Paper 15 – Strategic Cost Management and Decision Making

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

Section A

1. Answer the following and each question carries 2 marks. [10×2= 20]

(i) B Ltd. Has earned net profit of ₹ 1 lakh, and its overall P/V ratio and margin of safety are 25% and 50% respectively. What is the total fixed cost of the company?
(a) ₹2,50,000 (b) ₹2,00,000 (c) ₹ 3,00,000 (d) ₹ 1,00,000

(ii) A company determines its selling price by marking up variable costs 60%. In addition, the company uses frequent selling price mark down to stimulate sales. If the mark down average 10%, what is the company's contribution margin ratio?
(a) 30.6% (b) 44% (c) 86.4% (d) None of these

(iii) If the direct labour cost is reduced by 20% with every doubling of output, what will be the cost of labour for the sixteenth unit produced as an approximate percentage of the cost of the first unit produced?
(a) 51.2% (b) 40.96% (c) 62% (d) None of these

(iv) A company has the capacity of production of 80,000 units and presently sells 20,000 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 at full capacity if profit margin on sale is taken as 25%?
(a) ₹75 (b) ₹ 90 (c) ₹ 60 (d) ₹ 25

(v) A company has 2,000 units of an obsolete item which are carried in inventory at the original purchase price of ₹ 30,000. If these items are reworked for ₹10,000, they can be sold for ₹18,000. Alternatively, they can be sold as scrap for ₹ 3,000 in the market. In a decision model used to analyze the reworking proposal, the opportunity cost should be taken as:
(a) ₹ 8,000 (b) ₹ 12,000 (c) ₹ 3,000 (d) ₹10,000

(vi) A company manufactures two products using common material handling facility. The total budgeted material handling cost is ₹60,000. The other details are:

	Product X	Product Y
Number of units produced	30	30
Material moves per product line	5	15
Direct labour hour per unit	200	200

Under activity based costing system the material handling cost to be allocated to product X (per unit) would be:
(a) ₹1,000 (b) ₹ 500 (c) ₹ 1,500 (d) ₹2,500

(vii)The total cost of manufacturing a component is as under at a capacity of 50,000 units of production:

	₹
Prime cost	10.00
Variable overheads	2.40
Fixed Overheads	4.00
	16.40

The selling price is ₹ 21 per unit. The variable selling and administrative expenses is 60 paise per component extra. During the next quarter only 10,000 units can be produced and sold. Management plans to shut down the plant estimating that the fixed manufacturing cost can be reduced to ₹ 74,000 per quarter. When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shutdown for the quarter are estimated at ₹ 14,000. The shut down pint for the quarter in units of product will be:

(a) ₹ 25,000 (b) ₹14,000 (c) ₹11,000 (d) ₹ 20,000

(viii)If the time taken to produce the first unit of a product is 4000 hrs, what will be the total time taken to produce the 5th to 8th unit of the product, when a 90% learning curve applies?

(a) 10,500 hours (b) 12,968 hours (c) 9,560 hours (d) 10,368 hours

(ix) A company operates throughput accounting system. The details of product X per unit are as under.

Selling Price	₹50
Material Cost	₹20
Conversion cost	₹15
Time on bottleneck resources	10 minutes

The return per hour for product X is:

(a) ₹ 210 (b) ₹300 (c) ₹ 180 (d) ₹90

(x) The information relating to the direct material cost of a company is as under:

	₹
Standard price per unit	3.60
Actual quantity purchased in units	1,600
Standard quantity allowed for actual production in units	1.450
Material price variance on purchase (favourable)	240

What is the actual purchase price per unit?

(a) ₹ 3.45 (b) ₹ 3.75 (c) ₹ 3.20 (d) ₹ 3.25

Answer: 1

(i)(d)

MS=Profit/PV Ratio = ₹4 Lakh: MS=50%; BE Sales = (1-0.50) = 0.50

Hence BES = ₹4 lakh

Fixed Cost 25% of ₹4,00,000 = ₹1,00,000

(ii) (a)

When V (Var. cost) = 100, SP = 160, M.Cost/SP = 60/100

SP after 10% mark down of SP = 144, Cost = 60-16=44

Contribution Margin Ratio = 44/144=0.3056=30.6%

(iii) (b)

1st	100%
2nd	80% x 100%
4th	80% of 2nd
8th	80% of 4th
16th	80% of 8th = 0.80 x 0.80 x 0.80 x 0.80 = 40.96%

Say, 41% of the time required for the 1st unit.

(iv) (c)

Demand	Price (₹)
20,000	100
40,000	90
80,000	80

Target Cost = ₹80 - (25% of 80) = ₹ 80 - 20 = ₹ 60

(v) (c) Original price is not relevant

Rework income	₹18,000	
Deduct cost of rework	10,000	
Net inflow	₹8,000	It is relevant

The other alternative relevant cash flow is from sale as scrap = ₹3,000. Hence, the opportunity cost is ₹3,000.

(vi) (b)

Total moves in material handling = 5+15=20

Percentage move for Product A = 5/20=25%

Material handling cost to be allocated to Product A = ₹60,000/25%=Rs.15,000

i.e., ₹ 15,000/30= ₹500 per unit.

(vii) (b)

Contribution per unit of component	₹	₹
Variable Prime cost	10.00	
Variable overhead	2.40	
Selling/Administrative expenses	0.60	13.00
Contribution		Rs. 8.00

Avoidable fixed cost per quarter

= total fixed cost-(unavoidable fixed cost + additional shut down cost)

=(50,000 x ₹4)- (₹74,000 + ₹14,000) = ₹1,12,000.

The required shut down point for the quarter = ₹1,12,000 / ₹8 = 14,000 units.

(viii) (d)

Units	Average Time (hours)	Total Time (hours)
1	4000	4000
2	3600	7200
4	3240	12960
8	2916	23328

Total time for 5th to 8 units = 23328 - 12960 = 10368 hrs.

(ix)(c) (Selling Price - Material Cost)/ Time of bottleneck resource

= [(₹ 50 - ₹ 20)/10 minutes] x 60 = ₹180 per hour.

(x)(a)

Actual quantity bought x standard price

= 1,600 x ₹ 3.60 = Rs. 5,760

Deduct favorable price variance 240

Actual quantity x actual price = 5,520

Or, 1,600 x actual price = ₹ 5,520 So,

Actual price ₹ 5,520/1,600 = ₹ 3.45

Section B

Answer any five questions from Question No. 2 to 8
Each question carries 16 marks. [5 ×16 = 80]

2. (a) A company is considering the purchase of a machine for ₹3,50,000. It feels quite confident that it can sell the goods produced by the machine as to yield an annual cash surplus of ₹1,00,000. There is however me uncertainly as to the machine working life. A recently publish Trade Association Survey shows that members of the Association have between them owned 250 of these machines and have found the lives of the machines vary as under:

No. of year of machine life	3	4	5	6	7	Total
No. of machines having given life	20	50	100	70	10	250

Assuming discount rate of 10% the net present value for each different machine life is follows:

Machine life	3	4	5	6	7
NPV (₹)	(1,01,000)	(33,000)	29,000	86,000	1,37,000

You required to advice whether the company should purchase a machine or not. [6]

2 (b) A manufacturing company currently operating at 80% capacity has received an export order from Middle East, which will utilise 40% of the capacity of the factory. The order has to be either taken in full and executed at 10% below the current domestic prices or rejected totally.

The current sales and cost data are given below.

Sales	₹16.00 lakhs.
Direct Material	₹ 5.80 lakhs.
Direct Labour	₹ 2.40 lakhs.
Variable Overheads	₹ 0.60 lakhs.
Fixed Overheads	₹ 5.20 lakhs.

The following alternatives are available to the management:

(a) Continue with domestic sales and reject the export order.
(b) Accept the export order and allow the domestic market to starve to the extent of excess of demand.
(c) Increase capacity so as to accept the export order and maintain the domestic demand by
(i) Purchasing additional plant and increasing 10% capacity and there by increasing fixed overheads by ₹65,000 and
(ii) Working overtime at one and half time the normal rate to meet balance of the required capacity.

You are required to evaluate each of the above alternatives and suggest the best one.

[10]

Answer: 2(a)

Computation of NPV of an asset considering the probability of life of machine.

Year	Probability (a) ₹	NPV (b) ₹	Expected value (a × b)
3	20/250	(1,01,000)	(8,080)
4	50/250	(33,000)	(6,600)
5	100/250	29,000	11,600
6	70/250	86,000	24,080
7	10/250	1,37,000	5,480
			26,480

So, Assets should be purchased.

Answer: 2(b)

Statement showing computation of profit at different alternatives:

(In Lakhs)

	Particulars	I Present Sales 80%	II 40% - Foreign 60% - Domestic	III 40% - Foreign 80% - Domestic
I.	Sales(₹)	16	19.2 (7.2+12)	23.2 (7.2+16)
II.	Variable Cost (₹)			
	Direct Material (₹)	5.8	7.25	8.70
	Direct Labour (₹)	2.4	3.00	3.60
	Variable Overheads (₹)	0.6	0.75	0.90
	Overtime Premium (₹)	----	----	0.15
		8.80	11.00	13.35
III.	Contribution (₹)	7.20	8.20	9.85
IV.	Fixed Cost(₹)	5.20	5.20	5.85 (5.20+0.65)
V.	Profit(₹)	2.00	3.00	4.00

From the above computation, it was found that the profit is more at the III alternative i.e. accepting the foreign order fully and maintaining the present domestic sales, it is the best alternative to be suggested.

3 (a) A Company manufacturing a highly successful line of cosmetics intends to diversify the product line to achieve fuller utilization of its plant capacity. As a result of considerable research made the company has been able to develop a new product called 'EMO'.

EMO is packed in tubes of 50 grams capacity and is sold to the wholesalers in cartons of 24 tubes at ₹240 per carton. Since the company uses its spare capacity for the manufacturer of EMO, no additional fixed expenses will be incurred. However, the cost account has allocated a share of ₹4,50,000 per month as fixed expenses to be absorbed by EMO as a fair share of the company's present fixed costs to the new production for costing purposes.

The company estimated the production and sale of EMO at 3,00,000 tubes per month and on this basis the following cost estimates have been developed.

	₹ per carton
Direct Materials	**108**
Direct Wages	**72**
All overheads	**54**
Total costs	**234**

After a detailed market survey the company is confident that the production and sales of EMO can be increased to 3,50,000 empty tubes and the cost of empty tubes, purchased from outside will result in a saving of 20% in material and 10% in direct wages and variable overhead costs of EMO. The price at which the outside firm is willing to supply the empty tubes is ₹1.35 per empty tube. If the company desires to manufacture empty tubes in excess of 3,00,000 tubes, new machine involving an additional fixed overheads ₹30,000 per month will have to be installed. Required-

(i) State by showing your working whether company should make or buy the empty tubes at each of the three volumes of production of EMO namely 3,00,000; 3,50,000 and 4,50,000 tubes.

(ii) At what volume of sales will it be economical for the company to install the additional equipment for the manufacture of empty tubes?

(iii) Evaluate the profitability on the sale of EMO at each, of the aforesaid three levels of output based on your decision and showing the cost of empty tubes as a separate element of cost. [10]

3 (b) The profit for the year of PIT Ltd. work out to 12.5% of the capital employed and the relevant figures are under:

	₹
Sales	**5,00,000**
Direct Material	**2,50,000**
Direct labour	**1,00,000**
Variable overheads	**40,000**
Capital employed	**4,00,000**

The new sales manager who has joined the company recently estimates for the next year a profit of about 23% on the capital employed provided the volume of sales is increased by 10% and simultaneously there is an increase in Selling Price of 4% and an overall cost reduction in all the elements of cost by 2%.

Find out by computing in detail the cost and profit for next year, whether the proposal of sales manager can be adopted. [6]

Answer: 3 (a)

Total Cost per tube including EMO:

Direct Material (108/24) = ₹ 4.50

Direct Wages (72/24) = ₹ 3.00

Variable Overheads [54/24 – 450000/300000] = ₹ 0.75

Particulars	Total Cost (₹)	Tube Cost (₹)	Product Cost (₹)
Material	4.5	0.9	3.60
Wages	3.0	0.3	2.70
Variable Overhead	0.75	0.075	0.675
	8.25	1.275	6.975

Statement showing computation of manufacturing cost of 300000 tubes

Cost of making (300000 x 1.275) = ₹ 3,82,500

Cost of buying (300000 x 1.35) = ₹ 4,05,000

It is better to make the tubes at 300000 level of output.

Computation of Cost for additional tubes:

Particulars	50000	150000
Cost of Making (₹)	93750 [(50000 x 1.275) + 30000]	221750 [(150000 x 1.275) + 30000]
Cost of Buying (₹)	67500 (50000 x 1.35)	202500 (150000 x 1.35)

From the above, it is better to buy at these levels.

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

[Indifference Point] x (Fixed Cost/Diff. in Variable Cost per unit) = 30,000 x (1.35-1.275)
= 4,00,000 units.

The Company will be justified to install the additional Equipment for the manufacture of Empty tubes at a sales volume of 700000 units.

Statement showing computation of Profit at three levels of output:

	Particulars	300000	350000	450000
I.	Sales [240/24] (₹)	3000000	3500000	4500000
II.	Cost (₹)	2092500 (300000x6.975)	2441250 (350000x6.975)	3138750 (450000x6.975)
III.	Tube Cost (₹)	382500 (300000x1.275)	472500 (350000x1.35)	607500 (450000x1.35)
IV.	Fixed cost (₹)	450000	450000	450000
V.	Total Cost (₹)	2925000	3363750	4196250
VI.	Profit (I – V) (₹)	75000	136250	303750

Answer: 3 (b)

(a) Computation of Fixed Cost:

		₹
Sales		5,00,000
(-) Profit	4,00,000 x 12.5%	50,000
Total Cost		4,50,000
(-) VC: DM		2,50,000
DL		1,00,000
VOH	40,000	3,90,000
Fixed Cost		60,000

Statement showing computation of profit obtained on adopting the sales manager's proposal:

			₹
(I)	Sales	5,00,000 x(110/100) x (104/100)=	5,72,000
(II)	Variable Cost	3,90,000 $\times \frac{110}{100} \times \frac{98}{100}$ =	4,20,420
(III)	Contribution		1,51,580
(IV)	Fixed Cost	60,000 x 98%	58,800
(V)	Profit		92,780

$$\% \text{ of profit on capital employed} = \frac{92,780}{4,00,000} \times 100 = 23.195 > 23\%$$

$\therefore$ Proposal is adoptable.

4 (a) ANRO use traditional standard costing system. The inspection and setup costs are actually ₹ 1,760 against a budget of ₹2,000.

ABC system is being implemented and accordingly, the number of batches is identified as the cost driver for inspection and setup costs. The budgeted production is 10,000 units in batches of 1,000 units, whereas actually, 8,800 units were produced in 11 batches.

(i) Find the volume and total fixed overhead variance under the traditional standard costing system.

(ii) Find total fixed overhead cost variance under the ABC system. [10]

4 (b) One kilogram of product 'Kit' requires two chemicals A and B. The following were the details of product 'Kit' for the month of June, 2017:

(a) Standard mix Chemical 'A' 50% and Chemical 'B' 50%

(b) Standard price per kilogram of Chemical 'A' ₹12 and Chemical 'B' ₹15

(c) Actual input of Chemical 'B' 70 kilograms.

(d) Actual price per kilogram of Chemical 'A' ₹15

(e) Standard normal loss 10% of total input.

(f) Materials Cost variance total ₹650 adverse.

(g) Materials Yield variance total ₹135 adverse.

You are required to calculate:

1. Materials mix variance total

2. Materials usage Variance total

3. Materials price variance total

4. Actual loss of actual input

5. Actual input of chemical 'A'

6. Actual price per kilogram of Chemical 'B' [6]

Answer: 4 (a)

(i) Calculation of volume and total fixed overhead under Traditional Standard Costing System

Budgeted overhead cost per unit	= ₹ 2,000/10,000 units	= ₹ 0.20
Actual overhead cost per unit	= ₹ 1,760/8,800 units	= ₹ 0.20
Total fixed overhead variance	= Absorbed budgeted overhead - Actual overhead	
	= (₹ 0.20 x 8,800 units) - ₹ 1,760	= Nil
Fixed overhead expenditure variance	= Budgeted overhead - Actual overhead	
	= 2,000- 1,760	= ₹240 (F)
Standard absorption rate	= ₹ 2,000/10,000 units	= ₹ 0.20 per unit
Fixed overhead volume variance	=Standard absorption rate×(Budgeted units-Actual units)	
	= ₹ 0.20 (10,000 units - 8,800 units)	= ₹ 240 (A)

Verification:

Total fixed overhead variance	= Expenditure variance + Volume variance	
	= 240 (F) + 240 ((A)	= Nil

(ii) Calculation of fixed overhead cost variance under ABC System

Particulars	Budget	Actual	ABC standard
Total cost (₹)	2,000	1,760	1,800
Production (units)	10,000	8,800	8,800
No. of batches	10	11	9
Batch size (units/batch)	1,000	800	1,000
Cost per batch	200	160	200

Under ABC 8,800 units should have been produced in standard batch size of 1,000 units/batch.

No. of batches = 8,800/1,000 = 9 approx.

Standard cost under ABC = Budgeted cost per batch × ABC standard number of batches

= ₹ 200 x 9 = 1,800

Under ABC, variability is with respect to batches and not units

Absorbed overheads = 9 batchs × Standard rate per batch

= 9 × ₹ 200 = ₹ 1,800

Actual overheads = ₹ 1,760

Total overheads cost variance = ₹ 40 (F)

Answer: 4(b)

Let, actual output of chemical A be 'a' kgs

Actual price per Kg of chemical B be ₹ b

Standard input be 100Kgs

Actual output be 90Kgs

	Standard			Actual		
	Q	P	V	Q	P	V
A	50	12	600	a	15	15a
B	50	15	750	70	b	70b
	100		1350	70 + a		15a + 70b
(-) normal loss	10	--	--	a – 20	--	--
	90		1350	90		15a + 70b

	(1)	(2)	(3)	(4)
	SQSP	RSQSP	AQSP	AQAP
A		12 x (70+a/100) x 50	12 x a	
B		15 x (70+a/100)/50	15 x 70	
	1350	945 + 13.5a	1050 + 12a	15a + 70b

Given material cost variance = (1) – (4) = - 650

= 15a + 70b = ₹ 2000

Material yield variance = (1) – (2) = - 135

⇒ a = 40

⇒ b = 20

1) SQSP = ₹ 1350
2) RSQSP = 945 + (13.5 x 40) = ₹ 1485
3) AQSP = 1050 + (12 x 40) = ₹ 1530
4) AQAP = (15 x 40) + (70 x 20) = ₹ 2000

(a) Material mix variance = ₹ 45(A)

(b) Material usage variance = ₹ 180(A)

(c) Material price variance = ₹ 470(A)

(d) Actual loss of actual input = ₹ 20

(e) Actual input of chemical A = 40Kgs

(f) Actual price per Kgs of chemical B = ₹ 20

5 (a) What is Bench trending and how does it differ from Bench Marking? [6]

5 (b) Infamach Ltd. wants to fix proper selling prices for their products 'A' and 'B' which they are newly introducing in the market. Both these products will be manufactured in Department D, which is considered as a Profit Centre.

The estimated data are as under: -

	A	B
Annual Production (unit)	1,00,000	2,00,000
Direct Materials per unit (₹)	15.00	14.00
Direct Labour per unit (₹)	9.00	6.00
(Direct Labour Hour Rate = ₹ 3)		

The proportion of overheads other than interest, chargeable to the two products are as under:

Factory overheads (50% fixed) 100% of Direct Wages. Administration overheads (100% fixed) 10% of factory costs. Selling and Distribution overheads (50% variable) ₹ 3 and ₹ 4 respectively per unit of products A and B.

The fixed capital investment in the Department is ₹50 lakhs. The working capital requirement is equivalent to 6 months stock of cost of sales of both the product. For this project a term loan amounting to ₹40 lakhs has been obtained from Financial Institutions on a interest rate of 14% per annum. 50% of the working capital needs are met by bank borrowing carrying interest at 18% per annum. The Department is expected to give a return of 20% on capital employed.

You are required to:

(i) Fix the selling price of products A and B such that the contribution per direct labour hour is the same for both the products.

(ii) Prepare a statement showing in details the overall profit that would be made by the Department. [10]

Answer: 5(a)

Continuous monitoring of specific process performance with a selected group of benchmarking is a systematic and continuous measurement process of comparing through measuring an organization business processes against business leaders (role models) anywhere in the world, to gain information that will help organization take action to improve its performance. The continuous process of enlisting the best practices in the world for the processes, goals and objectives leading to world class levels of achievement.

Benchmarking is the process of comparing the cost, time or quality of what one organization does against what another organization does. The result is often a business case for making changes in order to make improvements.

Benchmarking is a powerful management tool because it overcomes "paradigm blindness". Paradigm Blindness can be summed up as the mode of thinking, "the way we do it is the best because this is the way we've always done it". Bench Marking opens organizations to new methods, ideas and tools to improve their effectiveness. It helps crack through resistance to change by demonstrating other methods of solving problems than the one currently employed and demonstrating that they work, because they are being used by others.

Answer: 5(b)

Statement of Cost

Material	A	B
	₹	₹
Direct Material	15	14
Direct Labour	9	6
Price Cost	24	20
Factory Overhead (100% Direct Labour	9	6
Factory Cost	33	26
Administration Overhead (10% of Factory Cost)	3.30	2.6
Cost of production	36.30	28.6
Selling and Distribution	3	4
Cost of Sales (or) Unit Cost	39.30	32.60

Variable Cost:

	A	B
	₹	₹
Prime Cost	24	20
Factory Overhead (Variable) (9 x 50%) (6 x 50%)	4.5	3
Selling (Variable)	1.5	2
Total	30	25

Computation of Total capital Employed:

Fixed Capital		₹
Working Capital:		50,00,000
A = 1,00,000 x 39.3	39,30,000	
B = 2,00,000 x 32.6	65,20,000	
	1,04,50,000 x 6/12	52,25,000
Total Capital employed		1,02,25,000
Required Return @ 20% on Total Capital employed		20,45,000
Total Cost		1,04,50,000
Add: EBIT		20,45,000
Sales Value		1,24,95,000
Less: Variable Cost	1,00,000 x 30 + 2,00,000 x 25	80,00,000
Contribution		44,95,000
Contribution per hour	44,95,000/7,00,000	6.4214
Contribution for unit of 'A"	3 x 6.4214	19.2463
Contribution per hour	44,95,000/7,00,000	
Contribution for unit of 'B"	2 x 6.4214	12.8429

Computation of Selling Price:

	A	B
	₹	₹
Variable cost	30	25
Add: Required Contribution	19.4643	12.8429
Selling Price	**49.4643**	**37.8429**

(b)

		₹
I	Sales	1,24,95,000
II	Cost	1,04,50,000
III	EBIT (Profit)	20,45,000
IV	Interest on term loan (40,00,000 x 14%)	(5,60,000)
V	Interest on bank borrowing 52,25,000 x ½ x 18/100	(4,70,250)
VI	Profit	10,14,750

6 (a) An automobile production line turns out about 100 cars a day, but deviations occur owing to many causes. The production is more accurately described by the probability distribution given below

Production/Day	Prob.	Production/Day	Prob.
95	**0.03**	**101**	**0.15**
96	**0.05**	**102**	**0.10**
97	**0.07**	**103**	**0.07**
98	**0.10**	**104**	**0.05**
99	**0.15**	**105**	**0.03**
100	**0.20**		
		Total	**1.00**

Finished cars are transported across the bay, at the end of each day, by ferry. If the ferry has space for only 101 cars, what will be the average number of cars waiting to be shipped, and what will be the average number of empty space on the boat? [8]

6 (b) A company has four zones open and four salesmen available for assignment. The zones are not equally rich in their sales potentials. It is estimated that a typical salesman operating in each zone would bring in the following annual sales:
Zone: A: 1,26,000: Zone B:1,05,000; Zone C: 84,000; Zone D: 63,000.
The four salesmen are also considered to differ in ability. It is estimated that working under the same condition their yearly sales would be proportionately as follows:
Salesman P:7; Salesman Q: 5; Salesman R:5; Salesman S:4. If the criterion is maximum expected total sales, the intuitive answer is to assign the best salesman to the richest zone, the next best to the second richest zone and so on. Verify this by the method of assignment. [8]

Answer: 6(a)

Simulation of data of an Automobile Production line			
Production/day	**Probability**	**Cumulative Probability**	**Random No. Range**
95	0.03	0.03	0-2
96	0.05	0.08	3-7
97	0.07	0.15	8-14
98	0.10	0.25	15-24
99	0.15	0.40	25-39
100	0.20	0.60	40-59
101	0.15	0.75	60-74
102	0.10	0.85	75-84
103	0.07	0.92	85-91
104	0.05	0.97	92-96
105	0.03	1.00	97-99
	1.00		

Stimulated data				
Day	**Random No.**	**Production**	**No.of cars waiting to be shipped**	**No. of empty space on the boat**
1	20	98	-	3
2	63	101	-	-
3	46	100	-	1
4	16	98	-	3
5	45	100	-	1
6	41	100	-	1
7	44	100	-	1
8	66	101	-	-
9	87	103	2	-
10	26	99	-	2
11	78	102	1	-
12	40	100	-	1
13	29	99	-	2
14	92	104	3	-
15	21	98	-	3
Total			6	18

Average no. of cars waiting to be shipped = 6/15 = 0.40
Average no. of empty space on the boat = 18/15 = 1.2

Answer: 6(b)

Sales Man	A	B	C	D
P	42	35	28	21
Q	30	25	20	15
R	30	25	20	15
S	24	20	16	12

Loss Matrix

0	7	14	21
12	17	22	27
12	17	22	27

Row Operation

0	7	14	21
0	5	10	15
0	5	10	15
1	4	8	12

Column Operation

0	3	6	9
0	1	2	3
0	1	2	3
0	0	0	0

Row Operation

0	2	5	8
0	0	1	2
0	0	1	2
1	0	0	0

Column Operation

0	2	4	7
0	0	0	1
0	0	0	1
2	1	0	0

P → A - 42
Q → B - 25
R → C - 20
S → D - 12

99 x 3000 = ₹ 2,97,000 Maximum sales

7 (a) A civil engineering firm has to bid for the construction of a dam. The activities and time estimates are given below:

Activity	Duration		
	Optimistic	Most likely	Pessimistic
1-2	14	17	25
2-3	14	18	21
2-4	13	15	18
2 – 8	16	19	28
3 – 4 (dummy)			
3 – 5	15	18	27
4 – 6	13	17	21
5 – 7 (dummy)			
5 – 9	14	18	20
6 – 7 (dummy)			
6 – 8 (dummy)			
7 – 9	16	20	41
8 – 9	14	16	22

The policy of the firm with respect to submitting bids is to bid the minimum amount that will provide a 95% of probability of at best breaking even. The fixed costs for the project are 8 lakhs and the variable costs are ₹ 9,000 everyday spent working on the project. The duration is in days and the costs are in terms of rupees. What amount should the firm bid under this policy? (You may perform the calculations on duration etc. upto two decimal places). [10]

7(b) A Company produces the products P, Q and R from three raw materials A, B and C. One unit of product P requires 2 units of A and 3 units of B. A unit of product Q requires 2 units of B and 5 units of C and one unit of product R requires 3 units of A, 2 unit of B and 4 units of C. The Company has 8 units of material A, 10 units of B and 15 units of C available to it. Profits/unit of products P, Q and R are ₹3, ₹5 and ₹4 respectively.

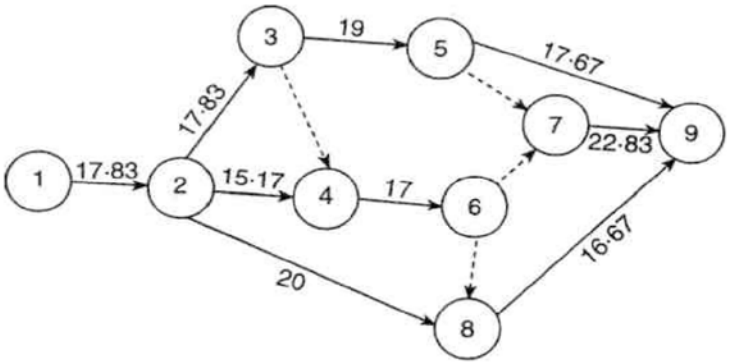
(a) Formulate the problem mathematically,

(b) Write the Dual problem.

Answer: 7(a)

The expected duration and variance of each activity is computed in the following table:

Activity	Optimistic (t_0)	Time most likely (t_m)	Pessimistic (t_p)	Expected duration $t_e \frac{1}{6}(t_0 + 4t_m + t_p)$	Variance $\left[\frac{1}{6}(t_p - t_0)\right]^2$
1—2	14	17	25	17.83	3.36
2—3	14	18	21	17.83	1.36
2—4	13	15	18	15.17	
2—8	16	19	28	20.00	
3—4	—	—	—	—	
3—5	15	18	27	19.00	4
4—6	13	17	21	17.00	
5—7	—	—	—	—	
5—9	14	18	20	17.67	
6—7	—	—	—	—	
6—8	—	—	—	—	
7—9	16	20	41	22.83	17.36
8—9	14	16	22	16.67	



The various paths and their lengths are as follows:

	Path	Duration
I.	1-2-3-5-7-9	77.49*
II.	1-2-3-5-9	72.33
III.	1-2-3-4-6-7-9	75.49
IV.	1-2-3-4-6-8-9	69.33
V.	1-2-8-9	54.50
VI.	1-2-4-6-8-9	66.67
VII.	1-2-4-6-7-9	72.83

Thus, the critical path is 1—2—3—5—7—9 with project duration of 77.49 days. Project variance is obtained by summing variances of critical activities, σ^2 = 3.36 + 1.36 + 4 + 17.36 = 26.08.

∴ Standard duration of project length, $\sigma = \sqrt{26.08} = 5.11$

To calculate the project duration which will have 95% chances of its completion, we find the value of Z corresponding to 95% area from normal distribution area table which is 1.645. Thus

$$P(X \le T_s) = P\left(Z \le \frac{T_S - 77.49}{5.11}\right) = 0.95$$

$$= \frac{T_S - 77.49}{5.11} = 1.645 \quad \text{or} \quad T_s = 1.645 \times 5.12 + 77.49 = 86 \text{ days.}$$

Since the fixed cost of the project is ₹ 8 lakhs and the variable cost is ₹ 9000 per day, amount to bid = ₹ 8 lakhs + ₹ 9000 x 86 = ₹ 15,74,000.

Answer: 7(b)

Raw Materials	P	Q	R	Available units
A	2	-	3	8
B	3	2	2	10
C	-	5	4	15

Profits 3/- 5/- 4/-

Let x_1 be the no. of units of P

Let x_2 be the no. of units of Q

Let x_3 be the no. of units of R

Objective function: Max. $Z = 3x_1 + 5x_2 + 4x_3$

Subject to constraints:

$2x_1 + 3x_2 \le 8$

$3x_1 + 2x_2 + 2x_3 \le 10$

$5x_2 + 4x_3 \le 15$

And $x_1, x_2, x_3 \ge 0$.

Primal

Max.$Z = 3x_1+5x_2+4x_3$

Subject to

$2x_1+3x_2 \leq 8$

$3x_1+2x_2+2x_3 \leq 10$

$5x_2+4x_3 \leq 15$

And $x_1, x_2, x_3 \geq 0$

Dual

Min. $Z = 8y_1+10y_2+15y_3$

Subject to

$2y_1+3y_2 \geq 3$

$3y_1+2y_2+5y_3 \geq 5$

$2y_2+4y_3 \geq 4$

And $y_1, y_2, y_3 \geq 0$

$2x_1+3x_2 + S1 = 8$

$3x_1+2x_2+2x_3 + S_2 = 10$

$5x_2+4x_3 + S_3 = 15$

Max $Z = 3x_1+ 5x_2+4x_3+0.S_1+0.S_2+0.S_3$

$\therefore x_1 = 23/20 \quad x_2 = 19/10 \quad x_3 = 11/8$

$Z = 18.45$

8. Write short notes on any four out of the following five questions. [4 × 4 = 16]

(a) Six Sigma

(b) Kaizen Costing

(c) The Variants of Backflush Accounting

(d) Business Process Re-engineering.

(e) Uses of Learning curve

Answer: 8

(a) Six Sigma

Six Sigma has two key methodologies: DMAIC and DMADV, both inspired by W. Edwards Deming's Plan-Do-Check- Act Cycle: DMAIC is used to improve an existing business process, and DMADV is used to create new product or process designs for predictable, defect-free performance.

DMAIC

Basic methodology consists of the following five (5) steps:

- Define the process improvement goals that are consistent with customer demands and enterprise strategy.
- Measure the current process and collect relevant data for future comparison.
- Analyze to verify relationship and causality of factors. Determine what the relationship is, and attempt to ensure that all factors have been considered.
- Improve or optimize the process based upon the analysis using techniques like Design of Experiments.
- Control to ensure that any variances are corrected before they result in defects. Set up pilot runs to establish process capability, transition to production and thereafter continuously measure the process and institute control mechanisms.

DMIADV

Basic methodology consists of the following five steps:

- Define the goals of the design activity that are consistent with customer demands and enterprise strategy.
- Measure and identify CTQs (critical to qualities), product capabilities, production process capability, and risk assessments.
- Analyze to develop and design alternatives, create high-level design and evaluate design capability to select the best design.
- Design details, optimize the design, and plan for design verification. This phase may require simulations.
- Verify the design, set up pilot runs, implement production process and handover to process owners.

Some people have used DMAICR (Realize). Others contend that focusing on the financial gains realized through Six Sigma is counter-productive and that said financial gains are simply byproducts of a good process improvement.

(b) Kaizen Costing

The initial VE review may not be complete and perfect in all cost aspects. There may be further chances of waste reduction, cost and time reduction and product improvement. Such continuous cost reduction technique is called as Kaizen Costing.

Kaizen Costing refers to the ongoing continuous improvement program that focuses on the reduction of waste in the production process, thereby further lowering costs below the initial targets specified during the design phase. It is a Japanese term for a number of cost reduction steps that can be used subsequent to issuing a new product design to the factory floor.

Toyota's Experience of Kaizen Costing: Toyota aggressively pursued Kaizen Costing to reduce costs in the manufacturing phase. Methods for achieving these kaizen goals include cutting material costs per unit and improvement in standard operating procedures. These are pursued based on employee's suggestions. About two million suggestion were received from Toyota employees in t\one recent year alone roughly thirty-five per employee. Ninety-seven percent of them were adopted. This is really a prime example of concept of employee empowerment in which workers are encouraged to take their own initiatives to improve operations, reduce costs, and improve product quality and customer service.

(c) The Variants of Backflush Accounting

There are a number of variants of the Backflush system, each differing as to the 'trigger points' at which costs are recognized within the cost accounts and thus associated with products. All variants, however, have the following common features:

• the focus is on output – costs are first associated with output (measured as either sales or completed production) and then allocated between stocks and costs of goods sold by working back.

• Conversion costs (labour and overheads) are never attached to products until they are complete (or even sold) – thus the traditional WIP account doesn't exist.

Two variants of the Backflush system are summarized below. Note that in each as conversion costs (labour and overheads) are incurred they will be recorded in a conversion cost (CC) account.

Variant 1

This has two trigger points (TP) :

TP 1 - purchase of raw materials / components. A 'raw and in process (RIP)' account will be debited with the actual cost of materials purchased, and creditors credited.

TP 2 - completion of good units. The finished goods (FG) account will be debited with the standard cost of unit produced and the RIP and CC account will be credited with the standard cost.

Under this variant, then, there will be two stock accounts :

- raw materials (which may, in fact, be incorporated into WIP)
- finished goods

Variant 2

This has only one trigger point – the completion of good units. The FG account is debited with the standard cost of units produced, with corresponding credits to the CC account and the creditors account.

Thus the cost records exclude :

- raw materials purchased but not yet used for complete production
- the creditors for these materials (and any price variance)

and there is only stock account, carrying the standard cost of finished goods stock.

Other variants include those using the sale of complete goods units as a trigger point for the attachment of conversion cost to unit -- thus there is no finished goods account, just a raw materials stock account, carrying the materials cost of raw materials, WIP and finished goods.

(d) Business Process Re-engineering.

Business Process Re-engineering (BPR) refers to the fundamental rethinking and redesign of business processes to achieve improvement in critical measures of performance such as cost, quality, service, speed and customer satisfaction. In contrast the concept of Kaizen, which involves small, incremental steps towards gradual improvement, re-engineering involves a giant leap. It is the complete redesign of a process with an emphasis on finding creative new way to accomplish an objective. It has been described as taking a blank piece of paper and starting from scratch to redesign a business process. Rather than searching continually for minute improvement, reengineering involves a radical shift in thinking about how an objective should be met. Re-engineering prescribes radical, quick and significant change. Admittedly, it can entail high risks, but it can also bring big rewards. These benefits are most dramatic when new models are discovered for conducting business.

(e) Uses of Learning curve

Learning curve is now being widely issued in business. Some of the uses are as follows:

1. Where applicable the learning curve suggest great opportunities for cost reduction to be achieved by improving learning.
2. The learning curve concept suggests a basis for correct staffing in continuously expanding production. The curve shows that the work force need not be increased at the same rate as the prospective output. This also helps in proper production planning through proper scheduling of work; providing manpower at the right moment permitting more accurate forecast of delivery dates.

3. Learning curve concept provides a means of evaluating the effectiveness of training programs.
4. Learning curve is frequently used in conjunction with establishing bid price for contracts. Usually, the bid price is based on the cumulative average unit cost for all the units to be produced for a given contract. If production is not interrupted. Additional units beyond this quantity should be costed at the increment costs incurred, and not at the previous cumulative average. If the contract agreement so provides, a contract may be cancelled and production stopped before the expected efficiency is reached.
5. The use of learning curve, where applicable, is important in the working capital required. If the requirement is based on average cumulative unit cost, the revenues from the first few units may not cover the actual expenditures.
6. As employees become more efficient, the rate of production increases and so more materials are needed, the work-in-progress inventory turns over faster, and finished goods inventory grows at an accelerated rate.
7. Learning curve techniques are useful in exercising control, Variable norms can be established for each situation, and a comparison between these norms and actual expenses can be made. Specific or average incremental unit cost should be used for this purpose.
8. The learning curve may be used for make-or- buy decisions especially if the outside manufacturer has reached the maximum on the learning curve. Help to calculate the sensitive rates in wage bargaining.