = 81 − 15 = 66$, $L_4 = L_5 − t_{45} = 66 − 2 = 64$, $L_3 = L_4 − t_{34} = 64 − 60 = 4$,

$L_2 = L_3 − t_{23} = 4 − 3 = 1$, $L_1 = Min. [(L_2 − t_{12}), (L_4 − t_{14}) \& (L_6 − t_{16})] = Min. [(1-1), (64-1) \& (81-10)] = 0$

These values are shown in the lower one of the two quadrants drawn in each circle to represent events. From the above diagram, different paths of the Network and their corresponding durations are as follows –

1. A – B – C – F – G – H or 1 – 2 – 3 – 4 – 5 – 6 -- 7 & Duration = 1+3+60+2+15+45 = 126 Minutes
2. D – F – G – H or 1 – 4 – 5 - 6 – 7 & Duration = 1+2+15+45 = 63 Minutes
3. E – H or 1 – 6 – 7 & Duration = 10+45 = 55 Minutes

Of the above three, the duration of the path A – B – C – F - G – H is maximum. So this is the CRITICAL PATH. Time required to make the loaf is 126 Minutes. (This is the project completion time)

[Note: In this example, there is a clear sequence of events that have to happen in the right order. If any of the events on the critical path is delayed, then the bread will not be ready as soon. However, tasks D (prepare tins) and E (heat the oven) can be started at any time as long as they are done by the latest time in the following node.

So, we can see that the oven could be switched on as early as time 0, but we can work out that it could be switched on at any time before 71 – any later than this and it won't be hot enough when the dough is ready for cooking. There is some 'float' available for tasks D and E as neither is on the critical path.]

(b)   **(i)** $Y = aX^b$

$Y = 10(20)-0.322$

Taking logarithm on both sides

$\text{Log } Y = \log 10 + \log 20^{(-0.322)}$

$\text{Log } Y = \log 10 - (0.322) \log 20$

$= 1 - (0.322) \log 20$

$= 1 - (0.322) \times (1.3010)$

$= 1 - 0.41892 = 0.5811$

$\text{Log } Y = 0.5811$

$Y = \text{Anti log } (0.5811) = 3.812$ hrs (average time for 20 units)

(ii) $\text{Log } Y = \log 10 + \log 30^{(-0.322)}$

$\text{Log } Y = 1 - (0.322) \times (1.4771)$

$= 1 - (0.4756) = 0.5244$

$Y = \text{anti log } (0.5244) = 3.345$ hrs (average time for 30 units)

Total time for 30 units $= 3.345 \times 30 = 100.35$ hrs

(iii) $\text{Log } Y = \log 10 + \log 40^{(-0.322)}$

$= 1 - (0.322) \times (1.6021)$ $\text{Log } Y = 0.4841$

$Y = \text{anti log } (0.4841) = 3.049$ hrs

Total time for 40 units $= 40 \times 3.049 = 121.96$ hrs

Time from 31 to 40 units $= 121.96 - (100.35) = 21.61$ hrs

8.   **(a)**   **Solve the Game using Domine Principle** $\begin{bmatrix} 15 & 2 & 3 \\ 6 & 5 & 7 \\ -7 & 4 & 0 \end{bmatrix}$ **[7]**

(b)   **Find trend values of the following year wise data of Goods carried by a fleet of trucks of a Transport Company having pan India network using the Moving Average Method. [Assume a 4 yearly cycle]**

[7]

Year	1975	1976	1977	1978
Goods carried (Tons)	2204	2500	2360	2680
Year	1979	1980	1981	1982
Goods carried (Tons)	2424	2634	2904	3098
Year	1983	1984	1985	1986
Goods carried (Tons)	3172	2952	3248	3172

Answer:

(a)

$$A = \begin{bmatrix} 15 & 2 & 3 \\ 6 & 5 & 7 \\ -7 & 4 & 0 \end{bmatrix}$$

	B1	B2	B3	Row Minimum
A1	15	2	3	2
A2	6	5	7	5
A3	-7	4	0	-7
Column Maximum	15	5	7	

To check,

Minimax = Maximin

Min {15,5,7} = Max {2, 5, -7}

      5 = 5

Saddle point exist at (A_2, B_2)

It is a pure strategy game.

Pure Strategy for A = A_2

Pure Strategy for B = B_2

Value of the game = 5

i.e., expected gain to A = 5/-

expected loss of B = 5/-

(b) **Calculations for 4 Yearly Moving Average Trend values**

Year	Goods carried (Tons)	4 Yearly Moving Total	4 Yearly Moving Average (Not centred)	2 item Moving Total (Centred)	4 Yearly Moving Average (Centred)
(1)	(2)	(3)	(4) = (3) 4	(5)	(6) = (5) 2
1975	2204	-	-	-	-
1976	2500	-	-	-	-
		9744	2436		
1977	2360			4927	**2463.50**
		9964	2491		
1978	2680			5015.5	**2507.75**
		10098	2524.5		
1979	2424			5185	**2592.50**
		10642	2660.5		
1980	2634			5425.5	**2712.75**
		11060	2765		
1981	2904			5717	**2858.50**
		11808	2952		
1982	3098			5983.5	**2991.75**
		12126	3031.5		
1983	3172			6149	**3074.5**
		12470	3117.5		

1984	2952			6253.5	**3126.75**
		12544	3136		
1985	3248	-	-	-	-
1986	3172	-	-	-	-

Method of calculation –

1st entry of Column (3) = Sum of the entries in Column (2) for the period 1975 to 1978 = 2204+2500+2360+2680 and it is placed in between the years 1976 & 1977 i.e., at the middle of the first 4 year period under consideration.

2nd entry of Column (3) = Sum of the entries in Column (2) for the period 1976 to 1979 = 2500+2360+2680+2424 and it is placed in between the years 1977 & 1978 i.e., at the middle of the second 4 year period under consideration.

3rd entry of Column (3) = Sum of the entries in Column (2) for the period 1977 to 1980 = 2360+2680+2424+2634 and it is placed in between the years 1978 & 1979 i.e., at the middle of the third 4 year period under consideration.

Thus it is clear that except the first entry, each of the other entries are made by omitting the first value of the previous period and adding the value against the new year taken into consideration. This way all the other entries of column (3) are made. As none of these entries appear against a particular year, they are called "Not centred" values.

Similarly, in case of column (5) except the first entry, each of the other entries are made by omitting the first value considered for the previous calculation and adding a new value from the column (4) values. It is shown below.

1st entry of Column (5) = Sum of the first two entries of column (4) = 2436 + 2491 = 4927

2nd entry of Column (5) = Sum of the second & third entries of column (4) = 2491 + 2524.5 = 5015.5

3rd entry of Column (5) = Sum of the third & fourth entries of column (4) = 2524.5 + 2660.5 = 5185
Other entries of Column (5) are made using the same method.