

PAPER – 5 : COST MANAGEMENT

Question No. 1 is compulsory. Answer **any four** questions from the rest..

Working notes should form part of the answer.

Wherever appropriate, suitable assumptions should be made.

Question 1

- (a) Briefly describe the different methods of Transfer Pricing.
- (b) How Pareto analysis is helpful in pricing of product in the case of firm dealing with multi-products?
- (c) Kitchen King company makes a high-end kitchen range hood 'Maharaja'. The company presents the data for the year 2003 and 2004:

	2003	2004
1. Units or maharaja produced and sold	40,000	42,000
2. Selling Price per unit in Rs.	1,000	1,100
3. Total Direct Material (Square feet)	1,20,000	1,23,000
4. Direct material cost per square feet in Rs.	100	110
5. Manufacturing Capacity (in units)	50,000	50,000
6. Total Conversion cost in Rs.	1,00,00,000	1,10,00,000
7. Conversion cost per unit of capacity (6)/(5)	200	220
8. Selling and customer service capacity	300	290
	customer	customer
9. Total selling and customer service cost in Rs.	72,00,000	72,50,000
10. Cost per customer of selling and customer service capacity (9)/(8)	24,000	25,000

Kitchen King produces no defective units, but it reduces direct material used per unit in 2004. Conversion cost in each year depends on production capacity defined in terms of Maharaja units that can be produced. Selling and Customer service cost depends on the number of customers that the selling and service functions are designed to support. Kitchen King has 230 customers in 2003 and 250 customers in 2004.

You are required

- 1. Describe briefly key elements that would include in Kitchen King's Balance Score Card.
- 2. Calculate the Growth, Price-recovery and productivity component that explain the change in operating income from 2003 to 2004. (3+3+18 = 24 Marks)

Answer

- (a) The methods of pricing usually employed in industry when goods or services are transferred from one unit to the other can be broadly classified under the following three categories:
- (i) Pricing at cost or variants of cost e.g. manufacturing cost; standard cost; full cost and full cost plus mark up.
 - (ii) Pricing at market price.
 - (iii) Pricing at bargained or negotiated price.
- (b) In the case of firm dealing with multi products, it would not be possible for it to analyse price-volume relationship for all of them. Pareto Analysis is used for analysing the firm's estimated sales revenue from various products and it might indicate that approximately 80% of its total sales revenue is earned from about 20% of its products. Such analysis helps the top management to delegate the pricing decision for approximately 80% of its product to the lower level of management, thus freeing them to concentrate on the pricing decisions for products approximately 20% of which is essential for the company's survival. Thus, a firm can adopt more sophisticated pricing methods for small proportion of products that jointly account for 80% of total sales revenue. For the remaining 80% products, which account for 20% of the total sales value the firm may use cost based pricing method.
- (c) Kitchen King's Score card should describe its product differentiation strategy. The key points that should be included in its balance score card are
- Financial Prospective – Increase in operating income by charging higher margins on Maharaja.
 - Customer Prospective – Market share in high-end kitchen range market and customer satisfaction.
 - Internal business perspectives: Manufacturing quality, order delivery time, on time delivery and new product feature added.
 - Learning and Growth prospective: Development time for designing new end product and improvement in manufacturing process.

Operative Income:

	<i>(Amount in 000 Rs.)</i>	
	2003	2004
Revenue (40000×1000: 42000×1100)	40000	46200
Direct Material	12000	13530
Conversion cost	10000	11000
Selling and Customer service	7200	7250
Total cost	29200	31780
Operative Income	10800	14420

Change in operating Income 36, 20,000 (F)

A. *Growth Component*

- (a) Revenue effect = Output Price in 2003{Actual units sold in 04 – Actual units sold in 03}
= Rs.1, 000 (42,000 units – 40,000 units)

= Rs.20, 00,000 (F)

- (b) The cost effect = Input price in 2003{Actual units of input to produce 2003 output less Actual units of input which would have been used to produce year 2004 output on the basis of 2003}

$$(i) \text{ Direct Material} = \text{Rs.}100 [1, 20,000\text{sqft} - 1, 20,000\text{sqft} \times \frac{42,000 \text{ units}}{40,000 \text{ units}}] \\ = \text{Rs.}6, 00,000 (A)$$

- (ii) Conversion cost and selling and customer service will not change since adequate capacity exists in 2003 to support 2004 output and customers. Hence variance

$$\text{Conversion cost} = 200(50000 - 50000) = 0$$

$$\text{S \& Customer Service} = 25000(300 - 300) = 0$$

Increase in operating effect of Growth component is Rs14, 00,000 (F)

B. *Price recovery Component:*

- (i) Revenue effect = Actual output in 2004 [Selling price per unit in 2004 less Selling price per unit in 2003]
= 42,000units (Rs.1, 100 – Rs1, 000) = Rs.42, 00,000 (F)

- (ii) Cost effect = Unit of input based on 2003 actual that would have been used to produce 2004 output {Input prices per unit in 2003 less Input prices per unit in 2004}

$$(a) \text{ Direct material} = 1, 26,000\text{sqft} (\text{Rs.}100/\text{sqft} - \text{Rs.}110/\text{sqft}) \\ = \text{Rs.}12, 60,000 (A)$$

$$(b) \text{ Conversion Cost} = 50,000 \text{ units} (\text{Rs.}200/\text{unit} - \text{Rs.}220/\text{unit}) \\ = \text{Rs.}10, 00,000 (A)$$

$$(c) \text{ S \& Custr Service} = 300 \text{ customers} (\text{Rs.}24, 000 - \text{Rs.}25,000) \\ = \text{Rs.}3,00,000 (A) \\ = \text{Rs.}25, 60,000 (A)$$

Increase in Operating income due to Price Recovery is Rs.16, 40,000 (F) {Rs.42, 00,000 – Rs.25, 60,000}

(C) *Productivity Component*

Productivity component = Input Prices in 04{Actual units of input which would have been used to produce year 2004 output on the basis of 2003 actual less Actual Input}

(i) *Direct Material*: Rs.110/sqft (1, 26,000 units – 1, 23,000 units) = Rs.3, 30,000(F)

(ii) *Conversion Cost*: Rs.200/unit (50,000 units – 50,000 units) = 0

(iii) *Selling & Customer* = Rs.25, 000 (300 customers – 290 customers)
= Rs.2,50,000 (F)

= Rs. 5,80,000 (F)

The change in operating income from 2003 to 2004 is analysed as follows:

(Amount in 000 Rs.)

	2003	Growth component	Price recovery	Cost effect of productivity component	2004
Revenue	40000	2000 (F)	4200 (F)	-----	46200
Cost	29200	600 (A)	2560 (A)	580 (F)	31780
Operating Income	10800	1400(F)	1640 (F)	580 (F)	14420

Question 2

Rainbow Ltd. manufactures paint in batches. The company uses standard costing system and the variances are reported weekly. You have taken the account sheet for study for variance analysis discussion. While working coffee was spilled on these sheets and only following could have been retrieved:

Dr.		Cr.
	<i>Raw Material -1</i>	
<i>Beg. Balance</i>	0	18,000
	<i>Closing Balance</i>	6,000
	<i>Raw Material -2</i>	
<i>Beg. Balance</i>	18,000	
	<i>Closing Balance</i>	41,400
	<i>Work in Progress</i>	
<i>Beg. Balance</i>	0	
<i>Raw Material -2</i>	72,000	<i>Closing Balance</i> 0

<i>Sundry Creditors</i>	
	1,27,200
<i>Wages outstanding</i>	
51,750	
<i>Quantity Variance-Material-1</i>	
1,200	
<i>Price Variance-Material-2</i>	
	6,600
<i>Efficiency Variance-Labour</i>	
	7,200

Other information's are: standard cost of Material – 2 is Rs180 per litre and standard quantity is 5 litres. Standard wages rate is Rs24 per hour and a total 2,300 hours were worked during the week. 1,000 kg of Material -1 and 550 litres of Material-2 were purchased. Sundry creditors are for material acquisition, and wages outstanding pertain to direct labour.

You are required to compute Material-1 Rate Variance, Material-2 Quantity Variance & Labour Spending Variance, Standard hours allowed for production and purchase value of Material-1 for variance analysis discussion.

(b) Write short note on pricing by service sector.

(c) Write short note on 'Zero Base Budgeting' as an approach towards productivity improvement.' (11+4+4 = 19 Marks)

Answer

- (a) Material – 1 Rate Variance = Standard cost of material purchased – Actual cost
= Rs24, 000 – Rs21, 600 = Rs2, 400 (F)
- Material – 2 Quantity Variance = SR × SQ – SR × AQ
= Rs900 × 80 units – Rs75, 600
= Rs3, 600 (A)
- Labour Spending Variance = SR × AH – AR × AH
= Rs24/per hour × 2300 hours – Rs51, 750
= Rs3, 450 (A)
- Labour Efficiency Variance = SR × (SH – AH)
– 7200 = 24 (SH – 2300)
SH = 2000 Hrs.

	<i>Rs</i>
Total Cost of material purchased	1,27,200
Less: Purchase Value of Material – 2	1,05,600
Cost of material –1	21,600

Working Notes:

- (1) Standard Cost of Material – 2 actually consumed in production = Rs72, 000 (Given)
 Standard cost of Material – 2 per unit: 5 litres × Rs.180 = Rs900
 $\therefore$ No of units produced = Rs.72, 000 / Rs900 = 80 units
 Total material – 1 used in production = Rs.18, 000 (Given)
 Add Closing Inventory = Rs.6, 000 (Given)
 Less Opening Inventory = 0
 Hence Standard Cost of Material – 1 purchased = Rs24, 000
- (2) Standard Rate of Material -1 = Rs.24, 000 / 1,000kg = Rs.24 per kg
 Standard Cost of Material – 1 = Rs.18, 000
 Add favourable Quantity Variance = Rs.1, 200
 Material – 1 allowed = Rs.19, 200
 Standard quantity of Material – 1 allowed = Rs19, 200/Rs24 = 800 Kg.
 Standard quantity per unit = 800kg/80units = 10 kg
 Standard purchase price for Material – 2 = (550liters × Rs180) = Rs.99, 000
 Add unfavourable Rate Variance = Rs.6, 600
 Actual cost Price of Material – 2 = Rs.1, 05, 600
- (3) Opening balance of Material – 2 = Rs.18, 000
 Add Standard Cost of Purchase (550 litres × Rs180) = Rs.99, 000
 Less Closing Balance = Rs.41, 400
 Material-2 Consumed at Standard cost = Rs.75, 600
- (b) The service has no physical existence and it must be priced and billed to customers. Most service organizations use a form of time and material pricing to arrive at the price of a service. Service companies such as appliance repair shops, automobile repair business arrives at prices by using two computations, one for labour and other for material and parts. If material and parts are not part of service being performed, then only direct labour costs are used as basis for determining price. For professionals such as accountants and consultants a factor representing all overhead costs is applied to the

base labour costs to establish a price for the service, which are generally worked out on the basis of rate per man hour.

- (c) Zero Base Budgeting (ZBB) is an expenditure control device where without reference to the past budget figures or achievements each division head has to justify the requirement of funds for each head of expenditure and prepare the budget accordingly. ZBB is defined as "An operating, planning and budgeting process which requires each manager to justify the entire budget request in detail from scratch (hence zero base) and shifts the burden of proof to each manager who has to justify why he should spend any money at all."

ZBB provides a basis for evaluating decision package on basis of cost-benefit considerations. It focuses attention on output in relation to value of money. It reduces inefficiency and achieves high level of effectiveness. It can be applied to cost reduction programmes. Scarce resources can be utilised effectively. Ineffective entries are eliminated and duplicate activities are easily identified. Thus wasteful expenditure is reduced or eliminated fully. It leads to increase in staff participation creating greater motivation and job satisfaction. All these aspects will ultimately result in greater productivity of the resources and organization performance by way of higher profit at lower costs.

Question 3

- (a) *X Video Company sells package of blank video tapes to its customer. It purchases video tapes from Y Tape Company @ Rs140 a packet. Y Tape Company pays all freight to X Video Company. No incoming inspection is necessary because Y Tape Company has a superb reputation for delivery of quality merchandise. Annual demand of X Video Company is 13,000 packages. X Video Co. requires 15% annual return on investment. The purchase order lead time is two weeks. The purchase order is passed through Internet and it costs Rs2 per order. The relevant insurance, material handling etc Rs3.10 per package per year. X Video Company has to decide whether or not to shift to JIT purchasing. Y Tape Company agrees to deliver 100 packages of video tapes 130 times per year (5 times every two weeks) instead of existing delivery system of 1,000 packages 13 times a year with additional amount of Rs0.02 per package. X Video Co. incurs no stock out under its current purchasing policy. It is estimated X Video Co. incurs stock out cost on 50 video tape packages under a JIT purchasing policy. In the event of a stock out, X Video Co. has to rush order tape packages which costs Rs4 per package. Comment whether X Video Company should implement JIT purchasing system.*

Z Co. also supplies video tapes. It agrees to supply @ Rs13.60 per package under JIT delivery system. If video tape purchased from Z Co., relevant carrying cost would be Rs3 per package against Rs3.10 in case of purchasing from Y Tape Co. However Z Co. doesn't enjoy so sterling a reputation for quality. X Video Co. anticipates following negative aspects of purchasing tapes from Z Co.

- *To incur additional inspection cost of 5 paisa per package.*

- Average stock out of 360 tapes packages per year would occur, largely resulting from late deliveries. Z Co. cannot rush order at short notice. X Video Co. anticipates lost contribution margin per package of Rs8 from stock out.
 - Customer would likely return 2% of all packages due to poor quality of the tape and to handle this return an additional cost of Rs25 per package.
 - Comment whether X Video Co places order to Z Co
- (b) A Pharmaceutical company produces formulations having a shelf life of one year. The company has an opening stock of 30,000 boxes on 1st January, 2005 and expected to produce 1, 30,000 boxes as was in the just ended year of 2004. Expected sale would be 1, 50,000 boxes. Costing department has worked out escalation in cost by 25% on variable cost and 10% on fixed cost. Fixed cost for the year 2004 is Rs40 per unit. New price announced for 2005 is Rs100 per box. Variable cost on opening stock is Rs40 per box. You are required to compute breakeven volume for the year 2005.

(12+7 = 19 Marks)

Answer

- (a) (i) **Comparative Statement of cost for purchasing from Y Co Ltd under current policy & JIT**

Particulars	Current Policy	JIT
	Rs	Rs
Purchasing cost	18,20,000	18,20,260
	(13,000 × 140)	(13,000 × 140.02)
Ordering cost	26.00	260.00
	(2×13 orders)	(2×130 orders)
Opportunity carrying cost	10,500.00	1,050.15
	(1/2×1000×140×15%)	(1/2×100×140.02×15%)
Other carrying cost(Insurance, material handling etc)	1,550.00	155.00
	(1/2×1000×3.10)	
Stock out cost		200
		(4 × 50)
Total relevant cost	18,32,076	18,21,925.15

Comments: As may be seen from above, the relevant cost under the JIT purchasing policy is lower than the cost incurred under the existing system. Hence, a JIT purchasing policy should be adopted by the company.

(ii) Statement of cost for purchasing from Z Co Ltd.

Particulars	Rs.
Purchasing cost	1,76,800
	(13,000x13.60)
Ordering Cost	260.00
	(2x130 orders)
Opportunity Carrying Cost	102.00
	(1/2x100x13.60x 15%)
Other Carrying Cost	150.00
	(1/2x100x3.00)
Stock out Cost	2,880
	(8x360)
Inspection Cost	650.00
	(13,000 x .05)
Customer Return Cost	6,500.00
	(13,000 x 2% x 25)
Total Relevant Cost	1,87,342

Comments : The comparative costs are as follows,

Under current policy	Rs 18,32,076.00
Under purchase under JIT	Rs 18,21,925.10
Under purchase from Z Co Ltd	Rs 1,87,342.00

Packages should be bought from Z Co as it is the cheapest.

- (b)** Shelf life is one year hence opening stock of 30,000 boxes is to be sold first. Contribution on these boxes is $30,000(100 - 40) = \text{Rs}18,00,000$

In the question production of 2004 is same as in 2005. Hence fixed cost for the year 2004 is Rs52, 00,000 (1, 30,000x40). Therefore fixed cost for the year 2005 is Rs57, 20,000 (52, 00,000 + 10% of 52, 00,000).

Variable Cost for the year 2005 (Rs.40 + 25% of Rs.40) = Rs50 per Unit

Hence Contribution per unit during 2005 is Rs.50 (100 – 50)

Break even volume is the volume to meet the fixed cost i.e. fixed cost equals to contribution. Therefore, remaining fixed cost of Rs.39, 20,000 (57, 20,000 – 18, 00,000) to be recovered from production during 2005.

Production in 2005 to reach BEP = $3920000 / 50 = 78,400$ units

Therefore BEP for the year 2005 is 1, 08,400 boxes (30000 + 78400)

Question 4

- (a) Critically examine "It is prudent to hold large inventories in an inflationary economy".
- (b) A businessman employs 20 sewing machinists, but he is aware that ten are the better workers than others. He is considering to conduct a training programme for his ten less efficient machinists to increase their efficiency to be equal to that achieved by "better" workers. Relevant data are as follows;
- There is one sewing machine for each machinist.
 - All the machinists are engaged on similar work and are paid Rs2.20 each good garment produced on piece work system.
 - To rectify each rejected garment costs Rs4, this work is done by subcontractor.
 - Garment machining department operates 2,000 hours a year.
 - Average output of per machinist (on the basis of all 20 machinists) is 12 good garments with one rejected per worker per hour. However 10 less efficient machinists' averages only 10 good garments with 1.5 rejected per worker per hour.
 - Depreciation of each sewing machine is Rs10,000 per year and the variable cost of power, cleaning and preventive maintenance is Rs5 per hour per machine.
 - Fixed production overhead other than depreciation is Rs20 per machine hour.
 - Selling price per garment is Rs18.
 - Direct material cost per garment is Rs12.
 - Training will not reduce productive hours.
 - There is no problem in selling increased output.

You are required

- (a) To prepare a statement of comparative costs for the "better" worker and the "less efficient" workers excluding material costs.
- (b) To find out the benefit derived over a one year period, if Rs1,00,000 is spent on a training course for the "less efficient" workers to match the efficiency with the "better" workers.
- (c) Explain the concept of activity based costing. How ABC system supports corporate strategy? (4+11+4=19 Marks)

Answer

- (a) In an inflationary economy, prices rise rapidly. Holding large inventories will affect the inventory carrying cost including interest on funds blocked. However, there are other risks like obsolescence, deterioration in quality, limited shelf-life in case of certain materials etc. In addition to these risks, cheaper substitutes may be available at a later date. New sources of supply may be available at competitive rate or else price may fall. Hence speculation should be avoided.

The funds so blocked may be invested for expansion or diversification, which may result into higher profitability than the benefit arising from holding large inventory. Hence normal level of inventory may be held to avoid stock-out leading to loss of production. In view of above points all inventory control techniques may be applied for deciding the amount to be invested in inventory. Inflationary economy is one factor. There are several other considerations for deciding the quantum of inventory.

- (b) (a) Average output of all 20 machinist is 12 good units and 1 rejected piece while average output of 10 "less efficient" workers is 10 good units and 1.5 rejected pieces. Hence average output of 10 "better worker" is 14 good units and 0.5 rejected piece.

Statement showing annual comparative cost for the "better machinist" and the "less efficient" machinist excluding direct material cost.

	Better Worker	Less Efficient worker
Good Units (14×2000×10 efficient workers)	2,80,000	
(10×2000×10 less efficient worker)		2,00,000
Rejects after correction (2000 hrs ×0.5×10) (2000 hrs ×1.5×10)	10,000	30,000
	Rs	Rs
Labour cost (280000×2.20) (200000×2.20)	616000	440000
Rectification Cost (10000×4) (30000×4)	40000	120000
Variable production cost (2000×5×10) (a) (b) Sales (290000×18) (230000×18)	100000 756000 5220000	100000 660000 4140000

Direct material (290000×12)	3480000			
(230000×12)			2760000	
Variable Cost as per (a)	756000	4236000	660000	3420000
Contribution		984000		720000
After training increase in contribution (984000 – 720000)			264000	
Cost of training			100000	
Benefit from training			164000	

- (c) ABC is an accounting methodology that assigns costs to activities rather than products and services. This enables resources and overhead costs to be more accurately assigned to products and services that consume them when compared to traditional methods where either labour or machine hrs are considered as absorption basis over cost centres. In order to correctly associate costs with products and services, ABC assigns cost to activities based on their resources. It then assigns cost to 'Cost objects', such as products and customers, based on their use of activities. ABC can track the flow of activities in organization by creating a link between the activity and the cost objects.

ABC supports corporate strategy in many ways such as:

- ABC system can effectively support the management by furnishing data, at the operational level and strategic level. Accurate product costing will help the management to compare the profits of various customers, product lines and to decide on price strategy etc.
- Information generated by ABC system can also encourage management to redesign the products.
- ABC system can change the method of evaluation of new process technologies, to reduce setup times, rationalization of plant lay out in order to reduce or lower material handling cost, improve quality etc.
- ABC system will report on the resource spending.
- ABC analysis helps managers' focus their attention and energy on improving activities and the actions allow the insights from ABC to be translated into increased profits.
- Performance base accurate feedback can be provided to cost centre managers.
- Accurate information on product costs enables better decisions to be made on pricing, marketing, product design and product mix.

Question 5

- (a) A Company is organised into two divisions. Division X produces a component, which is used by division Y in making of a final product. The final product is sold for Rs540 each. Division X has capacity to produce 2,500 units and division Y can purchase the entire production. The variable cost of division X in manufacturing each component is Rs256.50.

Division X informed that due to installation of new machines, its depreciation cost had gone up and hence wanted to increase the price of component to be supplied to division Y to Rs297, however division Y can buy the component from outside the market at Rs270 each. The variable cost of division Y in manufacturing the final product by using the component is Rs202.50 (excluding component cost).

Present the statement indicating the position of each Division and the company as whole taking each of the following situations separately:

- (i) If there is no alternative use for the production facility of X, will the company benefit, if division Y buys from outside suppliers at Rs270 per component.
 - (ii) If internal facilities of X are not otherwise idle and the alternative use of the facilities will bring an annual cash saving of Rs50,625 to division X, should division Y purchase the component from outside suppliers?
 - (iii) If there is no alternative use for the production facilities of division X and the selling price for the component in the outside market drops by Rs20.25, should division Y purchase from outside supplier?
 - (iv) What transfer price would be fixed for the component in each of the above circumstances?
- (b) A small project is composed of seven activities, whose time estimates are listed below. Activities are identified by their beginning (i) and ending (j) node numbers.

Activity (I-j)	Estimated durations (in days)		
	Optimistic	Most likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

- (a) Draw the project network.
- (b) Find the expected duration and variance for each activity. What is the expected project length?

(c) If the project due date is 38 days, what is the probability of meeting the due date ?

Given:	z	0.50	0.67	1.00	1.33	2.00
	P	0.3085	0.2514	0.1587	0.0918	0.0228

(12+7=19 Marks)

Answer

(a) (i) When component is purchased by division Y from outside

(a)	Rs	(Rs.)
Division Y sales 2500×540		13,50,000
Less: cost of purchase 2500×270	6,75,000	
Variable cost 2500×202.50	5,06,250	11,81,250
Division Y contribution		1,68,750
Division X contribution		Nil
Total contribution		1,68,750

(b) When component is purchased from division X

(b)		(Rs.)
Division X		
Sales 2500×297	7,42,500	
Less variable cost 2500×256.50	6,41,250	1,01,250
Division Y		
Sales 2500×540	13,50,000	
Less: Variable cost		
Purchase cost 2500×297	7,42,500	
Variable cost of division Y 2500×202.50	5,06,250	1,01,250
Total contribution		2,02,500

Thus it will be beneficial for the company as whole to buy component from division X.

(ii) When there is alternative use of Division X with given cash saving

		(Rs.)
Division X Contribution from alternative use of facilities		50,625
Division Y sales 2500×540	13,50,000	
Less: Cost of purchase 2500×270	6,75,000	

Variable cost 2500×202.50	5,06,250	
Division Y contribution		1,68,750
Company's total contribution		2,19,375

(iii) When there is no alternative use of Division X & selling price of component reduces in the market

Rs

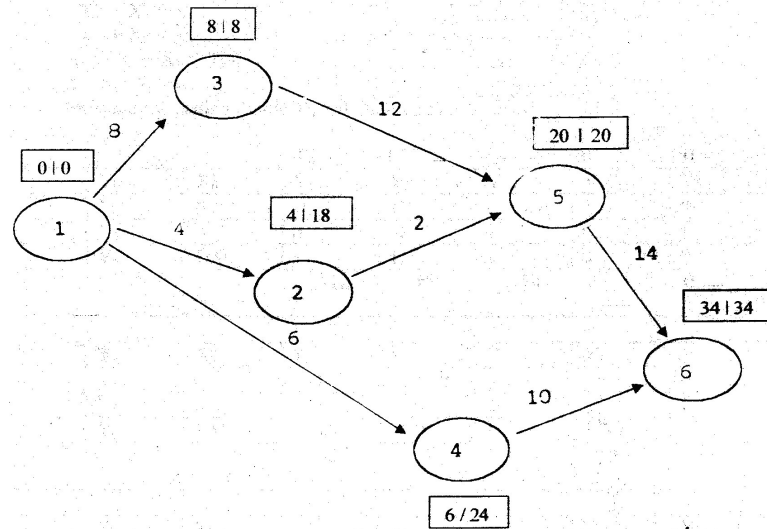
Division Y sales 2500×540	13,50,000	
Less: Cost of purchase 2500×249.75	6,24,375	
Variable cost 2500 × 202.20	5,06,250	
Total contribution		2,19,375

It is beneficial to buy component from outside.

(iv) Transfer price

- Where there is no alternative use of capacity of division X, then variable cost i.e. Rs256.50 per component will be charged
- If facilities of division X can be put to alternative use then variable cost Rs256.50+ opportunity cost Rs20.25 =Rs276.75 will be transfer price.
- If market price gets reduced to Rs. 249.75 and there is no alternative use of facilities of Division X the variable cost Rs256.50 per component should be charged.

(c) Activity	Estimated durations (in days) = $\frac{a + 4m + b}{6}$			$\sigma^2 = \left(\frac{b-a}{6}\right)^2$	
(I – j)	a	m	b		
1-2	2	2	14	4	4
1-3	2	8	14	8	4
1-4	4	4	16	6	4
2-5	2	2	2	2	0
3-5	4	10	28	12	16
4-6	4	10	16	10	4
5-6	6	12	30	14	16



The critical path is 1-----3-----5-----6

(b) The expected duration of the project $8+12+14 = 34$ days

(c) Variance of project length is $\sigma^2 = 4 + 16 + 16 = 36$

The standard normal deviate is:

$$Z = \frac{\text{due date} - \text{expected date of completion}}{\sqrt{\text{variance}}}$$

$$Z = \frac{26 - 34}{6} = \frac{8}{6} = -1.33 \text{ probability of meeting the due date is } 0.0918 \text{ or } 9.18\%$$

(d) When due date is 38 days

$$Z = \frac{38 - 34}{6} = \frac{4}{6} = 0.67 \text{ Probability meeting the date is } 0.2514 \text{ or } 25.14\%.$$

Question 6

(a) Three grades of coal A, B and C contains phosphorus and ash as impurities. In a particular industrial process, fuel up to 100 ton (maximum) is required which could contain ash not more than 3% and phosphorus not more than .03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grade. The percentage of impurities and the profits of each grade are as follows:

Coal	Phosphorus (%)	Ash (%)	Profit in Rs. (per ton)
A	.02	3.0	12.00
B	.04	2.0	15.00
C	.03	5.0	14.00

You are required to formulate the Linear-programming (LP) model to solve it by using simplex method to determine optimal product mix and profit.

- (b) A Publishing house has bought out a new monthly magazine, which sells at Rs. 37.5 per copy. The cost of producing it is Rs. 30 per copy. A Newsstand estimates the sales pattern of the magazine as follows:

Demand Copies	Probability
$0 < 300$	0.18
$300 < 600$	0.32
$600 < 900$	0.25
$900 < 1200$	0.15
$1200 < 1500$	0.06
$1500 < 1800$	0.04

The newsstand has contracted for 750 copies of the magazine per month from the publisher.

The unsold copies are returnable to the publisher who will take them back at cost less Rs. 4 per copy for handling charges.

The newsstand manager wants to simulate of the demand and profitability. The of following random number may be used for simulation:

27, 15, 56, 17, 98, 71, 51, 32, 62, 83, 96, 69.

You are required to-

- Allocate random numbers to the demand patten forecast by the newsstand.
- Simulate twelve months sales and calculate the monthly and annual profit/loss.
- Calculate the loss on lost sales. (11+8=19 Marks)

Answer

- (a) Let X_1 , X_2 and X_3 respectively be the amounts in tons of grades A, B, and C used. The constraints are

- (i) Phosphorus content must not exceed 0.03%

$$.02 X_1 + .04 X_2 + 0.3 X_3 \leq .03 (X_1 + X_2 + X_3)$$

$$2X_1 + 4 X_2 + 3X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_1 + X_2 \leq 0$$

- (ii) Ash content must not exceed 3%

$$3X_1 + 2 X_2 + 5 X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_2 + 2X_3 \leq 0$$

- (iii) Total quantity of fuel required is not more than 100 tons. $X_1 + X_2 + X_3 \leq 100$

The Mathematical formulation of the problem is

Maximize $Z = 12 X_1 + 15X_2 + 14 X_3$

Subject to the constraints:

$$- X_1 + X_2 \leq 0$$

$$- X_2 + X_3 \leq 0$$

$$X_1 + X_2 + X_3 \leq 100$$

$$X_1, X_2, X_3 > 0$$

Introducing slack variable $X_4 > 0, X_5 > 0, X_6 > 0$

			12	15	14	0	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
0	Y_4	0	-1	1*	0	1	0	0
0	Y_5	0	0	-1	2	0	1	0
0	Y_6	100	1	1	1	0	0	1
	Z		-12	-15	-14	0	0	0

C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	0	-1	1	0	1	0	0
0	Y_5	0	-1	0	2	1	1	0
0	Y_6	100	2*	0	1	-1	0	1
	Z		-27		-14	15	0	0

C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	50	0	1	1/2	1/2	0	1/2
0	Y_5	50	0	0	5/2*	1/2	1	1/2
12	Y_1	50	1	0	1/2	-1/2	0	1/2
	Z		0	0	-1/2	3/2	0	27/2

C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	40	0	1	0	2/5	-1/5	2/5
14	Y_3	20	0	0	1	1/5	2/5	1/5
12	Y_1	40	1	0	0	-3/5	-1/5	2/5
	Z		0	0	0	8/5	1/5	68/5

The optimum solution is $X_1 = 40, X_2 = 40$ and $X_3 = 20$ with maximum $Z = 1360$.

(b) (i) Allocation of random numbers

<i>Demand</i>	<i>Probability</i>	<i>Cumulative probability</i>	<i>Allocated RN</i>
0<300	0.18	0.18	00—17
300 < 600	0.32	0.50	18—49
600 < 900	0.25	0.75	50—74
900 < 1200	0.15	0.90	75—89
1200 <1500	0.06	0.96	90—95
1500 < 1800	0.04	1.00	96—99

(ii) Simulation: twelve months sales, monthly and annual profit/loss

<i>Month</i>	<i>RN</i>	<i>Demand</i>	<i>Sold</i>	<i>Return</i>	<i>Profit on sales (Rs.)</i>	<i>Loss on return (Rs.)</i>	<i>Net (Rs.)</i>	<i>Loss on lost units</i>
1	27	450	450	300	3375	12000	2175	
2	15	150	150	600	1125	2400	-1275	
3	56	750	750	--	5625	--	5625	
4	17	150	150	600	1125	2400	-1275	
5	98	1650	750	--	5625	---	5625	900
6	71	750	750	--	5625	--	5625	
7	51	750	750	--	5625	--	5625	
8	32	450	450	300	3375	1200	2175	
9	62	750	750	--	5625	--	5625	
10	83	1050	750	--	5625	--	5625	300
11	96	1650	750	--	5625	--	5625	900
12	69	750	750	--	5625		5625	
					54000	7200	46800	2100

(iii) Loss on lost sale $2100 \times 7.5 = \text{Rs}15750$.