

Developments in the Business Environment

Question 1

XYZ Ltd. manufactures four products, namely A, B, C and D using the same plant and process. The following information relates to a production period:

Product	A	B	C	D
Output in units	720	600	480	504
Cost per unit:	₹	₹	₹	₹
Direct Material	42	45	40	48
Direct labour	10	9	7	8
Machine hours per unit	4 hrs.	3 hrs.	2 hrs.	1 hr.

The four products are similar and are usually produced in production runs of 24 units and sold in batches of 12 units. Using machine hour rate currently absorbs the production overheads. The total overheads incurred by the company for the period is as follows:

	₹
Machine operation and Maintenance cost	63,000
Setup costs	20,000
Store receiving	15,000
Inspection	10,000
Material handling and dispatch	2,592

During the period the following cost drivers are to be used for the overhead cost:

Cost	Cost driver
Setup cost	No. of production runs
Store receiving	Requisition raised
Inspection	No. of production runs
Material handling and dispatch	Orders executed

It is also determined that:

- Machine operation and maintenance cost should be apportioned between setup cost, store receiving and inspection activity in 4:3:2.

- Number of requisition raised on store is 50 for each product and the no. of order executed is 192, each order being for a batch of 12 of a product.

Required:

- (a) Calculate the total cost of each product, if all overhead costs are absorbed on machine hour rate basis.
- (b) Calculate the total cost of each product using activity base costing.
- (c) Comment briefly on differences disclosed between overhead traced by present system and those traced by activity based costing. (11 Marks)(May, 2004)

Answer

- (a) Total cost of different products (overhead absorption on Machine hour basis)

	A	B	C	D
	₹	₹	₹	₹
Direct material	42	45	40	48
Direct labour	10	09	07	08
Overhead	72	54	36	18
Cost of production per unit	124	108	83	74
Out put in unit	720	600	480	504
Total cost	89,280	64,800	39,840	37,296

Machine hours $(720 \times 4 + 600 \times 3 + 480 \times 2 + 504 \times 1) = 6,144$ hours.

Rate per hour = $\frac{\text{₹ } 1,10,592}{6,144 \text{ hours}} = \text{₹ } 18 \text{ per hour.}$

- (b) Activity based costing system

	Set up	re receiving	Inspection
Machine operation and maintenance cost of ₹ 63,000 to be distributed in the ratio of 4: 3: 2.	28,000	21,000	14,000

Cost	₹	Drivers	No	Cost per unit of driver (₹)
Set up	48,000	Production runs	96	500
Store receiving	36,000	Requisitions raised	200	180
Inspection	24,000	Production runs	96	250
Material handling and disp	2,592	Orders	192	13.50

Production Run for A (720/24) = 30 ; B (600/24) = 25 ; C (480/24) = 20 ; D (504/24) = 21.

	A (₹)	B (₹)	C (₹)	D (₹)
Direct material	30,240	27,000	19,200	24,192
Direct labour	7,200	5,400	3,360	4,032
Setup	15,000	12,500	10,000	10,500
Store receiving	9,000	9,000	9,000	9,000
Inspection	7,500	6,250	5,000	5,250
Material handling and dispatch	810	675	540	567
Total cost	69,750	60,825	47,100	53,541
Per unit cost	96.875	101.375	98.125	106.23

(c)

	A	B	C	D
Cost per unit (a)	124	108	83	74
Cost per unit (b)	96.88	101.38	98.13	106.23
Difference	(27.12)	(6.62)	15.13	32.23

The total overheads which are spread over the four products have been apportioned on different bases, causing the product cost to differ substantially: in respect of product A and D a change from traditional machine hour rate to an activity system may have effect on price and profits to the extent that pricing is based on cost plus approach.

Question 2

What is Product Life-cycle Costing ? Describe its characteristics and benefits.

(5 Marks)(Nov, 2004)

Answer

Product life cycle costing.

It is an approach used to provide a long-term picture of product line profitability, feedback on the effectiveness of the life cycle planning and cost data to clarify the economic impact on alternatives choices in the design, engineering phase etc. It is also considered as a way to enhance the control of manufacturing costs. It is important to track and measure costs during each stage of a product's life cycle.

Characteristics:-

- Product life cycle costing involves tracing of costs and revenues of each product over the several calendar periods throughout their entire life cycle.

- (ii) Product life cycle costing traces research and design and development costs and total magnitude of these costs for each individual product and compared with product revenue.
- (iii) Report generation for costs and revenues.

Benefits: -

- (i) The product life cycle costing results in earlier actions to generate revenue or to lower cost than otherwise might be considered.
- (ii) Better decision should follow from a more accurate and realistic assessment of revenues and costs, at least within a particular life cycle stage.
- (iii) Product life cycle thinking can promote long-term rewarding in contrast to short-term profitability rewarding.
- (iv) It provides an overall framework for considering total incremental costs over the life span of a product.

Question 3

What do you mean by 'Back flushing' in JIT system ? Explain briefly the problems with back flushing that must be corrected before it will work properly. (4 Marks)(Nov, 2004)

Answer

Back flushing in a JIT system

Traditional accounting systems record the flow of inventory through elaborate accounting procedures. Such systems are required in those manufacturing environment where inventory/WIP values are large. However, since JIT systems operate in modern manufacturing environment characterized by low inventory and WIP values, usually also associated with low cost variances, the requirements of such elaborate accounting procedures does not exist.

Back flushing requires no data entry of any kind until a finished product is completed. At that time the total amount finished is entered into the computer system which is multiplied by all components as per the Bill of materials (BOM) for each item produced. This yields a lengthy list of components that should have been used in the production process and this is subtracted from the opening stock to arrive at the closing stock to arrive at the closing stock/inventory.

The problems with back flushing that must be corrected before it works properly are:

- (i) The total production quantity entered into the system must be absolutely correct, if not, then wrong components and quantities will be subtracted from the stock.
- (ii) All abnormal scrap must be diligently tracked and recorded. Otherwise materials will fall outside the back flushing system and will not be charged to inventory.

- (iii) Lot tracing is impossible under the back flushing system. This is required when a manufacturer needs to keep records of which production lots were used to create a product in case all the items in a lot need be recalled.
- (iv) The inventory balance may be too high at all times because the back flushing transactions that relieves inventory usually does so only once a day, during which time other inventory is sent to the production process. This makes it difficult to maintain an accurate set of inventory records in the warehouse.

Question 4

During the last 20 years, KL Ltd's manufacturing operation has become increasingly automated with Computer-controlled robots replacing operators. KL currently manufactures over 100 products of varying levels of design complexity. A single plant wise overhead absorption rate, based on direct labour hours, is used to absorb overhead costs.

In the quarter ended March, KL's manufacturing overhead costs were:

	(₹'000)
<i>Equipment operation expenses</i>	125
<i>Equipment maintenance expense</i>	25
<i>Wages paid to technicians</i>	85
<i>Wages paid to Store men</i>	35
<i>Wages paid to despatch staff</i>	<u>40</u>
	<u>310</u>

During the quarter, the company reviewed the Cost Accounting System and concluded that absorbing overhead costs to individual products on a labour hour absorption basis is meaningless. Overhead costs should be attributed to products using an Activity Based Costing (ABC) system and the following was identified as the most significant activities:

- (i) *Receiving component consignments from suppliers*
- (ii) *Setting up equipment for production runs*
- (iii) *Quality inspections*
- (iv) *Despatching goods as per customer's orders.*

It was further observed that in the short-term KL's overheads are 40% fixed and 60% variable. Approximately, half the variable overheads vary in relating to direct labour hours worked and half vary in relation to the number of quality inspections.

Equipment operation and maintenance expenses are apportioned as:

- *Component stores 15% , manufacturing 70% and goods dispatch 15%*

Technician's wages are apportioned as :

- Equipment maintenance 30% , set up equipment for production runs 40% and quality inspections 30%

During the quarter:

- a total of 2000 direct labour hours were worked (paid at ₹12 per hr.)
- 980 components consignments were received from suppliers
- 1020 production runs were set up
- 640 quality inspections were carried out
- 420 orders were dispatched to customers.

KL's production during the quarter included components R, S and T. The following information is available:

	Component	Component	Component
	R	S	T
Direct labour Hrs worked	25	480	50
Direct Material	₹1,200	₹2,900	₹1,800
Component Consignments Recd.	42	24	28
Production runs	16	18	12
Quality Inspections	10	8	18
Orders (goods) despatched	22	85	46
Quantity produced	560	12,800	2,400

Required:

- Calculate the unit cost of R, S and T components, using KL's existing cost accounting system.
- Explain how an ABC system would be developed using the information given. Calculate the unit cost of components R, S and T using ABC system.

(11 Marks) (May, 2005)

Answer

- Single factory direct labour hour overhead rate = $\frac{\text{₹ } 3,10,000}{2,000} = \text{₹ } 155$ per direct labour hour

Computation of unit cost (existing system)

	R (₹)	S(₹)	T(₹)
Direct labour cost @ ₹ 12 per hour	300	5,760	600
Direct material	1,200	2,900	1,800

Overheads(direct labour hours × ₹ 155 per hour	3,875	74,400	7,750
	5,375	83,060	10,150
Quantity Produced (No)	560	12,800	2,400
Cost per unit	9.60	6.49	4.23

(2) ABC system involves the following stages,

1. Identifying the major activities that take place in an organisation.
2. Creating a cost pool /cost centre for each activity
3. Determining the cost driver for each activity
4. Assigning the cost of activities to cost objects (e.g. products, components, customers etc)

The most significant activities have been identified e.g. receiving components consignments from suppliers, setting up equipment for production runs, quality inspections, and despatching orders to customers. The following shows the assignment of the costs to these activities,

(₹ ,000)

	Receiving supplies	Set ups	Quality inspection	Dispatch	Total
Equipment operation expenses	18.75	87.50		18.75	125.00
Maintenance	3.75	17.50		3.75	25.00
Technicians wages initially allocated to Maintenance(30% of ₹ 85,000= ₹ 25,500 and then reallocated on same basis on maintenance)	3.83	17.85		3.82	25.50
Balance of technicians wages allocated to set ups and quality inspections		34.00	25.50		59.50
Stores wages – Receiving	35.00				35.00
Despatch wages – Despatch				40.00	40.00
	61.33	156.85	25.50	66.32	310.00

Note: Equipment operation expenses and Maintenance allocated on the basis 15%,70% and 15% as specified in the question.

The next stage is to identify the cost drivers for each activity and establish cost driver rates by dividing the activity costs by a measure of cost driver usage for the period. The calculations are as follows:-

$$\text{Receiving supplies} \left(\frac{\text{₹ } 61,330}{980} \right) = \text{₹ } 62.58 \text{ per component.}$$

$$\text{Performing set ups} \left(\frac{1,56,850}{1,020} \right) = ₹ 153.77 \text{ per set up}$$

$$\text{Despatching goods} \left(\frac{66,320}{420} \right) = ₹ 157.90 \text{ per despatch}$$

$$\text{Quality inspection} \left(\frac{25,500}{640} \right) = ₹ 39.84 \text{ per quality inspection}$$

Finally, costs are assigned to components based on their cost driver usage. The assignments are as follows,

	R (₹)	S (₹)	T (₹)
Direct labour	300	5,760	600
Direct materials	1,200	2,900	1,800
Receiving supplies	2,628.36	1,501.92	1,752.24
Performing set ups	2,460.32	2,767.86	1,845.24
Quality inspections	398.40	318.72	717.12
Despatching goods	3,473.80	13,421.50	7,263.40
Total costs	10,460.88	26,670.00	13,978.00
No of units produced	560	12,800	2,400
Cost per unit	18.68	2.08	5.82

For components, the overhead costs have been assigned as follows,

(Component R)

Receiving supplies (42 receipts at ₹ 62.58)

Performing set ups (16 production runs at ₹ 153.77)

Quality inspections (10 at ₹ 39.84)

Despatching goods (22 at ₹ 157.90).

Question 5

Explain which features of the Service organisations may create problems for the application of activity-based costing.
(4 Marks) (May, 2005)

Answer

The following may create problem for adoption of ABC system in service organisation –

- (i) Facility sustaining costs (such as property, rents etc.) represent a significant portion of total costs and may only be avoidable if the organisation ceases business. It may be impossible to establish appropriate cost drivers.
- (ii) It is often difficult to define products where they are of intangible nature. Cost objects can therefore be difficult to specify.
- (iii) Many service organisations have not previously had a costing system and much of the information required to set up a ABC system will be non-existent. Therefore introduction of ABC may be expensive.

Question 6

Define Total Quality Management? What are the six Cs for successful implementation of TQM?

(4 Marks) (May, 2005)

Answer

The total quality management is a set of concepts and tools for getting all employees focused on continuous improvement in the eyes of the customer. Quality is an important aspect of world-class manufacturing. The success of Japanese companies is grass rooted in their long-term commitment to improvement of quality. A world class manufacturing approach demands that the quality must be designed into product and the production process, rather than an attempt to remove poor quality by inspection. This means that the objectives of quality assurance in a world- class-manufacturing environment, is not just reject defective product, but to systematically investigate the cause of defects so that they can be gradually eliminated. Though the goal is zero defect, the methodology is one of continuous improvement.

Six Cs of TQM

- (i) Commitment - If a TQM culture is to be developed, so that quality improvement becomes normal part of everyone's job, a clear commitment, from the top must be provided. Without this all else fails.
- (ii) Culture - Training lies at the centre of effecting a change -in culture and attitudes. Negative perceptions must be changed to encourage individual contributions.
- (iii) Continuous improvement - TQM is a process, not a program, necessitating that we are committed in the long term to the never ending search for ways to do the job better.
- (iv) Co-operation: The on-the-job experience of all employees must be fully utilized and their involvement and co-operation sought in the development of improvement strategies and associated performance measures.
- (v) Customer focus: Perfect service with zero defects in all that is acceptable at either internal or external levels.

- (vi) Control: Documentation, procedures and awareness of current best practice are essential if TQM implementations are to function appropriately. The need for control mechanisms is frequently overlooked, in practice.

Question 7

Carlton Ltd. makes and sells a single product; the unit specifications are as follows:

<i>Direct Materials X</i>	<i>:</i>	<i>8 sq. metre at ₹ 40 per square metre</i>
<i>Machine Time</i>	<i>:</i>	<i>0.6 Running hours</i>
<i>Machine cost per gross hour</i>	<i>:</i>	<i>₹400</i>
<i>Selling price</i>	<i>:</i>	<i>₹1,000</i>

Carlton Ltd. requires to fulfil orders for 5,000 product units per period. There are no stock of product units at the beginning or end of the period under review. The stock level of material X remains unchanged throughout the period.

Carlton Ltd. is planning to implement a Quality Management Programme (QPM). The following additional information regarding costs and revenues are given as of now and after implementation of Quality Management Programme.

<i>Before the implementation of QMP</i>	<i>After the implementation</i>
<i>1. 5% of incoming material from suppliers scrapped due to poor receipt and storage organisation.</i>	<i>1. Reduced to 3%.</i>
<i>2. 4% of material X input to the machine process is wasted due to processing problems.</i>	<i>2. Reduced to 2.5%</i>
<i>3. Inspection and storage of Material X costs Re. 1 per square metre purchased.</i>	<i>3. No change in the unit rate</i>
<i>4. Inspection during the production cycle, calibration checks on inspection equipment vendor rating and other checks cost ₹2,50,000 per period</i>	<i>4. Reduction of 40% of the existing cost.</i>
<i>5. Production Qty. is increased to allow for the downgrading of 12.5% of the production units at the final inspection stage. Down graded units are sold as seconds at a discount of 30% of the standard selling price.</i>	<i>5. Reduction to 7.5%</i>
<i>6. Production Quantity is increased to allow for return from customers (these are</i>	<i>6. Reduction to 2.5%</i>

replaced free of charge) due to specification failure and account for 5% of units actually delivered to customer.

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|--|--------------------------------------|
| 7. Product liability and other claims by customers is estimated at 3% of sales revenue from standard product sale. | 7. Reduction to 1%. |
| 8. Machine idle time is 20% of Gross machine hrs used (i.e. running hour = 80% of gross/hrs.). | 8. Reduction to 12.5%. |
| 9. Sundry costs of Administration, Selling and Distribution total – ₹6,00,000 per period. | 9. Reduction by 10% of the existing. |
| 10. Prevention programme costs ₹2,00,000 | 10. Increase to ₹6,00,000. |

The Total Quality Management Programme will have a reduction in Machine Run Time required per product unit to 0.5 hr.

Required:

- (a) Prepare summaries showing the calculation of (i) Total production units (pre inspection), (ii) Purchase of Materials X (square metres), (iii) Gross Machine Hours.
- (b) In each case, the figures are required for the situation both before and after the implementation of the Quality Management Programme so that orders for 5,000 product units can be fulfilled.

Prepare Profit and Loss Account for Carlon Ltd. for the period showing the profit earned both before and after the implementation of the Total Quality Programme.

(16 Marks) (May, 2005)

Answer

(a)

		Existing		After TQM Programme
i.	Total production units (Preinspection)			
	Total sales requirements	5,000		5,000
	Specification losses 5%	250	2.5%	125
		5,250		5,125
	Downgrading at inspection	750		416

	$\frac{12.5}{87.5} \times 5,250$		$\frac{7.5}{92.5} \times 5,125$	
	Total units before inspection	6,000		5,541
ii	Purchase of material 'X' (Sq Mtr)			
	Material required to meet pre inspection production requirement 6,000 $\times$ 8 SqMtr	48,000 SqMtr	5,541 $\times$ 8 SqMtr	44,328 SqMtr
	Processing loss $\frac{4}{96} \times 48,000$	2,000		1,137
			$\frac{2.5}{97.5} \times 44,328$	
	Input to the process	50,000		45,465
	Scrapped material $\frac{5}{95} \times 50,000$	2,632		1,406
			$\frac{3}{97} \times 45,465$	
	Total purchases	52,632		46,871
iii	Gross Machine Hours			
	Initial requirements 6,000 $\times$ 0.6	3,600	5,541 $\times$ 0.5	2,771
	Idle time $\frac{20}{80} \times 3,600$	<u>900</u>	$\frac{12.5}{87.5} \times 2,771$	<u>396</u>
	Gross time	<u>4,500</u>		<u>3,167</u>

(b)

Profit and loss statement

	₹		₹
Sales revenue 5,000 Units $\times$ ₹ 1,000	50,00,000		50,00,000
Sales downgraded 750 Units $\times$ ₹ 700	5,25,000	416 Units $\times$ ₹ 700	2,91,200
	55,25,000		52,91,200
Costs:			
Material 52,632 Sq Mtr $\times$ ₹ 40	21,05,280	46,871 Sq Mtr $\times$ ₹ 40	18,74,840
Inspection and storage costs 52,632 Sq Mtr $\times$ Re 1	52,632	46,871 Sq Mtr $\times$ Re 1	46,871

Machine cost 4,500 Hrs × ₹ 400	18,00,000	3,167 Hrs × ₹ 400	12,66,800
Inspection and other cost	2,50,000	2,50,000 × 60%	1,50,000
Product liability (3% × 50,00,000)	1,50,000	1% × 50,00,000	50,000
Sundry cost of selling, distribution and administration.	6,00,000	6,00,000 × 90%	5,40,000
Preventive programme cost	2,00,000		6,00,000
	51,57,912		45,28,511
Net profit	3,67,088		7,62,689

Question 8

X Video Company sells package of blank video tapes to its customer. It purchases video tapes from Y Tape Company @ ₹ 140 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 ₹ 2 per order. The relevant insurance, material handling etc ₹ 3.10 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 ₹ 0.02 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 ₹ 4 per package. Comment whether X Video Company should implement JIT purchasing system.

Z Co. also supplies video tapes. It agrees to supply @ ₹ 13.60 per package under JIT delivery system. If video tape purchased from Z Co., relevant carrying cost would be ₹ 3 per package against ₹ 3.10 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 paise 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 ₹ 8 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 ₹ 25 per package.

Comment whether X Video Co places order to Z Co.

(12 Marks) (Nov, 2005)

Answer

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

Particulars	Current Policy	JIT
	₹	₹
Purchasing cost	18,20,000 (13,000 × 140)	18,20,260 (13,000 × 140.02)
Ordering cost	26.00(2×13 orders)	260.00(2×130 orders)
Opportunity carrying cost	10,500.00 (1/2×1000×140×15%)	1,050.15 (1/2×100×140.02×15%)
Other carrying cost (Insurance, material handling etc)	1,550.00(1/2×1000×3.10)	155.00
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	₹
Purchasing cost	1,76,800 (13,000×13.60)
Ordering Cost	260.00 (2×130 orders)
Opportunity Carrying Cost	102.00 (1/2×100×13.60× 15%)
Other Carrying Cost	150.00 (1/2×100×3.00)
Stock out Cost	2,880 (8×360)
Inspection Cost	650.00 (13,000 × .05)
Customer Return Cost	6,500.00 (13,000 × 2% × 25)
Total Relevant Cost	1,87,342

Comments : The comparative costs are as follows,

Under current policy ₹ 18,32,076.00

Under purchase under JIT ₹ 18,21,925.10

Under purchase from Z Co Ltd ₹ 1,87,342.00

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

Question 9

Explain the concept of activity based costing. How ABC system supports corporate strategy?

(4 Marks) (Nov, 2005)

Answer

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 10

Computo Ltd. manufactures two parts 'P' and 'Q' for Computer Industry.

P : annual production and sales of 1, 00,000 units at a selling price of ₹100.05per unit.

Q : annual production and sales of 50,000 units at a selling price of ₹150 per unit.

Direct and Indirect costs incurred on these two parts are as follows:

	(₹ in thousand)		
	P	Q	Total
Direct Material cost (variable)	4,200	3,000	7,200
Labour cost (variable)	1,500	1,000	2,500
Direct Machining cost (See Note)*	700	550	1,250
Indirect Costs:			
Machine set up cost			462
Testing cost			2,375
Engineering cost			<u>2,250</u>
			<u>16,037</u>

Note: Direct machining costs represent the cost of machine capacity dedicated to the production of each product. These costs are fixed and are not expected to vary over the long-run horizon.

Additional information is as follows:

	P	Q
Production Batch Size	1,000 units	500 units
Set up time per batch	30 hours	36 hours
Testing time per unit	5 hours	9 hours
Engineering cost incurred on each product	8.40 lacs	14.10 lacs

A foreign competitor has introduced product very similar to 'P'. To maintain the company's share and profit, Computo Ltd. has to reduce the price to ₹86.25. The company calls for a meeting and comes up with a proposal to change design of product 'P'. The expected effect of new design is as follows:

- Direct Material cost is expected to decrease by ₹5 per unit.
- Labour cost is expected to decrease by ₹2 per unit.
- Machine time is expected to decrease by 15 minutes; previously it took 3 hours to produce 1 unit of 'P'. The machine will be dedicated to the production of new design.
- Set up time will be 28 hours for each set up.
- Time required for testing each unit will be reduced by 1 hour.
- Engineering cost and batch size will be unchanged.

Required:

- (a) Company management identifies that cost driver for Machine set-up costs is 'set up hours used in batch setting' and for testing costs is 'testing time'. Engineering costs

are assigned to products by special study. Calculate the full cost per unit for 'P' and 'Q' using Activity-based costing.

- What is the Mark-up on full cost per unit of P?
 - What is the Target cost per unit for new design to maintain the same mark up percentage on full cost per unit as it had earlier? Assume cost per unit of cost drivers for the new design remains unchanged.
 - Will the new design achieve the cost reduction target?
 - List four possible management actions that the Computo Ltd. should take regarding new design.
- (16 Marks) (May, 2006)

Answer

Working Notes:

Particulars	P	Q
(a) Production/Sales Quantity (units)	1,00,000	50,000
(b) Batch Size (units)	1000	500
(c) No of batches $\left(\frac{a}{b}\right)$	100	100
(d) Set up time per batch (hours)	30	36
(e) Total set up hours (c × d) (hours)	3,000	3,600
(f) Machine set up cost (₹)		4,62,000
(g) Cost driver per machine set up hour $\frac{4,62,000}{6,600} = ₹ 70$		
(h) Testing time per unit	5 hours	9 hours
(i) Total testing time (a × h) (hours)	5,00,000	4,50,000
(j) Testing cost ₹23,75,000		
(k) Cost driver per testing hour $\frac{23,75,000}{9,50,000} = ₹ 2.50$		

(a) Computation of full cost per unit using Activity Based Costing:

Particulars	Basis	P	Q
Direct material	Direct	42,00,000	30,00,000
Direct labour	Direct	15,00,000	10,00,000

Direct machine cost	Direct	7,00,000	5,50,000
Machine set up cost	3,000 hours @ ₹70	2,10,000	
	3,600 hours @ ₹70		2,52,000
Testing cost	5,00,000 hours @ ₹2.50	12,50,000	
	4,50,000 hours @ ₹2.50		11,25,000
Engineering cost	Allocated	<u>8,40,000</u>	<u>14,10,000</u>
Total cost (₹)		<u>87,00,000</u>	<u>73,37,000</u>
Cost per unit (₹)		87.00	146.74

(b) Mark up on full cost basis for Product P:

Particulars	Per unit
Selling price	100.05
Less: Full cost	87.00
Mark up	13.05
Percentage of mark up on full cost	$\frac{13.05}{87.00} \times 100 = 15\%$

(c) Target cost of Product P after new design is implemented

	₹
Target price (given)	86.25
Mark-up $\frac{86.25 \times 15}{115}$	<u>11.25</u>
Target cost per unit (₹)	<u>75.00</u>

(d) Statement of cost for new design of P

Particulars	Basis	Cost P.U.	Total Cost
Direct Material	Decreased by ₹5 p.u.	37.00	37,00,000
Direct Labour	Decreased by ₹2 p.u.	13.00	13,00,000
Direct Machining cost	No change as machine is dedicated	7.00	7,00,000
Machine set up cost	100 set up $\times$ 28 hours $\times$ ₹70	1.96	1,96,000
Testing cost	1,00,000 units $\times$ ₹2.5 $\times$ 4 hours	10.00	10,00,000
Engineering cost	No change	<u>8.40</u>	<u>8,40,000</u>
Total cost		<u>77.36</u>	<u>77,36,000</u>

The target cost is ₹ 75 p.u. and estimated cost of new design is ₹ 77.36 p.u. The new design does not achieve the target cost set by Computo Ltd. Hence the target mark up shall not be achieved.

(e) Possible Management Action:

- Value engineering and value analysis to reduce the direct material costs.
- Time and motion study in order to redefine the direct labour time and related costs.
- Exploring possibility of cost reduction in direct machining cost by using appropriate techniques.
- Identification of non-value added activities and eliminating them in order to reduce overheads.
- The expected selling price based on estimated cost of ₹77.36 per unit is (₹ 77.36 + 15%) ₹88.96. Introduce sensitivity analysis after implementation of new design to study the sales quantity changes in the price range of ₹86.25 to ₹88.96.

Question 11

What is the concept of 'Value-chain' and why is it important for Cost Management?

(4 Marks) (May, 2006)

Answer

Value chain is the linked set of value creating activities from the basic raw materials and components sources to the ultimate end use of the product or service delivered to the customer.

The six business functions contained in the value chain are (i) Research and Development, (ii) Design (iii) Production (iv) Marketing (v) Distribution and (vi) Customer service.

The objective of value chain is to serve as means of increasing the customer satisfaction and managing costs effectively. Coordination of the individual parts of the value chain activities creates conditions to improve customer satisfaction in terms of cost efficiency, quality and delivery. A firm which performs value chain activities more efficiently and at a lower cost than its competitors will be able to gain competitive advantage. The following methodology should be adopted.

1. The firm should identify the industry value chain and then assign costs, revenues and assets to value activities.
2. Diagnose the cost drivers regulating each value activity.
3. Develop sustainable cost advantage either by controlling cost drivers better than competitors or by reconfiguring the chain value.

By analyzing costs, revenues and assets in each activity systematically a company can achieve low cost. Thus value chain helps managers in deciding how to apply the organization's valuable physical and human resources to each linked process so as to achieve cost effectiveness.

Question 12

What is total-life-cycle costing approach? What is it important? (4 Marks) (May, 2006)

Answer

Total life cycle costing approach: Life cycle costing estimates, tracks and accumulates the costs over a product's entire life cycle from its inception to abandonment or from the initial R & D stage till the final customer servicing and support of the product. It aims at tracing of costs and revenues on product by product basis over several calendar periods throughout their life cycle. Costs are incurred along the product's life cycle starting from product's design, development, manufacture, marketing, servicing and final disposal. The objective is to accumulate all the costs over a product life cycle to determine whether the profits earned during the manufacturing phase will cover the costs incurred during the pre and post manufacturing stages of product life cycle.

Importance:

Product life cycle costing is important for the following reasons:

- (i) When non-production costs like costs associated with R & D, design, marketing, distribution and customer service are significant, it is essential to identify them for target pricing, value engineering and cost management. For example, a poorly designed software package may involve higher costs on marketing, distribution and after sales service.
- (ii) There may be instances where the pre-manufacturing costs like R & D and design are expected to constitute a sizeable portion of life cycle costs. When a high percentage of total life cycle costs are likely to be so incurred before the commencement of production, the firm needs an accurate prediction of costs and revenues during the manufacturing stage to decide whether the costly R & D and design activities should be undertaken.
- (iii) Many costs are locked in at R & D and design stages. Locked in or Committed costs are those costs that have not been incurred at the initial stages of R & D and design but that will be incurred in the future on the basis of the decisions that have already been taken. For example, the adoption of a certain design will determine the product's material and labour inputs to be incurred during the manufacturing stage. A complicated design may lead to greater expenditure on material and labour costs every time the product is produced. Life cycle budgeting highlights costs throughout the product life cycle and facilitates value engineering at the design stage before costs are locked in.

Total life-cycle costing approach accumulates product costs over the value chain. It is a process of managing all costs along the value chain starting from product's design, development, manufacturing, marketing, service and finally disposal.

Question 13

Differentiate between 'Value-added' and 'Non-value-added' activities in the context of Activity-based costing.

Give examples of Value-added and Non-value-added activities. (4 Marks) (May, 2006)

Answer

A value added activity is an activity that customers perceive as adding usefulness to the product or service they purchase. In other words, it is an activity that, if eliminated, will reduce the actual utility or usefulness which customers obtain from using the product or service. For example, painting a car in a company manufacturing cars or a computer manufacturing company making computers with preloaded software.

A non-value added activity is an activity where there is an opportunity of cost reduction without reducing the product's service potential to the customer. In other words, it is an activity that, if eliminated, will not reduce the actual or perceived value that customers obtain by using the product or service. For example, storage and moving of raw materials, reworking or repairing of products, etc.

Value-added activities enhance the value of products and services in the eyes of the organisation's customers while meeting its own goals. Non-value added activities on the other hand do not contribute to customer-perceived value.

Question 14

Give two examples for each of the following categories in activity based costing:

- (i) Unit level activities
- (ii) Batch level activities
- (iii) Product level activities
- (iv) Facility level activities. .

(4 Marks) (Nov, 2006)

Answer

Examples:

- | | |
|---------------------------|--|
| (i) Unit level activities | (i) Use of indirect materials |
| | (ii) Inspection or testing of every item produced or say every 100 th item produced |
| | (iii) Indirect consumables |

- | | |
|-----------------------------|--|
| (ii) Batch level activities | (i) Material ordering |
| | (ii) Machine set up costs |
| | (iii) Inspection of products – like first item of every batch |
| (iii) Product level | (i) Designing the product |
| | (ii) Producing parts to a certain specification |
| | (iii) Advertising costs, if advertisement is for individual products |
| (iv) Facility level | (i) Maintenance of buildings |
| | (ii) Plant security |
| | (iii) Production manager's salaries |
| | (iv) Advertising campaigns promoting the company |

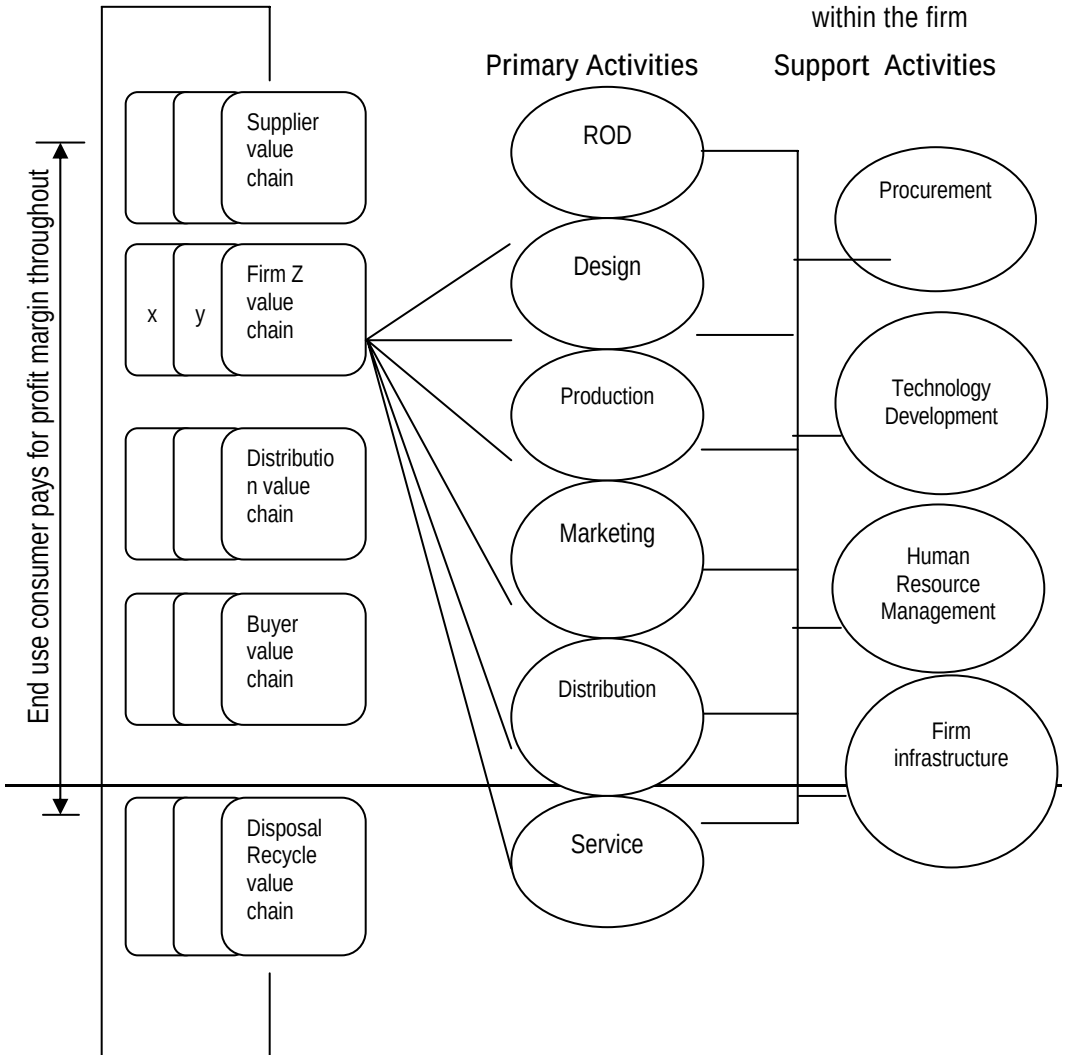
Question 15

Explain with a diagram the value chain activities within the firm with suitable classifications under primary and support activities and also the industry value chain indicating what the end use consumer pays for. .

(5 Marks) (Nov, 2006)

Answer

Industry Value Chain



Question 16

Name six benefits of ERP in an enterprise.

(3 Marks) (Nov, 2006); (4 Marks) (May, 2004)

Answer

Benefits of ERP

(a) Product costing.

- (b) Inventory management.
- (c) Distribution and delivery of pds.
- (d) E-commerce.
- (e) Automatic control of quality.
- (f) Sales service.
- (g) Improved production planning.
- (h) Quick response to change in market condition.
- (i) Competitive edge by improving business process.

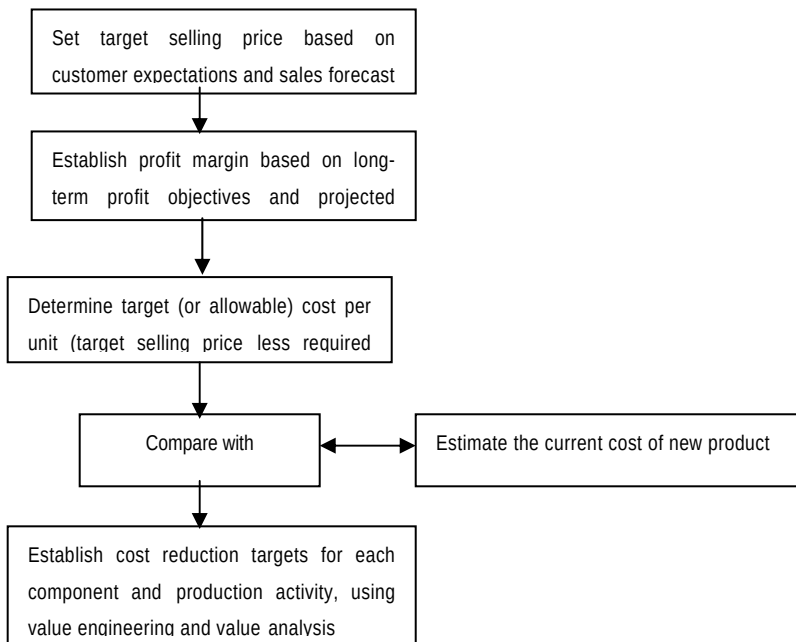
Question 17

List the steps involved in target costing process with the help of a block diagram.

(6 Marks) (Nov., 2006)

Answer

Target Costing Process



Question 18

What are the essential requirements for successful implementation of TQM?

(6 Marks) (May 2007)

Answer

Commitment: Quality improvement must be everyone's job. Clear commitment from the top management, steps necessary to provide an environment for changing attitudes and breaking down barriers to quality improvement must be provided. Support and training for this must be extended.

Culture: Proper training must be given to effect changes in culture and attitude.

Continuous Improvement: Recognition of room for improvement continually as a process, and not merely a one-off programme.

Cooperation: Must be ensured by involving employees by resorting to mutually agreeable improvement strategies and associated performance measures.

Customer Focus: Perfect service with zero defectives with satisfaction to end user whether external customer or internal customer.

Control: Documentation, procedures and awareness of current practices ensure checking deviation from the intended course of implementation.

Question 19

What is product life cycle costing? What are the costs that you would include in product life cycle cost? (4 Marks) (May 2007)

Answer

Product life cycle costing traces costs and revenues of each product over several calendar periods throughout their entire life cycle.

The costs are included in different stages of the product life cycle.

Development phase – R & D cost / Design cost.

Introduction phase – Promotional cost / Capacity costs.

Growth phase / Maturity – Manufacturing cost / Distribution costs / Product support cost.

Decline / Replacement phase – Plants reused / sold / scrapped / related costs.

Question 20

How does the JIT approach help in improving an organisation's profitability? (4 Marks) (May 2007)

Answer

JIT approach helps in the reduction of costs/increase in prices as follows:

- (i) Immediate detection of defective goods being manufactured so that early correction is ensured with least scrapping.
- (ii) Eliminates/reduces WIP between machines within working cell.

- (iii) OH costs in the form of rentals for inventory, insurance, maintenance costs etc. are reduced.
- (iv) Higher product quality ensured by the JIT approach leads to higher premium in the selling price.
- (v) Detection of problem areas due to better pdn/scrap reporting/labour tracing and inventory accuracy lead to reduction in costs by improvement.

Question 21

What is Target Costing? It is said that implementation of the target costing technique requires intensive marketing research. Explain why intensive marketing research is required to implement target costing technique.
(9 Marks) (Nov 2007)

Answer

Target cost is the difference between estimated selling price of a proposed product with specified functionality and quality and the target margin. This is a cost management technique that aims to produce and sell products that will ensure the target margin. It is an integral part of the product design. While designing the product, the company needs to understand what value target customers will assign to different attributes and different aspects of quality. This requires use of techniques like value engineering and value analysis. Intensive marketing research is required to understand customer preferences and the value they assign to each attribute and quality parameter. This insight is required to be developed must before the product is introduced. The company plays within the space between the maximum attributes and quality that the company can offer and the minimum acceptable to target customers. Therefore in absence of intensive marketing research, the target costing technique cannot be used effectively.

Question 22

"Cost can be managed only at the point of commitment and not at the point of incidence. Therefore, it is necessary to manage cost drivers to manage cost." Explain the statement with reference to structural and executional cost drivers.
(5 Marks)(Nov 2007)

Answer

A firm commits costs at the time of designing the product and deciding the method of production. It also commits cost at the time of deciding the delivery channel (e.g. delivery through dealers or own retail stores). Costs are incurred at the time of actual production and delivery. Therefore, no significant cost reduction can be achieved at the time when the costs are incurred. Therefore, it is said that costs can be managed at the point of commitment. Cost drivers are factors that drive consumption of resources. Therefore, management of cost drivers is essential to manage costs. Structural cost drivers are those which can be managed by effecting structural changes. Examples of structural cost drivers are scale of operation,

scope of operation (i.e. degree of vertical integration), complexity, technology and experience or learning. Thus, structural cost drivers arise from the business model adopted by the company. Executional cost drivers can be managed by executive decisions, examples of executional cost drivers are capacity utilization, plant layout efficiency, product configuration and linkages with suppliers and customers. It is obvious that cost drivers can be managed only at the point of structural and operating decisions, which commit resources to various activities.

Question 23

What is the fundamental difference between Activity Based Costing System (ABC) and Traditional Costing System? Why more and more organisations in both the manufacturing and non-manufacturing industries are adopting ABC? (10 Marks) (Nov 2007)

Answer

In the traditional system of assigning manufacturing overheads, overheads are first allocated and apportioned to cost centres (production and support service cost centres) and then absorbed to cost objects (e.g. products). Under ABC, overheads are first assigned to activities or activity pools (group of activities) and then they are assigned to cost objects. Thus, ABC is a refinement over the traditional costing system. Usually cost centres include a series of different activities. If different products create different demands on those activities, the traditional costing system fails to determine the product cost accurately. In that situation, it becomes necessary to use different rates for different activities or activity pools.

The following are the reasons for adoption of ABC by manufacturing and non-manufacturing industries:

- (i) Fierce competitive pressure has resulted in shrinking profit margin. ABC helps to estimate cost of individual product or service more accurately. This helps to formulate appropriate marketing / corporate strategy.
- (ii) There is product and customer proliferation. Demand on resources by products / customers differ among product / customers. Therefore, product / customer profitability can be measured reasonably accurately, only if consumption of resources can be traced to each individual product / customer.
- (iii) New production techniques have resulted in the increase of the proportion of support service costs in the total cost of delivering value to customers. ABC improves the accuracy of accounting for support service costs.
- (iv) The costs associated with bad decisions have increased substantially.
- (v) Reduction in the cost of data processing has reduced the cost of tracking resources consumption to large number of activities.

Question 24

Explain the main features on 'Enterprise Resource Planning.'

(4 Marks) (Nov 2007)

Answer

Some of the major features of "Enterprise Resource Planning" (ERP) areas follows:

- (i) ERP facilitates company-wide integrated information system covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory etc.
- (ii) It performs core activities and increases customer services thereby augmenting the corporate image.
- (iii) ERP bridges the information gap across organization.
- (iv) ERP provides complete integration of systems.
- (v) It is a solution for better project management.
- (vi) It allows automatic induction of latest technologies like electronic fund transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video Conferencing, E-commerce etc.
- (vii) ERP eliminates most business problems like material shortage, productivity enhancements, customer service, cash management etc.
- (viii) It provides business intelligence tools.

Question 25

Biscuit Ltd. Manufactures 3 types of biscuits, A, B and C, in a fully mechanised factory. The company has been following conventional method of costing and wishes to shift to Activity Based Costing System and therefore wishes to have the following data presented under both the systems for the month.

Inspection cost	₹ p.m.	73,000
Machine – Repairs & Maintenance	₹ p.m.	1,42,000
Dye cost	₹ p.m.	10,250
Selling overheads	₹ p.m.	1,62,000

	Product A	B	C
Prime cost (₹ per unit)	12	9	8
Selling price (₹ per unit)	18	14	12
Gross production (units/production run)	2,520	2,810	3,010
No. of defective units / production run	20	10	10

<i>Inspection:</i>			C
<i>No. of hours / production run</i>	3	4	4
<i>Dye cost / production run (₹)</i>	200	300	250
<i>No. of machine hours / production run</i>	20	12	30
<i>Sales – No. of units / month</i>	25,000	56,000	27,000

The following additional information is given:

- No accumulation of inventory is considered. All good units produced are sold.
- All manufacturing and selling overheads are conventionally allocated on the basis of units sold.
- Product A needs no advertisement. Due to its nutritive value, it is readily consumed by diabetic patients of a hospital. Advertisement costs included in the total selling overhead is ₹ 83,000.
- Product B needs to be specially packed before being sold, so that it meets competition. ₹ 54,000 was the amount spent for the month in specially packing B, and this has been included in the total selling overhead cost given.

You are required to present product wise profitability of statements under the conventional system and the ABC system and accordingly rank the products. (11 Marks) (May 2008)

Answer

Sales	A	B	C	Total
(i) Units ₹	25,000	56,000	27,000	1,08,000
Selling price/unit	18	14	12	
(ii) Sales Value (₹)	4,50,000	7,84,000	3,24,000	15,58,000
(iii) Prime Cost Overhead	12	9	8	
(iv) No. of units/run	2,520	2,810	3,010	
(v) Prime Cost ₹	3,02,400	5,05,800	2,16,720	
(vi) Gross Margin (ii – v)	1,47,600	2,78,200	1,07,280	5,33,080

	Total	A	B	C
Inspection Cost				
$\left(\frac{7,3000}{146} \times 30/80/36 \text{ respectively} \right)$	73,000	15,000	40,000	18,000

Machine Maintenance				
$\left(\frac{1,42,000}{710} \times 200/240/270 \text{ respectively} \right)$	1,42,000	40,000	48,000	54,000
Dye Cost	<u>10,250</u>	<u>2,000</u>	<u>6,000</u>	<u>2,250</u>
Sub Total	<u>2,25,250</u>	<u>57,000</u>	<u>94,000</u>	<u>74,250</u>
Selling Overhead Advertisement				
$\left(\frac{83,000}{56,000 + 27,000} \times 56/27 \text{ respectively} \right)$	83,000	—	56,000	27,000
Other Overheads				
$\left(\frac{25,000}{108} \times 25/56/27 \text{ respectively} \right)$	25,000	5,787	12,963	6,250
Packing			<u>54,000</u>	
Sub Total Selling Overhead	<u>1,62,000</u>	<u>5,787</u>	<u>1,22,963</u>	<u>33,250</u>

Workings:

	A	B	C	Total
Gross Production/unit /run (1)	2,520	2,810	3,010	
Defectives/run (2)	20	10	10	
Good units / run (3)	2,500	2,800	3,000	
Sales (Goods units)(4)	25,000	56,000	27,000	
No. of runs (5)	10	20	9	
Gross Production (6) = (1) × (5)	25,200	56,200	27,090	
Prime Cost / unit (7)	12	9	8	
Prime Cost (8) ₹	3,02,400	5,05,800	2,16,720	10,24,920
Inspection hours/run (9)	3	4	4	
Inspection hours (10) = (9) × (5)	30	80	36	146
M/c hours / run (11)	20	12	30	
M/c hours (12) = (1) × (5)	200	240	270	710
Dye Cost/run (13)	200	300	250	
Dye cost (14) (13) × (5)	2,000	6,000	2,250	10,250

Conventional Accounting System

	Total	A	B	C
Sales – units / Production (good units)	1,08,000	25,000	56,000	27,000
Gross Margin (₹)	5,33,080	1,47,600	2,78,200	1,07,280
Production overheads (₹)	2,25,250	52,141	1,16,797	56,313
Selling Overhead (₹)	1,62,000	37,500	84,000	40,500
Sub-Total Overhead (₹)	3,87,250	89,641	2,00,797	96,813
Net profit (₹)	1,45,830	57,959	77,403	10,467
Ranking		II	I	III

Activity Based System

	A	B	C
Sales – units / Production (good units)	25,000	56,000	27,000
Gross Margin (₹)	1,47,600	2,78,200	1,07,280
Production overheads (₹)	57,000	94,000	74,250
Selling Overhead (₹)	5,787	1,22,963	33,250
Sub-Total Overhead (₹)	62,787	2,16,963	1,07,500
Net profit (₹)	84,813	61,237	(220)
Ranking	I	II	III

Question 26

Explain the concept and aim of theory of constraints. What are the key measures of theory of constraints? (7 Marks) (May 2008)

Answer

The theory of constraints focuses its attention on constraints and bottlenecks within organisation which hinder speedy production. The main concept is to maximize the rate of manufacturing output is the throughput of the organisation. This requires to examine the bottlenecks and constraints. A bottleneck is an activity within the organization where the demand for that resource is more than its capacity to supply.

A constraint is a situational factor which makes the achievement of objectives / throughput more difficult than it would otherwise, for example of constraint may be lack of skilled labour, lack of customer orders, or the need to achieve high quality in product output.

For example let meeting the customers' delivery schedule be a major constraint in an organisation. The bottleneck may be a certain machine in the factory. Thus bottlenecks and constraints are closely examined to increase throughput.

Key measures of theory of constraints:

- (i) **Throughput contribution:** It is the rate at which the system generates profits through sales. It is defined as, sales less completely variable cost, sales – direct are excluded. Labour costs tend to be partially fixed and conferred are excluded normally.
- (ii) **Investments:** This is the sum of material costs of direct materials, inventory, WIP, finished goods inventory, R & D costs and costs of equipment and buildings.
- (iii) **Other operating costs:** This equals all operating costs (other than direct materials) incurred to earn throughput contribution. Other operating costs include salaries and wages, rent, utilities and depreciation.

Question 27

A company manufactures three types of products namely P, Q and R. The data relating to a period are as under:

	P	Q	R
Machine hours per unit	10	18	14
Direct labour hours per unit @ ₹ 20	4	12	8
Direct Material per unit (₹)	90	80	120
Production (units)	3,000	5,000	20,000

Currently the company uses traditional costing method and absorbs all production overheads on the basis of machine hours. The machine hour rate of overheads is ₹6 per hour.

The company proposes to use activity based costing system and the activity analysis is as under:

	P	Q	R
Batch size (units)	150	500	1,000
Number of purchase orders per batch	3	10	8
Number of inspections per batch	5	4	3

The total production overheads are analysed as under:

Machine set up costs	20%
Machine operation costs	30%
Inspection costs	40%
Material procurement related costs	10%

Required:

- (i) *Calculate the cost per unit of each product using traditional method of absorbing all production overheads on the basis of machine hours.*
- (ii) *Calculate the cost per unit of each product using activity based costing principles.*

(7 Marks) (Nov 2008)

Answer

- (i) Cost per unit using traditional method of absorbing all production overheads on the basis of machine hours:

Products	P	Q	R
	₹	₹	₹
Direct materials	90	80	120
Direct labour (4:12:8 hours) × ₹20	80	240	160
Production Overheads (10:18:14 hours) × ₹6	<u>60</u>	<u>108</u>	<u>84</u>
Cost per unit	<u>230</u>	<u>428</u>	<u>364</u>

- (ii) 1. Cost per unit of each product using activity based costing:

Products	P	Q	R	Total
A. Production (units)	3,000	5,000	20,000	
B. Batch size (units)	150	500	1000	
C. Number of batches [A ÷ B]	20	10	20	50
D. Number of purchase order per batch	3	10	8	
E. Total purchase orders [C × D]	60	100	160	320
F. Number of inspections per batch	5	4	3	
G. Total inspections [C × F]	100	40	60	200

2. Total Production overhead

A. Machine hours per unit	10	18	14
B. Production units	3,000	5,000	20,000
C. Total machine hours [A × B]	30,000	90,000	2,80,000
Total machine hours	= 4,00,000		
Total production overheads	= 4,00,000 × ₹6 = ₹24,00,000.		

3. Cost driver rates:

Cost Pool	%	Overheads	Cost Driver	Cost Driver Rate
		₹	Units	₹
Set up	20%	4,80,000	50	9,600 per set up
Inspection	40%	9,60,000	200	4,800 per inspection
Purchases	10%	2,40,000	320	750 per purchase
Machine hours	30%	7,20,000	4,00,000	1.80 per Machine Hour

4. Cost per unit of P, Q and R:

Products	P	Q	R
Production (units)	3,000	5,000	20,000
	₹	₹	₹
Direct Materials (90:80:120)	2,70,000	4,00,000	24,00,000
Direct Labour (80:240:160)	2,40,000	12,00,000	32,00,000
Overheads:			
Machine related costs @ ₹1.80/hour (30,000:90,000:2,80,000)	54,000	1,62,000	5,04,000
Set-up costs @ ₹9600 / set up (20 : 10 : 20)	1,92,000	96,000	1,92,000
Inspection costs @ ₹4800 / inspection (100 : 40 : 60)	4,80,000	1,92,000	2,88,000
Purchase related costs @ ₹750 / purchase (60 : 100 : 160)	45,000	75,000	1,20,000
Total costs	12,81,000	21,25,000	67,04,000
Cost per unit (Total cost ÷ units)	427.00	425.00	335.20

Question 28

Describe the four types of bench marking of critical success factors.

(4 Marks) (Nov., 2008)

Answer

The Benchmarking is of following types:

- Competitive benchmarking:** It involves the comparison of competitors products, processes and business results with own.
- Strategic benchmarking:** It is similar to the process benchmarking in nature but differs in its scope and depth.
- Global benchmarking:** It is a benchmarking through which distinction in international culture, business processes and trade practices across companies are bridged and their ramification for business process improvement are understood and utilized.
- Process benchmarking:** It involves the comparison of an organisation critical business processes and operations against best practice organization that performs similar work or deliver similar services.
- Functional Benchmarking or Generic Benchmarking:** This type of benchmarking is used when organisations look to benchmark with partners drawn from different business sectors or areas of activity to find ways of improving similar functions or work processes.

- (vi) **Internal Benchmarking:** It involves seeking partners from within the same organization, for example, from business units located in different areas.
- (vii) **External Benchmarking:** It involves seeking help of outside organisations that are known to be best in class. External benchmarking provides opportunities of learning from those who are at the leading edge, although it must be remembered that not every best practice solution can be transferred to others.

Question 29

Discuss, how target costing may assist a company in controlling costs and pricing of products.

(4 Marks) (Nov 2008)

Answer

Target costing may assist control of costs and pricing of product as under:

- (i) Target costing considers the price that ought to be charged by a company to achieve a given market share.
- (ii) Target costing should take life cycle costs in to consideration.
- (iii) If there is a gap between the target cost and expected cost, ways and means of reducing or eliminating it can be explored.
- (iv) The target cost may be used for controlling costs by comparison.

Question 30

Differentiate between 'Traditional Management Accounting' and 'Value Chain Analysis in the strategic framework'.

(Nov., 2008) (5 Marks)

Answer

Traditional management accounting focuses on internal information. It often places excessive emphasis on manufacturing costs. It also assumes that cost reduction must be found in the "value-added" process i.e. selling price less the cost of raw material. The value chain analysis approach encompasses external and internal data, uses appropriate cost drivers for all major value-creating processes, exploits linkages throughout the value chain, and provides continuous monitoring of a firm's strategic competitive advantages.

Value Chain vs. Traditional Management Accounting

	Traditional Management Accounting	Value Chain Analysis in the strategic framework
1.	If focuses on internal information	Focuses on external informations.

2.	Application of single cost driver at the overall firm level is taken.	Application of multiple cost drivers i.e. structural and executional are taken for each value activity.
3.	It assume that cost reduction must be found in the value added process	Exploits linkages throughout the value chain i.e. within firm, with suppliers and customers.
4.	Insights for strategic decisions somewhat limited in traditional management accounting	Identify cost driver at the individual activity level and develop cost / differentiation advantage either by controlling those drivers better than competitors by reconfiguring the value chain.

Question 31

Describe the Just-in-time systems

(6 Marks) (Nov., 2008)

Answer

A complete JIT system begins with production, includes deliveries to a company's production facilities, continues through the manufacturing plant and even includes the types of transactions processed by the accounting system.

- (i) The company must ensure that it receives its supplies on time, preferably directly at the production facility that needs them. The company engineers must assist suppliers at their premises and ensure defect free supplies. Thus raw material inventory is reduced if correct quantities are delivered as per production schedules.
- (ii) Long set-up times are reduced into short ones by eliminating inefficiency. Thus the WIP is reduced and so is the number of products before defects are identified.
- (iii) A 'Kanban' card, which authorizes production of the right quantity by its feeder machine ensures 'pulling' the production process and elimination of inventory. Another method is the introduction of a working cell, which is a cluster of machines run by a single trained operator. This also identifies defects quickly and reduces maintenance costs. Both methods are used together.
- (iv) Work force is trained to be empowered to halt operations understand more about the system, product flow, different machines and thus, elaborate reporting of a past variance is eliminated.
- (v) Suppliers may be paid based on production units adjusted for defects.

Question 32

Explain, how the implementation of JIT approach to manufacturing can be a major source of competitive advantage.

(4 Marks) (Nov 2008)

Answer

JIT provides competitive advantage in the following ways:

- (i) Stocks of raw materials and finished goods are eliminated, stock holding costs are avoided.
- (ii) JIT aims at elimination of non-value added activities and elimination of cost in this direction will improve competitive advantage.
- (iii) It affords flexibility to customer requirements where the company can manufacture customized products and the competitive advantage is thereby improved.
- (iv) It focuses the direction of performance based production of high quality product.
- (v) It minimize waiting times and transportation costs.

Question 33

Discuss the benefits accruing from the implementation of a Total Quality Management programme in an organization.
(4 Marks) (Nov 2008)

Answer

The benefits accruing from the implementation of a Total Quality Management programme in an organisation are:

- (i) There will be increased awareness of quality culture in the organization.
- (ii) It will lead to commitment to continuous improvement.
- (iii) It will focus on customer satisfaction.
- (iv) A greater emphasis on team work will be achieved.

Question 34

A company produces three products A, B and C. The following information is available for a period:

	A	B	C
Contribution (Rupees per unit) (Sales – Direct materials)	30	25	15

Machine hours required per unit of production:

	Hours			
	A	B	C	Throughout accounting ratio
Machine 1	10	2	4	133.33%

Machine 2	15	3	6	200%
Machine 3	5	1	2	66.67%

Estimated sales demand for A, B and C are 500 units each and machine capacity is limited to 6,000 hours for each machine.

You are required to analyse the above information and apply theory of constraints process to remove the constraints.

How many units of each product will be made?

(5 Marks)(Nov.,2008)

Answer

Throughout Accounting ratio is highest for 'Machine 2'.

∴ 'Machine 2' is the bottleneck

Contribution per unit of bottleneck machine hour :

Total 'Machine 2' hours available = 6,000

	A	B	C
A. Contribution per unit (₹)	30	25	15
B. 'Machine 2' hours	15	3	6
C. Contribution per 'Machine 2' hours (A / B)	2	8.33	2.50
D. Ranking	3	1	2
E. Maximum Demand	500	500	500
'Machine 2' hours required (B × E)	7,500	1,500	3,000
'Machine 2' hours available	1,500	1,500	3,000
Units	100	500	500

Question 35

TQ Ltd. implemented a quality improvement programme and had the following results:

	(Figures in ₹ '000)	
	2007	2008
Sales	6,000	6,000
Scrap	600	300
Rework	500	400
Production inspection	200	240
Product warranty	300	150
Quality training	75	150
Materials inspection	80	60

You are required to:

- (i) Classify the quality costs as prevention, appraisal, internal failure and external failure and express each class as a percentage of sales.
- (ii) Compute the amount of increase in profits due to quality improvement. **(4 Marks)(Nov. 2008)**

Answer

(i) Classification of Quality Costs

Figures ₹ '000

	2007	% of sales	2008	% of sales
Sales	<u>6,000</u>		<u>6,000</u>	
Prevention				
Quality training	<u>75</u>	1.25	<u>150</u>	2.5
Appraisal				
Product Inspection	<u>200</u>		<u>240</u>	
Materials Inspection	<u>80</u>		<u>60</u>	
	<u>280</u>	4.67	<u>300</u>	5
Internal Failure				
Scrap	<u>600</u>		<u>300</u>	
Rework	<u>500</u>		<u>400</u>	
	<u>1100</u>	18.33	<u>700</u>	11.67
External Failure				
Product warranty	<u>300</u>	5	<u>150</u>	2.5
	<u>1755</u>	29.25	<u>1300</u>	21.67

- (ii) Cost reduction was effected by 7.58% (29.25 – 21.67) of sales, which is an increase in profit by ₹ 4,55,000.

Question 36

Traditional Ltd. is a manufacturer of a range of goods. The cost structure of its different products is as follows:

Particulars	Product	Product	Product	
	A	B	C	
Direct materials	50	40	40	₹ /u
Direct labour @ 10 ₹ /hour	30	40	50	₹ /u
Production overheads	30	40	50	₹ /u
Total Cost	110	120	140	₹ /u
Quantity produced	10,000	20,000	30,000	Units

Traditional Ltd. was absorbing overheads on the basis of direct labour hours. A newly appointed management accountant has suggested that the company should introduce ABC system and has identified cost drivers and cost pools as follows:

Activity Cost Pool	Cost Driver	Associated Cost
Stores Receiving	Purchase Requisitions	2,96,000
Inspection	Number of Production runs	8,94,000
Dispatch	Orders Executed	2,10,000
Machine Setup	Number of setups	12,00,000

The following information is also supplied:

Details	Product A	Product B	Product C
No. of Setups	360	390	450
No. of Orders Executed	180	270	300
No. of Production runs	750	1,050	1,200
No. of Purchase Requisitions	300	450	500

You are required to calculate activity based production cost of all the three products.

(5 Marks)(June, 2009)

Answer

The total production overheads are ₹ 26,00,000:

Product A: $10,000 \times ₹ 30 = ₹ 3,00,000$

Product B: $20,000 \times ₹ 40 = ₹ 8,00,000$

Product C: $30,000 \times ₹ 50 = ₹ 15,00,000$

On the basis of ABC analysis this amount will be apportioned as follows:

Statement of Activity Based Production Cost

Activity Cost Pool	Cost Driver	Ratio	Total Amount (₹)	A (₹)	B (₹)	C
Stores Receiving	Purchase requisition	6:9:10	2,96,000	71,040	1,06,560	1,18,400
Inspection	Production Runs	5:7:8	8,94,000	2,23,500	3,12,900	3,57,600
Dispatch	Orders Executed	6:9:10	2,10,000	50,400	75,600	84,000
Machine Setups	Set ups	12:13:15	12,00,000	3,60,000	3,90,000	4,50,000
Total Activity Cost				7,04,940	8,85,060	10,10,000
Quantity Sold				10,000	20,000	30,000
Unit Cost				70.49	44.25	33.67
Add: Conversion Cost				80	80	90
Total				150.49	124.25	123.67

Question 37

Explain the essential features of Life-cycle costing.

(5 Marks)(June, 2009)

Answer

Essential features of Life Cycle Costing:

Product Life Cycle costing involves :

- Tracing of costs and revenue of product over several calendar period. Throughout their entire life cycle.
- Emphasis is on Cost and revenue accumulation over the entire life cycle of the product.
- Life cycle costing traces research and design.
- It focus on development costs, incurred to individual products over their entire life cycles.
- Total magnitude of research and development costs are reported and compared with product revenues generated in later periods.

Question 38

What is disinvestments strategy? Highlight the main reasons for disinvestments.

(4 Marks)(June, 2009)

Answer

Divestment Strategy: Divestment involves a strategy of selling off or shedding business operations to divert the resources, so released, for other purposes. Selling off a business segment or product division is one of the frequent forms of divestment strategy. It may also include selling off or giving up the control over subsidiary where by the wholly owned subsidiaries may be floated as independently quoted companies.

Reason for Divestment Strategy

1. In case of a firm having an opportunity to get more profitable product or segment but have resource constraint, it may selling off it's unprofitable or less profitable division and utilized the recourse so released. Cost Benefit analysis & Capita Budgeting Method are the useful tool for analyzing this type of situation.
2. In case of purchase of new business, it may be found that some of the part of the acquired business is not upto the mark. In such type of situation disposal of the unwanted part of the business is more desirable than hold it.
3. In case where any business segment or product or subsidiary is pull down the profit of the whole organization, it is better to cut down of that operation of the product or business segment.

Question 39

How can value analysis achieve cost reduction?

(5 Marks)(Nov., 2009)

Answer

Value analysis can do cost reduction in the following manner:

- By identifying and removing unnecessary components in a product which had utility earlier.
- By introducing component substitution at a lesser cost without affecting the quality of the product.
- By simplifying the product design.
- By introducing alternative methods with less cost but improved efficiency.

Question 40

What are the critical success factors for the implementation of a "Total Quality Management" programme?

(5 Marks)(Nov., 2009); (4 Marks) (May, 2004)

Answer

Critical success factors of TQM:

- Focus on customer needs.
- Everyone in the organisation should be involved.
- Focus on continuous improvement.
- Design quality in product and production process.
- Effective performance measurement system.
- Rewards and performance measurements should be renewed.
- Appropriate training and education to everyone to understand the aim of TQM.

Question 41

A bank offers three products, viz., deposits, Loans and Credit Cards. The bank has selected 4 activities for a detailed budgeting exercise, following activity based costing methods.

The bank wants to know the product wise total cost per unit for the selected activities, so that prices may be fixed accordingly.

The following information is made available to formulate the budget:

Activity	Present Cost (₹)	Estimation for the budget period
(i) ATM Services:		

(a) Machine maintenance	4,00,000	(all fixed, no change)
(b) Rents	2,00,000	(fully fixed; no change)
(c) Currency Replenishment Cost	1,00,000	(expected to double during budget period)
(ii) Computer Processing	7,00,000	(This activity is driven by no. of ATM transactions)
	5,00,000	(Half this amount is fixed and no change is expected) (The variable portion is expected to increase to three times the current level). This activity is driven by the number of computer transactions.
(iii) Issuing Statements	18,00,000	Presently, 3 lac statements are made. In the budget period, 5 lac statements are expected; For every increase of one lac statement, one lac rupees is the budgeted increase (this activity is driven by the number of statements)
(iv) Computer Inquiries	2,00,000	Estimated to increase by 80% during the budget period. (This activity is driven by telephone minutes).

The activity drivers and their budgeted quantifies are given below:

	Deposits	Loans	Credit Cards
No. of ATM Transactions	1,50,000	-	50,000
No. of Computer Processing Transactions	15,00,000	2,00,000	3,00,000
No. of Statements to be issued	3,50,000	50,000	1,00,000
Telephone Minutes	3,60,000	1,80,000	1,80,000

The bank budgets a volume of 58,600 deposit accounts, 13,000 loan accounts, and 14,000 Credit Card Accounts.

You are required to:

- Calculate the budgeted rate for each activity.
- Prepare the budgeted cost statement activity wise.
- Find the budgeted product cost per account for each product using (i) and (ii) above.

(12 Marks)(Nov., 2009)

Answer

Budget Cost Statement

Activity	Activity Cost (₹) (Budgeted)	Activity Driver	No. of Units of Activity Driver (Budget)	Activity Rate (₹)	Deposits	Loans	Credit Cards
1. ATM Services	8,00,000	ATM Transaction	2,00,000	4	6,00,000	-	2,00,000
2. Computer Processing	10,00,000	Computer Transaction	20,00,000	0.50	7,50,000	1,00,000	1,50,000
3. Issuing Statements	20,00,000	No. of Statements	5,00,000	4.00	14,00,000	2,00,000	4,00,000
4. Customer Inquiries	3,60,000	Telephone Minutes	7,20,000	0.50	1,80,000	90,000	90,000
Budgeted Cost	41,60,000				29,30,000	3,90,000	8,40,000
Units of product as estimated in the budget period					58,600	13,000	14,000
Budgeted Cost per unit of the product					50	30	60

Working Notes:

- (i) ATM $4,00,000 + 2,00,000 + 2 \times 1,00,000 = 8,00,000$
- (ii) Computer $5,00,000$ (Fixed = 2,50,000) Variable = 10,00,000
 $2,50,000$ increase to 3 times = 7,50,000
- (iii) Customer Inquiries $2,00,000 + 80\% \times 2,00,000 = 2 + 1.6 = 3,60,000$.

Question 42

AML Ltd. is engaged in production of three types of ice-cream products: Coco, Strawberry and Vanilla. The company presently sells 50,000 units of Coco @ ₹ 25 per unit, Strawberry 20,000 @ ₹ 20 per unit and Vanilla 60,000 units @ ₹ 15 per unit. The demand is sensitive to selling price and it has been observed that every reduction of ₹ 1 per unit in selling price, increases the demand for each product by 10% to the previous level. The company has the production capacity of 60,500 units of Coco, 24,200 units of Strawberry and 72,600 units of Vanilla. The company marks up 25% on cost of the product.

The Company management decides to apply ABC analysis. For this purpose it identifies four activities and the rates as follows:

<u>Activity</u>	<u>Cost Rate</u>
Ordering	₹ 800 per purchase order
Delivery	₹ 700 per delivery
Shelf stocking	₹ 199 per hour
Customer support and assistance ₹ 1.10 p.u. sold.	

The other relevant information for the products are as follows:

	Coco	Strawberry	Vanilla
Direct Material p.u. (₹)	8	6	5
Direct Labour p.u. (₹)	5	4	3
No. of purchase orders	35	30	15
No. of deliveries	112	66	48
Shelf stocking hours	130	150	160

Under the traditional costing system, store support costs are charged @ 30% of prime cost. In ABC these costs are coming under customer support and assistance.

Required:

- Calculate target cost for each product after a reduction of selling price required to achieve the sales equal to the production capacity.
- Calculate the total cost and unit cost of each product at the maximum level using traditional costing.
- Calculate the total cost and unit cost of each product at the maximum level using activity based costing.
- Compare the cost of each product calculated in (i) and (ii) with (iii) and comment on it.

(12 Marks) (May, 2010)

Answer

- Cost of products under target costing

Demanded unit and selling price

Coco		Strawberry		Vanilla	
Selling Price	Demand	Selling Price	Demand	Selling Price	Demand
25	50000	20	20000	15	60000
24	55000	19	22000	14	66000
23	60500	18	24200	13	72600

Target cost of each product after reduction in selling price

	Coco	Strawberry	Vanilla
Selling price after reduction	23.00	18.00	13.00
Profit marks up 25% on cost i.e 20 % on selling price	4.60	3.60	2.60
Target cost of production (per unit)	18.40	14.40	10.40

(ii) Cost of product under traditional costing

	Coco	Strawberry	Vanilla
	(₹)	(₹)	(₹)
Units	60500	24200	72600
Material cost (8,6,5 per unit)	8	6	5
Labour cost (5,4,3 per unit)	5	4	3
Prime cost	13	10	8
Store support costs (30% of prime)	<u>3.90</u>	<u>3</u>	<u>2.40</u>
Cost per unit	<u>16.90</u>	<u>13.00</u>	<u>10.40</u>

(iii) Cost of product under activity based costing

	Coco	Strawberry	Vanilla
	(₹)	(₹)	(₹)
Units	60500	24200	72600
Material cost (8,6,5 per unit)	484000	145200	363000
Labour cost (5,4,3 per unit)	<u>302500</u>	<u>96800</u>	<u>217800</u>
Prime cost	786500	242000	580800
Ordering cost @ ₹ 800 (35, 30, 15)	28000	24000	12000
Delivery cost @ ₹ 700 (112, 66, 48)	78400	46200	33600
Shelf stocking @ ₹ 199, (130,150,160)	25870	29850	31840
Customer Support ₹ 1.10	<u>66550</u>	<u>26620</u>	<u>79860</u>
Total Cost	<u>985320</u>	<u>368670</u>	<u>738100</u>
Cost Per unit	16.29	15.23	10.17

(iv) Comparative Analysis of cost of production (₹)

	Coco	Strawberry	Vanilla
	(₹)	(₹)	(₹)
(a) As per Target Costing	18.40	14.40	10.40
(b) As per traditional Costing	16.90	13.00	10.40
(c) As per Activity Based Costing	16.29	15.23	10.17
(a) - (c)	2.11	-0.83	0.23
(b) - (c)	0.61	-2.23	0.23

Note : The cost of product of strawberry is higher in ABC method in comparison to target costing and traditional methods. It indicated that actual profit under ABC costing is less than targeted. For remaining two products, ABC is most suitable.

Question 43

What is Backflushing in JIT? State the problems that must be addressed for the effective functioning of the system. (4 Marks)(May, 2010)

Answer

Back flushing requires no data entry of any kind until a finished product is completed. At the time the total amount finished is entered into the computer system, which multiplies it by all the components listed in the bill of materials for each item produced.

To work system properly some serious problems must corrected.

- (i) Production reporting: The total production figure entered into the system must be absolutely correct.
- (ii) Scrap reporting: All abnormal scrap must be diligently tracked and recorded; otherwise these materials will fall outside the back flushing system and will not be charged to inventory.
- (iii) Lot tracing: Lot tracing is impossible under the back flushing system. It is required when a manufacturer need to keep records of which production lots were used to create a product in case all the items in a lot must be recalled.
- (iv) Inventory accuracy: Maintain accurate set of inventory records.

Question 44

Brief the principles associated with synchronous manufacturing. (5 Marks)(May, 2010)

Answer

Synchronous Manufacturing

It is an all encompassing manufacturing management philosophy which includes a set of principles, procedures, and techniques where every action is evaluated in terms of common goals of the organization.

The 7 principles are :

- i. Focus on synchronizing the production flow than on idle capacities.
- ii. Value of time at a bottleneck resource is equal to the throughput rate of products processed by the bottle neck.
- iii. Value of time at a non bottleneck resource is negligible.
- iv. Level of utilization of a non bottleneck resource is controlled by other constraints within the system.
- v. Resources must be utilized, not simply activated.
- vi. Transfer batch should not be equal to the process batch.

vii. A process batch should be variable both along its route and overtime.

Question 45

Mention the data required to operate the material requirement planning system.

(4 Marks)(Nov., 2010)

Answer

Data requirements to operate material requirement planning system:

1. The master Production schedule: This schedule specifies the quantity of each finished unit of products to be produced and the time at which each unit will be required.
2. The Bill of material file: The bill of material file specifies the sub-assemblies, components and materials required for each of the finished goods.
3. The inventory file: This file maintains details of items in hand for each sub-assembly, components and materials required for each of the finished goods.
4. The routing file: This file specifies the sequence of operations required to manufacture sub-assemblies, components and finished goods.
5. The master parts file: This file contains information on the production time of sub-assemblies; components produced internally and lead times for externally acquired items.

Question 46

Explain the major components of balanced score card.

(4 Marks)(Nov., 2010)

Answer

Well designed balanced score card combines financial measures of past performance with measures of the firm's drivers of future performance. Generally the Balanced Score Card has the following perspectives from which a company's activity can be evaluate

1. Customer perspective i.e how customers see us?
2. Internal perspective ie. In what processes must the firm excel?
3. Innovation & learning perspective i.e, can we continue to improve and create value?
4. Financial perspective i.e., how we look to our share holders?

Question 47

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

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

Budgeted factory costs for the period are ₹ 2,21,600. The bottleneck resources time available is 75120 minutes per period.

Required:

- (i) Company adopted throughput accounting and products are ranked according to 'product return per minute'. Select the highest rank product.
- (ii) Calculate throughput accounting ratio and comment on it. (5 Marks)(Nov., 2010)

Answer

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

Particulars	X	Y	Z
Selling Price	66	75	90
Variable Cost	24	30	40
Throughput Contribution	42	45	50
Minutes per unit	15	15	20
Contribution per minute	2.8	3	2.5
Ranking	II	I	III

- (ii)

Factory Cost per minute(221600/75120)	2.95	2.95	2.95
TA Ratio = Contrb per min / cost per minute	0.95	1.02	0.85
Ranking based on TA Ratio	II	I	III

Comment : Product Y yields more contribution compared to average factory contribution per minute, whereas X and Z yield less.

Question 48

Fruitolay had decided to increase the size of the store. It wants the information about the probability of the individual product lines : Lemon, grapes and papaya. It provides the following data for the 2009 for each product line:

	Lemon	Grapes	Papaya
Revenues	₹ 79,350.00	₹ 2,10,060.00	₹ 1,20,990.00

Cost of goods sold	₹ 60,000.00	₹ 1,50,000.00	₹ 90,000.00
Cost of bottles returned	₹ 1,200.00	₹ 0	₹ 0
Number of purchase orders placed	36	84	36
Number of deliveries received	30	219	66
Hours of shelf stocking time	54	540	270
Items sold	12,600	1,10,400	30,600

Fruitolay also provides the following information for the year 2009:

S. No.	Activity	Description of Activity	Total costs (₹)	Cost allocation basis
1.	Bottle returns	Returning of empty bottles to the store	1,200.00	Direct tracing to product line
2.	Ordering	Placing of orders of purchases	15,600.00	156 purchase orders
3.	Delivery	Physical delivery and the receipts of merchandise	25,200.00	315 deliveries
4.	Self stocking	Stocking of merchandise on store shelves and ongoing restocking	17,280.00	864 hours of time
5.	Customer support	Assistance provided to customers including bagging and checkout	30,720.00	153600 items sold

Required:

- Fruitolay currently allocates store support costs (all costs other than the cost of goods sold) to the product line on the basis of the cost of goods sold of each product line. Calculate the operating income and operating income as the percentage of revenue of each product line.
- If Fruitolay allocates store support costs (all costs other than the cost of goods sold) to the product lines on the basis of ABC system, calculate the operating income and operating income as the percentage of revenue of each product line.
- compare both the systems.

(11 Marks)(Nov., 2010)

Answer

(i)

Particulars	Lemon	Grapes	Papaya	Total
Revenue	79,350	2,10,060	1,20,990	4,10,400

Less: Cost of goods sold (COGS)	60,000	1,50,000	90,000	3,00,000
Less: Store Support Cost	18,000	45,000	27,000	90,000
Operating income	1,350	15,060	3,990	20,400
Operating Income %	1.70%	7.17%	3.30%	4.97%

(ii) ABC System

Activity	Cost Hierarchy Level	Total Costs (₹)	Quantity Of Cost Allocation Base	Overhead Allocation Rate
Ordering	Batch	15600.00	156 Purchase orders	₹ 100
Delivery	Batch	25200.00	315 delivering orders	₹ 80
Shelf stocking	Output unit	17280.00	864 self stocking hours	₹ 20
Customer support	Output unit	30,720.00	153600 items sold	₹ 0.20

Particulars	Cost Driver	Lemon	Grapes	Papaya	Total
Bottle Returns	Direct	1,200	0	0	1,200
Ordering	Purchase orders	3,600	8,400	3,600	15,600
Delivery	Deliveries	2,400	17,520	5,280	25,200
Self Stocking	Hours of time	1,080	10,800	5,400	17,280
Customer Support	Items Sold	2,520	22,080	6,120	30,720
Grand Total		10,800	58,800	20,400	90,000

Particulars	Lemon	Grapes	Papaya	Total
Revenue	79,350	2,10,060	1,20,990	410,400
Less: Cost of goods sold	60,000	1,50,000	90,000	300,000
Less: Store Support Cost	10,800	58,800	20,400	90,000
Operating income	8,550	1,260	10,590	20,400
Operating Income %	10.78%	0.60%	8.75%	4.97%

Summary

	Lemon	Grapes	Papaya	Total
Under Traditional Costing System	1.70%	7.17%	3.30%	4.97%
Under ABC System	10.78%	0.60%	8.75%	4.97%

The grapes line drops sizeably when ABC is used. Although it constitutes 50 % COGS, it uses a higher percentage of total resources in each activity area., especially the high cost of customer support area. In contrast, lemon line draws a much lower percentage of

total resources used in each activity area than its percentage of total COGS. Hence under ABC, Lemon is most profitable. Fruitolay can explore ways to increase sales of lemons and also explore price increases on grapes.

Operating Income Ranking is highest for Grapes under Traditional System because other products bear its overhead cost, whereas under ABC a more accurate picture shows Grapes as the lowest ranking product.

Question 49

List out the remedies available for difficulties experienced during implementation of PRAISE.

(4 Marks)(Nov., 2010)

Answer

Remedies available for difficulties experienced in each step available during implementation of praise:

Sl. No.	Activities	Remedies
1.	Problem Identification	Participate in programs like brain storming, multi voting, GD etc Precise definition of a problem and quantification.
2.	Ranking	• Participative approach • Sub ordination of individual to group approach.
3.	Analysis	• Lateral thinking/Brain storming.
4.	Innovation	• Systematic evaluation of all aspects of each strategy.
5.	Solution	• Effective internal communication. • Training of personnel/managers
6.	Evaluation	• Participative approach • Effective control system to track actual feedback system

Question 50

Classify the following items under the three measures used in the theory of constraints:

- (i) Research and Development Cost
- (ii) Rent/Utilities
- (iii) Raw materials used for production
- (iv) Depreciation
- (v) Labour Cost

(vi) *Stock of raw materials*

(vii) *Sales*

(viii) *Cost of equipments and buildings.*

(4 Marks) (May 2011)

Answer

The 3 key measures are :

Contribution (iii) Raw Material for production (vii) Sales

Operating Costs (ii) Rent/utilities (iv) Depreciation (v) Labour

Investments: (i) R& D (vi) Raw Material Stock

(viii) Building and Equipment Cost

Question 51

Name any four stage in the process of bench marking

(4 Marks) (May 2011)

Answer

Various stages in the process of benchmarking.

- I Planning
 - Determination of benchmarking goal statement
 - Identification of best performance
 - Establishment of the benchmarking or process improvement team
 - Defining the relevant benchmarking measures
- II Collection of data and information
- III Analysis of finding based on data collected
- IV Formulation and implementation of recommendation
- V Constant Monitoring and reviewing.

Question 52

Classify the following measures under appropriate categories in a balanced score card for a banking company which excels in it s home loan products:

(i) *A new product related to life insurance is being considered for a tie up with the successful housing loan disbursements.*

e.g. every housing loan applicant to be advised to take a life policy or compelled to take a fire insurance policy.

(ii) *How different sectors of housing loans with different interest rates have been sanctioned, their volumes of growth in the past 4 quarters.*

- (iii) *How many days are taken to service a loan, how many loans have taken longer, what additional loans are to be released soon, e.t.c*

(Students are not required to copy these statements into their answer books)

(3 Marks)(May, 2011)

Answer

- | | |
|------------------------------------|-----------------------------------|
| (i) New product tie up | - Innovation/learning perspective |
| (ii) Growth of Volume | - Financial perspective |
| (iii) Time for loan/Fresh products | - Customer perspective |

Question 53

Explain the pre-requisites for successful operation of material requirement planning.

(5 Marks)(May, 2011)

Answer

Pre-requisites for successful operation of MRP system are:

- (i) The latest production and purchasing schedules prepared should be strictly adhered to. Day to Day change from predetermined schedules will cause chaos.
- (ii) Raw Materials, sub-assemblies and components required for production should be pre-determined in quantifiable terms. Standard should be set for the consumption quantity, quality, mix and yield of raw materials for every unit of finished product.
- (iii) Work-force must be appraised of the system and the need for absolute adherence to the schedules prepared.
- (iv) Necessary internal control system should be developed to ensure total adherence to the schedule.
- (v) Accuracy of the data supplied is vital to the MRP system.

Question 54

A company makes a single product which sells at ₹ 800 per unit and whose variable cost of production is ₹ 500 per unit. Production and sales are 1000 units per months. Production is running to full capacity and there is market enough to absorb an additional 20% of output each month.

The company has two options:

Option-I

Inspect finished goods at ₹ 10,000 per month. 4% of production is detected as defectives and scrapped at no value. There will be no warranty replacement, since every defect is detected. A small spare part which wears out due to defective material is required to be replaced at

₹ 2,000 per spare for every 20 units of scrap generated. This repair cost is not included in the manufacturing cost mentioned above.

Option-II

Shift the finished goods inspection at no extra cost, to raw material inspection, (since defective raw materials are entitled to free replacement by the supplier), take up machine set-up tuning and machine inspection at an additional cost of ₹ 8,000 per month, so that scrap of finished goods is completely eliminated. However, delivery of uninspected finished products may result in 1 % of the quantity sold to be replaced under free warranty due to minor variation in dimensions, which does not result in the wearing out of the spare as stated in Option-I

- (i) Using monthly figures relevant for decision making, advise which option is more beneficial to the company from a financial perspective.
- (ii) Identify the quality costs that can be classified as
 - (a) appraisal costs and
 - (b) external failure costs.

(5 Marks)(May 2011)

Answer

	Option I		Option II	
Production	1000 Units		1000 Units	
Finished Goods Inspection	10,000	Appraisal	-	
Raw Material Inspection scrap 4% = 40 units x variable cost per unit 500	20,000	Appraisal	10,000	
Contribution lost 300 x 40	12,000	Appraisal		
Machine repair	4,000	Appraisal	-	
Machine set up			8,000	
Warranty replacement	-			
1% x 1000 = 10 unit				
Contribution lost 10 x 300			3,000	External failure
Variable Cost lost 10 x 500	_____		<u>5,000</u>	External failure
Quality Cost	<u>46,000</u>		<u>26,000</u>	

Better Option II

Question 55

During the last 20 years, KL Ltd's manufacturing operation has become increasingly automated with computer-controlled robots replacing operators. KL currently manufactures

over 100 products of varying levels of design complexity. A single plant wise overhead absorption rate, based on direct labor hours is absorb overhead costs.

In the quarter ended March, KL's manufacturing overhead costs were:

	(₹ 000)
Equipment operation expenses	125
Equipment maintenance expenses	25
Wages paid to technicians	85
Wages paid to component stores staff	35
Wages paid to dispatch staff	<u>40</u>
Total	<u>310</u>

During the quarter, the company reviewed the Cost Accounting System and concluded that absorbing overhead costs to individual products on a labour hour absorption basis was meaningless and that overhead costs should be attributed to products using an Activity Based Costing (ABC) system, The following are identified as the most significant activities.

- (i) Receiving component consignments from suppliers.
- (ii) Setting up equipment for production runs
- (iii) Quality inspections
- (iv) Dispatching goods as per customer's orders.

Equipment operation and maintenance expense are apportioned as :

- Component stores 15% production runs 70% and dispatch 15%

Technician's wages are apportioned as:

- Equipment maintenance 30% set up equipment for production runs 40% and quality inspections 30%

During the quarter:

- (i) 980 component consignments were received from suppliers.
- (ii) 1020 production runs were set up
- (iii) 640 quality inspections were carried out.
- (iv) 420 orders were dispatched to customers.

KL's production during the quarter included component R. The following information is available:

	Component R
Component Consignments received	45
Production runs	16

Quality Inspections	10
Orders (goods) dispatched	22
Quantity produced	560

Calculate the unit manufacturing overhead cost of component R using ABC system.

(8 Marks) (May 2011)

Answer

	Receiving Supplies (₹ 000)	Set ups (₹ 000)	Quality Inspection (₹ 000)	Despatch (₹ 000)	Total (₹'000)
Equipment Operation Expenses	18.75	87.50		18.75	125.00
Maintenance technicians wages initially allocated to maintenance (30% of ₹ 85,000 = ₹ 25,500	3.75	17.50		3.75	25.00
and then reallocated on the same basis on maintenance	3.83	17.85		3.82	25.50
Balance of technician wages, allocated to set ups and quality inspections		34.00	25.50		59.50
Stores wages – Receiving	35.00				35.00
Despatch wages – Despatch				40.00	40.00
	<u>61.33</u>	<u>156.85</u>	<u>25.50</u>	<u>66.32</u>	<u>310.00</u>

Note: Equipment operations expenses and Maintenance allocated on the basis 15%, 70%, and 15% as specified in the question.

The next stage is to identify cost drivers for each activity and established cost driver rates by dividing the activity costs by a measure of cost drive usage for the period. The Calculations are as follows:

Receiving supplies (₹ 61,330/980) = ₹ 62.58 per component

Performing set ups (₹ 1,56,850/1020) = ₹ 153.77 per set up

Despatching goods (₹ 66,320/420) = ₹ 157.90 per goods order despatched

Quality Inspection (₹ 25,500/640) = ₹ 39.84

Finally the costs are assigned to components based on their cost driver usage. The assignments are as follows:

	(₹)
Receiving supplies	2816.10
Performing Set Up	2460.32
Quality Inspection	398.40
Despatching goods	<u>3473.80</u>
Total Overhead Costs	<u>9148.62</u>
	(₹)
No. of units produced	560
Cost per unit	16.34

For components the overhead costs have been assigned as follows (for components R)

Receiving supplies	(45 receipts at ₹ 62.58)
Performing setups	(16 production runs at ₹ 153.77)
Quality Inspections	(10 at ₹ 39.84)
Despatching goods	(22 at ₹ 157.90)

Question 56

Classify the following items under appropriate categories of equality costs viz. Prevention Costs, appraisal Cost, Internal Failure Costs and External Failure costs:

- (i) Rework
- (ii) Disposal of scrap
- (iii) Warranty Repairs
- (iv) Revenue loss
- (v) Repair to manufacturing equipments
- (vi) Discount on defective sale
- (vii) Raw material inspection
- (viii) Finished product inspection
- (ix) Establishment of quality circles
- (x) Packaging inspection

(5 Marks)(Nov, 2011)

Answer

- | | | |
|-----|-------------------|------------------|
| i | Rework | Internal Failure |
| ii | Disposal of Scrap | Internal Failure |
| iii | Warranty Repairs | External Failure |

iv	Revenue Loss	External Failure
v	Repairs to Manufacturing Equipment	Internal Failure
vi	Discount on Defective Sales	External Failure
vii	Raw Material Inspection	Prevention Cost
viii	Finished Product Inspection	Appraisal Cost
ix	Establishment of Quality Circles	Prevention Cost
X	Packaging Inspection	Appraisal Cost

Question 57

Briefly explain the phases in the life cycle of a product.

(4 Marks)(Nov, 2011)

Answer

Phases in Life Cycle of a Product

Phase	Characteristics
Introduction	Product is launched. Profits are almost non existent. Competition is almost negligible.
Growth	Sales/ Profits rise rapidly. Competiton enters. At phase end, profits begin to decline.
Maturity	Sales increases but at a declining rate. Some firms extend their product lines with new models.
Saturation and decline	Drop in sales volume, need for product demand disappears. Better and cheaper substitutes are available in the market.

Question 58

Explain the concept of Just In time approach in a production process. (4 Marks) (Nov, 2011)

Answer

Just in Time in Production Process

1. Products, Spare parts/materials are received directly at production floor. Inspection is completed before delivery of materials.
2. Setup time is minimized while also reducing long production runs, thereby eliminating defectives, scrap and product obsolescence.
3. Work-in-progress is reduced by use of kanban card or working cells or both.
4. Workers are trained on a variety of machines, allowed to stop machines when they identify a problem, fix it or call the repair team and adequately compensated.

5. Supporting systems such as administration, accounting and cost reporting are suitably modified to shift from the conventional mode to the improved JIT requirements.

Question 59

State whether each of the following independent activities is value-added or non-value-added:

- (i) *Polishing of furniture used by a systems engineer in a software firm.*
- (ii) *Maintenance by a software company of receivables management software for a banking company.*
- (iii) *Painting of pencils manufactured by a pencil factory.*
- (iv) *Cleaning of customers' computer key boards by a computer repair centre.*
- (v) *Providing, brake adjustments in cars received for service by a car service station.*

(5 Marks)(May, 2012)

Answer

Sl. No	Item	
i)	Polishing furniture used by a Systems Engineer in a software firm	Non-value added
ii)	Maintenance by a software company of receivables management software for a banking company	Value-added
iii)	Painting of pencils manufactured by a pencil factory	Value-added
iv)	Customers' computer key board cleaning by a computer repair centre	Value-added
v)	Providing brake adjustments in cars for repairs by a care service station.	Value-added

Question 60

State with a brief reason whether you would recommend an activity based system of costing in each of the following independent situations:

- (i) *Company K produces one product. The overhead costs mainly consist of depreciation.*
- (ii) *Company L produces 5 different products using different production facilities.*
- (iii) *A consultancy firm consisting of lawyers, accountants and computer engineers provides management consultancy services to clients.*
- (iv) *Company S produces two different labour intensive products. The contribution per unit in both products is very high. The BEP is very low. All the work is carried on efficiently to meet the target costs.*

(5 Marks)(May, 2012)

Answer

Sl. No	Description	Recommend ABC Yes/No	Reason
i)	K produces one product. Overhead is mainly depreciation	No	- One product situation. For allocation of overhead, ABC is not required. - ABC for cost reduction not beneficial since most of the overhead is depreciation.
ii)	L produces 5 different products with different facilities.	Yes	- Multi product situation. ABC is required for allocation of overhead. - ABC is necessary for pricing. - Cost drivers are likely to be different. - Cost reduction may be possible. - Production facilities are different.
iii)	Professional services – lawyers/ accountants/ computer engineers	Yes	- Variety of services. Hence ABC is required for cost allocation. - Services are very different. - ABC is necessary for pricing. - Cost reduction possible.
iv)	S produces 2 different labour intensive products. High unit contribution and efficient operations.	No	- Different products, but labour intensive. Hence, overhead allocation based on readily traceable direct labour cost will be accurate. Hence, ABC not required for cost allocation. - Low BEP level implies low level of fixed cost as a % of sale price or as a % of total cost. - Many fixed cost activity drivers are likely to align with the direct labour costs. Hence not required for cost allocation. - Efficient operation. Hence ABC not required even for cost reduction or ABC management.

Question 61

Classify the following items under the more appropriate category:

Category (CC) – Cost Control Or Category (CR) – Cost Reduction:

- (i) Costs exceeding budgets or standards are investigated.*
- (ii) Preventive function*
- (iii) Corrective function*
- (iv) Measures to standardize for increasing productivity*
- (v) Provision of proper storage facilities for materials.*
- (vi) Continuous comparison of actual with the standards set.*
- (vii) Challenges the standards set*
- (viii) Value analysis*

(4 Marks)(May, 2012)

Answer

Classification of items under cost reduction/ cost control

Sl. No.	Item	Category Cost Control (CC) Cost Reduction (CR)
(i)	Costs exceeding budgets or standards are investigated	CC
(ii)	Preventive function	CC
(iii)	Corrective function	CR
(iv)	Measures to standardize for increasing productivity	CR
(v)	Provision of proper storage facilities for materials	CC
(vi)	Continuous comparison of actual with the standards set	CC
(vii)	Challenges the standards set	CR
(viii)	Value analysis	CR

Question 62

PQR Limited sells two versions: Deluxe and Premium of its only product GoGo Juicer. The GoGo Juicer uses patented technology to extract the last drop of juice from most fruits. The 'Premium' version can handle larger fruit and has more options relative to the 'Deluxe' version. The following table provides the financial results of the most recent year of operations:

Particulars	Deluxe 90,000 units	Premium 10,000 units	Total 1,00,000 units
Revenue (₹)	63,00,000	9,00,000	72,00,000
Material cost (₹)	10,80,000	2,50,000	13,30,000
Direct labour cost (₹)	14,40,000	1,60,000	16,00,000
Contribution margin (₹)	37,80,000	4,90,000	42,70,000
Allocated fixed manufacturing overhead (₹)	34,20,000	3,80,000	38,00,000
Allocated fixed selling and administrative overheads (₹)	2,51,563	35,937	2,87,500
Profit margin (₹)	1,08,437	74,063	1,82,500
Profit margin per unit (₹)	1.2048	7.4063	

Labour cost is ₹ 16 per hour and each product requires one hour of labour. The company currently allocates all fixed manufacturing overheads, using labour hours as the allocation basis. It allocates fixed selling and administrative overheads, using revenue as the allocation base.

Although the profit margin per unit of 'Deluxe' juicer is rather low, PQR Limited believes that it is important to keep this model in the product mix. However, PQR can tailor its promotion and sales strategies to improve the sales mix to 16:4 ratio from the current 9:1 ratio of 'Deluxe' to 'Premium' juicers, with total volume staying at 1,00,000 units.

PQR Limited finds that ₹ 1.1 million of the ₹ 3.8 million of fixed manufacturing overheads pertains to batch related activities such as scheduling production runs. Similarly, ₹ 1,15,000 is the amount of administrative overheads out of the ₹ 2,87,500 of selling and administrative overheads.

It is found that the 'premium' juicer is produced in smaller batches (250 units per batch) than that of 'Deluxe' juicer (500 units per batch). Similarly, it takes 10 sales visits to sell 1,000 units of the 'Deluxe' juicer, while it takes 25 visits to sell 1,000 units of 'Premium' juicer.

Required:

- (i) Prepare a profitability statement based on the proposed sales mix, using the most appropriate basis of allocating fixed overheads.

(In absence of an appropriate basis, do not allocate overheads to products)

- (ii) Advise the company on whether it should go ahead with the propose change in sales mix.

(10 Marks)(Nov, 2012)

Answer

(i) Profitability Statement New Mix -Most Appropriate Basis

Particulars	Deluxe 80,000 Units		Premium 20,000 Units		Total (₹)
	Per Unit (₹)	Amount (₹)	Per Unit (₹)	Amount (₹)	
Revenue	70.00	56,00,000.00	90.00	18,00,000.00	74,00,000.00
Material Cost	12.00	9,60,000.00	25.00	5,00,000.00	14,60,000.00
Direct Labour Cost (One hour per unit) 80,000 Hrs., 20,000 hrs.	16.00	12,80,000.00	16.00	3,20,000.00	16,00,000.00
Contribution Margin	42.00	33,60,000.00	49.00	9,80,000.00	43,40,000.00
Unit related Fixed Mfg. Overheads (Allocation on the basis of direct labour hours) 80,000:20,000 [W.N. 1]		21,60,000.00		5,40,000.00	27,00,000.00
Batch- related Fixed Mfg. Overheads (Allocation on the basis no. of batches) 160:80 [W.N. 1 & 4]		7,33,333.33		3,66,666.67	11,00,000.00
Fixed Selling Overheads (Allocated on the basis of sales visits) 800:500 [W.N. 2 & 3]		1,06,153.85		66,346.15	1,72,500.00
Profit Margin Ex Admin Overheads		3,60,512.82		6,987.18	3,67,500.00
Admin Overheads [W.N. 2]					1,15,000.00
Profit Margin					2,52,500.00

Working Note

W.N.1

	₹
Fixed Mfg. Overheads	38,00,000.00
Less: Related to batch related activities	11,00,000.00
Fixed Mfg. Overheads– unit related	27,00,000.00

W.N.2

	₹
Selling & Admn. Overheads	2,87,500.00
Less: Admn. Overhaeds	1,15,000.00
Selling Overheads	1,72,500.00

W.N.3

No. of Visits	10 Sales Visit for 1,000 Units (Deluxe)	25 Sales Visit for 1,000 Units (Premium)	Total
For Proposed Mix-Sales Visit	800	500	1,300

W.N.4

No. of Batches	1 Batch for 500 Units (Deluxe)	1 Batch for 250 Units (Premium)	Total
For Proposed Mix-Batches	160	80	240

- (ii) Change in product mix, yields profit of ₹ 70,000/- (₹ 2,52,500 - ₹ 1,82,500). Accordingly company should go with proposed change mix.

☞ This problem can be solved by assuming that some portion of the fixed cost as fixed with respect to units of production, but variable with respect to certain activities. When the production size is altered, these activities are increased and therefore, the activity cost varies for the proposed production level. More batches of production and more sales visits will set off the incremental contribution.

Question 63

In the context of Activity Based Costing System, explain the following statement:

"Strategic cost analysis should exploit internal linkages"

(4 Marks) (Nov, 2012)

Answer

Activity based costing is an accounting methodology that assigns cost to activities rather than to products or services. Activity based Costing tracks the flow of activities by creating internal link between activity/resource consumption and cost object. Exploiting internal linkages means taking advantage of the relationships among the activities that exist within a firm's segment of value chain. Activity cost and analysis are essential parts of this strategic analysis. Activities not based on production units/sales units, based on the variable activity drivers are analyzed. The traditional costing system is not rich enough to supply the information needed for thorough analysis of linkages.

Question 64

What is target costing? It is said that target costing fosters team work within the organisation. Explain how target costing creates an environment in which team work fosters.

(4 Marks)(Nov, 2012)

Answer

Target cost is the difference between the estimated selling price of a proposed product with specified functionality and quality and target margin. This is a cost management technique that aims to produce and sell products that will ensure the target margin. It is an integral part of the product design. While designing the product the company allocates value and cost to different attributes and quality. Therefore, they use the technique of value engineering and value analysis. The target cost is achieved by assigning cost reduction targets to different operations that are involved in the production process. Eventually, all operations do not achieve the cost reduction targets, but the overall cost reduction target is achieved through team work. Therefore, it is said that target costing fosters team work.

Question 65

What qualitative factors should be considered in an decision to outsource manufacturing of a product?

(4 Marks)(Nov, 2012)

Answer

The following qualitative factors should be considered in an outsourcing decision:

- (i) Whether the vendor will acquire the technology and will emerge as a competitor?
- (ii) Whether the vendor will be able to maintain the quality? If the vendor fails to maintain the quality, will the company lose customers?
- (iii) Whether the company will lose its skills in manufacturing the product and it will find difficult to resume production internally?
- (iv) Whether laying off employees will demoralize the work force?
- (v) Whether the price quoted by the vendor is a penetrating price? If so, it is likely to increase i.e. Whether price will increase.

Question 66

Brief the principles associate with synchronous manufacturing.

(4 Marks)(Nov, 2012)

Answer

Synchronous Manufacturing: In an all-encompassing management philosophy which includes a set of principles, procedures and techniques where every action is evaluated in terms of common goals of the organization.

The seven principles are:

- (i) Focus on synchronizing the production flow than on idle capacities.
- (ii) Value of time at a bottleneck resource is equal to the throughput rate of products processed by the bottleneck.
- (iii) Value of time at a non-bottleneck resource is negligible.
- (iv) Level of utilization of a non-bottleneck resource is controlled by other constraints within the system.
- (v) Resources must be utilized, not simply activated.
- (vi) Transfer batch should not be equal to process batch.
- (vii) A process batch should be variable both along its route and overtime.

Question 67

DEF Bank operated for years under the assumption that profitability can be increased by increasing Rupee volumes. But that has not been the case. Cost analysis has revealed the following:

Activity	Activity Cost (₹)	Activity Driver	Activity Capacity
Providing ATM service	1,00,000	No. of transactions	2,00,000
Computer processing	10,00,000	No. of transactions	25,00,000
Issuing Statements	8,00,000	No. of statements	5,00,000
Customer inquiries	3,60,000	Telephone minutes	6,00,000

The following annual information on three products was also made available:

	Checking Accounts	Personal Loans	Gold Visa
Units of product	30,000	5,000	10,000
ATM transactions	1,80,000	0	20,000
Computer transactions	20,00,000	2,00,000	3,00,000
Number of statements	3,00,000	50,000	1,50,000
Telephone minutes	3,50,000	90,000	1,60,000

Required:

- (i) Calculate rates for each activity.
- (ii) Using the rates computed in requirement (i), calculate the cost of each product.

(8 Marks)(May, 2013)

Answer

Calculation showing Rates for each Activity

Activity	Activity Cost [a] (₹)	Activity Driver	No. of Units of Activity Driver [b]	Activity Rate [a] / [b] (₹)
Providing ATM Service	1,00,000	No. of ATM Transactions	2,00,000	0.50
Computer Processing	10,00,000	No. of Computer Transactions	25,00,000	0.40
Issuing Statements	8,00,000	No. of Statements	5,00,000	1.60
Customer Inquiries	3,60,000	Telephone Minutes	6,00,000	0.60

Calculation showing Cost of each Product

Activity	Checking Accounts (₹)	Personal Loans (₹)	Gold Visa (₹)
Providing ATM Service	90,000 (1,80,000 tr. x ₹ 0.50)	—	10,000 (20,000 tr. x ₹ 0.50)
Computer Processing	8,00,000 (20,00,000 tr. x ₹ 0.40)	80,000 (2,00,000 tr. x ₹ 0.40)	1,20,000 (3,00,000 tr. x ₹ 0.40)
Issuing Statements	4,80,000 (3,00,000 tr. x ₹ 1.60)	80,000 (50,000 tr. x ₹ 1.60)	2,40,000 (1,50,000 tr. x ₹ 1.60)
Customer Inquiries	2,10,000 (3,50,000 tr. x ₹ 0.60)	54,000 (90,000 tr. x ₹ 0.60)	96,000 (1,60,000 tr. x ₹ 0.60)
Total Cost [a]	₹ 15,80,000	₹ 2,14,000	₹ 4,66,000
Units of Product [b]	30,000	5,000	10,000
Cost of each Product [a]/[b]	52.67	42.80	46.60

Question 68

Gupta Ltd. produces 4 products P, Q, R and S by using three different machines X, Y and Z. Each machine capacity is limited to 6,000 hours per month. The details given below are for July, 2013:

	P	Q	R	S
Selling price p.u. (₹)	10,000	8,000	6,000	4,000
Variable cost p.u. (₹)	7,000	5,600	4,000	2,800

Machine hours required p.u.				
Machine X	20	12	4	2
Machine Y	20	18	6	3
Machine Z	20	6	2	1
Expected Demand (units)	200	200	200	200

Required:

- Find out the bottleneck activity.
- Allocate the machine hours on the basis of the bottleneck.
- Ascertain the profit expected in the month if the monthly fixed cost amounts to ₹9,50,000.
- Calculate the unused spare hours of each machine.

(8 Marks)(May,13)

Answer

(i)

Machine	Time Required for Products (Hours)				Total Time	Time Available	Machine Utilization
	P	Q	R	S			
X	4,000 (200 units x 20 hours)	2,400 (200 units x 12 hours)	800 (200 units x 4 hours)	400 (200 units x 2 hours)	7,600	6,000	126.67%
Y	4,000 (200 units x 20 hours)	3,600 (200 units x 18 hours)	1,200 (200 units x 6 hours)	600 (200 units x 3 hours)	9,400	6,000	156.67%
Z	4,000 (200 units x 20 hours)	1,200 (200 units x 6 hours)	400 (200 units x 2 hours)	200 (200 units x 1 hours)	5,800	6,000	96.67%

Since Machine Y has the *highest machine utilization* it represents the bottleneck activity. Hence Product Ranking & Resource Allocation should be based on Contribution/Machine Hour of Machine Y.

(ii)

Allocation of Resources						
Particulars	P	Q	R	S	Machine Utilization	Spare capacity
Selling Price per unit (₹)	10,000	8,000	6,000	4,000		
Variable Cost per unit (₹)	7,000	5,600	4,000	2,800		

Contribution per unit (₹)	3,000	2,400	2,000	1,200		
Time Required in Machine 'Y' (hrs.)	20	18	6	3		
Contribution per Machine Hour (₹)	150	133.33	333.33	400		
Rank	III	IV	II	I		
Allocation of Machine 'Y' time (hrs.)	4,000 (200 units x 20 hrs.)	200 (Balance)	1,200 (200 units x 6 hrs.)	600 (200 units x 3 hrs.)	6,000	
Production (units)	200	11.11 (200 hrs. / 18 hrs.)	200	200		
Allocation of Machine 'X' time (hrs.)	4,000 (200 units x 20 hrs.)	133.32 (11.11 units x 12 hrs.)	800 (200 units x 4 hrs.)	400 (200 units x 2 hrs.)	5,333.32	666.68
Allocation of Machine 'Z' time (hrs.)	4,000 (200 units x 20 hrs.)	66.66 (11.11 units x 6 hrs.)	400 (200 units x 2 hrs.)	200 (200 units x 1 hrs.)	4,666.66	1,333.34

(iii) Calculation of Expected Profit

Particulars	Amount (₹)
P (200 units x ₹ 3,000)	6,00,000
Q (11.11 units x ₹ 2,400)	26,664
R (200 units x ₹ 2,000)	4,00,000
S (200 units x ₹ 1,200)	2,40,000
Total Contribution	12,66,664
Less: Fixed Cost	9,50,000
Expected Profit	3,16,664

(iv) Unused Spare Hours

Machine 'X'

Particulars	Amount (₹)
Machine Hours Available	6,000.00 hrs.
Less: Machine Hours Utilized	5,333.32 hrs.
Spare Hours	666.68 hrs.

Machine 'Z'

Particulars	Amount (₹)
Machine Hours Available	6,000.00 hrs.
Less: Machine Hours Utilized	4,666.66 hrs.
Spare Hours	1,333.34 hrs.

While calculating Production (units) of Product 'Q' on the basis of allocated hours, round figure (complete units) can also be considered and rest of the solution will be changed accordingly.

Question 69

What are the focuses of Theory of Constraints ? How it differs with regard to cost behavior ?
(4 Marks)(May, 2013)

Answer

The theory of constraint focuses its attention on constraints and bottlenecks within the organisation which hinder speedy production. The main concept is to maximize the rate of manufacturing output i.e. the throughput of the organisation. This requires examining the bottlenecks and constraints which are defined as:

- A bottleneck is an activity within the organisation where the demand for that resource is more than its capacity to supply.
- A constraint is a situational factor which makes the achievement of objectives/throughput more difficult than it would otherwise be. Constraints may take several forms such as lack of skilled employees, lack of customer orders or the need to achieve a high level of quality product output.

Using above definition, therefore, a bottleneck is always a constraint but a constraints need not be a bottleneck.

The theory of constraints assumes few costs are variable –generally materials, purchased parts, piecework labour, and energy to run machines. It assumes that most direct labour and overheads are fixed. This is consistent with the idea that the shorter the time period, the more costs are fixed, and the idea that the theory of constraints focuses on the short run.

Question 70

The following independent situations are given in JIT systems of production. You are required to state if each recommendation is valid or invalid and give a brief reason.

Sl. No.	Situation	Recommendation by the Cost Accountant
(i)	A company produces LCD TVs.	Compute inventory turnover every month. Break

	<i>Presently total inventory turnover is measured annually.</i>	<i>it down into raw material, WIP, expensive inventory and finished goods.</i>
(ii)	<i>Textile company.</i>	<i>Accept employees' claim for piece rate incentive for exceeding a certain production volume.</i>
(iii)	<i>Sports goods manufacturing company.</i>	<i>Closely monitor direct labour variances including idle time variances to convince employees to work faster.</i>
(iv)	<i>Multiproduct production</i>	<i>Monitor the average set up time per machine in a period which is given by</i> <u><i>Aggregate set up time of all machines</i></u> <i>Total number of machines.</i>

(4 Marks)(Nov, 2013)

Answer

Situation		Valid / Invalid
(i)	A company produces LCD TVs. Presently total inventory turnover is measured annually.	Valid - JIT system emphasize extraordinary high inventory turnover. When a company is producing LCD TVs, total turnover of inventory will be high, when the recommendation of computing of inventory turnover and breaking it into raw material, W-I-P and finished goods is given JIT system is very much valid.
(ii)	Textile company.	Invalid - In textile industry, employees are paid extra if they exceed certain production volume targets. JIT focuses on producing only what is needed not to accumulate inventory on account of high incentives. So any piece rate system must be eliminated and replaced with measures that focus instead on the quality of output or the number of employee suggestions for improving the system, which are much more important outcomes in a JIT system.
(iii)	Sports goods manufacturing company.	Invalid - Monitoring Direct labour efficiency is highly inappropriate in JIT system. As JIT system unlike traditional system does not focus on fast workings of employees. Instead JIT focuses on quality of product manufactured. JIT system strives to avoid all unnecessary activities and hence eliminate non-value-added activities like monitoring direct labour variance including idle variance.
(iv)	Multiproduct production.	Invalid - The average setup time per machine is of great

importance as it can be measured periodically and plotted on a trend line. The shortest possible setup intervals are crucial for the success of short production runs, so this is a major JIT measurement. It is best to measure it by machine, rather than in the aggregate, since an aggregate measure does not reveal enough information about which equipments requires more setup time reduction work.

 Conceptual correct brief reason along with the validity of recommendation (valid or invalid) is sufficient.

Question 71

MK Ltd. manufactures four products, namely A, B, C and D using the same plant and process. The following information relates to a production period:

Product	A	B	C	D
Output in Units	720	600	480	504

The four products are similar and are usually produced in production runs of 24 units and sold in batches of 12 units. The total overheads incurred by the company for the period are as follows:

	₹
Machine operation and maintenance cost	63,000
Setup costs	20,000
Store receiving	15,000
Inspection	10,000
Material handling and dispatch	2,592

During the period the following cost drivers are to be used for the overhead cost:

Cost	Cost driver
Setup cost	No. of production runs
Store receiving	Requisitions raised
Inspection	No. of production runs
Material handling and dispatch	Orders executed

It is also determined that:

- Machine operation and maintenance cost should be apportioned between setup cost, store receiving and inspection activity in the ratio 4: 3: 2.

- Number of requisition raised on store is 50 for each product and the no. of orders executed is 192, each order being for a batch of 12 units of a product.

Calculate the total overhead cost per unit of each product using activity based costing after finding activity wise overheads allocated to each product. (8 Marks)(Nov, 2013)

Answer

Statement Showing Overhead Cost per unit

Particulars	A (₹)	B (₹)	C (₹)	D (₹)
Setup	15,000 $\left[\frac{720\text{units}}{24\text{units}} \times ₹500 \right]$	12,500 $\left[\frac{600\text{units}}{24\text{units}} \times ₹500 \right]$	10,000 $\left[\frac{480\text{units}}{24\text{units}} \times ₹500 \right]$	10,500 $\left[\frac{504\text{units}}{24\text{units}} \times ₹500 \right]$
Store Receiving	9,000 [50Req.x₹180]	9,000 [50Req.x₹180]	9,000 [50Req.x₹180]	9,000 [50Req.x₹180]
Inspection	7,500 $\left[\frac{720\text{units}}{24\text{units}} \times ₹250 \right]$	6,250 $\left[\frac{600\text{units}}{24\text{units}} \times ₹250 \right]$	5,000 $\left[\frac{480\text{units}}{24\text{units}} \times ₹250 \right]$	5,250 $\left[\frac{504\text{units}}{24\text{units}} \times ₹250 \right]$
Material Handling and Dispatch	810 $\left[\frac{720\text{units}}{12\text{units}} \times ₹13.5 \right]$	675 $\left[\frac{600\text{units}}{12\text{units}} \times ₹13.5 \right]$	540 $\left[\frac{480\text{units}}{12\text{units}} \times ₹13.5 \right]$	567 $\left[\frac{504\text{units}}{12\text{units}} \times ₹13.5 \right]$
Total Overhead Cost	32,310	28,425	24,540	25,317
Overhead Cost per unit	44.875	47.375	51.125	50.232

Workings

Allocation of Machine Operation and Maintenance Cost

Particulars	Setup	Store Receiving	Inspection
Machine operation and maintenance cost of ₹63,000 to be distributed in the ratio of 4: 3: 2	28,000	21,000	14,000

Activities, Drivers and Cost

Activity	Cost (₹)	Drivers	Nos.	Cost per unit of Driver (₹)
Setup (₹20,000 + ₹28,000)	48,000	Production Runs	96	500.00
Store Receiving	36,000	Requisitions Raised	200	180.00

(₹15,000 + ₹21,000)				
Inspection (₹10,000 + ₹14,000)	24,000	Production Runs	96	250.00
Material Handling and Disp.	2,592	Orders	192	13.50

Note:

Production Run for

A (720/24)	=	30
B (600/24)	=	25
C (480/24)	=	20
D (504/24)	=	21

Question 72

In Value Chain analysis, business activities are classified into primary activities and support activities. Classify the following under the more appropriate activity.

- (i) Order processing and distribution
- (ii) Installation, repair and parts replacement
- (iii) Purchase of raw material and other consumable stores
- (iv) Transforming inputs into final products
- (v) Selection, promotion, appraisal and employee relations
- (vi) Material handling and warehousing
- (vii) General management, planning, finance, accounting
- (viii) Communication, pricing and channel management

(4 Marks)(Nov, 2013)

Answer

Activity		Primary Activity/Support Activity
(i)	Order processing and distribution	Primary Activity
(ii)	Installation, repair and parts replacement	Primary Activity
(iii)	Purchase of raw material and other consumable stores	Support Activity
(iv)	Transforming inputs into final products	Primary Activity
(v)	Selection, promotion, appraisal and employee relations	Support Activity
(vi)	Material handling and warehousing	Primary Activity
(vii)	General management, planning, finance, accounting	Support Activity
(viii)	Communication, pricing and channel management	Primary Activity

Question 73

State the type of cost in the following cases:

- (i) Cost associated with the acquisition and conversion of material into finished product.
- (ii) Cost arising from a prior decision which cannot be changed in the short run.
- (iii) Increase in cost resulting from selection of one alternative instead of another.
- (iv) Rent paid for a factory building which is temporarily closed. (4 Marks)(Nov, 2013)

Answer

Cases	Type of Cost
(i) Cost associated with the acquisition and conversion of material into finished product.	Product Cost
(ii) Cost arising from a prior decision which cannot be changed in the short run.	Committed Cost
(iii) Increase in cost resulting from selection of one alternative instead of another.	Differential/Incremental Cost
(iv) Rent paid for a factory building which is temporarily closed.	Shut Down Cost

Decision Making Using Cost Concepts and CVP Analysis

Question 1

Panchwati Cement Ltd. produces '43 grade' cement for which the company has an assured market. The output for 2004 has been budgeted at 1,80,000 units at 90% capacity utilisation. The cost sheet based on output (per unit) is as follows:

	₹
Selling price	130
Direct material	30
Component 'EH'	9.40
Direct wages @ ₹ 7 per hour	28
Factory overhead (50% fixed)	24
Selling and distribution overheads (75% variable)	16
Administrative overhead (fixed)	5

The factory overheads are applied on the basis of direct labour hours.

To utilise the idle capacity and to improve the profitability of the company, the following proposals were put up before the Board of Directors for consideration:

- (i) *An order has been received from abroad for 500 units of product '53 grade' cement per month at ₹ 175 per unit. The cost data are:*

Direct material ₹ 56 per unit, direct labour 10 hours per unit, selling and distribution overhead applicable to this product order is ₹ 14 per unit and variable factory overhead are chargeable on the basis of direct labour hours.

- (ii) *The company at present manufactures component 'EH', one unit of which is required for each unit of product '43 grade'. The cost details for 15,000 units of component 'EH' are as follows:*

	₹
Direct materials	30,000
Direct labour	52,500
Variable overheads	25,500
Fixed overheads	<u>33,000</u>
Total	<u>1,41,000</u>

The component 'EH' however is available for purchase at the market at ₹ 7.90 per unit.

(iii) In the event of company deciding to purchase the component 'EH' from market, the company has two alternatives for the use of the capacity so released, which are as under:

- Rent out the released capacity at Re. 1 per hour.
- Manufacture component 'GYP' which can be sold at ₹ 8 per unit. The cost data of this component for 15,000 units are:

	₹
Direct materials	42,000
Direct labour	31,500
Factory variable overheads	13,500
Other variable overheads	<u>25,500</u>
Total	<u>1,12,500</u>

Required:

- Prepare a statement showing profitability of the company envisaged in the budget.
- Evaluate the export order and state whether it is acceptable or not.
- Make an appraisal of proposal to manufacture component 'EH' and state whether the component 'EH' should be manufactured in the factory or purchased from the market. Assume that no alternative use of spare capacity is available.
- Evaluate the alternative use of the spare capacity and state whether to manufacture or buy the component 'EH' and if you decision is to buy the component 'EH', which of the two alternatives for the use of spare capacity will you prefer ?

(16 Marks)(Nov. 2004)

Answer

(i) Profitability as per original Budget

		₹ ('000s)	₹ ('000s)
Sales(1,80,000 units × ₹ 130)	(A)		23,400
Direct Material (1,80,000 units × ₹ 30)		5,400	
Component 'EH' (variable cost = ₹ 7.20 per unit)		1,296	
Direct wages (1,80,000 units × ₹ 28)		5,040	
Variable factory overheads (1,80,000 units × ₹ 24 × 50%)		2,160	
Variable selling & distribution (1,80,000 units × ₹ 24 × 50%)		2,160	
Total variable cost	(B)		16,056
Contribution	(A – B)		7,344
Fixed factory overheads		2,160	
Fixed selling & distribution overheads		720	
Component 'EH' @2.20		396	
Administrative overhead		900	4,176
Profit			3,168

(ii) Export order

	₹ per Unit	₹ per Unit
Direct material	56	
Direct labour (10 hours × ₹ 7 per hour)	70	
Variable factory overhead (₹ 3 × 10 labour hours)	30	
Selling and distribution overheads	14	
Total variable cost		170
Selling price (export)		175
Contribution		5

Since the product earns contribution of ₹ 5 per unit, it should be accepted.

Total units 500(per month) = 6000 units(per annum)

Therefore additional contribution (6000 units × ₹ 5) = ₹ 30,000

Total hours on product '43 grade' (1,80,000 units × 4) = 7,20,000 Hrs

Total hours on component 'EH' (1,80,000 units $\times$ 0.5*) = 90,000 Hrs

* $\frac{\text{Direct Labour cost}}{\text{No of units produced} \times \text{Labour rate per hour}}$

= $\frac{\text{₹ 52,500}}{15,000 \text{ units} \times \text{₹ 7 per hour}} = 0.5 \text{ Hrs}$

Total hours utilised at 90% capacity = 7,20,000 hours + 90,000 hours = 8,10,000 hours

100% capacity hours = $\frac{8,10,000 \text{ hours} \times 100}{90} = 9,00,000 \text{ Hrs}$

Balance hours available = 90,000 hours p.a

Hours required for export order 60,000 hours.

Both contribution per unit of export order and availability of capacity confirm its acceptance.

(iii) Component 'EH' make or buy

(per 15,000 units)	Make (₹)	Buy (₹)
Direct material	30,000	
Direct labour	52,500	
Variable factory overhead	25,500	
Total	1,08,000	1,18,500
Per unit	7.20	7.90

If the company makes the component the out of pocket cost is ₹ 7.20 per unit whereas if the component is bought, the out of pocket cost is ₹ 7.90.

Decision : If the capacity remains idle it is profitable to make.

(iv) Alternative use of the spare capacity

Units required = 1,80,000 units and hours required = $1,80,000 \times 0.5 = 90,000 \text{ Hrs}$

Cost of buying component 'EH' = $(1,80,000 \text{ units} \times \text{₹ 7.90}) = \text{₹ } 14,22,000$

Cost of making component 'EH' = $(1,80,000 \text{ units} \times \text{₹ 7.20}) = \text{₹ } 12,96,000$

Hence, excess cost of buying = ₹ 1,26,000

Rent income (90,000 hours $\times$ Re1) = ₹ 90,000

Contribution per unit from making component 'GYP' = $\text{₹ } 8 - \frac{\text{₹ } 1,12,500}{15,000 \text{ Units}} = \text{₹ } 0.5$
per unit.

$$\text{Direct labour cost per unit of 'GYP'} = \frac{\text{₹ } 31,500}{15,000 \text{ Units}} = \text{₹ } 2.10 \text{ per unit.}$$

$$\text{No. of labour hours required for one unit of 'GYP'} = \frac{\text{₹ } 2.10}{\text{₹ } 7} = 0.3 \text{ Hrs}$$

$$\text{No. of units of 'GYP' in 90,000 hours} = \frac{90,000 \text{ hours}}{0.3 \text{ hours}} = 3,00,000$$

$$\text{Contribution from component 'GYP'} = 3,00,000 \times \text{₹ } 0.50 = \text{₹ } 1,50,000$$

Since the contribution from 'GYP' is greater than the extra variable cost of buying component 'EH', component 'GYP' should be manufactured and component 'EH' should be purchased.

Question 2

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 ₹ 40 per unit. New price announced for 2005 is ₹ 100 per box. Variable cost on opening stock is ₹ 40 per box. You are required to compute breakeven volume for the year 2005. (7 Marks) (Nov. 2005)

Answer

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

In the question production of 2004 is same as in 2005. Hence fixed cost for the year 2004 is ₹ 52, 00,000 ($1, 30,000 \times 40$). Therefore fixed cost for the year 2005 is ₹ 57, 20,000 ($52, 00,000 + 10\% \text{ of } 52, 00,000$).

Variable Cost for the year 2005 ($\text{₹ } 40 + 25\% \text{ of } \text{₹ } 40$) = ₹ 50 per Unit

Hence Contribution per unit during 2005 is ₹ 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 ₹ 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 3

Jay Kay Limited is a single product manufacturing company. The following information relates

to the months of May and June, 2003:

	May	June
	₹	₹
(i) Budgeted Costs and Selling prices:		
Variable manufacturing cost per unit	2.00	2.20
Total fixed manufacturing cost (based on budgeted output of 25,000 units per month)	40,000	44,000
Total fixed marketing cost	14,000	15,400
Selling price per unit	5.00	5.50
(ii) Actual production and sales:		
	Units	Units
Production	24,000	24,000
Sales	21,000	26,500

(iii) There was no stock of finished goods at the beginning of May, 2003. There was no wastage or loss of finished goods during May or June, 2003.

(iv) Actual costs incurred corresponded to those budgeted for each month.

You are required to calculate the relative effects on the monthly operating profits of applying: (i) Absorption costing and (ii) Marginal costing. (11 Marks) (May, 2006)

Answer

(a) Quantity tally:

		May 2003	June 2003
Opening Stock	units	—	3,000
Production	units	24,000	24,000
Total	units	24,000	27,000
Sales	units	21,000	26,500
Closing Stock	units	3,000	500
Fixed manufacturing overheads	₹	40,000	44,000
Budgeted output	units	25,000	25,000
Fixed overheads absorption rate per unit	₹	1.60	1.76

(i) Profitability based on absorption costing:

	May 2003	June 2003
	₹	₹
Sales:		
May: 21,000 units @ ₹ 5.00	1,05,000	
June: 26,500 units @ ₹ 5.50		1,45,750
Production Costs:		
Variable: May 24,000 units @ ₹ 2.00	48,000	
June 24,000 units @ ₹ 2.20		52,800
Fixed: May 24,000 units @ ₹ 1.60	38,400	
June 24,000 units @ ₹ 1.76		42,240
Total production costs	86,400	95,040
Add: Opening stock		
May Nil		
June 3,000 units @ Res. 3.60*		10,800
Total	86,400	1,05,840
Less: Closing stock		
May 3,000 units @ ₹ 3.60*	10,800	
June 500 units @ ₹ 3.96*		1,980
Production cost of goods sold	75,600	1,03,860
Marketing fixed costs	14,000	15,400
Total cost of goods sold	<u>89,600</u>	<u>1,19,260</u>
Profit (Sales – COGS)	15,400	26,490
Budgeted output		
Actual output		
Shortfall		
Under recovery of fixed overheads		
May 1,000 units @ ₹ 1.60	1,600	
June 1,000 units @ ₹ 1.76		1,760
Net profit	<u>13,800</u>	<u>24,730</u>

*Total cost =

VC + FC

May

2.00 + 1.60 = 3.60

June

2.20 + 1.76 = 3.96

(ii) Profitability based on marginal costing:

	May 2003	June 2003
	₹	₹
Sales	1,05,000	1,45,750
Production cost – variable	48,000	52,800
Add: Opening stock		
May Nil		
June 3,000 units @ ₹ 2.00		<u>6,000</u>
Total	48,000	58,800
Less: Closing stock		
May 3,000 units @ ₹ 2.00	6,000	
June 500 units @ ₹ 2.20		1,100
Variable cost of goods sold	42,000	57,700
Contribution	63,000	88,050
Fixed costs: May June		
Production 40,000 44,000		
Marketing 14,000 15,400	54,000	59,400
Net profit	9,000	28,650

Question 4

Zilmil Ltd. makes two products 'Brightly; and 'Lightly'. Both the products use the same labour force, the size of which is restricted to 78,000 hours per month. Brightly needs 2 hours per unit to make whereas lightly needs one hour. The estimated production and sales, manufacturing and selling expenses per month are as follows:

	Brightly		Lightly	
Production and Sales (in Nos.)	12,000	16,000	40,000	48,000
Cost per month (₹)	34,00,000	38,00,000	62,00,000	66,80,000

The Company is considering pricing option in a highly competitive market. It has estimated sales demand at various selling prices:

Brightly:						
Selling Price per unit (₹)	276	272	268	264	260	254
Sales demand per month	12,000	14,000	16,000	18,000	20,000	22,000
Lightly:						

Selling Price per unit (₹)	163	162	161	160	156	152
Sales demand per month	40,000	42,000	44,000	46,000	48,000	50,000

You are required to compute profit maximizing price and quantity for each product.

(11 Marks) (May, 2006)

Answer

Brightly

Unit price ₹	Contribution per unit ₹	Volume Units	Total contribution (₹ in 000)	Incremental contribution (₹ 000)	Labour hours	Incremental labour hours	Incremental contribution per labour hour ₹	Rank
276	176	12000	2112	2112	24000	24000	88	2
272	172	14000	2408	296	28000	4000	74	6
268	168	16000	2688	280	32000	4000	70	7
264	164	18000	2952	264	36000	4000	66	8
260	160	20000	3200	248	40000	4000	62	9
254	154	22000	3388	188	44000	4000	47	10

Lightly

Unit price	Contribution per unit	Volume	Total contribution (₹ in 000)	Incremental contribution (₹ 000)	Labour hours	Incremental labour hours	Incremental contribution per labour hour	Rank
163	103	40,000	4120	4,120	40,000	40,000	103	1
162	102	42,000	4284	164	42,000	2,000	82	3
161	101	44,000	4444	160	44,000	2,000	80	4
160	100	46,000	4600	156	46,000	2,000	78	5
156	96	48,000	4608	8	48,000	2,000	4	11
152	92	50,000	4600	(8)	50,000	2,000	(4)	Loss

As the labour time is scarce source (time available 78,000 hours), the decision has to be taken on the basis of ranks based upon incremental contribution per labour hour.

Product	Price	Incremental volume	Incremental labour hours	Balance hours	Incremental Contribution (in 000 ₹)
Lightly	163	40,000	40,000	38,000	4120

Brightly	276	12,000	24,000	14,000	2112
Lightly	162	2,000	2,000	12,000	164
Lightly	161	2,000	2,000	10,000	160
Lightly	160	2,000	2,000	8,000	156
Brightly	272	2,000	4,000	4,000	296
Brightly	268	2,000	4,000		<u>280</u>
Total					<u>7,288</u>

Hence product mix is Brightly – 16,000 units and Lightly 46,000 units

Optimal contribution per month	₹ 72,88,000
Fixed costs per month	₹ 60,00,000
Optimal profit per month	₹ 12,88,000

Working Notes:

	Brightly	Lightly
Variable cost (p.u.)	$\frac{(38,00,000 - 34,00,000)}{(16,000 - 12,000)} = ₹ 100$	$\frac{(66,80,000 - 62,00,000)}{(48,000 - 40,000)} = ₹ 60$
Fixed cost (₹)	22,00,000	38,00,000

Contribution = Unit selling price less variable cost per unit.

Question 5

“The use of Absorption costing method in decision-making process leads to anomalies.” Discuss.
(4 Marks) (May, 2006)

Answer

In absorption costing, fixed overheads are assigned to products by establishing overhead absorption rates based on budgeted or normal output. By using absorption costing principles, it is possible for profit to decline when sales volume increases. If the stock levels fluctuate significantly, profits may be distorted because stock changes will significantly affect the amount of fixed overheads allocated to a period. If profits are measured on monthly or quarterly or on periodical basis, seasonal variations in sales may cause significant fluctuations in profits.

Internal profit statements on monthly or quarterly basis are used for measuring the managerial performance. In the circumstances, managers may deliberately alter inventory levels to influence profit, if absorption costing is used. When sales are less and the closing inventory increases, a part of the fixed overheads contained in the value of the closing stock is reduced from the fixed costs allocated to production for the period. Thus, if sales are reduced,

inventories will increase and absorption cost will post higher profits. Similarly, if sales are increased as compared to production, inventories will be reduced and absorption costing will return lower profits.

Question 6

X Ltd. manufactures a semiconductor for which the cost and price structure is given below:

	₹ per unit
Selling price	500
Direct material	150
Direct labour	100
Variable overhead	50
Fixed cost = ₹ 2 lakhs.	

The product is manufactured by a machine, whose spare part costing ₹ 2,000 needs replacement after every 100 pieces of output. This is in addition to the above costs. Assume that no defectives are produced and that the spare part is readily available in the market at all times at ₹ 2,000.

- Prepare the profitability statement for production levels of 2,000 units and 3,000 units, when fixed cost = ₹ 1 lakhs.*
- What is the break-even point (BEP) for the above data?*
- Comment on the BEP, if the fixed cost can be reduced to ₹ 1,80,000 from the existing level of 2 lakhs.*

(6 Marks) (Nov. 2006)

Answer

- X Ltd. Profitability Statement:**

Particulars	Volume Level	
	2000 units ₹ '000	3000 units ₹ '000
Sales	1,000	1,500
Variable costs		
Direct Material	300	450
Direct Labour	200	300
Variable overhead	100	150
Part costs*	40	60
Fixed cost	100	100
Total cost	740	1,060
Profit	260	440

$$\text{*Part cost: } \frac{2,000}{100} \times 2,000 = 40,000$$

$$\frac{3,000}{100} \times 2,000 = 60,000$$

- (ii) For computing the BEP: Parts cost although a step fixed cost can be considered as variable for the limited purpose of computing the range in which BEP occurs. The variable parts cost per unit is ₹ 20 $\left(\frac{2,000}{100} \right)$.

Range in which the BEP occur	$\frac{1,00,000}{(200 - 20)} = 555.55$	$\frac{2,00,000}{(200 - 20)} = 1,111.11$
Range	501–600	1,101–1,200
General Fixed Cost	1,00,000*	2,00,000
Parts cost	$(6 \times 2,000) = 12,000$	$(12 \times 2,000) = 24,000$
Total Fixed Cost	1,12,000	2,24,000
Gross Contribution/unit**	200	200
BEP	560 units	1,120 units

**Gross Contribution per unit

Sales – Direct Material – Direct Labour – Variable Overheads

$$₹ 500 - ₹ 150 - ₹ 100 - ₹ 50 = ₹ 200$$

- (iii) When fixed cost is ₹ 1,80,000. Range of BEP will be $\frac{1,80,000}{180} = 1,000$ (901–1,000)

Since the BEP of 1,000 falls on the upper most limits in the range 901 – 1,000 there will be one more BEP in the subsequent range in 1,001 – 1,100.

Range	901 – 1,000	1,001 – 1,100
	₹	₹
Gross fixed cost	1,80,000	1,80,000
Parts cost	20,000	22,000
	$10 \times 2,000$	$11 \times 2,000$
Total fixed cost	2,00,000	2,02,000
Gross contribution/unit	200	200
BEP	1,000 units	1,010 units

Question 7

A company has produced 1,500 units against a budgeted quantity of 2,000 units. Actual sales were 1,300 units. The company's policy is to value stocks at standard absorption cost.

Other data are:

Direct material	₹ 100 per unit
Direct labour	₹ 100 per unit at normal efficiency
Variable OH	₹ 50 per unit
Fixed OH at budgeted capacity	₹ 1,00,000
Variable selling OH	₹ 26,000
Budgeted fixed selling OH	₹ 30,000
Actual fixed selling OH	₹ 25,000
Selling price	₹ 400 per unit

There was no opening stock.

- (i) Present the profitability statement under absorption costing system.
- (ii) Assuming actual labour was 25% below normal efficiency and that 100 units of production had to be scrapped after complete manufacture, compute the actual profit or loss.
- (iii) Reconcile the profits under (i) and (ii) above. (11 Marks, May, 2007)

Answer

(i & ii)

Profitability under absorption costing system		Actual profit and loss account	
Particulars	₹ 000's	Particulars	₹ 000's
Sales (1,300×400)	520	Sales (1,300×400)	520
Absorption costs		Closing Stock (100×300)	30
Opening Stock	Nil	Total	550
Cost of production		Cost	
1,500 units × 300	450	Direct materials (1,500×100)	150
Less: Closing stock (200×300)	60	Direct labour (1,500×100/75%)	200
Net Absorption costs	390	Variable overhead (1,500×50)	75
Add: Under-absorption	25	Fixed manufacturing overhead	100
(500×50)			
Total absorption costs	415	Fixed Selling overhead	25

Gross profit	105	Variable selling overhead	26
Less: Selling overhead variable	26	Total costs	576
Selling overhead fixed	25		
Profit/(loss)	54	Profit / (Loss)	(26)

Working Notes:

	₹		Units
Absorption cost per unit		Budgeted capacity	2,000
Direct materials	100	Production	1,500
Direct labour	100	Under-absorption	500
Variable overhead	50	Sales	1,300
Fixed Overhead (1,00,000 / 2,000)	<u>50</u>	Closing stock	200
Total	<u>300</u>		

(iii) Reconciliation

	₹ 000's
Profit under absorption costing	54
Less: Labour inefficiency**	(50)
Less: Value of units scrapped	(30)
Actual profit / (loss)	(26)

** $(1,500 \times (133 \frac{1}{3} - 100))$

Note: In case budgeted fixed selling overheads are considered while arriving at absorption profit a saving of ₹ 5,000 shall need to be identified as part of reconciliation.

Question 8

A research project, to date, has cost a company ₹ 2,50,000 and is under review. It is anticipated that, should the project be allowed to proceed, it will be completed in about one year and can be sold for ₹ 4,00,000. The following additional information is available:

- Materials have just been received for ₹ 60,000. These are extremely toxic, and if not used in the project, have to be disposed of by special means at ₹ 15,000.
- Labour: ₹ 75,000. The men are highly skilled. If they are released from the Research Project, they may be transferred to the Works Department of the company and consequently the sales could increase by ₹ 1,50,000. The accountant estimates that the prime cost of those sales would be ₹ 1,00,000 and the overhead absorbed (all fixed) would amount to ₹ 25,000.

(iii) Research staff: ₹ 1,60,000. A decision has already been taken that this will be the last major piece of research undertaken and consequently, when work on the project ceases, the staff involved will be made redundant. Redundancy and severance pay have been estimated at ₹ 25,000.

(iv) Share of General Building Expenses : ₹ 35,000.

The Managing Director is not sure what is included in this amount, but the accounts staff charge similar amounts each year to each department.

You are required to advise whether the project should be allowed to proceed and explain the reasons for the treatment of each of the amounts above in your analysis.

(May 2007, 10 marks)

Answer

Research Project

Particulars	Relevancy	Reason	Amount
			(₹ '000s)
Project cost till date	Not relevant	Sunk cost	—
Sale price of the project	Relevant	Incremental revenue/opportunity gain	400
Cost of materials received	Not relevant	Sunk cost	—
Cost of disposal of materials	Relevant	Avoidable/opportunity cost	15
Cost of labour	Not relevant	Common costs	—
Contribution lost on the alternative use	Relevant	Opportunity cost [Sales — (Prime cost — labour)]	(125)
Absorbed Fixed overheads	Not relevant	Sunk cost	—
Cost of Research Staff	Relevant	Incremental / out of pocket	(160)
Redundancy and severance pay	Not relevant	Common costs	—
Share of General Building expenses	Not relevant	Sunk costs	—
Total incremental inflow if the project is proceeded with			<u>130</u>

Decision: Better to continue the project.

Question 9

The following information of a company is available for the year 2006:

	₹
Sales	40,000
Raw materials	20,000
Direct wages	6,000
Variable and fixed OH	10,000
Profit	4,000
Units sold	200 Nos.

In the year 2007, wages rate will increase by 50% and fixed cost will decrease by ₹ 600. If 300 units are sold in 2007, the total fixed and variable OH will be 11,400. How many units should be sold in 2007, so that the same amount of profit per unit as in year 2006 may be earned?
(May 2007, 4 Marks)

Answer

Particulars (Data per unit)	2006	2007
	₹	₹
Selling price (40,000 / 200)		200
Raw materials (20,000 / 200)		100
Direct wages (6,000 / 200)	30	(30 × 150%) 45
Variable overhead		20
Total variable cost		165
Contribution		35
Profit per unit (4,000 / 200)		20
Net contribution per unit to cover fixed overheads		15
Fixed overheads	6,000	5,400
No. of units		5,400 / 15 = 360 units

Working Notes:

No. of units sold	200	300
Total variable and fixed overheads	10,000	11,400 + 600 = 12,000
Differential cost in 2007		100 units ₹ 2,000
Variable overhead per unit		2,000 / 100 = 20
Total variable cost	4,000	6,000
Total fixed cost	6,000	(6,000 – 600) 5,400

Question 10

A company makes 1,500 units of a product for which the profitability statement is given below:

₹			
Sales			1,20,000
Direct materials	30,000		
Direct labour	36,000		
Variable OH	<u>15,000</u>		
Subtotal variable cost		81,000	
Fixed cost		<u>16,800</u>	
Total cost			<u>97,800</u>
Profit			<u>22,200</u>

After the first 500 units of production, the company has to pay a premium of ₹ 6 per unit towards overtime labour. The premium so paid has been included in the direct labour cost of ₹ 36,000 given above.

You are required to compute the Break-even point.

(6 Marks, May 2007)

Answer

Data / Unit	1 – 500	501 – 1,500
	₹	₹
Sales (1,20,000 / 1,500)	80	80
Direct material (20,000 / 1,000)	20	20
Direct labour	20	26
Variable overheads 15,000 / 1,500	10	10
Contribution	30	24
No. of units	500	
Total contribution	15,000	
Fixed costs	16,800	
Shortfall	1,800	
No. of units required above 500 to recover shortfall		1,800 / 24 = 75
Break even point		(500 + 75) = 575 units

Let X be the Direct Labour per unit upto 500 units.

Total Direct Labour $500X + 1,000(X + 6) = 36,000$

$$1,500X + 6,000 = 36,000$$

$$X = 20.$$

Therefore, up to 500 units the Direct Labour is ₹ 20. After 500 units it is ₹ 26.

Question 11

A manufacturer produces three products whose cost data are as follows:

	X	Y	Z
Direct materials (₹ / Unit)	32.00	76.00	58.50

Direct Labour:

Deptt.	Rate / hour (₹)	Hours	Hours	Hours
1	2.50	18	10	20
2	3.00	5	4	7
3	2.00	10	5	20
Variable overheads (₹)		8	4.50	10.50

Fixed overheads (₹) 4,00,000 per annum.

The budget was prepared at a time, when market was sluggish. The budgeted quantities and selling prices are as under:

Product	Budgeted quantity (Units)	Selling Price / unit (₹)
X	19,500	135
Y	15,600	140
Z	15,600	200

Later, the market improved and the sales quantities could be increased by 20 per cent for product X and 25 per cent each for product Y and Z. The sales manager confirmed that the increased sales could be achieved at the prices originally budgeted. The production manager stated that the output could not be increased beyond the budgeted level due to the limitation of Direct labour hours in department 2.

Required:

- Prepare a statement of budgeted profitability.
- Set optimal product mix and calculate the optimal profit. (14 Marks, Nov 2007)

Answer

Working Notes:

(Amount in Rupees)

	X	Y	Z
Selling price per unit (A)	135.00	140.00	200.00
Variable costs per unit			
Direct material	32.00	76.00	58.50
Direct labour			

Department 1	45.00	25.00	50.00
Department 2	15.00	12.00	21.00
Department 3	20.00	10.00	40.00
Variable overheads	<u>8.00</u>	<u>4.50</u>	<u>10.50</u>
Total variable costs (B)	<u>120.00</u>	<u>127.50</u>	<u>180.00</u>
Contribution per unit (A–B)	<u>15.00</u>	<u>12.50</u>	<u>20.00</u>

(i) Statement of budgeted profitability

	X	Y	Z	
Budgeted quantity (units)	19,500	15,600	15,600	
Contribution per unit (₹)	15.00	12.50	20.00	
Total contribution (₹)	2,92,500	1,95,000	3,12,000	
Contribution fund (₹)				7,99,500
Fixed overheads (₹)				<u>4,00,000</u>
Profit (₹)				<u>3,99,500</u>

(ii) Contribution per direct labour hour for Department 2

	X	Y	Z
Contribution per unit (₹)	15.00	12.50	20
Direct labour hours per unit	5	4	7
Contribution per labour hour	3.00	3.125	2.857
Rank	II	I	III

(iii) Total hours available in department 2

X	19,500 units × 5 =	97,500 hours
Y	15,600 units × 4 =	62,400 hours
Z	15,600 units × 7 =	<u>1,09,200 hours</u>
Total	=	<u>2,69,100 hours</u>

Optimal Product Mix

Product	Maximum Sales (units)	Direct labour hours available	Hours per unit	Output (units)	Hours used	Balance hours
Y	19,500	2,69,100	4	19,500	78,000	1,91,100

X	23,400	1,91,100	5	23,400	1,17,000	74,100
Z	19,500	74,100	7	10,585	74,095	5

Optimal profit (₹)

Contribution (₹)

Y $19,500 \times ₹ 12.50 = ₹ 2,43,750$ X $23,400 \times ₹ 15 = ₹ 3,51,000$ Z $10,585 \times ₹ 20 = ₹ 2,11,700$

Total Contribution = ₹ 8,06,450

Less fixed cost = ₹ 4,00,000

Profit = ₹ 4,06,450

Question 12

A company manufactures a single product, which requires two components. The company purchases one of the components from two suppliers: X Limited and Y Limited. The price quoted by X Limited is ₹ 180 per hundred units of the component and it is found that on an average 3 per cent of the total receipt from this supplier is defective. The corresponding quotation from Y Limited is ₹ 174 per hundred units, but the defective would go up to 5 per cent. If the defectives are not detected, they are utilised in production causing a damage of ₹ 180 per 100 units of the component.

The company intends to introduce a system of inspection for the components on receipt. The inspection cost is estimated at ₹ 24 per 100 units of the component. Such an inspection will be able to detect only 90 per cent of the defective components received. No payment will be made for components found to be defective in inspection.

Required:

(i) Advise whether inspection at the point of receipt is justified?

(ii) Which of the two suppliers should be asked to supply?

(Assume total requirement is 10,000 units of the component). (Nov 2007, 10 Marks)

Answer

Calculation of cost of per 100 units of good components:

(A)	X Ltd.	Y Ltd.
If not inspected		
Units required	10,000	10,000
Estimated defectives	300	500

	(3%)	(5%)
Cost	₹	₹
Purchase price (₹)	18,000	17,400
Production damage (₹)	<u>540</u>	<u>900</u>
Total Cost (₹)	<u>18,540</u>	<u>18,300</u>
Good component (units)	9,700	9,500
Cost per 100 good component (₹)	<u>191.13</u>	<u>192.63</u>
(B) If inspected		
Defectives not detected	30	50
Defectives detected	270	450
Components paid for	9,730	9,550
Cost	₹	₹
Purchase cost	17,514	16,617
Inspection cost	2,400	2,400
Production damage	<u>54</u>	<u>90</u>
Total cost	<u>19,968</u>	<u>19,107</u>
Good components	<u>9,700</u>	<u>9,500</u>
Cost per 100 good components (₹)	<u>205.86</u>	<u>201.3</u>

Decision:

- (i) On the basis of the cost per 100 good component calculated at (A) and (B) above, it is concluded that inspection at the point of receipt is not justified.
- (ii) It will be advantageous to purchase the component from X Ltd.

Question 13

A Ltd. Makes and sells a single product. The company's trading results for the year are:

Figs. – ₹ '000 (Year 2007)

Sales		3,000
Direct materials	900	
Direct labour	600	
Overheads	<u>900</u>	<u>2,400</u>
Profits		<u>600</u>

For the year 2008, the following are expected:

- (i) Reduction in the selling price by 10%.
- (ii) Increase in the quantity sold by 50%.
- (iii) Inflation of direct material cost by 8%.
- (iv) Price inflation in variable overhead by 6%.
- (v) Reduction of fixed overhead expenses by 25%.

It is also known that :

- (a) In 2006, overhead expenditure totalled to ₹ 8,00,000.
- (b) Total overhead cost inflation for 2007 has been 5% more than 2006.
- (c) Production and sales volumes have been 25% higher in 2007 than in 2006.

The high-low method is being used by the company to estimate overhead expenditure.

You are required to:

- (i) Prepare a statement showing the estimated trading results for 2008.
- (ii) Calculate the Break-even point for 2007 and 2008.
- (iii) Comment on the BEP and profits of the years 2007 and 2008. (May 2008, 12 Marks)

Answer

(a) (i) Trading Results

Figures ₹ '000

	2006	2007	2008	Workings
Sales:		3,000	4,050 (Refer to Note 1)	$(3,000 \times 1.5 \times .9)$
Direct Material		900	1,458	$(900 \times 1.5 \times 1.08)$
Direct Labour		600	900	$(600 \times 1.5 \times 1)$
Variable Overhead		<u>300*</u> (Refer Note 2)	<u>477</u>	$(300 \times 1.06 \times 1.5)$
Total Variable Cost		<u>1,800</u>	<u>2,835</u>	Total variable cost
Contribution		1,200	1,215	
Fixed Overhead		600 (Refer to Note 3)	450	$(600 \times .75)$
Total Overhead	800	<u>900</u>	<u>927</u>	

Total Cost		2,400	3,285	
Profits		600	765	

(ii) P/V Ratio Contribution/ Sales 40%30%

$$\text{BEP} = \frac{\text{Fixed Cost}}{\text{PV Ratio}} = \frac{600}{40\%} = 1,500 \quad \frac{450}{30\%} = 1,500$$

(Note 1) $3,000 \times 1.5 \times 0.9$

(Note 2) Overhead Cost in 2006 = 800

Increase in price = 5%

$\therefore$ Overhead cost for same production $800 \times 5\% + 800 = 840$.

Overhead increase due to quantity = $900 - 840 = ₹ 60$

₹ 60 represents increase in variable Overhead in 2007 due to increase in quantity by 25%.

$\therefore$ Variable Overhead amount in 2007 = $1\frac{1}{4}$ times

$$\text{i.e. } \frac{5}{4} = 5 \text{ times } \left(\frac{1}{4} \text{ th quantity} \right) = 5 \times 60 = 300$$

(Note 3)

In 2007 Total Overhead 900

Variable Overhead (Refer to Note 2) 300

Fixed Overhead 600

(iii)

	2007	2008	Difference	%
BEP	1,500	1,500	0	
Fixed Overhead	600	450	150	25%
PV Ratio	40%	30%	10%	25% $\frac{10}{40}$
Profit	600	765	165	27.5%

$$\text{BEP} = \frac{\text{Fixed Cost}}{\text{P/V ratio}}$$

Both Fixed Cost and P/V ratio have declined by 25% equally. So BEP sales remains the same.

The contribution is only ₹ 1,215 in 2008 though quantity is increased by 50%. This is due to increase in production cost and decrease in selling price. This is more than made up by decrease in fixed cost so that overall profit has increased by 27.5%.

Alternative Solution (for identifying variability and fixedness of overheads):

$$V_1 q_1 = \text{Variable Overhead / unit in 2007} \times \text{quantity in 2007}$$

$$V_2 q_2 = \text{Variable Overhead / unit in 2008} \times \text{quantity in 2008}$$

$$V_2 q_2 = V_1 (1.06) (1.5) q_1 = 1.59 V_1 q_1$$

$$V_0 q_0 + F_0 = 800$$

$$V_1 q_0 + F_0 = \underline{840} \text{ where } q_0 \times 1.25 = q_1$$

$$V_1 q_0 - V_0 q_0 = 40$$

$$V_0 q_0 = V_1 q_0 - 40$$

$$V_1 q_0 + F_1 - (V_0 q_0 + F_0) = \frac{5}{100} \times 800 = 40$$

$$\text{i.e. } V_1 q_0 + F_1 = 840$$

$$V_1 q_1 + F_1 = \underline{900}$$

$$V_1 (q_0 - q_1) = -60$$

$$V_1 (q_1 - 1.25 q_0) = -60 \times 1.25$$

$$V_1 (-.25) q_1 = -75$$

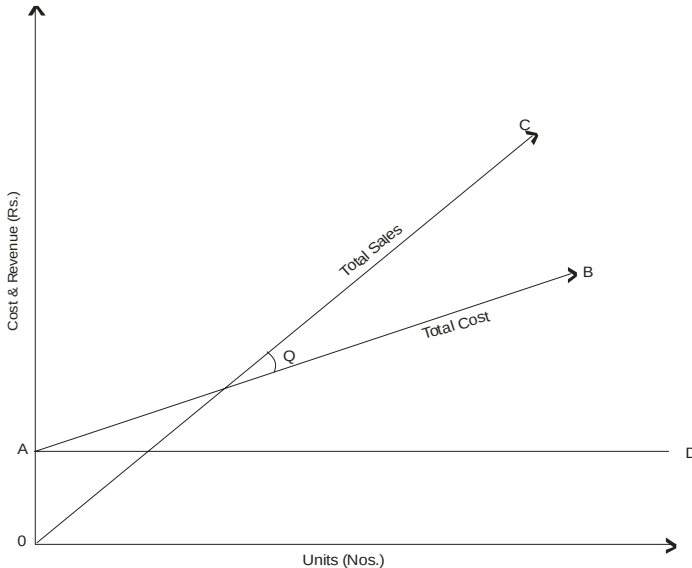
$$V_1 q_1 = \frac{-75}{-.25} = 300$$

	Variable Overhead	300
Year 2007	Fixed Overhead	<u>600</u>
		900

Question 14

Draw and explain the angle of incidence in a break-even chart. What is its significance to the management? (May 2008, 3 Marks)

Answer



Angle of incidence (Q) is the angle between the total cost line and the total sales line.

If the angle is large, the firm is said to make profits at a high rate and vice-versa.

A high angle of incidence and a high margin of safety indicate sound business conditions.

Question 15

Is it justifiable to sell at a price below marginal cost at any time? Mention the circumstances in which it is justifiable.
(May 2008, 6 Marks)

Answer

It is justifiable to sell at a price below marginal cost for a limited period.

The circumstances may be:

- (i) Where materials are of perishable nature.
- (ii) Where stocks have been accumulated in large quantities and the market prices have fallen. This will save the carrying cost of stocks, e.g., electronic goods – market prices fall due to quick obsolescence or advanced technological replenishment.
- (iii) It is essential to reduce the prices to such an extent in order to popularize a new product.
- (iv) Where such reduction enables the firm to boost the sales of other products having larger profit margin.

Question 16

What are the major areas of decision-making in which differential costing is used?

(May 2008, 4 Marks)

Answer

Differential costing can be used for all short, medium and long term decisions. When two levels of activities are being considered, or while choosing between competing alternatives differential cost analysis is essential. The differential cost is useful for decision making in the following areas:

- ◆ Capital expenditure decisions
- ◆ Make or buy decision
- ◆ Production planning
- ◆ Sales mix decision
- ◆ Production or product decision
- ◆ Change in level or nature of an activity.

Question 17

Kangan Resorts operates a lodging house with attached facilities of a shopping arcade and restaurant on a National Highway. The following details are available:

- (i) *The lodging house has 40 twin-bedded rooms, which are to be rented for ₹ 200 per night on double occupancy basis. The occupancy ratio is expected at 85% and always both the beds in the room will be occupied. The lodging facilities are operated, for 200 days in the year during foreign tourists season time only.*
- (ii) *As per past record the spending pattern of each tourist staying in the lodge will be as under:*

₹ 50 per day in the shopping arcade and	₹ 80 per day in the restaurant.
---	---------------------------------
- (iii) *Ratios of variable cost to respective sales volume are:*

Shops	Restaurant
50%	60%
- (iv) *For the lodging house the variable cost on house-keeping and electricity will amount ₹ 30 per day per occupied room.*
- (v) *Annual fixed overhead for the entire complex is estimated at ₹ 10,00,000.*

Required:

- (i) *Prepare an income statement for the next year.*

- (ii) The Lodging House Manager suggests a proposal of reducing room rent to ₹ 150 per day on double occupancy basis, which will increase occupancy level to 95%. Should the proposal be accepted or not?
(May 2008, 7 Marks)

Answer

- (i) Income Statement of Kangan Resort for the next year

	₹
Sales Revenue	
Lodging house room receipts (40 Rooms × 200 days × ₹ 200 × 85%)	13,60,000
Shopping Arcade (40 Rooms × 2 persons × 200 days × ₹ 50 × 85%)	6,80,000
Restaurant (40 Rooms × 2 persons × 200 days) × ₹ 80 × 85%)	<u>10,88,000</u>
Total Sales Revenue	<u>31,28,000</u>
Variable Cost	
Lodging house rooms (40 Rooms × 200 days × ₹ 30 × 85%)	2,04,000
Shopping Arcade (50% of ₹ 6,80,000)	3,40,000
Restaurant (60% of ₹ 10,88,000)	<u>6,52,800</u>
Total Variable Cost	<u>11,96,800</u>
Contribution (Total Sales Revenue – Total Variable Cost)	19,31,200
Less: Fixed Cost	<u>10,00,000</u>
Profit (Estimated)	<u>9,31,200</u>

- (ii) Income Statement on the basis of reduced room rent

	₹
Sales Revenue	
Lodging house room receipts (40 Rooms × 200 days × ₹ 150 × 95%)	11,40,000
Shopping Arcade (40 Rooms × 2 persons × 200 days × ₹ 50 × 95%)	7,60,000
Restaurant (40 Rooms × 2 persons × 200 days × ₹ 80 × 95%)	<u>12,16,000</u>
Total Revenue	<u>31,16,000</u>
Less: Variable Cost	
Lodging house rooms (40 Rooms × 200 days × ₹ 300 × 95%)	2,28,000
Shopping Arcade (50% of ₹ 7,60,000)	3,80,000
Restaurant (60% of ₹ 12,16,000)	<u>7,29,600</u>
Total Variable Cost	<u>13,37,600</u>

Contribution	17,78,400
Less: Fixed Cost	<u>10,00,000</u>
Profit	<u>7,78,400</u>

The profitability decreases by $9,31,200 - 7,78,400 = ₹ 1,52,800$.

Hence reducing room rent proposal may not be accepted.

Alternative Solution :

Occupancy ratio 85%

Lodging facilities for 200 days

40 twin bedded rooms – ₹ 200 per night

Shopping Arcade = ₹ 50 per day.

Restaurant = ₹ 80 per day.

Annual Fixed Overhead ₹ 10,00,000.

	Lodging House	Shopping Arcade	Restaurant	
	30/days/ occupied/room	Variable Cost 50%	60%	
Revenue 40 rooms × 200 days × 85% × 200 ₹ / person × 2 persons / room				
Days:	170	170	170	
No. of persons: 2 × 170 × 40:	13,600			
Revenue / person	100	50	80	
Revenue	1,360	680	1,088	in '000
Variable Cost 30 × 170 × 40	<u>204</u>	<u>340</u>	<u>652.80</u>	
Contribution	1,156	340	435.20	

Contribution 19,31,200

Fixed Cost 10,00,000

Profit 9,31,200

Room Days: $95\% \times 40 \times 200 = 7,600$

Person days 15,200

Rev. $150/2 \times 15,200$	1,140	760	1,216
Cost: 30/days :	<u>228</u>	<u>380</u>	<u>729.6</u>
	<u>912</u>	<u>380</u>	<u>486.4</u>

1,778.40

No, do not accept the proposal as there is decrease in profit by ₹ 1,52,800.

Question 18

State the characteristic features of a database created for operational control and decision making.
(Nov 2008, 4 Marks)

Answer

The characteristic features of a data-base created for operational control and decision making are as under:

- (i) There should be a file structure that facilitates the association of one internal record with other internal records.
- (ii) There should be cross functional integration of files.
- (iii) Independence of program / data file for ease of updating and maintenance of data base.
- (iv) There must be common standards throughout with respect to data definitions, record formats and other data descriptions.
- (v) A data dictionary should be available.

Question 19

A single product manufacturing company has an installed capacity of 3,00,000 units per annum. The normal capacity utilization of the company is 90%. The company has prepared the following budget for a year:

Variable costs:

<i>Factory costs</i>	<i>₹ 33 per unit</i>
<i>Selling and Administration costs</i>	<i>₹ 9 per unit</i>

Fixed costs:

<i>Factory costs</i>	<i>₹ 21,60,000</i>
<i>Selling and Administration costs</i>	<i>₹ 7,56,000</i>

Selling Price

<i>Selling price per unit</i>	<i>₹ 60</i>
-------------------------------	-------------

The actual production, sales, price and cost data relating to the year under review are as

given below:

Production	2,40,000 units
Sales	2,25,000 units
Finished goods stock in the beginning of the year:	15,000 units
Actual factory variable costs exceeded the budget by	₹ 1,20,000

Required:

- Calculate the budgeted profit and break-even point in units.
- What increase in selling price was necessary during the year under review to maintain the budgeted profit?
- Prepare statements showing the actual profit during the year under review by using (1) absorption costing method and (2) marginal costing method. (11 Marks, Nov 2008)

Answer

(i) Contribution per unit:

	₹	₹
Selling price per unit		60
Variable costs per unit:		
Factory	33	
Selling & Administration	<u>9</u>	<u>42</u>
Contribution per unit		<u>18</u>
(Selling price – Variable cost)		

Budgeted Profit:

	Units	₹	₹
Installed capacity	3,00,000		
Normal capacity utilization (3,00,000 × 90%)	2,70,000		
Total contribution (A)			
(Contribution per unit × Normal capacity utilization) (2,70,000 × 18)			48,60,000
Fixed Costs (B)			
Factory Costs		21,60,000	
Selling and Administration costs		<u>7,56,000</u>	<u>29,16,000</u>
Profit (A – B)			<u>19,44,000</u>

$$\text{Break - even point (in units)} = \frac{\text{Fixed costs}}{\text{Contribution per unit}}$$

$$= \frac{29,16,000}{18} = 1,62,000.$$

(ii) 1.	Actual variable costs per unit	₹	₹
	Budgeted factory costs	33	
	Increase in Factory costs per unit $\left(\frac{1,20,000}{2,40,000} \right)$	<u>0.50</u>	33.50
	Selling and Administration costs		<u>9.00</u>
			<u>42.50</u>

2. Selling price required to maintain the budgeted profit:

A. Total contribution required (₹)	48,60,000
B. Actual production (units)	2,40,000
C. Contribution desired per unit (A ÷ B) (₹)	20.25
D. Variable cost per unit (₹)	42.50
E. Selling price required to maintain budgeted profit (C + D) (₹)	62.75
F. Increase in selling price necessary ₹ (62.75 – 60)	2.75

(iii) Fixed overhead recovery rate:

Fixed factory overheads ₹ 21,60,000

Normal Production 2,70,000 units

Absorption Rate per unit : 21,60,000 / 2,70,000 = ₹ 8

Stock analysis:

	Units
Opening stocks	15,000
Add: Production	2,40,000
Total	2,55,000
Less: Sales	2,25,000
Closing stocks	30,000

1. Profitability based on Absorption Costing Method:

	₹	₹
A. Sales (2,25,000 units @ ₹ 60)		<u>1,35,00,000</u>
B. Production costs:		
Variable factory cost: (2,40,000 units × ₹ 33)	79,20,000	
Increase in cost	1,20,000	
Fixed factory costs (2,40,000 units × ₹ 8)	<u>19,20,000</u>	
Total production costs	99,60,000	
Less: Closing stock		
(30,000 units × 99,60,000) / 2,40,000	<u>12,45,000</u>	
	87,15,000	
Add: Opening stock 15,000 units × ₹ 41*	<u>6,15,000</u>	
Production cost of goods sold		93,30,000
C. Selling and Administration Costs:		
Variable costs: 2,25,000 units × ₹ 9	20,25,000	
Fixed Costs	<u>7,56,000</u>	<u>27,81,000</u>
D. Less: Total cost of goods sold (B + C)		<u>1,21,11,000</u>
		13,89,000
Less: Under absorption of factory fixed overheads		
(2,40,000 – 2,70,000 units) × ₹ 8		<u>2,40,000</u>
Profit		<u>11,49,000</u>

$$\begin{aligned}
 \text{Cost of opening stock (per unit)} &= \text{Variable Factory cost} + \text{Fixed overhead recovery rate} \\
 &= ₹ 33 \text{ per unit} + ₹ 8 \text{ per unit} \\
 &= ₹ 41 \text{ per unit.}
 \end{aligned}$$

Profitability based on Marginal Costing Method:

	₹	₹
A Sales (2,25,000 units @ ₹ 60)		<u>1,35,00,000</u>
Production variable costs:		
Variable cost (2,40,000 units × ₹ 33)	79,20,000	
Increase in cost	<u>1,20,000</u>	

Total	80,40,000	
Less: Closing stock:		
(30,000 × 80,40,000) / 2,40,000	<u>10,05,000</u>	
	70,35,000	
Add: Opening Stock (15,000 units × ₹ 33)	<u>4,95,000</u>	
B Production variable cost of goods sold	75,30,000	
C Variable Selling & Administrative Expenses (2,25,000 × ₹ 9)	20,25,000	
D Total variable costs (B + C)		<u>95,55,000</u>
E Contribution (A – D)		39,45,000
F Less: Fixed overheads: Factory	21,60,000	
Selling & Administration	<u>7,56,000</u>	<u>29,16,000</u>
G Profit (E – F)		<u>10,29,000</u>

Question 20

Explain the concept of relevancy of cost by citing three examples each of relevant costs and non-relevant costs.
(Nov 2008, 4 Marks); (May 2004, 4 Marks)

Answer

Relevant costs are those costs which are pertinent to a decision. In other words, these are the costs which are influenced by a decision. Those costs which are not affected by the decision are not relevant costs.

Examples of relevant costs are:

- (1) All variable costs are relevant costs.
- (2) Fixed Costs which vary with the decision are relevant costs.
- (3) Incremental costs are relevant costs.

Examples of non-relevant costs:

- (1) All fixed costs are generally non-relevant.
- (2) Variable costs which do not vary with the decision are not relevant costs.
- (3) Book value of the asset is not relevant.

Question 21

Bloom Ltd. makes 3 products, A, B and C. The following information is available:

	(Figures in Rupees per unit)		
	A	B	C
Selling price (peak-season)	550	630	690
Selling price (off-season)	550	604	690
Material cost	230	260	290
Labour (peak-season)	110	120	150
Labour (off-season)	100	99	149
Variable production overhead	100	120	130
Variable selling overhead (only for peak-season)	10	20	15
Labour hours required for one unit of production	8	11	7 (hours)

Material cost and variable production overheads are the same for the peak-season and off-season. Variable selling overheads are not incurred in the off-season. Fixed costs amount to ₹ 26,780 for each season, of which ₹ 2,000 is towards salary for special technician, incurred only for product B, and ₹ 4,780 is the amount that will be incurred on after-sales warranty and free maintenance of only product C, to match competition.

Labour force can be interchangeably used for all the products. During peak-season, there is labour shortage and the maximum labour hours available are 1,617 hours. During off-season, labour is freely available, but demand is limited to 100 units of A, 115 units of B and 135 units of C, with production facility being limited to 215 units for A, B and C put together.

You are required to:

- Advise the company about the best product mix during peak-season for maximum profit.
- What will be the maximum profit for the off-season? (12 Marks) (Nov., 2008)

Answer

Bloom Ltd.
Peak Season.
Statement of Contribution and BEP (in units)

Figures ₹

Product	A	B	C	
A. Selling Price per unit	550	630	690	
Variable Costs per unit:				

Direct Material	230	260	290	
Direct Labour	110	120	150	
Variable Overhead – Production	100	120	130	
Variable Overhead-Selling	<u>10</u>	<u>20</u>	<u>15</u>	
B. Total Variable Cost	450	520	585	
C. Contribution / unit (A – B)	100	110	105	
D. Direct Labour hours / required per unit	8	11	7	
E. Contribution per Labour Hour (C / D)	12.5	10	15	
F. Ranking	2	3	1	
General Fixed Overhead				20,000
Specific Fixed overhead		2,000	4,780	<u>6,780</u>
G. Total Fixed Overhead				26,780
H. BEP (units) (for only 1 Product at a time) (G/C)	$\frac{20,000}{100} = 200$	$\frac{22,000}{110} = 200$	$\frac{24,780}{105} = 236$	

Maximum units that can be produced of product C with limited labour hours 1,617.

$$= \frac{1,617}{7} = 231.$$

231 < Break Even units.

Hence, Bloom Ltd. cannot produce C.

Next rank = A

Maximum units of A that can be produced with limited labour hours = $\frac{1,617}{8} = 202$ units. Break

Even units of A = 200

∴ Profit if only A is produced

	₹
Contribution = ₹ 202 × 100	20,200
Fixed Cost	<u>20,000</u>
Profit	<u>200</u>

Bloom Ltd.
Off Season
Statement of Contribution and demand

Figures ₹ per unit

Product		A	B	C	
A	Selling Price	550	604	690	
	Direct Material	230	260	290	
	Direct Labour	100	99	149	
	Production-Variable Overhead	<u>100</u>	<u>120</u>	<u>130</u>	
B	Total Variable Cost	430	479	569	
C	Contribution per unit (A – B)	120	125	121	
	Ranking	3	1	2	
	Maximum demand	100	115	135	
	Overall limit of production				215 units

Statement of profitability under different options
(limit of production = 215 units)

	A	B	C	Total	Fixed Cost	Profit (loss)
Contribution per unit	120	125	121	-		
Option 1: Units	-	115	100	215		
Contribution (₹)	-	14,375	12,100	26,475	26,780	(305)
Option 2: Units	100	115	-	215		
Contribution (₹)	12,000	14,375	-	26,375	22,000	4,375
Option 3: Units	80	-	135	215		
Contribution (₹)	9,600	-	16,335	25,935	24,780	1,155

Best strategy is to produce 100 units of product A and 115 units of product B during off-season.

Maximum profit = ₹ 4,375.

- (i) Best strategy for peak-season is to produce 202 units of A.
(ii) Maximum profit for off-season ₹ 4,375.

Question 22

A company has prepared the following budget for the forthcoming year:

	₹ lakhs
Sales	<u>20.00</u>
Direct materials	3.60
Direct labour	6.40
Factory overheads:	
Variable	2.20
Fixed	2.60
Administration overheads	1.80
Sales commission	1.00
Fixed selling overheads	<u>0.40</u>
Total costs	<u>18.00</u>
Profit	<u>2.00</u>

The policy of the company in fixing selling prices is to charge all overheads other than the prime costs on the basis of percentage of direct wages and to add a mark up of one-ninth of total costs for profit.

While the company is confident of achieving the budget drawn up as above, a new customer approached the company directly for execution of a special order. The direct materials and direct labour costs of the special order are estimated respectively at ₹ 36,000 and ₹ 64,000. This special order is in excess of the budgeted sales as envisaged above. The company submitted a quotation of ₹ 2,00,000 for the special order based on its policy. The new customer is willing to pay a price of ₹ 1,50,000 for the special order. The company is hesitant to accept the order below total cost as, according to the company management, it will lead to a loss.

You are required to state your arguments and advise the management on the acceptance of the special order. (7 Marks)(Nov., 2008)

Answer

Analysis of Cost and profit:

	₹ (lakhs)	₹ (lakhs)
Direct material	3.60	
Direct labour	<u>6.40</u>	

Prime cost		10.00
Overhead:		
Variable factory overhead	2.20	
Fixed factory overhead	2.60	
Administration overheads	1.80	
Selling commission	1.00	
Fixed selling overheads	<u>0.40</u>	<u>8.00</u>
Total cost		18.00
Profit		<u>2.00</u>
Rate of profit on costs (2/18) = 1/9		

Overhead absorption rate based on direct wages = $(8.00 / 6.40) \times 100 = 125\%$ of direct wages

Break up of new order:

	₹
Direct Materials	36,000
Direct Labour	64,000
Overheads 125% of direct wages	80,000
Total costs	1,80,000
Profit 1/9	20,000
Selling Price	2,00,000

The following points emerge:

- (i) Factory overheads only are to be recovered on the basis of direct wages.
- (ii) The special order is a direct order. Hence commission is not payable.
- (iii) The budgeted sales are achieved. Hence all fixed overheads are recovered. Hence, no fixed overheads will be chargeable to the special order.

Based on the above, the factory variable overheads recovery rate may be calculated as under:

Total variable factory overheads ₹ 2.20 lakhs

Direct wages ₹ 6.40 lakhs

Factory overhead rate = $(2.20 / 6.40) \times 100 = 34.375\%$

Applying this rate the cost of the special order will be as under:

	₹
Direct materials	36,000

Direct labour	64,000
Overheads 34.375% of direct wages	22,000
Total costs	1,22,000
Price offered	1,50,000
Margin	28,000 (more than 1/9)

Hence, the order is acceptable at the price of ₹ 1,50,000.

Question 23

Paints Ltd. manufactures 2,00,000 tins of paint at normal capacity. It incurs the following manufacturing costs per unit:

	₹
Direct material	7.80
Direct labour	2.10
Variable overhead	2.50
Fixed overhead	<u>4.00</u>
Production cost / unit	<u>16.40</u>

Each unit is sold for ₹ 21, with an additional variable selling overhead incurred at ₹ 0.60 per unit.

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 for the quarter.

When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shut down for the quarter are estimated at ₹ 14,000.

You are required:

- To advise whether it is more economical to shut down the plant during the quarter rather than operate the plant.*
- Calculate the shut down point for the quarter in terms of numbering units.*

(6 Marks) (Nov., 2008)

Answer

Contribution per tin = Selling Price – Variable cost

$$= 21 - (7.8 + 2.1 + 2.5 + 0.6)$$

= ₹ 8 per tin.

Loss on operation:

Fixed cost per annum = 2,00,000 units × 4 per unit = 8 lakhs.

$$\therefore \text{Fixed cost for 1 quarter} = \frac{8}{4} = 2 \text{ lakhs}$$

	₹
Fixed cost for the quarter	2,00,000
Less: Contribution on operation (8 × 10,000)	<u>80,000</u>
Expected loss on operation	<u>(1,20,000)</u>

Loss on shut down:

	₹
Unavoidable Fixed Cost	74,000
Additional shut down cost	<u>14,000</u>
Loss on shut-down	<u>(88,000)</u>

Conclusion: Better to shut down and save ₹ 32,000.

$$\begin{aligned}
 \text{Shut-down point (number of units)} &= \frac{\text{Avoidable Fixed Cost}}{\text{Contribution per unit}} \\
 &= \frac{2,00,000 - 88,000}{8} \\
 &= \frac{1,12,000}{8} = 14,000 \text{ units.}
 \end{aligned}$$

Question 24

Vikram Ltd. produces 4 products using 3 different machines. Machine capacity is limited to 3,000 hours for each machine. The following information is available for February, 2009

Products	A	B	C	D
Contribution (Sales-direct material) ₹	1,500	1,200	1,000	600
Machine Hours Required/Unit :				
Machine 1	10	6	2	1
Machine 2	10	9	3	1.5
Machine 3	10	3	1	0.5
Estimated Demand (units)	200	200	200	200

From the above information you are required to identify the bottleneck activity and allocate the machine time. (7 Marks)(June, 2009)

Answer

Machine	Time required for products				Total Time	Time Available	Machine utilization
	A	B	C	D			
1	2000	1200	400	200	3800	3000	126.67%
2	2000	1800	600	300	4700	3000	156.67%
3	2000	600	200	100	2900	3000	96.67%

Since Machine 2 has the highest machine Utilization it represents the bottleneck activity hence product, ranking & resource allocation should be based on contribution/machine hour of Machine 2.

Allocation of Resources						
	A	B	C	D	Machine Utilization	Spare Capacity
Contribution per unit (₹)	1500	1200	1000	600		
Time required in Machine 2	10	9	3	1.5		
Contribution per Machine – hour (₹)	150	133.33	333.33	400		
Rank as per contribution / mach. Hour	3 rd	4 th	2 nd	1 st		
Allocation of Machine 2 time	$200 \times 10 = 2000$	100 (balancing figure)	$200 \times 3 = 600$	$200 \times 1.5 = 300$	3000	
Production Quantity	200	$100/9 = 11.11$	200	200		
Allocation Machine 1 time	2000	$11.11 \times 6 = 66.66$	400	200	2666.66	333.34
Allocation of Machine 3 time	2000	$11.11 \times 3 = 33.33$	200	100	2333.33	666.67

Question 25

Explain briefly the concepts of Opportunity costs and Relevant costs. (4 Marks)(June, 2009)

Answer

Opportunity cost is a measure of the benefit of opportunity forgone when various alternatives are considered.

Or

It is the cost of sacrifice made by alternative action chosen.

E.g. opportunity cost of funds invested in business is the interest that could have been earned by investing the funds in bank deposit.

Relevant Cost:

Expected future costs which differ for alternative course.

(Or)

It is not essential that all variable costs are relevant and all fixed costs are irrelevant. Fixed, or variable costs that differ for various alternatives are relevant costs. Relevant costs draw our attention to those elements of cost which are relevant for the decision.

E.g. Direct labour under alternative I – ₹ 10/ hour

Direct labour under alternative II – ₹ 20/hour

Then, direct labour is relevant cost.

Question 26

XYZ Ltd. has two divisions, A and B. Division A makes and sells product A, which can be sold outside as well as be used by B. A has a limitation on production capacity, that only 1,200 units can pass through its machining operations in one month. On an average, about 10% of the units that A produces are defective. It may be assumed that out of each lot that A supplies, 10% are defectives.

When A sells in the outside market, the defectives are not returned, since the transportation costs make it uneconomical for the customer. Instead, A's customers sell the defectives in the outside market at a discount.

But, when B buys product A, it has to fix it into its product, which is reputed for its quality. Therefore, B returns all the defective units to A. A can manually rework the defectives, incurring only variable labour cost and sell them outside at ₹ 150 and not having to incur any selling costs on reworked units. If A chooses not to rework, it can only scrap the material at ₹ 30 per unit. B can buy product A from outside at ₹ 200 per unit, but has to incur ₹ 10 per unit as variable transport cost. B can insist to its outside suppliers also that it will accept only good units.

A incurs a variable selling overhead only on units (other than reworked units) sold outside. The following figures are given for the month:

Variable cost of production – Dept. A (₹/unit)	120
Variable selling overhead (₹/u)	20
Selling price per unit in the outside market (₹/u)	200
Current selling price to B (₹/u)	190
Additional variable labour cost of reworking defectives (₹/u)	100

Selling price of reworked defectives (₹/u)	150
Fixed costs for the month (₹)	36,000
Maximum demand from B at present (no. of units)	630

The outside demand can be freely had upto 900 units.

Given the demand and supply conditions, you are required to present appropriate calculations for the following:

- Evaluation of the best strategy for A in the present condition.
- If B can buy only upto 540 units and the outside demand is only 600 units, how much should A charge B to maintain the same level of profit as in (i) above?

(12 Marks)(June, 2009)

Answer

- Contribution per unit against sale to outside = ₹ (200-120-20) = ₹ 60

In case of transfer, good units and rejected units are in proportion of 9:1

In case of transfer, contribution per good unit = ₹ (190 – 120) = ₹ 70

In case of transfer, contribution per rejected unit = ₹ (150 – 120-100) = ₹ -70

Thus, effective contribution per unit of transfer = ₹ (70 x 0.9 – 70x 0.1) = ₹ 56

As contribution per unit against outside sale is higher, the best strategy should be to sell maximum number of unit to outside market.

Contribution from outside market from sale of 900 units = ₹ 54,000

₹ (900 x 60)

Contribution from transfer of 300 units to B = ₹ 16,800

₹ (300 x 56)

Total Contribution from best strategy = ₹ 70,800

- If B's demand is 540 unit, total production required = 600 units.

(540 /0.9)

Taking outside market demand of 600, it is within production capacity of 1200 units.

Now contribution from 600 units of outside sale = ₹ 36,000

₹ (600 x 60)

Contribution from rejected 60 units = ₹ (4,200)

₹ (60 x – 70)

= ₹ 31,800

To keep same level of contribution as in (i), the contribution required from transfer of 540 unit to B = ₹ 39,000

(₹ 70,800 – 31,800)

Thus, contribution required per unit = ₹ 72.22

₹ 39,000 /540

Hence price to be charged per unit against transfer to B = ₹ 192.2

₹ (20 + 72.22)

Alternative Solution:

Let x be the number of units sold outside and y be the number of units sold to B, before B returns 10% as defectives.

Then, $x + y = 1,200$, is the limitation on production capacity of A.

	Department A	
	Outside ₹	to B ₹
Selling Prices	200	190
Variable Cost – Production	120	120
Variable Cost – Sale	<u>20</u>	<u>--</u>
Total Variable Cost	<u>140</u>	<u>120</u>
Contribution	60	70

Contribution on x units sold outside = $60x$

Out of y units to B, 10% = $\frac{1}{10}y = .1y$ is returned to A. If A scraps, amount got = 30 per unit.

If A reworks and sells, it gets $150 - 100 = 50$ / unit.

∴ Decision to reworks all defectives. i.e. (.1) (y)

Contribution on good units of B = $0.9y \times 70 = 63y$

Contribution on reworked units of B = $(.1) (y) \times 50 = 5y$

Amount of material lost on manufacture of defectives to B = $12y$

$(.1) (y) \times 120$

∴ Contribution on y gross units transferred to B = $56y$

$63y + 5Y - 12y$

Total contribution earned by A = $60x + 56y$

where $x + y = 1200$

To maximize contribution, maximize units sold outside.

∴ 900 units – sell outside.

Balance $\frac{300}{1200}$ units (gross transfer to B, of which B gives back 30 defectives)

Contribution : ₹ 60 (900) + ₹ 56 (300)
= ₹ 54,000 + ₹ 16,800

Contribution = ₹ 70,800

Fixed Cost = ₹ 36,000

(i) Profit = ₹ 34,800

(ii) Outside demand = 600 units

Contribution = $600 \times ₹ 60$ = ₹ 36,000

Balance to be got = ₹ 34,800

= ₹ 70,800

Out of ₹ 34,800, defectives of B will give

₹ 3,000 60×50

₹ 31,800 charge to B for 540 units

Contribution to be obtained from 540 units of B = ₹ 31,800

Add: Production cost of 600 units @ 120/- = ₹ 72,000

Amount charged for 540 units = ₹ 1,03,800

∴ Price to be charged to B = $\frac{1,03,800}{540} = 192.22$

Per good unit transferred, to maintain the same level of profit as in (a).

Question 27

PQ Ltd. makes and sells a labour-intensive product. Its labour force has a learning rate of 80%, applicable only to direct labour and not to variable overhead.

The cost per unit of the first product is as follows:

Direct materials 10,000

Direct labour 8,000 (@ ₹ 4 per hour)

Variable overhead 2,000

Total variable cost 20,000

PQ Ltd. has received an order from X Ltd. for 4 units of the product. Another customer, Y Ltd. is also interested in purchasing 4 units of the product. PQ Ltd. has the capacity to fulfill both the orders. Y Ltd. presently purchases this product in the market for ₹ 17,200 and is willing to pay this price per unit of PQ's product. But X Ltd. lets PQ choose one of the following options:

(i) A price of ₹ 16,500 per unit for the 4 units it proposes to take from PQ.

Or

(ii) Supply X Ltd.'s idle labour force to PQ, for only 4 units of production, with PQ having to pay only Re. 1 per labour hour to X Ltd.'s workers. X Ltd.'s workers will be withdrawn after the first 4 units are produced. In this case, PQ need not use its labour for producing X Ltd.'s requirement. X Ltd. assures PQ that its labour force also has a learning rate of 80%. In this option, X Ltd. offers to buy the product from PQ at only ₹ 14,000 per unit.

X and Y shall not know of each other's offer.

If both orders came before any work started, what is the best option that PQ may choose?

Present suitable calculations in favour of your argument.

(8 Marks)(June, 2009)

Answer

Units	Average/ hrs/u.
1	2,000
2	1,600
4	1,280
8	1,024
Material Cost / u	= 10,000
Variable cost	= <u>2,000</u>
Variable Cost	= <u>12,000</u>

Option I

If both the orders came together, learning rate 80% applies and 8 units can be made, with average time of 1,024 hours per unit.

Cost to PQ:

Variable cost excl. labour	= ₹ 12,000
Labour cost 1,024 hrs × 4 ₹ /hr	= ₹ <u>4,096</u>
	= ₹ <u>16,096</u>

In this case,

	Y	X	
Selling Price p. u.	₹ 17,200	₹ 16,500	→ (under option I)

Variable Cost p. u.	<u>₹ 16,096</u>	<u>₹ 16,096</u>	
Contribution p. u.	₹ 1,104	₹ 404	
No. of units	4	4	
Contribution (₹)	4416	1616	6032

Option II

If X Ltd supplies its labour. 80% learning curve will apply to 4 units each of PQ & X.

Hence: hrs/ u = 1280

	Y	X	
Selling Price	₹ 17,200	₹ 14,000	
Variable Cost (excl. labour)	₹ 12,000	₹ 12,000	
Labour cost:			
1280 × 4	₹ 5,120		
1280 × 1	_____	<u>₹ 1280</u>	
Total Variable Cost	<u>₹ 17,120</u>	<u>₹ 13,280</u>	
Contribution	₹ 80	₹ 720	
Units	4	4	
Contribution (₹)	320	2,880	3,200

PQ should not take labour from X Ltd. It should choose option I.

Question 28

Ret Ltd., a retail store buys computers from Comp Ltd. and sells them in retail. Comp Ltd. pays Ret Ltd. a commission of 10% on the _selling price at which Ret sells to the outside market. This commission is paid at the end of the month in which Ret Ltd. submits a bill for the commission. Ret Ltd. sells the computers to its customers at its store at ₹ 30,000 per piece. Comp Ltd. has a policy of not taking back computers once dispatched from its factory. Comp Ltd. sells a minimum of 100 computers to its customers.

Comp Ltd. charges prices to Ret Ltd. as follows:

₹ 29,000 per unit, for order quantity 100 units to 140 units.

₹ 26,000 per unit, for the entire order, if the quantity is 141 to 200 units. Ret Ltd. cannot order less than 100 or more than 200 units from Comp Ltd.

Due to the economic recession, Ret Ltd. will be forced to offer as a free gift, a digital camera costing it ₹ 4,500 per piece, which is compatible with the computer. These cameras are sold by another Co., Photo Ltd. only in boxes, where each box contains 50 units. Ret Ltd. can order the cameras only in boxes and these cameras cannot be sold without the computer.

In its own store, Ret Ltd. can sell 110 units of the computer. At another far of location, Ret Ltd. can sell upto 80 units of the computer (along with its free camera), provided it is willing to spend ₹ 5,000 per unit on shipping costs. In this market also, the selling price that each unit will fetch is ₹ 30,000 per unit.

You are required to:

- State what is Ret's best strategy along with supporting calculations.
- Compute the break-even point in units, considering only the above costs.

(13 Marks)(June, 2009)

Answer

(a)

	Order Qty 100-140 (₹)	Order Qty 141-200 (₹)
Selling Price ₹ /u	30,000	30,000
Commission @ 10%	3,000	3,000
Sales revenue p. u.	33,000	33,000
Less: Variable purchase cost	29,000	26,000
Contribution / unit (before shipping)	4,000	7,000
Less: Shipping cost > 110 units		5,000
Contribution/ units after Shipping		2,000

- Upto 110 units, Ret Ltd. will earn a contribution of ₹ 4,000/u.
- Between 110 & 140 units, contribution of 4,000 will be wiped out by 5,000 on shipping costs. Hence we should not consider 110 – 140 range.
- 101 – 110 not to be considered since additional fixed costs 2,25,000 will not be covered by 10 units.
- Valid consideration, 100 units or 141 to 190 units.

Fixed cost of box of 50 cameras is ₹ 2,25,000

Units		100	141	150	190
No. of Camera Boxes	A	2	3	3	4
Cost of Cameras (₹)	B	4,50,000	6,75,000	6,75,000	9,00,000
Contribution (₹ /u) ₹ 4,000	C	400,000			
Contribution (₹) first 110 units @ 7,000/u	D		7,70,000	7,70,000	7,70,000

Contribution (₹) Balance units @ 2,000/u	E		62,000	80,000	1,60,000
Total Contribution (F = C + D + E) (₹)	F	4,00,000	8,32,000	8,50,000	9,30,000
Profit (F) – (B) (₹)	G	- 50,000	1,57,000	1,75,000	30,000

Best strategy buy 150 units from Comp. sell 110 at store and 40 outside.

BEP should be between 151 – 191 units

Extra Camera box cost beyond 150 units = 2,25,000

Less: Profit for 150 units = 1,75,000

Extra profit acquired = 50,000

No. of units to cover this additional costs at contribution 2000 ₹ /u = $\frac{50,000}{2,000} = 25$

∴ BEP = 150 + 25 = 175 units

Alternative Solution

The problem involves fixed cost of 50 Cameras i.e ₹ 2,25,000 for incremental sale of 50.

	Units sold			
	110	140	150	190
Margin per unit = Sales price – buying price + commission (₹)	4000	4000	7000	7000
Margin (Excluding shipping cost)	4,40,000	5,60,000	10,50,000	13,30,000
Shipping cost (₹)		30 x 5000	40 x 5000	80 x 5000
For sale beyond 110 units		= 1,50,00	= 2,00,000	= 4,00,000
Contribution (₹)	4,40,000	4,10,000	8,50,000	9,30,000
Fixed cost (Cost of Cameras)	6,75,000	6,75,000	6,75,000	9,00,000
Profit	-2,75,000	-2,65,000	1,75,000	30,000

Best strategy is sales level at 150 units.

The variations of profit is due to incremental fixed cost.

From the profits at different levels, it is seen that the BEP lies between 151 and 190.

Let BEP = X Units

Margin = 7000 X

Shipping Cost = (X -110)x 5000

Cost of Cameras = ₹ 9,00,000

We have, $7000 X = (X - 110) \times 5000 + 900000$

Or $7X = 5X - 550 + 900$

Or $2X = 350$ or $X = 175$

Thus, BEP = 175 units.

Question 29

Lee Electronic manufactures four types of electronic products, A,B,C and D. All these products have a good demand in the market. The following figures are given to you:

	A	B	C	D
Material cost (₹/u)	64	72	45	56
Machining Cost (₹/u @ ₹ 8 per hour)	48	32	64	24
Other variable costs (₹/u)	32	36	44	20
Selling Price (₹/u)	162	156	173	118
Market Demand (Units)	52,000	48,500	26,500	30,000

Fixed overhead at different levels of operation are :

Level of operation (in production hours)	Total fixed cost (₹)
Upto 1,50,000	10,00,000
1,50,000 – 3,00,000	10,50,000
3,00,000 – 4,50,000	11,00,000
4,50,000- 6,00,000	11,50,000

At present, the available production capacity in the company is 4,98,000 machine hours. This capacity is not enough to meet the entire market demand and hence the production manager wants to increase the capacity. The company wants to retain the customers by meeting their demands through alternative ways. One alternative is to sub-contract a part of its production. The sub-contract offer received as under :

	A	B	C	D
Sub-contract Price (₹/u)	146	126	155	108

The company seeks your advice in terms of products and quantities to be produced and/or sub-contracted, so as to achieve the maximum possible profit. You are required to also compute the profit expected from your suggestion.
(18 Marks)(Nov., 2009)

Answer

Demand	52,000	48,500	26,500	30,000
	A	B	C	D
Direct Material	64	72	45	56
M/c	48	32	64	24
Other Variable Cost	<u>32</u>	<u>36</u>	<u>44</u>	<u>20</u>
Total Variable Cost	<u>144</u>	<u>140</u>	<u>153</u>	<u>100</u>
Selling Price	162	156	173	118
Contribution (₹ /u)	18	16	20	18
M/s Hours per unit	6	4	8	3
Contribution (₹ / M/c hr.)	<u>3</u>	<u>4</u>	<u>2.5</u>	<u>6</u>
Ranking	III	II	IV	I
Sub-Contract Cost ₹ /u)	146	126	155	108
Contribution (₹ /u) on (Sub-Contract)	16	30	18	8

I Division: It is more profitable to sub-contract B, since contribution is higher sub-contract.

1st Level of Operations: 1,50,000 hours, Produce D as much as possible.

Hours required = 30,000 units × 3 = 90,000 hours

Balance hours available: 60,000 hours.

Produce the next best (i.e. A, Since B is better outsourced)

$$\frac{60,000 \text{ hrs}}{6 \text{ hrs/u}} = 10,000 \text{ units of A.}$$

1st Level of Operation:

		Contribution (units)	Contribution (₹)
A	Produce 10,000 units	18	1,80,000
A	Outsource 42,000 units	16	6,72,000
B	48,500 units		
	Outsource fully	30	14,55,000
C	26,500 units		
	Outsource fully	18	4,77,000
D	30,000 units		
	Fully produce	18	5,40,000

Total Contribution:	33,24,000
Less: Fixed cost	10,00,000
Net Gain	23,24,000

2nd Level of Operation:

Both A and C increase contribution by own manufacture only by ₹ 2/- per unit. 1,50,000 hrs can produce 25,000 units of A.

∴ Contribution increases by $25,000 \times 2 = 50,000$

(Difference in Contribution sub-contract and own manufacturing) = 2

But increase in fixed Cost = 50,000

At the 2nd level of operation, the increase in contribution by own manufacturing is exactly set up by increase in fixed costs by ₹ 50,000/-. It is a point of financial indifference, but other conditions like reliability or possibility of the sub-contractor increasing his price may be considered and decision may them but towards own manufacture.

3rd Level Additional: 1,50,000 hrs available

Unit of A that are needed = $[52,000 - 25,000 \text{ (2nd Level)} - 10,000 \text{ (1st Level)}]$
 $= 17,000 \text{ units} \times 6 \text{ hrs/u} = 1,02,000 \text{ hrs.}$

Balance 48,000 hrs are available for C to produce 6,000 units.

Increase in Contribution over Level 1st or 2nd :

A: $17,000 \times 2 = ₹ 34,000$

C: $6,000 \times 2 = ₹ 12,000$

$= ₹ 46,000$

Increase in fixed costs $= ₹ 50,000$

Additional Loss $= ₹ 4,000$

4th Level Additional: 1,50,000 hrs can give $\frac{1,50,000}{8} = 18,750$ unit of C.

Increase in Contribution $18,750 \times 2 = ₹ 37,500$

Increase in Cost $= (₹ 50,000)$

Level 3rd loss c/fd $= (₹ 4,000)$

Level 1st profit will order by $= (₹ 16,500)$

Advice: Do not expand capacities; sell maximum

No. of units by operating at 1,50,000 hrs. capacity (level 1st) and gain ₹ 23,24,000.

Summary:

Product	Produce (Units)	Sub-Contract (Units)	Contribution (Production)	Contribution (Sub-Contract)	Total Contribution
A	10,000	42,000	1,80,000	6,72,000	8,52,000
B	-	48,500	-	14,55,000	14,55,000
C	-	26,500	-	4,77,000	4,77,000
D	30,000	-	5,40,000	-	5,40,000
					33,24,000
Fixed Cost					10,00,000
Profit					23,24,000

Question 30

E Ltd. is engaged in the manufacturing of three products in its factory. The following budget estimates are prepared for 2009-10 :

	Products		
	A	B	C
Sales (Units)	10,000	25,000	20,000
Selling price per unit. (₹)	40	75	85
Direct Materials per unit. (₹)	10	14	18
Direct wages per unit @ ₹ 2 p.hr.	8	12	10
Variable overhead per unit (₹)	8	9	10
Fixed overhead per unit (₹)	16	18	20
Profit/Loss	-2	22	27

After the finalisation of the above manufacturing schedule, it is observed that presently only 80% capacity being utilised by these three products. The production activities are made at the same platform and it may be interchangeable among products according to requirement. In order to improve the profitability of the company the following three proposals are put for consideration:

- (a) Discontinue product A and capacity released may be used for either product B or C or equally shared. The fixed cost of product A is avoidable. Expected changes in material cost and selling price subject to the utilisation of product A's capacity are as under:

Product B : Material cost increased by 10% and selling price reduced by 2%

Product C : Material cost increased by 5% and selling price reduced by 5%.

- (b) Discontinue product A and divert the capacity so released and the idle capacity to produce a new product D for meeting export demand whose per unit cost data are as follows:

	₹
Selling Price	60
Direct material	28
Direct wages @ ₹ 3 p. hr.	12
Variable overheads	6
Fixed cost (Total)	1,05,500

- (c) Product A, B and C are continuously run and hire out the idle capacity fixing a price in such a way that the same rate of profit per direct labour hour is obtained in the original budget estimates.

Required:

- Prepare a statement of profitability of products A, B and C in existing situation.
- Evaluate the above proposals independently and calculate the overall profitability of the company under each proposal.
- What proposal should be accepted, if the company wants to maximise its Profit?

(10 Marks)(May, 2010)

Answer

- (i) Budgeted profitability statement under existing situation

	A (₹)	B(₹)	C (₹)	Total
Selling price	40	75	85	
Total Variable costs (Direct Material + Direct Labour + Variable overhead)	<u>26</u>	<u>35</u>	<u>38</u>	
Contribution	<u>14</u>	<u>40</u>	<u>47</u>	
Sales units	10000	25000	20000	
Contribution in (₹)	140000	1000000	940000	2080000
Fixed cost (₹)	<u>160000</u>	<u>450000</u>	<u>400000</u>	<u>1010000</u>
Profit/loss (₹)	<u>-20000</u>	<u>550000</u>	<u>540000</u>	<u>1070000</u>

- (ii) Proposal (a) Alternative use of A's Capacity for Product B or C or B & C Equally
Hours released for discontinuance of A = $10,000 \times 4 = 40,000$ hours

	Product B	Product C	B & C
No of Units Possible	40000/ 6 = 6666	40000/ 5 = 8000	B=3333 C= 4000

Revised Contribution of Product B and Product C

Particulars	B (₹)	C (₹)
Selling price	73.50	80.75
Variable cost: Direct Material	15.40	18.90
Direct wages	12.00	10.00
Variable overheads	9.00	10.00
Total Variable cost	36.40	38.90
Contribution	37.10	41.85
Number of Hours	6	5
Contribution per hour	6.18	8.37

Decision : It is better to produce C

Taking both changes in the selling price and material cost are for the entire production or the incremental production. Profitability is calculated below:

Proposal (a) : Profitability statement if A's capacity utilized by C

Particulars	Option 1 Changes for entire production (₹)	Option 2 Changes for incremental production (₹)
Sales Volume	28000	8000
Contribution per unit	41.85	41.85
Total Contribution	1,17,1800	3,34,800
Less Fixed Cost	400000	0
Profit	771800	334800
Existing Profit of B	550000	550000
Existing Profit of C		540000
Total Profit	1321800	1424800

Proposal (b)

Existing capacity = (4 x 10,000 + 6 x 25,000 + 5x 20,000) = 290000 hrs

Then, Idle capacity of 20% = .290000 /4 = 72500 hours

Capacity for product 'D' = (idle + A's spare) capacity = 72500 + 40000 = 112500 hours,

No. of units 'D' produced = 112500/4 = 28125 units.

Profitability Statement – proposal (b)

Units	D (₹)
Selling price	60
Less : Variable cost :	28
Direct wages	12
Variable Overheads	6
Contribution	14
Contribution amount (₹)	393750
Less fixed cost	105500
Profit	288250
Add : Existing Profit B & C	1090000
Total Profit	1378250

Proposal (c) Hiring Out idle capacity

Particulars	(₹)
Idle Hours	72,500
Existing Profit per hour (1070000/290000)	3.69
Revenue from Hire out	267500
Existing Profit	1070000
Total Profit	1337500

Profit Summary of alternatives (₹ in 000's)

Existing	Proposal(a) Option 1	Proposal (a) Option 2	Proposal (b)	Proposal (c)
1070.00	1321.80	1424.80	1378.25	1337.50

Decision on option on the basis of profitability :

- If price and cost under proposal (a) is for entire production of C: Proposal (b) of Export
- If price and cost under proposal (a) is for incremental prod C : Proposal (a) – Option 2

Question 31

What are the applications of incremental/differential costs?

(5 Marks)(May, 2010)

Answer

Applications of Incremental/Differential Cost:

1. Whether to process a product further or not.
2. Dropping or adding a product line.
3. Optimizing investment plan.
4. accepting an additional order from a special customer at lower than existing price.
5. Make or buy decision.
6. Opening a new sales territory or branch.
7. Optimizing investment plan out of multiple alternatives.
8. Submitting tenders.
9. Lease or buy decisions.
10. Equipment replacement decisions.

Question 32

X Ltd. supplies spare parts to an air craft company Y Ltd. The production capacity of X Ltd. facilitates production of any one spare part for a particular period of time. The following are the cost and other information for the production of the two different spare parts A and B:

<i>Per unit</i>	<i>Part A</i>	<i>Part B</i>
<i>Alloy usage</i>	<i>1.6 kgs.</i>	<i>1.6 kgs.</i>
<i>Machine Time : Machine A</i>	<i>0.6 hrs.</i>	<i>0.25 hrs.</i>
<i>Machine Time :Machine B</i>	<i>0.5 hrs.</i>	<i>0.55 hrs.</i>
<i>Target Price (₹)</i>	<i>145</i>	<i>115</i>

Total hours available : Machine A 4,000 hours

Machine B 4,500 hours

Alloy available is 13,000 kgs. @ ₹ 12.50 per kg.

Variable overheads per machine hours:

Machine A : ₹ 80

Machine B : ₹ . 100

You are required to identify the spare part which will optimize contribution at the offered price.

If Y Ltd. reduces target price by 10% and offers ₹ 60 per hour of unutilized machine hour, what will be the total contribution from the spare part identified above?

(8 Marks)(May, 2010)

Answer

- (i) Number of parts to be manufactured:

	Part A	Part B
Machine "A" (4,000 hours)	6666	16000
Machine "B" (4,500 hours)	9000	8181
Alloy available (13,000 kgs.)	8125	8125
Maximum number of parts to be manufactured	6666	8125
Cost per unit	₹	₹
Material (12.5 x 1.6)	20.00	20.00
Variable Overhead : Machine "A"	48.00	20.00
Variable Overhead: Machine "B"	50.00	55.00
Total variable cost per unit	118.00	95.00
Price offered	145.00	115.00
Contribution per unit	27.00	20.00
Total contribution for units produced (I)	179982	162500
Spare part A will optimize the contribution		

(ii)

	Part A
Parts to be manufactured numbers	6666
Machine A : to be used	4000
Machine B : to be used	3333
Underutilized machine hours (4500 – 3333)	1167
Compensation for unutilized machine hours (II) (₹ 1167 x 60)	70020
Reduction in price by 10% causing fall in contribution of ₹ 14.50 per unit i.e (₹ 6666 x 14.5) (III)	96657
Total contribution (I + II -III)	153345

Question 33

A company has two divisions : Division a and Division B. Both divisions of the company manufacture the same product but located at two different places. The annual output of division A is 6000 tons (at 80% capacity) and that of division B is 7500 tons (at 60% capacity). The basic raw material required for production is available locally at both the places, but at division A, it is limited to 4000 tons per annum at the rate of ₹ 100 per ton, at division B, it is limited to 8000 tons per annum at the rate of ₹110 per ton. Any additional requirement of material will have to be purchased at a rate of ₹125 per ton from other markets at either of division. Variable costs per ton at each division remain constant. For every 1000 tons of output, 800 tons raw material is required. The details of other costs of the divisions are as follows:

	Division A	Division B
Other variable costs of output (₹)	122 per ton	120 per ton
Fixed cost per annum(₹)	3,80,000	6,00,000

Required:

- Calculate variable cost per ton for each division's product and decide ranking in order to preference.
- The company desires to fully utilize the available local supplies of raw material to save the overall variable cost of production; keeping the total production of both the divisions putting together is the same as at present level. Calculate the quantity of production (output) that could be transferred between the two divisions and overall saving in variable cost.
- After considering the option (ii), how the balance capacity should be utilized if company is working at 100% capacity, and also calculate selling price per ton if company mark up 10% on full cost of each division's product. (12 Marks)(Nov., 2010)

Answer

Variable cost per ton in different alternatives

Particulars	Division A		Division B	
	Local	Outside	Local	Outside
Material per ton	0.8	0.8	0.8	0.8
Rate per ton	100	125	110	125
Cost of material	80	100	88	100
Other Variable cost per ton	122	122	120	120
Total Variable Cost	202	222	208	220
Ranking	I	IV	II	III

Maximum production at both divisions $6000+7500 = 13500$ tons

Rank	Division	Market	Material	Output	Total	Balance
I	A	Local	4,000	5,000	5,000	13,500
II	B	Local	6,800	8,500	13,500	8,500
	Total		10,800	13,500		0

Statement showing saving in overall variable cost of proposed mix

Production (Current Mix)	Production (tons)	Variable cost per ton	Amount (₹)
Division A from local Market	5,000	202	10,10,000
Division A from outside Market	1,000	222	2,22,000
Division B from local Market	7,500	208	15,60,000
Total Variable Cost of Production	13,500		27,92,000
Production (Proposed Mix)			
Division A from local Market	5,000	202	10,10,000
Transfer from Division A to B as variable cost in Division B is less than other market cost (6000-5000)=1000 output required 800 tons input.	8,500	208	17,68,000
Total Variable Cost of Production	13,500		27,78,000

Transfer from Division A to Division B 1000 tons output will save in variable cost ₹ 2792000-2778000=14000.

At 100% capacity the production is

	Div A	Div B	Total
Output (in tons)	$6000/0.80 = 7,500$	$7500/0.6 = 12,500$	20,000
Output already used	5,000	8,500	13,500
Balance capacity (tons)	2,500	4,000	6,500
Input required (tons)	6,000	10,000	
Input locally available	4,000	8,000	
Input locally used	4,000	6,800	
Balance available (input local)	NIL	1,200	

Rank	Div	Market	Material	Output	Total	Balance Output
						6500
2nd	B	Local	1200	1500	1500	5000
3rd	B	Outside	2000	2500	4000	2500
4th	A	Outside	2000	2500	2500	NIL

Total cost of production and Selling price per tone

	Division A	Amount (₹)	Division B	Amount (₹)
Variable Cost	Output x VC		Output x VC 8500+1500=10000	
Local Material	5000 × 202	10,10,000	× 208	20,80,000
Outside Material	2500 × 222	5,55,000	2500*220	5,50,000
Fixed Cost		3,80,000		6,00,000
TOTAL COST (full cost)		19,45,000		32,30,000
Profit		1,94,500		3,23,000
Selling Price		21,39,500		35,53,000
Selling Price per tonne		285.27		284.24

Alternative Answer

	Division A		Division B	
	Output	Raw Material	Output	Raw Material
Current production	6,000	4,800	7,500	6,000
Maximum Production	7,500		12,500	
Maximum production from Local Raw material	5,000	4,000	10,000	8,000

	Division A		Division B	
	Local Raw Material	Outside Raw Material	Local Raw Material	Outside Raw Material
Raw material cost per ton of output	80	100	88	100
Variable Overhead per ton of output	122	122	120	120
Total Variable Cost	202	222	208	220
Rank	I	IV	II	III
Current Mix (Output) M	5,000	1,000	7,500	-
Divisional subtotal of output	6,000		7,500	
Maximum Possible Output	5,000	2,500	10,000	2,500
Divisional subtotal of max. output	7,500		12,500	
Proposed optimal mix current output N	5,000	-	8,500	0

Savings in Variable Cost = $1000 \times (222 - 208) = 14,000$

(Difference between rows M and N)

	Division A		Division B	
	Local Raw Material	Outside Raw Material	Local Raw Material	Outside Raw Material
Maximum Prodn Capacity (Output)	5,000	2,500	10,000	2,500
Weighted average Variable Cost per tonne	$\frac{202 \times 2 + 222 \times 1}{3} = 208.67$		$\frac{208 \times 4 + 220 \times 1}{5} = 210.40$	

	Division A	Division B
Variable Cost per unit	208.67	210.40
Fixed Cost per unit	50.67	48.00
	380000/7500	600000/12500
Total Cost per ton	259.34	258.40
Markup @ 10%	25.93	25.84
Total Selling price per ton	285.27	284.24

Question 34

G Ltd. produces and sells 95,000 units of 'X' in a year at its 80% production capacity. The selling price of product is ₹ 8 per unit. The variable cost is 75% of sales price per unit. The fixed cost is ₹ 3,50,000. The company is continuously incurring losses and management plans to shut-down the plant. The fixed cost is expected to be reduced to ₹1,30,000. Additional costs of plant shut-down are expected at ₹15,000.

Should the plant be shut-down? What is the capacity level of production of shut-down point?

(5 Marks)(Nov., 2010)

Answer

	If plant is continued	If plant is shutdown
Sales	7,60,000	-
Less: Variable Cost	<u>5,70,000</u>	-
Contribution	1,90,000	
Less: Fixed Cost	3,50,000	1,30,000
Additional Cost		<u>15,000</u>
Operating Loss	<u>1,60,000</u>	<u>1,45,000</u>

A comparison of loss figures indicated as above points out that loss is reduced by (16,000-14,500) ₹ 15,000 if plant is shut down.

$$\text{Shut down point} = \frac{3,50,000 - 1,45,000}{8 - 6} = \frac{2,05,000}{2} = 1,02,500 \text{ units}$$

Capacity level of shut down point:

$$\text{At 100\% level production is } \frac{95,000}{0.80} = 1,18,750$$

$$\text{Capacity level at shut down} = \frac{1,02,500}{1,18,750} = 86.32\%$$

Alternative Solution

	₹
If the plant is shut down, the sunk cost or fixed expenses	1,45,000
If it is working at 80% capacity, the fixed cost	3,50,000
Additional fixed expenses	2,05,000
Contribution (95000*2)	1,90,000
Incremental Loss on Continuing	15,000

Decision - better to shut down

Production at shut-down point

$$\begin{aligned} 2 \times 350000 &= 1,45,000 \\ 2x &= 2,05,000 \\ x &= 1,02,500 \text{ Units} \\ \text{Capacity \%} &= 1,02,500 / (95,000 / 0.8) = 86.32\% \end{aligned}$$

Question 35

E Ltd. manufactures and sells four types of products under the brand names A, B, C and D. On a turnover of ₹ 30 crores in 2009, company earned a profit of 10% before interest and depreciation which are fixed. The details of product mix and other information are as follows:

Products	Mix% to total sales	PV Ratio (%)	Raw material as % on sales value
A	30	20	35
B	10	30	40
C	20	40	50
D	40	10	60

Interest and depreciation amounted to ₹ 225 lakhs and ₹ 115.50 lakhs respectively. Due to increase in prices in the international market, the company anticipates that the cost of raw materials which are imported will increase by 10% during 2010. The company has been able to secure a license for the import of raw materials of a value of ₹ 1,535 lakhs at 2010 prices. In order to counteract the increase in costs of raw materials, the company is contemplating to revise its product mix. The market survey report indicates that the sales potential of each of the products: 'A', 'B' and 'C' can be increased upto 30% of total sales value of 2009. There was no inventory of finished goods or work in progress in both the year.

You are required to :

Set an optimal product mix for 2010 and find the profitability.

(12 Marks)(Nov., 2010)

Answer

Revised P/V ratio and ranking of products:

Product	Existing P/V ratio %	Increase in Raw material cost as % of sales value	Revised P/V Ratio	Revised raw material as % of sale value	Contribution per ₹ 100 of raw material %	Rank
A	20	3.5	16.5	38.50	42.86%	III
B	30	4	26	44.00	59.09%	II
C	40	5	35	55.00	63.64%	I
D	10	6	4	66.00	6.06%	IV

Maximum Sales potential (₹ In lacs)

A	30 % ₹ 3000	900
B	30 % ₹ 3000	900
C	30 % ₹ 3000	900
D	40 % of 3000	1200

Allocation of raw material whose supply is restricted to ₹ 1535 lacs in order of raw material profitability.

Product	Rank	Sales ₹ In lacs	Raw Material per ₹ 100 Lacs Sales	Raw Material Equired	Balance Raw Material
C	I	900	55	495	1040
B	II	900	44	396	644
A	III	900	38.5	346.5	297.5
D	IV	451**	66	297.5*	0

* Balancing figure, hence sales will be restricted to 451** lakhs (297.5/66%)

Profitability Statement							₹ In Lakhs
Product	Existing (2009)			Proposed(2010)			
	Sales	P/V Ratio	Contribution	Sales	P/V Ratio	Contribution	
A	900	20	180	900	16.5	148.5	
B	300	30	90	900	26	234	
C	600	40	240	900	35	315	
D	1200	10	120	451	4	18.04	
Total	3000		630	3151		715.54	
Less : Fixed Costs*			330				330
Profit before Dep and Int.			300				385.54
Less :Depreciation			225				225.00
Less :Interest			115.5				115.50
Profit before tax			(40.5)				45.04

* Balancing figure(Contribution - Profit before Depreciation & Interest)

The increase of contribution of ₹ 85.54 in 2010 will set off loss of ₹ 40.50 lakhs and result in profit of ₹ 45.04 lakhs.

Question 36

The following information is given by Z Ltd.:

Margin of safety	₹ 1,87,500
Total cost	₹ 1,93,750
Margin of safety	7500 units
Break-even sales	2500 units

Required:

Calculate Profit, P/V Ratio, BEP Sales (in ₹) and Fixed Cost.

(4 Marks)(Nov., 2010)

Answer

Margin of Safety(%)	= MoS Units/Actual Sales Units
	= 7500/(7500+2500)
	= 75%
Total Sales	= 187500/0.75
	= ₹ 2,50,000/-

Profit	= Total sales – Total Cost
	= 250000 – 193750
	= ₹ 56250
P/V Ratio	= Profit/MoS (₹) × 100
	= 56250/187500 × 100 = 30%
BEP Sales	= Total Sales / (100 – MS)
	= 2,50,000 × 0.25
	= ₹ 62,500
Fixed Cost	= Sales x P/V Ratio
	= 250000 × 0.30-56250
	= 18750

Alternate Answer 1

Margin of Safety = Selling Price per unit × (7500 units)

₹ 187500 = Selling Price per unit × (7500 units)

Therefore ,

Selling Price per unit = $187500/7500$ = ₹ 25

Profit		₹
Sales	10000×25	2,50,000
Less: Total Cost		1,93,750
Profit		56,250
P/V Ratio	Profit/Margin of Safety	
	$56250/187500=$	30%
BEP Sales	2500×25	₹ 62,500
Fixed Cost	$62500 \times 30\%=$	₹ 18,750

Alternative Answer 2

Selling price = ₹ 187500/ 7500 = ₹ 25

Total Cost at Break Even point= ₹ 25 × 2500 = 62500 = Break Even Sales

(Total Cost – Total Cost of BE)/(Total Units – Break Even Units) = Variable Cost per Unit

$(1,93,750 - 62,500)/(10,000 - 2,500) = 1,31,250/7,500 = ₹ 17.50$ per unit

Selling Price	= 25.00
Variable Cost	= <u>17.50</u>
Contribution	= 7.50
P/V Ratio	= $7.50/25$ = 30%
Fixed Cost	= 7.50×2500 units = ₹ 18750.
Profit	= 7.50×7500 = ₹ 56,250

Question 37

Calculate the selling price per unit to earn a return of 12% net on capital employed (net of tax @40%). The cost of production and sales of 80,000 units are:

Variable cost including material cost ₹ 9,60,000

Fixed overheads ₹ 5,00,000

The fixed portion of capital employed is ₹ 12 lakhs and the varying portion is 50% of sales turnover.
(4 Marks)(Nov., 2010)

Answer

Let 'x' be the selling price per unit, Therefore, Turnover = $80000 \times x$

Capital Employed = $1200000 + 40000 \times x$

Return on capital employed after tax = 12%

Therefore,

Return on capital employed before tax = $12/0.6$

= 20%

Therefore,

Return on capital employed before tax = 20% of $(1200000 + 40000x) = 240000 + 8000x$

Sales $80000 \times x$

Variable Cost 960000

Fixed Cost 500000

Profit $80000x - 1460000$

Therefore

$$\begin{aligned} 80000x - 1460000 &= 240000 + 8000x \\ 72000x &= 1700000 \\ X &= ₹ 23.61 \end{aligned}$$

Alternative Answer

Selling price per unit should cover Variable cost unit, Fixed Cost per unit and ROCE per unit

Fixed Capital Employed = ₹ 12 lacs

Required Return (net of tax) = 12% = ₹ 1,44,000

Pre tax return = 1,44,000 / 0.6 = ₹ 2,40,000

Let Selling Price per unit = X

$$\begin{aligned} X &= (14,60,000 + 2,40,000) / 80,000 + (12\% \text{ of } 50\% \text{ of } X) / 0.6 \\ &= 17,00,000 / 80,000 + 6/100 \times 1/0.6 X \end{aligned}$$

$$X(1 - 0.1) = 21.25$$

$$X = 21.25 / 0.9 = ₹ 23.61 \text{ per unit}$$

Required Selling price = ₹ 23.61

Question 38

Pick out from each of the following items, costs that can be classified under 'committed fixed costs' or 'discretionary fixed costs'.

- (i) Annual increase of salary and wages of administrative staff by 5% as per agreement
- (ii) New advertisement for existing products is recommended by the Marketing Department for achieving sales quantities that were budgeted for at the beginning of the year.
- (iii) Rents paid for the factory premises for the past 6 months and the rents payable for the next six months. Production is going on in the factory.
- (iv) Research costs on a product that has reached 'maturity' phase in its life cycle and the research costs which may be needed on introducing a cheaper substitute into the market for facing competition.
- (v) Legal consultancy fees payable for patent rights on a new product Patenting rights have been applied for.

(5 Marks)(May 2011)

Answer

Committed Fixed Cost	Discretionary Fixed Cost
(i) Salary and wage increase	(ii) New Advertisement Cost
(iii) Rents payable for the next 6 months	(iv) Research cost for substitutes
(v) Legal fees for filing for patent rights.	

Question 39

A company can make any one of the 3 products X,Y or Z in a year. It can exercise its option only at the beginning of each year.

Relevant information about the products for the next year is given below.

	X	Y	Z
Selling Price (₹/u)	10	12	12
Variable Costs(₹/u)	6	9	7
Market Demand (units)	3000	2000	1000
Production capacity (units)	2000	3000	900
Fixed Costs (₹)			30,000

You are required to compute the opportunity costs for each of the products.

(3 Marks) (May, 2011)

Answer

	X	Y	Z
Contribution per unit	4	3	5
Units (lower of production/ market demand)	2000	2000	900
Possible Contribution (₹)	8000	6000	4500
Opportunity Cost	6000	8000	8000

(Note: Opportunity cost is maximum benefit forgone.)

Question 40

Entertain U Ltd. hires an air-conditioned theatre to stage plays on weekend evenings. One play is staged per evening. The following are the seating arrangements:

VIP rows-the first 3 rows of 30 seats per row, priced at ₹320 per seat.

Middle level-the next 18 rows of 20 seats per row priced at ₹220 per seat.

Last level -6 rows of 30 seats per row priced at ₹120 per seat.

For each evening a drama troupe has to be hired at ₹71,000, rent has to be paid for the theatre at ₹14,000 per evening and air conditioning and other state arrangements charges work out to ₹7,400 per evening. Every time a play is staged, the drama troupe's friends and guests occupy the first row of the VIP class, free or charged, by virtue of passes granted to these guest. the troupe ensures that 50% of the remaining seats of the VIP class and 50% of the seats of the other two classes are sold to outsiders in advance and the money is passed on to Entertain U. The troupe also finds for every evening, a sponsor who puts up his advertisements banner near the stage and pays Entertain U a sum of ₹9,000 per evening. Entertain U supplies snacks during though interval free of charge to all the guests in the hall, including the VIP free guests. The snacks cost Entertain U ₹20 per person. Entertain U sells the remaining tickets and observes that for every one seat demanded from the last level, there are 3 seats demanded from the middle level and 1 seat demanded from the VIP level. You may assume that in case any level is filled, the visitor busy the next higher or lower level, subject to availability.

- (i) You are required to calculate the number of seats that Entertain U has to sell in order to break-even and give the category wise total seat occupancy at BEP.
- (ii) Instead of the given pattern of demand, if Entertain U finds that the demand for VIP, Middle and Last level is in the ratio 2:2:5, how many seats each category will Entertain U have to sell in order to break-even.?
- (11 Marks) (May, 2011)

Answer

(i) Fixed Costs

		₹	₹
Troupe hire		71,000	
Rent		14,000	
A/C		7,400	
VIP Snacks		<u>600</u>	93,000
Fixed Revenues:			
Seats Sold by the troupe		54,000	
Sponsor's advertisement		<u>9,000</u>	<u>63,000</u>
Net fixed costs recovered by Entertain U to Break even			<u>30,000</u>
Seats Sold by the troupe	54,000		
Sponsor's advertisement	9,000		
		63,000	
	VIP	Med	Lost
Total seats available	90	360	180

Less: Free	30		
Less: Sold by troupe	30	180	90
Can be sold by Entertain U	30	180	90
Row Price	320	220	120
Variable cost	<u>20</u>	<u>20</u>	<u>20</u> (Snacks)
Contribution per seat	300	200	100
Demand	1	:	3 : 1

$$= \frac{300 \times 1 + 200 \times 3 + 100 \times 1}{1 + 3 + 1} = \frac{300 + 600 + 100}{5} = \frac{1000}{5} = 200$$

$$\therefore \text{Break Even Point for Entertain U} = ₹ \frac{30,000}{200} = 150 \text{ No. of seats}$$

	VIP Rows	Middle Level	Last Level	
BF Seats Total 150	30	90	30	
Contribution per unit	300	200	100	
Contribution (₹)	<u>9,000</u>	<u>18,000</u>	<u>3,000</u>	₹ 30,000

Category wise occupancy at Break Even Point

VIP 30+30+30 = 90

Middle = 90+180 = 270

Last = 120

(ii) If demand is in the ratio 2 : 2 : 5

$$\text{Weighted contribution per seats} = \frac{2 \times 300 + 2 \times 200 + 5 \times 100}{9}$$

$$= \frac{600 + 400 + 500}{9} = \frac{1500}{9} = \frac{30,000}{1,500} \times 9 = 180 \text{ seats}$$

Ratio	40	40	100
Quantity available	30	180	90
Break Even quantity	30	10	90
		10	10

	30	60	90
Contribution per unit	300	200	100
No. of seats	30	60	90
Contribution ₹	<u>9,000</u>	<u>12,000</u>	<u>9,000</u>

Total = 30,000

Question 41

Maruthi Agencies has received an order from a valuable client for supplying 3,00,000 pieces of a component at ₹550 per unit at a uniform rate of 25000 units a month.

Variable manufacturing costs amount to ₹ 404,70 per unit, of which direct materials is ₹ 355 per unit. Fixed production overheads amount to ₹ 30 lacs per annum, including depreciation. There is a penalty/reward clause of ₹ 30 per unit for supplying less/more than 25000 units per month to adhere to the schedule of supply, the company procured a machine worth ₹ 14.20 lacs which will wear out by the end of the year and will fetch ₹ 3.55 lakh at the year end. After this supply of machine, the supplier offers another advanced machine which will cost ₹ 10.65 lakhs, will wear out by the year end and not have any resale value. If the advanced machine is purchased immediately, the purchaser will exchange the earlier machine supplied at the price of the new machine. Fixed costs of maintaining the advanced machine will increase by ₹ 14,200/- per month for the whole year. While the old machine had the capacity to complete the production in 1 year, the new machine can complete the entire job in 10 months. The new machine will have material wastage of 0.5% . assume uniform production throughout the year for both the machines.

Using incremental cost/revenue approach, decide whether the company should opt for the advanced version.
(5 Marks) (May, 2011)

Answer

	Old (₹)	New (₹)	Incremental
Depreciation ₹ 14.2 lakhs – ₹ 3.55 lakhs	10,65,000	10,65,000	-
Fixed Cost increase		1,70,400	(-) 1,70,400
Resale value	+3,55,000	-	(-) 3,55,000
Material ₹ /u 355 x .5% 1.775 x 3,00,000		5,32,500	(-) 5,32,500
Increase in Costs in new Machine purchased			(-) 10,57,900
Penalty @ ₹ 30 per unit	-	-	
Reward @ ₹ 30 per unit			

5000 per months x 10 months			
= 50,000 x 30 =			+ 15,00,000
Gain			<u>4,42,100</u>

Decision: Buy the advanced version.

Working Note:

1st machine 25,000 per month, no penalty, no reward

new machine: $\frac{3,00,000}{10} = 30,000$ per months

advance supply per month = 5,000

= 5,000 x 10 months = 50,000 units reward.

Question 42

6000 pen drives of 2 GB to be sold in a perfectly competitive market to earn ₹ 1,06,000 profit, whereas in a monopoly market only 1200 units are required to be sold to earn the same profit. The fixed costs for the period are ₹ 74,000 . the contribution per unit in the monopoly market is as high as three fourths its variable cost. Determine the targets selling price per unit under each market condition.
(4 Marks) (May, 2011)

Answer

	Perfect Competition	Monopoly
Units	6,000	1,200
Contribution (1,06,000 + 74,000)	1,80,000	1,80,000
Contribution per unit	30	150
Variable Cost per unit $150 \div \frac{3}{4}$		200
Variable Cost per unit	200	
Selling Price per unit	230	350

Question 43

New Ltd. Plans to completely manufacture a single product Z., whose selling price and variable manufacturing costs will be ₹ 100 per unit and ₹ 80 per unit respectively. If the complete production is done at its own factory, fixed machining costs will be ₹ 3,62,000 and fixed administration and selling overheads will be ₹ 30,000 for the production period.

Alternatively, the product can be finished outside by sub contracting the machining operations at ₹ 10 per unit, but this will entail an increase in the fixed administration overheads by ₹ 1,20,000 while fully avoiding the machining cost of ₹ 3,62,000

Based on the above figures and assuming a production capacity of 30,000 units for the production period, advise with relevant supporting figures, from a financial perspective, for what volumes of market demand will:

- (i) a manufacture be recommended at all ?
- (ii) a fully in-house production be recommended?
- (iii) the sub contracting option be recommended ?

(5 Marks)(Nov, 2011)

Answer

Details	Options	
	Manufacturing	Sub Contract
	Amount (₹)	Amount (₹)
Selling price	100	100
Variable Cost	80	90
Contribution	20	10
Fixed Cost	3,92,000	1,50,000
BEP (units)	19,600	15,000

Point of Indifference = level of production where both options will have same outcome.

It can be calculated as :

Difference in Fixed cost = ₹ (3,92,000 – 1,50,000)=₹ 2,42,000

Difference in contribution per unit = ₹ 10

Point of indifference = 2,42,000 /10 = 24,200 units.

It may be calculated in alternative way.

Indifference Point (x): $(20x - 392000) = (10x - 150000)$

$10x = 242000$

$X = 24200$

- (i) If Market demand is above 15000 : manufacture is recommended
- (ii) For Demand 24201 to 30000 units : Manufacture fully in-house.
- (iii) For Demand 15000 to 24200 units : Sub-contract

Question 44

Pigments Ltd. is a chemical factory producing joint products J, K and L at a joint cost of production of ₹ 9, 60,000. The sales are:

J 60,000 units ₹ at 5 per unit,

K 20,000 units at ₹ 20 per unit and

L 40,000 units at ₹ 10 per unit

The company seeks your advice regarding the following options available:

Option I: After the joint process, all of L can be further processed to make 36,000 units of M, at an additional processing cost of ₹ 1,80,000 and M can be sold at ₹ 18 per unit.

Option II: the facilities used to convert L to M may be used to make 7000 units of an additional product A, with a different raw material input. A can be made at an additional variable manufacturing cost of ₹ 12 per unit and will fetch ₹ 30 as the selling price, but the company will have to offer one unit of J as a free gift for each unit of A sold.

Evaluate the proposals using the incremental cost approach.

(5 Marks)(Nov, 2011)

Answer

Working Notes:

Particulars	Option – I Process L to M	Option – II Sell new product A
	Amount (₹)	Amount (₹)
Sale of Product M	648,000	
Sale of Product A		210000
(Less: Revenue lost on Product L)	400,000	
(Less: Revenue lost on Product J)		35000
Less: Additional Cost	180,000	84000
Incremental Profit	68000	91000
Decision : Option II is better by ₹ 23000		

Question 45

PQ Ltd, makes two products P and Q, which are similar products with slight difference in dimensions, but use the same manufacturing processes and facilities. P's production may be made interchangeably after altering machine set-up. Production time is the same for both products. The cost structure is as follows:

(Figures ₹ per unit)	P	Q
Selling Price	100	120
Variable manufacturing cost (directly linked to units produced)	45	50
Contribution	55	70
Fixed manufacturing cost	10	10
Profit	45	60

Fixed cost per unit has been calculated based on the total practical capacity of 20,000 units per annum (which is either P or Q both put together). Market demand is expected to be the deciding factor regarding the product mix for the next 2 years. The company does not stock inventory of finished goods. The company wished to know whether ABC system is to be set up at a cost of ₹ 10,000 per month for the purpose of tracking and recording the fixed overhead costs for allocation to products.

Support your advice with appropriate reasons.

(6 Marks) (Nov, 2011)

Independent of the above, if you are told to assume that fixed costs stated above, consist of a non-cash component of depreciation to plant at 90,000 for the year, will you advice change? Explain.

(2 Marks) (Nov, 2011)

Answer

Working Notes

#	Data	Reasoning	Decision
i.	Similar Products Similar Production Resources	OH Cost based on production units is appropriate. ABC will also yield identical results	ABC system not required for OH allocation
ii	Present OH Cost = 10/u. Proposed Increase due to ABC system : $120000/20000 = 6/u$	Current OH cost of 10/u will increase by 6 per unit due to installing ABC system (60% increase)	For allocation purpose, ABC not justified
iii.	Both have +ive contribution / u. Market demand determines the mix	OH allocation has no role in decision making	No need for ABC System
iv.	For the purpose of OH allocation, ABC need not be installed. However, if the fixed overheads of ₹ 2,00,000 are analysed by activity and thereby a saving of at least ₹ 1,20,000 be expected (which is the cost of installing ABC system), then, ABC		

	system may be installed
v.	For the non cash component of depn = 90,000 , FC that can be saved is a maximum of 1,10,000 (2,00,000 – 90,000). Hence, this is clearly less than ABC cost installation. Hence <u>do not install ABC System</u>

Question 46

Happy Holidays company contracts to take children on excursion trips Relevant information for a proposed excursion trip is given below:

Revenue per trip per child	4000
Expenses that have to be incurred:	
Train fare per child per trip	1700
Meals per child per trip	300
Craft Materials per child per trip	600
Room rent per trip (4 children can be accommodated in a room)	760
Local Transport at picnic spots (per vehicle)	1200
(each vehicle can seat 6 children excluding the driver)	

Fixed costs that are required to be covered in a trip ₹ 5,18,130 .

Find the minimum number of children to cross the break-even point and start earning a profit.

(6 Marks) (Nov, 2011)

Answer

Item Description	₹
Revenue per trip	4,000
Less: Variable Cost	
Train Fare	1,700
Meals per Child	300
Craft Materials	600
Total Variable Cost	2,600
Contribution per child	1,400

$$\text{Relevant Range} = \frac{5,18,130}{1010} = 513$$

Step Fixed Cost

Items	₹
Room Rent (760/4)	190
Transport Cost (1200/6)	200
Total Step Fixed Cost	390

Net Contribution = 1400 – 390 = ₹ 1010.

Details	Amount
Sales	4000
Variable Cost	-2600
Contribution	1400

At 513 Students

General Fixed Cost		518,130
Room Rent	129*760	98,040
Transportation	86*1200	103,200
Total Fixed Cost		719,370
	513*140	
Gross Contribution	0	718,200
Loss		(1,170)

BEP = $513 + 1170/1400 = 513.83$. Hence the Minimum Students will be 514

Relevant Range for Earning Profit will be 514 to 516

Particulars	514	516
General Fixed Cost	518,130	518,130
Room Rent	98,040	98,040
Transportation	103,200	103,200
Total Fixed Cost	719,370	719,370
Gross Contribution	719,600	722,400
Profit	230	3,030

Question 47

Quickcomp is a successful version of a software package that is widely used. Fastercomp is the next version, for which the development is complete and it is ready to be sold immediately in the market as budgeted. However, for Fastercomp, user manuals, training modules and diskettes have not yet been made, whereas, for the Quickcomp version, these are overstocked by 5,000 units. Release of Fastercomp will render the Quickcomp version not saleable.

The following information is provided:

	Quickcomp	Fastercomp
Selling price per unit ₹	14,000	14,000
Variable cost per unit ₹ (consisting of user manuals, training modules and diskettes)	1000	4000
Development Cost per unit ₹ (total cost of development spread over the expected sales quantity during the product's life-cycle)	7,000	10,000
Marketing/Administration Cost per unit ₹ (Fixed budgeted annual outflow divided by the expected sales quantity for each product for the year)	3500	4000
Total Costs per unit ₹	11,500	18,000
Operating Income per unit	2,500	1,000

From a purely financial perspective, the company wants your advice whether to delay the release of the new version by 2 months by when the inventory of the existing version would have sold out or to release the new version immediately. Support your advice with relevant figures. (6 Marks) (Nov, 2011)

Answer

Particulars	Quickcomp	Fastercomp	Remarks
Sale Price	14,000	19,000	Given
Less:			
Variable Cost	-	4,000	Quickcomp Variable Cost is Sunk cost
Development Cost	-	-	Sunk Cost
Marketing Cost	-	-	Sunk Cost
Profit	14,000	15,000	
Incremental Profit is ₹ 1000/- Unit.			
Better to Release Fastercomp now in order to get higher profit by ₹ 5000 x 1000 = 50 lacs.			

Question 48

Two companies, H and L, have the same values for turnover and net profit and make a similar product. H has a higher P/V ration than L. Which company will perform better when: (i) the market demand is high ? (ii) the market demand is low? (2 Marks) (Nov, 2011)

Answer

- (i) In case Market Demand is High – Product H (Lower Variable Cost and Higher Fixed Cost)
- (ii) In case Market Demand is Low – Product L

Question 49

A company has decided to launch a new product X which is, expected to have demand of 10,000 units during the year at ₹160 per unit. The following information is furnished by the company:

- (i) Material - The manufacture of one unit of X requires one unit of each of materials A, B and C.

Raw Material	Current stock (units)	Cost per unit (₹)		
		Original cost	Current Purchase Price	Resale Value
A- Regularly being used	10,000	16	20	14
B- Old stock (Not in use)	6,000	28	24	8
C- New stock	---	---	48	---

- (ii) Direct labour

Skilled labour is paid at ₹80 per hour. It takes 0.25 hours/unit. Skilled labour has to be drawn from another production line which has a contribution of ₹240 per unit, with each unit requiring 2 hours of skilled labour.

Unskilled labour - 2 hours/unit @ ₹56 per hour. There is abundant Unskilled labour in the factory, but according to an agreement with the labour union, no unskilled worker can be retrenched.

- (iii) Variable overhead - ₹10 per unit.

- (iv) Fixed Costs –no increase.

Using relevant cost approach, you are required to find out the average variable cost per unit of X.

(5 Marks)(May 2012)

Answer

Average variable cost per unit of X

Cost Element	Relevancy		Total Cost (10,000 units) ₹	Average Cost per unit ₹
Raw material A	Replacement Cost	Current Purchase price	2,00,000	20.00
Raw material B	Opportunity Cost	Opportunity Cost (6,000 units * ₹8 per unit)	48,000	
Raw material B	Incremental Cost	Current Purchase Price (4000 units * ₹24 per unit)	96,000	
		Sub total- Raw material B	1,44,000	14.40
Raw material C	Incremental Cost	Current Purchase Price (10,000 units * ₹48 per unit)	4,80,000	48.00
Skilled Labour	Opportunity Cost	$10,000 \times 0.25 \times 240/2$ $+ 10,000 \times 0.25 \times ₹80$	5,00,000	50.00
Unskilled Labour	Sunk Cost		NIL	NIL
Variable Overhead	Incremental Cost	10,000* ₹10 per unit	<u>1,00,000</u>	<u>10.00</u>
		TOTAL	<u>12,24,000</u>	<u>142.40</u>

Question 50

XY Ltd. makes two products X and Y, whose respective fixed costs are F_1 and F_2 . You are given that the unit contribution of Y is one-fifth less than the unit contribution of X, that the total of F_1 and F_2 is ₹1,50,000, that the BEP of X is 1,800 units (for BEP of X F_2 is not considered) and that 3,000 units is the indifference point between X and Y. (i.e. X and Y make equal profits at 3,000 unit volume, considering their respective fixed costs). There is no inventory build up as whatever is produced is sold.

You are required to find out the values F_1 and F_2 and units contributions of X and Y.

(5 Marks)(May,2012)

Answer

Let C_x be the Contribution per unit of Product X.

Therefore Contribution per unit of Product Y $= C_y = 4/5 C_x = 0.8 C_x$

Given $F_1 + F_2 = 1,50,000$,

$F_1 = 1,800 C_x$ (Break even volume * contribution per unit)

Therefore $F_2 = 1,50,000 - 1,800 C_x$.

$3,000 C_x - F_1 = 3,000 * 0.8 C_x - F_2$ or $3,000 C_x - F_1 = 2,400 C_x - F_2$ (Indifference point)

ie., $3,000 C_x - 1,800 C_x = 2,400 C_x - 1,50,000 + 1,800 C_x$

ie., $3,000 C_x = 1,50,000$, Therefore $C_x = ₹ 50/-$ ($1,50,000 / 3,000$)

Therefore Contribution per unit of X = ₹ 50

Fixed Cost of X $= F_1 = ₹ 90,000$ ($1,800 * 50$)

Therefore Contribution per unit of Y is ₹ $50 * 0.8 = ₹ 40$ and

Fixed cost of Y $= F_2 = ₹ 60,000$ ($1,50,000 - 90,000$)

The value of $F_1 = ₹ 90,000$, $F_2 = ₹ 60,000$ and X = ₹ 50 and ₹ 40

Question 51

A company is operating at 60 % of its capacity with a turnover of ₹ 43.20 lacs. If the company works at 100 % capacity, the sales-cost relation is:

Factory cost is two thirds of sales value. Prime cost is 75% of factory cost. Administration and selling expenses (75% variable) are 20% of the sales value. Factory overhead will vary according to operating capacity as given below:

Operating capacity (%)	60	80	100	120
Factory overheads (₹ in lacs)	9.90	10.80	12	15

The company has planned to operate at 80 % of its capacity. Moreover, it has received an export order and its execution will involve 40 % of the capacity.

The prime cost of the order is estimated at ₹ 6.0 lacs and the shipping involved will be around ₹ 1.0 lac. Administration and selling expenses will be avoided on the export order. Taking the same percentage of profits as on the domestic sales, determine the minimum price to be quoted for the export order.
(8 Marks)(May, 2012)

Answer

	Capacity	
	80% (Domestic sale)	40% (Export order)
Sales Value	₹ in lakhs 57.60	
Prime cost (50% of Sales Value ie., $2/3 \times 75\%$)	28.80	6.00
Fixed Cost (Factory Overheads, as given)	10.80	4.20
Administration and selling - variable ($20\% \times 75\% = 15\%$ of Sales Value)	8.64	
- fixed	3.60	
Shipping		1.00
Total Cost	51.84	11.20
Profit	5.76	
Add : Profit (Domestic Profit @80% Capacity = 10% of Sales. Hence 11.11% on Cost)		1.24
Minimum Export price		12.44

Question 52

Ezee Ltd makes two products, E and Z. All units produced are sold. There is no inventory build up. Production facilities may be used interchangeably for both the products. Sales units are the limiting factor. The following information is given:

	Price Level			Proposed increase
	E	Z	Total	Total
Contribution ₹/units	25	20		
Fixed Cost ₹			46,000	47,500
Sales units (nos)	3,000	2,000	5,000	4,000

For increase in quantities above 4,000 units for each product, there will be an increase in variable selling costs, (for the increased portion only), thereby reducing the contribution per unit to the following figures:

Units	Contribution per unit (₹)	
	E	Z
4001-5000	20	15
5001-6000	15	10
Above 6000	No Sales possible	

- (i) For the present level, find the break-even point with the present product
- (ii) What is the minimum number of incremental units to be sold to recover the additional fixed cost off ₹ 47,500 to be incurred? (Present product mix need not be maintained):
- (iii) If you are allowed to choose the best product mix for the incremental level, (while taking the present mix given in the first table above for the present level), what would be the individual product quantities and the corresponding total contributions, the total average contribution per unit and the total profits for the complete production?

(8 Marks)(May'12)

Answer

- (i) Present Level:

Weighted average contribution per unit

$$(3,000 \times 25 + 2,000 \times 20)/(3,000+2,000) \text{ Or, } (3 \times 25 + 2 \times 20)/(2+3) = 23 \text{ ₹/unit.}$$

BEP = Present level Fixed cost/ weighted average Contribution per unit

$$= 46,000/23 = 2000 \text{ units.}$$

or (E 1200 units & Z 800 units)

- (ii) Minimum units for incremental level:

next 1,000 units of E get contribution of $25 \times 1000 = 25,000$

next 1,000 units of E or Z get 20/unit as Contribution = 20,000

next 125 units of E or Z get 20/unit as Contribution = 2,500

Total 2,125 units are the minimum requirement for 47,500

incremental fixed cost

Minimum units required:

E	Z	Total
2,000	125	2,125
or		
1,000	1,125	2,125

- (iii) Optimal profit – best mix:

	Product E		Product Z		Total quantity
	Units	Contribution/u	Units	Contribution/u	
Present	3,000	25	2,000	20	5,000
Next	1,000	25			1,000
Next	1,000	20	1,000	20	2,000

Next	-	-	1,000	20	1,000
Total for best mix	5,000		4,000		
Contribution value (₹)	4,000 x 25 + 1,000 x 20 = 1,20,000		4,000 x 20 = 80,000		2,00,000
Average Contribution per unit (₹) = 2,00,000 / 9,000 = 22.22					
Maximum profits (₹) = 2,00,000 – 93,500 = 1,06,500					

Question 53

A machine manufacturing company needs four components A, B, C and D.

The components may be procured from outside. The cost, market price for the components and other information are given below.

Number of units required	3,000	3,500	2,000	3,000
	Figs. ₹ per unit			
	A	B	C	D
Direct Material	120	140	150	120
Direct Wages	60	80	120	80
Direct expenses at ₹40 per machine hour	80	60	80	80
Fixed Cost	40	40	30	50
Total Cost	300	320	380	330
Market Price	300	320	400	270

There are constraints on the machine time in manufacturing all the components. Total machine hours available is only 12,000 hours.

It is possible to use the machine time in a second shift which will attract 20 % extra wages and other fixed overheads at ₹6,000 for every 1,000 hours or part thereof.

With relevant supporting figures, advise the best course of action to maximize the profits.

(Note: Students need not work out the complete profitability statement). (8 Marks)(May'12)

Answer

	A	B	C	D
Quantity	3,000	3,500	2,000	3,000
Market price (₹)	300	320	400	270
Total Variable cost/unit (₹)	260	280	350	280
Contribution per unit (₹)	40	40	50	(10)*

*Decision: do not make D				
Machine Hours per unit	2	1.5	2	
Contribution per Machine Hour	20	26.67	25	
Ranking	III	I	II	
Hours required	6,000	5,250	4,000	15250 total hours
Allocation of Available hours	2,750**	5,250	4,000	12,000 hours
** (Balancing figure)				

Hours required in 2nd Shift

3250 hours

1625 units of A

Contribution per unit for Product A in second shift

₹ 40 – ₹12 = ₹ 28 (Direct wages will go up by ₹12)

For every 1000 hours in second shift the Contribution from A would be

₹14,000 i.e., $1,000/2 \times 28$

The increase in Fixed Cost is ₹6,000. After 3,000 hours the Contribution will be only ₹ $250/2 \times 28$ i.e. ₹3,500, whereas the increase in fixed cost will be ₹6,000. Hence it is not advantageous to go beyond 3,000 hours in the second shift.

Best Course of action:

- (i) Purchase D from outside: 3,000 units.
- (ii) Make B and C fully in-house in the normal shift, B:3,500 units, C:2,000 units.
- (iii) Make and buy A as follows:
 - Normal shift: 1,375 units
 - 2nd shift: 1,500 units
 - Purchase: 125 units

Question 54

If Moonlite Limited operates its plant at normal capacity it produces 2,00,000 units from the plant 'Meghdoot'. The unit cost of manufacturing at normal capacity is as under:

	₹
Direct material	65
Direct labour	30
Variable overhead	33
Fixed overhead	<u>7</u>
	<u>135</u>

Direct labour cost represents the compensation to highly-skilled workers, who are permanent employees of the company. The company cannot afford to lose them. One labour hour is required to complete one unit of the product.

The company sells its product for ₹ 200 per unit with variable selling expenses of ₹ 16 per unit. The company estimates that due to economic down turn, it will not be able to operate the plant at the normal capacity, at least during the next year. It is evaluating the feasibility of shutting down the plant temporarily for one year.

If it shuts down the plant, the fixed manufacturing overhead will be reduced to ₹ 1,25,000. The overhead costs are incurred at a uniform rate throughout the year. It is also estimated that the additional cost of shutting down will be ₹ 50,000 and the cost of re-opening will be ₹ 1,00,000.

Required:

Calculate the minimum level of production at which it will be economically beneficial to continue to operate the plant next year if 50% of the labour hours can be utilized in another activity, which is expected to contribute at the rate of ₹ 40 per labour hour. The additional activity will relate to a job which will be off-loaded by a sister company only if the company decides to shut down the plant.

(Assume that the cost structure will remain unchanged next year. Ignore income tax and time value of money)

(5 Marks) (Nov,2012)

Answer

Contribution per unit

Particulars	(₹)
Selling Price	200
Variable Cost (₹ 65 + ₹ 33 + ₹ 16)	114
Contribution per unit (Excluding direct labour, considered irrelevant and fixed)	86

Savings and earnings if the plant is shut down

Particulars	₹
Savings in Fixed Cost (₹ 14,00,000* – ₹ 1,25,000)	12,75,000
Contribution from Alternate Activity (₹ 40 x 50% of 2,00,000 hrs)	40,00,000
Shutting Down and Reopening Cost (₹ 50,000 + ₹100,000)	(1,50,000)
Total	51,25,000

* [2,00,000 units x ₹ 7]

Indifference Point: ₹51,25,000 / ₹86 = 59,593 units

Minimum level of production to justify continuation = 59,594 units

Question 55

"Sunk cost is irrelevant in decision making, but all irrelevant costs are not sunk costs." Explain with examples.
(4 Marks)(Nov, 2012)

Answer

Sunk costs are costs that have been created by a decision made in the past and that cannot be changed by any decision that will be made in the future.

Example, the written down value of assets previously purchased are sunk cost. Sunk costs are not relevant for decision making because they are past cost.

But not all irrelevant costs are sunk cost. For example, a comparison of two alternative production methods may result in identical material costs for both the alternatives. In this case, the direct material cost will remain the same whichever alternative is chosen. In this situation, though direct material cost is the future cost to be incurred in accordance with the production, it is irrelevant, but it is not a sunk cost.

Irrelevant is only with respect to alternatives being considered and not for fund flows whereas for sunk cost there is no further cash flow. Cash flows have already been incurred.

Question 56

A process industry unit manufactures three joint products: A, B and C. C has no realisable value unless it undergoes further processing after the point of separation. The cost details of C are as follows:

	Per Unit ₹
<i>Upto point of separation</i>	
Marginal cost	30
Fixed Cost	20
<i>After point of separation</i>	
Marginal cost	15
Fixed cost	5
	70

C can be sold at ₹37 per unit and no more.

- (i) *Would you recommend production of C?*
- (ii) *Would your recommendation be different if A, B and C are not joint products?*

(5 Marks)(May, 2013)

Answer

- (i) Cost incurred on Product 'C' *upto point of separation* is irrelevant for decision making as Product 'C' is a Joint Product. Joint Products are the result of same raw material & same process Operations.

Cost incurred *after point of separation* will be considered for decision making as *specifically* incurred for Product 'C'.

After further processing Product 'C' will *contribute* ₹17 per unit toward 'Joint Production Cost'.

Calculation is as follows:

Particulars	Amount (₹)	Amount (₹)
Selling Price <i>per unit</i>		37.00
Less: Cost after separation:		
Marginal Cost <i>per unit</i>	15.00	20.00
Fixed Cost <i>per unit</i>	5.00	
Contribution toward 'Joint Production Cost'		17.00

Hence, *further processing* of Product 'C' is recommended.

- (ii) If Product 'C' is not a joint product with same cost structure. In this case there will be *negative contribution* on production of Product 'C'. The calculation is as follows:

Particulars	Amount (₹)
Selling Price <i>per unit</i>	37.00
Less: Marginal Cost (₹ 30 + ₹ 15)	45.00
Contribution	(8.00)

Hence, production of Product 'C' will not be recommended.

Question 57

HTM Ltd., by using 12,00,000 units of a material M produces jointly 2,00,000 units of H and 4,00,000 units of T. The costs and sales details are as under:

	₹
Direct Material M @ ₹5 per unit	60,00,000
Other variable costs	42,00,000
Total fixed costs	18,00,000
Selling price of H per unit	25
Selling price of T per unit	20

The company receives an additional order for 40,000 units of T at the rate of ₹15 per unit. If this order has been accepted, the existing price of T will not be affected. However, the present price of H should be reduced evenly on the entire sale of H to market the additional units to be produced.

Find the minimum average unit price to be charged on H to sustain the increased sales.

(5 Marks)(May, 2013)

Answer

Product H & T are joint products and produced in the ratio of 1:2 from the same direct material- M.

Production of 40,000 additional units of T results in production of 20,000 units of H.

Calculation of contribution under existing situation

Particulars	Amount (₹)	Amount (₹)
Sales Value:		
H – 2,00,000 units @ ₹ 25 per unit	50,00,000	
T – 4,00,000 units @ ₹ 20 per unit	<u>80,00,000</u>	1,30,00,000
Less: Material- M (12,00,000 units @ ₹ 5 per unit)		60,00,000
Less: Other Variable Costs		42,00,000
Contribution		<u>28,00,000</u>

Let Minimum Average Selling Price *per unit* of H is ₹ X

Calculation of contribution after acceptance of additional order of 'T'

Particulars	Amount (₹)	Amount (₹)
Sales Value:		
H – 2,20,000 units @ ₹ X per unit	2,20,000 X	
T – 4,00,000 units @ ₹ 20 per unit	80,00,000	
40,000 units @ ₹ 15 per unit	<u>6,00,000</u>	2,20,000 X + 86,00,000
Less: Material- M (12,00,000 units x 110%) @ ₹ 5 per unit		66,00,000
Less: Other Variable Costs (₹ 42,00,000 x 110%)		<u>46,20,000</u>
Contribution		<u>2,20,000 X – 26,20,000</u>

Minimum Average Selling Price *per unit* of H

Contribution after additional order of T = Contribution under existing production

$$\Rightarrow 2,20,000 X - 26,20,000 = 28,00,000$$

$$\Rightarrow 2,20,000 X = 54,20,000$$

$$\Rightarrow X = \frac{54,20,000}{2,20,000} = ₹ 24.64$$

Minimum Average Selling Price *per unit* of H is ₹ 24.64

Question 58

X Ltd. wants to replace one of its old machines. Three alternative machines namely M_1 , M_2 and M_3 are under its consideration. The costs associated with these machines are as under:

	M_1	M_2	M_3
	₹	₹	₹
Direct material cost p.u.	50	100	150
Direct labour cost p.u.	40	70	200
Variable overhead p.u.	10	30	50
Fixed cost p.a.	2,50,000	1,50,000	70,000

You are required to compute the cost indifference points for these alternatives. Based on these points suggest a most economical alternative machine to replace the old one when the expected level of annual production is 1,200 units. (5 Marks)(May, 2013)

Answer**Computation of Cost Indifference Points for three alternatives**

$$\text{Cost Indifference Point of two machines} = \frac{\text{Difference in Fixed Cost}}{\text{Difference in Variable Cost per unit}}$$

$$\begin{aligned} \text{Machine } M_1 \text{ \& } M_2 &= \frac{₹ 2,50,000 - ₹ 1,50,000}{(₹ 100 + ₹ 70 + ₹ 30) - (₹ 50 + ₹ 40 + ₹ 10)} \\ &= \frac{₹ 1,00,000}{₹ 100} = 1,000 \text{ units} \end{aligned}$$

$$\begin{aligned} \text{Machine } M_2 \text{ \& } M_3 &= \frac{₹ 1,50,000 - ₹ 70,000}{(₹ 150 + ₹ 200 + ₹ 50) - (₹ 100 + ₹ 70 + ₹ 30)} \\ &= \frac{₹ 80,000}{₹ 200} = 400 \text{ units} \end{aligned}$$

$$\text{Machine } M_1 \text{ \& } M_3 = \frac{\text{₹ } 2,50,000 - \text{₹ } 70,000}{(\text{₹ } 150 + \text{₹ } 200 + \text{₹ } 50) - (\text{₹ } 50 + \text{₹ } 40 + \text{₹ } 10)}$$

$$= \frac{\text{₹ } 1,80,000}{\text{₹ } 300} = 600 \text{ units}$$

From the above computations, it is clear that at activity level below the indifference point the alternative (machine) with lower fixed cost and higher variable costs should be used. In case the activity level exceeds the indifference point, a machine with lower variable cost per unit (or higher contribution per unit) and higher fixed cost, is more profitable to operate.

At the activity level equal to the indifference point both machines are on equal footing. Hence from the above we conclude as follows:

Activity Level	Machine Preference
Less than 400 units	M ₃
Exactly 400 units	Either M ₂ or M ₃
Above 400 units but less than 1,000 units	M ₂
Exactly 1,000 units	Either M ₁ or M ₂
Above 1,000 units	M ₁

When expected level of activity is 1,200 units i.e. more than 1,000 units, Machine M₁ should be used.

Question 59

A company has to decide whether to accept a special order or not for a certain product M in respect of which the following information is given:

Material A required	5,000 kg	Available in stock. It was purchased 5 years ago at ₹ 35 per kg. If not used for M, it can be sold as scrap @ ₹ 15 per kg.
Material B required	8,000 kg	This has to be purchased at ₹ 25 per kg from the market.
Other hardware items	₹ 10,000	To be incurred
Dept X - Labour oriented	5 men for 1 month @ ₹ 7,000 per month per man	Labour to be freshly hired. No spare capacity available.
Dept Y - Machine oriented	3,000 machine hours @ ₹ 5 per machine hour	Existing spare capacity may be used.
Patten and Specification	₹ 15,000	To be incurred for M, but after the order, it can be sold for ₹ 2,000

Considering relevant costs, find out the minimum value above which the company may accept the order.
(5 Marks)(Nov, 2013)

Answer

Determination of Minimum Value of Special Order (considering relevant cost)

Cost Element	Relevant / Irrelevant	Calculation	Amount (₹)
Material – A	Realisable value is relevant.	5,000 Kg. × ₹15	75,000
Material – B	Relevant as it has to be purchased.	8,000 Kg. × ₹25	2,00,000
Other hardware items	Relevant as it is to be incurred.	----	10,000
Dept X – Labour oriented	Relevant as fresh labours are to be hired.	5 men × 1 month × ₹7,000	35,000
Dept Y – Machine oriented	Irrelevant, as spare capacity is available.	----	----
Pattern and Specification	Relevant, Net cost after considering its resale value.	₹ 15,000 – ₹ 2,000	13,000
Minimum Value of Special Order			3,33,000

Question 60

A company can produce any of its 4 products, A, B, C and D. Only one product can be produced in a production period and this has to be determined at the beginning of the production run. The production capacity is 1,000 hours. Whatever is produced has to be sold and there is no inventory build-up to be considered beyond the production period. The following information is given:

	A	B	C	D
Selling Price (₹/unit)	40	50	60	70
Variable Cost (₹/unit)	30	20	20	30
No. of units that can be sold	1,000	600	900	600
No. of production hours required per unit of product.	1 hour	1 hour and 15 minutes	1 hour and 15 minutes	2 hours

What are the opportunity costs of A, B, C and D?

(5 Marks)(Nov.,2013)

Answer

Statement Showing Calculation of Opportunity Cost

Product	A	B	C	D
Selling Price (₹ per unit)	40	50	60	70

Variable Cost (₹ per unit)	30	20	20	30
Contribution (₹ per unit) ...[A]	10	30	40	40
Demand (units)	1,000	600	900	600
No. of Units can be Produced (within 1,000 hours of production capacity)	1,000 $\left(\frac{1,000\text{hrs.}}{1\text{hr.}}\right)$	800 $\left(\frac{1,000\text{hrs.}}{1.25\text{hr.}}\right)$	800 $\left(\frac{1,000\text{hrs.}}{1.25\text{hr.}}\right)$	500 $\left(\frac{1,000\text{hrs.}}{2\text{hr.}}\right)$
No. of Units can be Sold (lower of demand and production) [B]	1,000	600	800	500
Possible contribution of product (₹) ...[A] × [B]	10,000	18,000	32,000	20,000
Opportunity Cost*	32,000	32,000	20,000	32,000

(*) Opportunity cost is the maximum possible contribution foregone by not producing alternative products i.e. if product A is produced then opportunity cost will be maximum of possible contribution from product B, C and D i.e. ₹ 32,000. Same is for Product B and D. In case of product C opportunity cost will be the maximum of possible contribution from product A, B and D i.e. ₹ 20,000.

Question 61

State the type of cost in the following cases:

- Cost associated with the acquisition and conversion of material into finished product.
- Cost arising from a prior decision which cannot be changed in the short run.
- Increase in cost resulting from selection of one alternative instead of another.
- Rent paid for a factory building which is temporarily closed. (4 Marks)(Nov, 2013)

Answer

Cases	Type of Cost
(i) Cost associated with the acquisition and conversion of material into finished product.	Product Cost
(ii) Cost arising from a prior decision which cannot be changed in the short run.	Committed Cost
(iii) Increase in cost resulting from selection of one alternative instead of another.	Differential/Incremental Cost
(iv) Rent paid for a factory building which is temporarily closed.	Shut Down Cost

Pricing Decisions

Question 1

Explain Skimming pricing strategy.

(4 Marks)(Nov, 2004)

Answer

Skimming pricing:

It is a policy where the prices are kept high during the early period of a product's existence. This can be synchronised with high promotional expenditure and in the latter years the prices can be gradually reduced. The reasons for following such a policy are as follows:

- (1) The demand is likely to be inelastic in the earlier stages till the product is established in the market.
- (2) The gradual reduction in price in the latter years will tend to increase the sales.
- (3) This method is preferred in the beginning because in the initial periods when the demand for the product is not known the price covers the initial cost of production.
- (4) High initial capital outlays needed for manufacture, results in high cost of production. In addition to this, the producer has to incur huge promotional activities resulting in increased costs. High initial prices will be able to finance the cost of production particularly when uncertainties block the usual sources of capital.

Question 2

How Pareto analysis is helpful in pricing of product in the case of firm dealing with multi-products?

(4 Marks)(Nov, 2005)

Answer

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.

Question 3

An organisation manufactures a product, particulars of which are detailed below:

Annual Production (Units)	20,000
Cost per annum (Rs.)	
Material	50,000
Other variable cost	60,000
Fixed cost	<u>40,000</u>
Apportioned Investment (Rs.)	<u>1,50,000</u>

Determine the unit selling price under two strategies mentioned below. Assume that the organisation's Tax rate is 40%—

- (a) 20% return on investment.
 (b) 6% profit on list sales, when trade discount is 40%. (11 Marks)(May, 2006)

Answer

- (i) Selling price to yield 20% return on investment:

	Rs.
Investment	1,50,000
After tax required ROI 20%	30,000
Tax	
After tax profit	
Pre tax profit (return) $(30,000 \div 60) \times 100$	50,000
Sales = cost + return or $1,50,000 + 50,000$	2,00,000
Number of units produced	20,000
Selling price Rs. $2,00,000 \div 20,000 = \text{Rs. } 10 \text{ per unit}$	

Alternative solution

$$(\text{Sales} - \text{cost}) (1 - \text{Tax}) = \text{ROI}$$

$$(\text{Sales} - 1,50,000) (1 - 0.40) = 1,50,000 \times 20\%$$

$$(0.60 \text{ Sales} - 90,000) = 30,000$$

0.60 Sales = 1, 20,000

Sales = 1, 20,000 ÷ 0.60 = Rs. 2, 00,000

Number of units 20,000

Selling price Rs. 2, 00,000 ÷ 20,000 = Rs. 10.

(ii) Selling price to yield 6% profit on list price.

	Rs.	Rs.
Investment		1,50,000
Let the list price be	100	
Desired after tax profit of 6%	6	
Pre-tax profit $(1 - 0.40) = 0.60 = (6 \div 0.60) =$	10	
List price		100
Discount		40
Net price		60
Profit desired		10
Cost		50
Cost of 50% = Rs. 1,50,000		
Sales = $(\text{Rs. } 1,50,000 \div 50) \times 100 = \text{Rs. } 3,00,000$		
Number of units 20,000		
List selling price $(3,00,000 \div 20,000) = \text{Rs. } 15$		
Discount 40%		
Net price $(15 \times 60\%)$ Rs. 9 per unit		

Alternative solution

Let s be the list sales

$[\text{List Sales} (1 - \text{tax discount}) - \text{cost}] (1 - \text{Tax rate}) = 0.06s$

$[s (1 - .40) - 1, 50,000] (1 - 0.40) = .06s$

$s = \text{Rs. } 3, 00,000$

List sales price per unit is Rs. 15 $\left(\frac{3,00,000}{20,000} \right)$

Net selling price per unit is Rs. 9 (Rs. 15 - 40% of 15%).

Question 4

Outline the features of penetration pricing strategy.

(4 Marks)(Nov, 2006)

Answer

- (i) Penetration Pricing: It is a policy of using a low price as the principal instrument for penetrating mass markets early.
- (ii) This method is used for pricing a new product and to popularize it initially.
- (iii) Profits may not be earned in the initial stages. However, prices may be increased as and when the product is established and its demand picks up.
- (iv) The low price policy is introduced for the sake of long term survival and profitability and hence it has to receive careful consideration before implementation. It needs an analysis of the scope for market expansion and hence considerable amount of research and forecasting are necessary before determining the price.
- (v) The circumstances in which penetrating pricing can be adopted are:

Elastic demand: The demand of the product is high when price is low. Hence, lower prices mean large volumes and hence more profits.

Mass Production: When there are substantial savings in large-scale production, increase in demand is sustained by the adoption of low pricing policy.

Frighten off competition: The prices fixed at a low-level acts as an entry barrier to the prospective competitors. The use of this policy by existing concerns will discourage the new concerns to enter the market. This pricing policy is also known as “stay-out-pricing”.

Question 5

S Limited is engaged in manufacturing activities. It has received a request from one of its important customers to supply a product which will require conversion of material 'M', which is a non-moving item.

The following details are available:

<i>Book value of material M</i>	<i>Rs. 60</i>
<i>Realisable value of material M</i>	<i>Rs. 80</i>
<i>Replacement cost of material M</i>	<i>Rs. 100</i>

It is estimated that conversion of one unit of 'M' into one unit of the finished product will require one labour hour. At present, labour is paid at the rate of Rs. 20 per hour. Other costs are as follows:

<i>Out-of-pocket expenses</i>	<i>Rs. 30 per unit</i>
<i>Allocated overheads</i>	<i>Rs. 10 per unit</i>

The labour will be re-deployed from other activities. It is estimated that the temporary redeployment will not result in loss of contribution. The employees to be re-deployed are permanent employees of the company.

Required:

Estimate the minimum price to be charged from the customer so that the company is not worse off by executing the order.
(4 Marks, Nov 2007)

Answer

Relevant costs of producing one unit of the finished product

	Rs.
Cost of material 'M' (realisable value)	80
Cost of labour (Being sunk cost)	0
Out-of-pocket expenses	<u>30</u>
	<u>110</u>

Allocated overhead is not relevant for the decision. The customer should be charged Rs. 110 per unit.

Question 6

What is Pareto Analysis? Name some applications.

(5 Marks, May 2008)

Answer

Vilfredo Pareto, an Italian economist, observed that about 70 – 80% of value was represented by 30 – 20% of volume. This observation was found to exist in many business solutions.

Analysing and focusing on the 80% value relating to 20% volume helps business in the following areas.

- (i) Pricing of a product (in a multi-product company)
- (ii) Customer profitability.
- (iii) Stock control.
- (iv) Activity Based Costing (20% cost drivers are responsible for 80% of total cost)
- (v) Quality Control.

Question 7

State the general guidelines to be used in adopting a pricing policy in a manufacturing organization.
(3 Marks, Nov 2008)

Answer

The general guidelines to be used in adopting a pricing policy are as under:

- (i) The pricing policy should encourage optimum utilization of resources.

- (ii) The pricing policy should work towards a better balance between demand and supply.
- (iii) The pricing policy should promote exports.
- (iv) The pricing policy should serve as an incentive to the manufacturers to maximize production by adopting improved technology.
- (v) The pricing policy should avoid adverse effects on the rest of the economy.

Question 8

Briefly explain skimming pricing and penetration pricing policies. (4 Marks) (Nov., 2008)

Answer

Skimming prices: Policy of highly pricing a product at the entry level into the market and reducing it later.

For example: Electronic goods, mobile phone, Flat, TVs, etc.

It is used when market is price insensitive, demand inelastic or to recover high promotional costs.

Penetration Pricing: Policy of entering the market with a low price, then establishing the product and then increasing the price.

This is also used by companies with established markets, when products are in any stage of their life cycle, to avoid competition. This is also known as “stay-out pricing”.

For example, entry of a new model small segment car into the market.

Question 9

Enumerate the uses of Pareto Analysis. (3 Marks Nov 2008)

Answer

Pareto analysis is useful to:

- (i) Prioritize problems, goals and objectives.
- (ii) Identify the root causes.
- (iii) Select and define the key quality improvement programs, key employee relations improvement programs etc.
- (iv) Verify the operating procedures and manufacturing processes.
- (v) Allocate physical, financial and human resources effectively.
- (vi) Maximise research and product development time.

Question 10

Hind Metals Manufactures an alloy product 'Incop' by using iron and Copper. The metals pass through two plants, X and Y. The company gives you the following details for the manufacture of one unit of Incop :

Materials	Iron: 10 kgs @ ₹ 5 per kg. Cooper: 5 kg @ ₹ 8 per kg.
Wages	3 hours @ ₹ 15 per hour in Plant X 5 hours @ ₹ 12 per hour in Plant Y
Overhead recovery	On the basis of direct labour hours
Fixed overhead	₹ 8 per hour in Plant X ₹ 5 per hour in Plant Y
Variable overhead	₹ 8 per hour in Plant X ₹ 5 per hour in Plant Y
Selling overhead :	(fully variable) – ₹ 20 per unit

- (i) Find out the minimum price to be fixed for the alloy, when the alloy is new to the market. Briefly explain this pricing strategy.
- (ii) After the alloy is well established in the market. What should be the minimum selling price? Why? (6 Marks)(Nov.,2009)

Answer

₹ /u of alloy

Materials:			
Iron 10kg @ ₹ 5/-	50		
Copper 5 kg @ ₹ 8/-	<u>40</u>		90
Wages			
X : 3 hrs @ 15 ₹ /Hr.	45		
Y : 5 hrs @ 12 ₹ /Hr	<u>60</u>		105
Variable OH (Production)			
X : 8 hrs × 3 hrs	24		
Y : 5 hrs × 5 hrs	<u>25</u>		49
Variable OH – Selling			<u>20</u>
Total Variable Cost			264
Fixed Off:			

X : 8/hrs × 3 hrs.	24		
Y : 5/hrs × 5 hrs	<u>25</u>		<u>49</u>
Total Cost			<u>313</u>

- (i) If pricing strategy is to penetrate the market, the minimum price for a new product should be the variable cost i.e. ₹ 264/-. In some circumstances, it can also be sold below the variable cost, if it is expected to quickly penetrate the market and later absorb a price increase. Total Variable Cost is the penetration price.
- (ii) When the alloy is well established, the minimum selling price will be the total cost – including the fixed cost i.e. ₹ 313 per unit. Long run costs should cover at least the total cost.

Question 11

Explain briefly the concept of skimming pricing policy.

(2 Marks)(Nov., 2009)

Answer

Skimming Pricing Policy:

When the product enters the market, a high price is charged so that price covers the initial cost of production and the demand is unknown e.g. Mobile Phones, Flat LCD TVs, etc. Price are gradually reduced.

Question 12

What is Price Discrimination? Under what circumstances it is possible? (4 Marks)(May, 2010)

Answer

Price discrimination is charging different prices with respect to customers, products, places and time

It is possible when

- the market being capable of being segmented
- the customers is not able to resell the product at a higher price
- The competitors' underselling is not possible

Question 13

What are the disadvantages of Cost Plus Pricing ?

(5 Marks)(May, 2011)

Answer

Disadvantages of cost plus pricing:

- (i) If ignores demand, facts to take into account buyers' needs and willingness to pay.

- (ii) Fails to reflect competition adequately.
- (iii) Assumes correct cost estimation, whereas in multiproduct firm, costs may be arbitrarily allocated.
- (iv) In many decision, incremental costs are more relevant than full cost. This is ignored.
- (v) Fixed Overheads depends on volume if volume is more cost is less, and vice-versa. Increase decrease in sales volume depends on price. Thus it is a vicious circle – cost plus markup is a price based on sales volume & sales volume is based on price.

Question 14

In a company, factory, overheads are applied on the basis of direct labour hours.

The following information is given:

	Department	
	A	B
Fixed factory overheads(₹)	3,36,000	1,26,000
Variable labour hours (₹ per hour) required as per direct labour hour budget	0.50	1.50
For product X	1,40,000	70,000
For product Y	28,000	56,000

(4 Marks) (May, 2011)

Answer

	Products	
	X	Y
Variable Overheads	175000	98000
Fixed Overheads	<u>350000</u>	<u>112000</u>
Total	<u>525000</u>	<u>210000</u>

	Department A	Department B
Variable Overheads		
Product X	70,000	1,05,000
Product Y	14,000	84,000
Fixed Overheads		
Product X	2,80,000	70,000

Product Y	56,000	56,000
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Question 15

State the pricing policy most suitable in each of the following independent situations:

- (i) The company makes original equipments and does defence contract work. There are other companies which also undertake such projects.*
- (ii) The product made by a company is new to the market. It is expected to enjoy a long-term demand. Competition is expected very soon, since the product will be desirable to most customers.*
- (iii) Stock of processed ready-to-eat product, whose shelf-life will soon be over in the next 2 months. The product is going to be discontinued.*
- (iv) A company sells a homogeneous product in a highly competitive market.*

(Candidates need to only write the pricing policy with the corresponding sub-division numbers of the questions. The situations need not be copied into the answer books)

(4 Marks)(Nov, 2011)

Answer

- (i) Sealed Bid Pricing*
- (ii) Penetration Pricing*
- (iii) Any price that the market will pay (even below variable cost any cash received)*
- (iv) Going rate pricing or market price*

Question 16

Explain briefly Pareto analysis and mention some of its uses.

(4 Marks)(Nov, 2011)

Answer

Pareto Analysis

Pareto Analysis is based on 80:20 rule that was a phenomenon first observed by Vilfredo Pareto, a nineteenth century Italian economist. He noticed that 80% of the wealth of Milan was owned by 20% of its citizens. This phenomenon or some kind of approximation of it says, (70:30) can be observed in many different business situations. The Management can use it in a number of different circumstances to direct management attention to the key control mechanism or planning aspects.

That is, about 70 to 80% of the value corresponds to 30 to 20 % of the volume.

Use of Pareto Analysis

1. Prioritize problems, goals and objectives

2. Identify root causes
3. Select and define key quality improvement programs
4. Select key employee relations improvement programs
5. Select key customers relations and service programs
6. Maximise research and product development times
7. Verify operating procedures and manufacturing processes
8. Product or services sales and distribution
9. Allocate physical, financial and human resources

Question 17

The Board of Directors XY Company Limited are considering a new type of handy sewing machine which their R & D Department has developed. The expenditure so far on research has been ₹ 95,000 and a consultant's report has been prepared at a cost of ₹ 22,500. The report provides the following information:

Cost of production per unit:

	₹
Material	45.00
Labour	75.00
Fixed overheads (Based on Company's normal allocation rates)	20.00
	<u>140.00</u>

Anticipated additional fixed costs:

Rent for additional space ₹ 1,25,000 per annum

Other additional fixed costs ₹ 70,000 per annum

A new machine will be built with the available facilities with a cost of ₹ 1,10,000 (material ₹ 90,000 and labour ₹ 20,000). The materials are readily available in stores which are regularly used. However, these are to be replenished immediately. The price of these materials have since been increased by 50%. Scrap value of the machine at the end of the 10th year is estimated at ₹ 20,000. The product scraps generated can be disposed off at the end of year 10 for a price of ₹ 1,43,000.

Years 1-5		Years 6-10	
Demand (Unit)	Probability	Demand	Probability
40,000	0.15	24,000	0.30
20,000	0.60	16,000	0.50
12,000	0.25	4,000	0.20

It is estimated that the commercial life of the machine will be no longer than 10 years and the after tax cost of capital is 10%. The full cost of the machine will be depreciated on straight line basis, which is allowed for computing the taxable income, over a period of 10 years. Tax rate is 30%.

DCF factors at 10%:	
1 - 5 years (cumulative)	3.79
6 - 10 years (cumulative)	2.355
10th year	0.386

Required:

Compute minimum selling price for the handy sewing machine. (12 Marks)(Nov, 2012)

Answer

(i) Expected Sales Volume:

Years 1-5: $(40,000 \times 0.15 + 20,000 \times 0.60 + 12,000 \times 0.25) = 21,000$ units

Years 6-10: $(24,000 \times 0.30 + 16,000 \times 0.50 + 4,000 \times 0.20) = 16,000$ units

(ii) Capital Cost:

	₹
Materials (₹ 90,000 x 1.50)	1,35,000
(Replacement cost) Labour	20,000
Overheads (Not Relevant)	-
	<u>1,55,000</u>

(iii) Production Variable Cost:

	₹
Materials	45
Labour	75
Overheads (Not relevant)	-
Total	<u>120</u>

(iv) Profitability:

Details	Years 1-5	Years 6-10
Sales Units	21,000	16,000
Selling Price (₹)	X	X
Sales Value (₹) [A]	21,000X	16,000X
Material and Labour Cost @ ₹120	25,20,000	19,20,000

Incremental Fixed Cost (₹)	1,95,000	1,95,000
Depreciation (1,55,000/10)	15,500	15,500
Total Cost (₹) [B]	27,30,500	21,30,500
Profit (₹) [A-B]	21,000X – 27,30,500	16,000X – 21,30,500
Less: Tax @ 30%	6,300X – 8,19,150	4,800X – 6,39,150
Profit After Tax	14,700X – 19,11,350	11,200X – 14,91,350
Add: Depreciation	15,500	15,500
Cash Inflow	14,700X – 18,95,850	11,200X – 14,75,850

(v) Cash Inflow in the Terminal Year (year 10)

	₹
Sale Value of the Machine	20,000
Scrap Realization	<u>143,000</u>
Total	163,000
Tax @ 30%	<u>(48,900)</u>
After Tax Cash Inflow	<u>114,100</u>

(vi) Present Value of Cash Flows:

Details	Year 0	Year 1-5	Year 6-10	Year 10
Capital Cost	1,55,000	–	–	–
Cash Flow from Operation	–	14,700X – 18,95,850	11,200X – 14,75,850	–
Cash Flow Terminal Year	–	–	–	1,14,100
Discount Factor	1	3.79	2.355	0.386
Present Value of Cash Flows	- 1,55,000	55,713X – 71,85,271.5 0	26,376X – 34,75,626.7 0	44,042.6

(vii) Net Cash Inflows:

$$= (-1,55,000) + (55,713X - 71,85,271.50) + (26,376X - 34,75,626.70) + (44,042.60)$$

$$= 82,089X - 1,07,71,855.60$$

(viii) Computation of Minimum Selling Price:

For determining Minimum Selling Price, Net Cash Inflows should be equal to zero:

$$82,089X - 1,07,71,855.60 = 0$$

$$\text{Or } X = 131.22$$

Minimum selling price is ₹ 131.22

Note:

- (a) R&D expenses of ₹ 95,000 is not relevant.
- (b) Fee for consultant's report of ₹ 22,500 is not relevant.
- (c) Tax element on irrelevant costs not considered, since the benefit will arise even without this product.

Question 18

Better and Best Ltd. manufacture only one product. Production is regular throughout the year and the capacity of the factory is 1,50,000 units per annum. The summarized Profit and Loss Account for the year ended 31st December is being reviewed by the Board of Directors.

	₹
Sales @ ₹10 per unit	10,00,000
Cost of sales:	
Direct materials	2,50,000
Direct labour	1,50,000
Production overheads:	₹
Variable	30,000
Fixed	2,30,000
Administrative overheads:	
Fixed	1,00,000
Selling and distribution overhead:	
Variable	50,000
Fixed	1,50,000

- (i) The Production Director proposed to reduce selling price to ₹ 9 in order to utilize full capacity.
- (ii) The Sales Director proposed to increase selling price by 20 percent. By spending ₹ 2,25,000 on advertisement, sales will be increased to 1,20,000 units per annum.
- (iii) The Personnel Director pleaded for a change in the method of wage payment. For the present piece rate of ₹ 1.50 per unit, a bonus scheme (for each 2% increase in production over the target, there would be an increase of 1% in the basic wage of each employee) will be implemented. A target of 2,000 units per week for the company will be set for 50 week year. Selling price increase by 10%. With an additional advertisement cost of ₹ 1,60,000, 20% increase in present sales will be achieved.

- (iv) The Chairman felt that the packaging of the product required improvement. He wanted to know the sales required to earn a target profit of 10% on turnover with the introduction of an improved packing at an additional cost of 20 paise per unit (no change in selling price).

You are required to evaluate individually the proposals of each of the board member and give your recommendation.
(12 Marks)(May, 2013)

Answer

Workings:

Full Capacity: ₹ 1,50,000 units p.a.

Current Capacity: ₹ 1,00,000 units p.a. which is equals to 66.67% of full capacity.

Existing Situation

Particulars	Amount (₹)	Per Unit (₹)
Sales (1,00,000 units x ₹ 10)	10,00,000	10.00
Less: Variable Cost		
Direct Material	2,50,000	2.50
Direct Labour	1,50,000	1.50
Production Overheads	30,000	0.30
Selling and Distribution Overhead	50,000	0.50
Contribution	5,20,000	5.20
Less: Fixed Cost		
Production Overheads	2,30,000	2.30
Administrative Overheads	1,00,000	1.00
Selling and Distribution Overhead	1,50,000	1.50
Profit	40,000	0.40

Variable Cost
₹ 4.80 p.u.

Proposal (i) - Reduce Selling Price to ₹ 9, Capacity Utilization 100%

Particulars	Amount (₹)
Sales (1,50,000 units x ₹ 9)	13,50,000
Less: Variable Cost (1,50,000 units x ₹ 4.80)	7,20,000
Contribution	6,30,000
Less: Fixed Cost	4,80,000
Profit	1,50,000

Proposal (ii) - Increase in Selling Price by 20%, Additional Advertising Cost ₹ 2,25,000, Sales Volume 1,20,000 units per annum.

Particulars	Amount (₹)
Sales (1,20,000 units x ₹ 12)	14,40,000
Less: Variable Cost (1,20,000 units x ₹ 4.80)	5,76,000
Contribution	8,64,000
Less: Fixed Cost	4,80,000
Less: Advertising Cost	2,25,000
Profit	1,59,000

Proposal (iii) - Increase in Selling Price by 10%, Additional Advertising Cost ₹ 1,60,000, 20% Increase in Present Sales and Bonus Scheme (for each 2% increase in production over the target, there would be an increase of 1% in the basic wages of each employee)

Particulars	Amount (₹)
Sales (1,20,000 units x ₹ 11)	13,20,000
Less: Variable Cost [1,20,000 units x ₹(2.50 + 1.65* + 0.30 + 0.50)]	5,94,000
Contribution	7,26,000
Less: Fixed Cost	4,80,000
Less: Advertising Cost	1,60,000
Profit	86,000

Workings:

Present Labour Rate = ₹ 1.50 *per unit*

Target Production Volume = 2,000 units x 50 weeks = 1,00,000 units

Production above the target volume = 1,20,000 units – 1,00,000 units = 20,000 units
or 20% of Target Production Volume

Bonus (for each 2% increase in production over the target, there would be an increase of 1% in the basic wages of each employee) = $\frac{1\%}{2\%} \times 20\% = 10\%$ increase in basic wages.

It means wages would be ₹ 1.65 (₹ 1.50 x 1.10) per unit.

Proposal (iv) -Target Profit 10% on Turnover, Additional Packing Cost 0.20 paise per unit, No Change in Selling Price, Sales Volume =?

Let Sales Volumes is K units.

Particulars	Amount (₹)
Sales (K units x ₹ 10)	10K
Less: Variable Cost [K units x ₹(4.80 + 0.20)]	5K
Contribution	5K
Less: Fixed Cost	4,80,000
Profit	5K-4,80,000

Profit equals to 10% of Turnover. It means-

$$\Rightarrow 5K - 4,80,000 = 10\% \text{ of } 10K$$

$$\Rightarrow 4K = 4,80,000$$

$$\Rightarrow K = 1,20,000 \text{ units}$$

$$\text{Turnover} = 1,20,000 \text{ units} \times ₹ 10$$

$$= ₹ 12,00,000$$

$$\text{Profit} = 10\% \text{ of } ₹ 12,00,000$$

$$= ₹ 1,20,000$$

Particulars	Capacity Utilization	Profit (₹)
Existing Situation	66.67%	40,000
Proposal (i)	100.00%	1,50,000
Proposal (ii)	80.00%	1,59,000
Proposal (iii)	80.00%	86,000
Proposal (iv)	80.00%	1,20,000

Company should accept Proposal (ii).

Question 19

List out the qualities required for a good pricing policy.

(4 Marks)(May, 2013)

Answer

Quality required for a good pricing policy:

The pricing policy plays an important role in a business because the long run survival of a business depends upon the firm's ability to increase its sales and device the maximum profit from the existing and new capital investment. Although cost is an important aspect of pricing,

consumer demand and competitive environment are frequently far more significant in pricing decisions.

The pricing policy structure should:

- provide an incentive to producer for adopting improved technology and maximising production;
- encourage optimum utilisation of resources;
- work towards better balance between demand and supply;
- promote exports; and
- avoid adverse effects on the rest of the economy.

Question 20

State the appropriate pricing policy in each of the following independent situations:

- (i) 'A' is a new product for the company and the market and meant for large scale production and long term survival in the market. Demand is expected to be elastic.
- (ii) 'B' is a new product for the company, but not for the market. B's success is crucial for the company's survival in the long term.
- (iii) 'C' is a new product to the company and the market. It has an inelastic market. There needs to be an assured profit to cover high initial costs and the usual sources of capital have uncertainties blocking them.
- (iv) 'D' is a perishable item, with more than 80% of its shelf life over. (4 Marks)(Nov, 2013)

Answer

Situation		Appropriate Pricing Policy
(i)	'A' is a new product for the company and the market and meant for large scale production and long term survival in the market. Demand is expected to be elastic.	Penetration Pricing
(ii)	'B' is a new product for the company, but not for the market. B's success is crucial for the company's survival in the long term.	Market Price or Price Just Below Market Price
(iii)	'C' is a new product to the company and the market. It has an inelastic market. There needs to be an assured profit to cover high initial costs and the unusual sources of capital have uncertainties blocking them.	Skimming Pricing
(iv)	'D' is a perishable item, with more than 80% of its shelf life over.	Any Cash Realizable Value*

(*) this amount decreases every passing day.

Budget & Budgetary Control

Question 1

A Company manufactures two Products A and B by making use of two types of materials, viz., X and Y. Product A requires 10 units of X and 3 units of Y. Product B requires 5 units of X and 2 units of Y. The price of X is ₹ 2 per unit and that of Y is ₹ 3 per unit. Standard hours allowed per product are 4 and 3, respectively. Budgeted wages rate is ₹ 8 per hour. Overtime premium is 50% and is payable, if a worker works for more than 40 hours a week. There are 150 workers.

The Sales Manager has estimated the sales of Product A to be 5,000 units and Product B 10,000 units. The target productivity ratio (or efficiency ratio) for the productive hours worked by the direct worker in actually manufacturing the product is 80%, in addition, the non-productive downtime is budgeted at 20% of the productive hours worked. There are twelve 5-day weeks in the budget period and it is anticipated that sales and production will occur evenly throughout the whole period.

It is anticipated that stock at the beginning of the period will be:

Product A 800 units; Product B 1,680 units. The targeted closing stock expressed in terms of anticipated activity during the budget period are Product A 12 days sales; Product B 18 days sales. The opening and closing stock of raw material of X and Y will be maintained according to requirement of stock position for Product A and B.

You are required to prepare the following for the next period:

- (i) Material usage and Material purchase budget in terms of quantities and values.*
- (ii) Production budget.*
- (iii) Wages budget for the direct workers.*

(8 Marks)(Nov. 2004)

Answer

(i) Material usage budget

	Products A (units)	Products B (units)	Total material usage units	Cost per unit (₹)	Total cost of materials (₹)
Estimated sales	5,000	10,000			
Material X : 10 units per product A and 5 units per product B	50,000	50,000	1,00,000	2	2,00,000
Material Y : 3 units per product A and 2 units per product B	15,000	20,000	35,000	3	1,05,000
Total	65,000	70,000	1,35,000		3,05,000

Material Purchase Budget

	X Units	Y Units	Total
Required for sales	1,00,000	35,000	
Add: desired closing stock			
Product A:			
1,000 units (A) $\times$ 10 units (X) = 10,000 units of X			
3,000 units (B) $\times$ 5 units (X) = 15,000 units of X.	25,000		
Product B:			
1,000 units (A) $\times$ 3 units (Y) = 3,000 units of Y		9,000	
3,000 units (B) $\times$ 2 units (Y) = 6,000 units of Y.	1,25,000	44,000	
Less: Opening stock			
Product A:			
800 units (A) $\times$ 10 units (X) = 8,000 units of X			
1,680 units (B) $\times$ 5 units (X) = 8,400 units of X	16,400		
Product B			
800 units (A) $\times$ 3 units (Y) = 2,400 units of Y		5,760	
1,680 units (B) $\times$ 2 units (Y) = 3,360 units of Y.			
Units to be purchased	1,08,600	38,240	1,46,840
Cost per unit	₹2	₹3	
Cost of purchase (₹)	2,17,200	1,14,720	3,31,920

(ii) Production Budget

	<i>Product A</i> <i>Units</i>	<i>Product B</i> <i>Units</i>
Sales	5,000	10,000
Add: Closing stock**	1,000	3,000
	6,000	13,000
Less: Opening stock	800	1,680
Production	5,200	11,320

**Calculation of closing stock:

Budgeted period is 12 weeks of 5 days each =60 days.

$$\text{Product A} = \frac{5,000 \times 12}{60} = 1,000 \text{ units}$$

$$\text{Product B} = \frac{10,000 \times 18}{60} = 3,000 \text{ units}$$

(iii) Wages budget for direct workers

	<i>Product A</i> <i>(hrs)</i>	<i>Product B</i> <i>(hrs)</i>	<i>Total</i> <i>(hrs.)</i>
Standard hours (budgeted) 5,200 units (A) × 4 hours per unit and 11,320 units (B) × 3 hours per unit.	20,800	33,960	54,760
Standard hours at 80% efficiency ratio			68,450
Add: non productive time (20% of 68,450)			13,690
			82,140
Labour hours required (150 workers × 8 hours per day × 60 days)			72,000
Overtime			10,140

Wages for normal hours (72,000 × 8) = ₹ 5,76,000

Wages for overtime (10,140 × 8 × 1.5) = ₹ 1,21,680

Total wages = ₹ 6,97,680

Question 2

A company manufactures two products X and Y. Product X requires 8 hours to produce while Y requires 12 hours. In April, 2004, of 22 effective working days of 8 hours a day, 1,200 units of X and 800 units of Y were produced. The company employs 100 workers in production department to produce X and Y. The budgeted hours are 1,86,000 for the year.

Calculate Capacity, Activity and Efficiency ratio and establish their relationship.

(6 Marks)(Nov. 2004)

Answer

Standard hours produced

	Product X	Product Y	Total
Out put (units)	1,200	800	
Hours per unit	8	12	
Standard hours	9,600	9,600	19,200

Actual hours worked

$$100 \text{ workers} \times 8 \text{ hours} \times 22 \text{ days} = 17,600$$

Budgeted hours per month

$$1,86,000/12 = 15,500$$

$$\text{Capacity Ratio} = \frac{\text{actual hours}}{\text{Budgeted hours}} \times 100 = \frac{17,600}{15,500} = 113.55 \%$$

$$\text{Efficiency Ratio} = \frac{\text{Standard Hours Produced}}{\text{Actual hours}} \times 100 = \frac{19,200}{17,600} \times 100 = 109.09\%$$

$$\text{Activity Ratio} = \frac{\text{Standard Hours Produced}}{\text{Budget hours}} \times 100 = \frac{19,200}{15,500} \times 100 = 123.87\%$$

Relationship : Activity Ratio = Efficiency Ratio $\times$ Capacity Ratio

$$\text{or} \quad 123.87 = \frac{109.09 \times 113.55}{100}$$

Question 3

"Because a single budget system is normally used to serve several purposes, there is a danger that they may conflict with each other". Do you agree? Discuss.

(4 Marks)(May 2005)

Answer

A single budget system may be conflicting in planning and motivation, and planning and performance evaluation roles as below:

- (i) Planning and motivation roles – Demanding budgets that may not be achieved may be appropriate to motivate maximum performance but they are unsuitable for planning purposes. For these, a budget should be a set based on easier targets that are expected to be met.
- (ii) Planning and performance evaluation roles - For planning purposes budgets are set in advance of the budget period based on an anticipated set of circumstances or environment. Performance evaluation should be based on a comparison of active performance with an adjusted budget to reflect the circumstance under which managers actually operated.

Question 4

A Company is engaged in manufacturing two products 'X' and 'Y'. Product X uses one unit of component 'P' and two units of component 'Q'. Product 'Y' uses two units of component 'P', one unit of component 'Q' and two units of component 'R'. Component 'R' which is assembled in the factory uses one unit of component 'Q'.

Component 'P' and 'Q' are purchased from the market. The company has prepared the following forecast of sales and inventory for the next year:

	Product 'X'	Product 'Y'
Sales (in units)	80,000	1,50,000
At the end of the year	10,000	20,000
At the beginning of the year	30,000	50,000

The production of both the products and the assembling of the component 'R' will be spread out uniformly throughout the year. The company at present orders its inventory of 'P' and 'Q' in quantities equivalent to 3 months production. The company has compiled the following data related to two components:

	P	Q
Price per unit (₹)	20	8

Order placing cost per order (₹)	1,500	1,500
Carrying cost per annum	20%	20%

Required:

- (a) Prepare a Budget of production and requirements of components during next year.
 (b) Suggest the optimal order quantity of components 'P' and 'Q'.

(11 Marks)(May 2006)

Answer

- (a) Production Budget for product X and Y

	X units	Y units
Inventory at the end of the year	10,000	20,000
Sales forecast	80,000	1,50,000
Total requirements	90,000	1,70,000
Less: Beginning inventory	30,000	50,000
Production	60,000	1,20,000

Budgeted requirements of components P, Q and R

Components	P	Q	R
For Product X: Production 60,000 units			
P: 60,000 × 1 per unit	60,000		
Q: 60,000 × 2 per unit		1,20,000	
For Product Y: Production 1,20,000 units			
P: 1,20,000 × 2 per unit	2,40,000		
Q: 1,20,000 × 1 per unit		1,20,000	
R: 1,20,000 × 2 per unit			2,40,000
For comp R: Production 2,40,000 comp			
Q: 2,40,000 × 1 per component R		2,40,000	
Total requirements	3,00,000	4,80,000	2,40,000

- (b) The company is advised to adopt EOQ system.

P	Q
EOQ $\sqrt{\frac{2 \times 3,00,000 \times 1,500}{20 \times 20\%}} = 15,000$ components	$\sqrt{\frac{2 \times 4,80,000 \times 1,500}{8 \times 20\%}} = 30,000$ components

Question 5

Describe the process of zero-base budgeting.

(4 Marks)(May, 2007)

Answer

The zero Base Budgeting involves the following steps:

- (i) Corporate objectives should be established and laid down in details.
- (ii) Decide about the techniques of ZBB to be applied.
- (iii) Identify those areas where decisions are required to be taken.
- (iv) Develop decision programmes and rank them in order of preferences.
- (v) Preparation of budget, that is translating decision packages into practicable units/items and allocating financial resources.

Question 6

What do you mean by a flexible budget? Give an example of an industry where this type of budget is typically needed?

(2 Marks) (May 2008)

Answer

A flexible budget is a budget which, by recognizing the difference between fixed, semi-variable and variable costs, is designed to change in relation to the level of activity attained.

E.g. seasonal products – e.g. soft drink industry

industries in make to order business like ship building

industries influenced by change in fashion.

Industries which keep on introducing new products / new designs.

Question 7

The budgeted and actual cost data of M Ltd. for 6 months from April to September, 2008 are as under:

	<i>Budget</i>	<i>Actual</i>
<i>Production units</i>	16,000	14,000
<i>Material cost</i>	₹ 25,60,000 (1,600 MT @ ₹ 1,600)	₹ 41,60,000 (at ₹ 1,650)
<i>Labour cost</i>	₹ 16,00,000 (at ₹ 40 per hour)	₹ 15,99,840 (@ ₹ 44 per hour)

Variable overhead	₹ 3,00,000	₹ 2,76,000
Fixed overhead	₹ 4,60,000	₹ 5,80,000

In the first half of financial year 2009-10, production is budgeted for 30,000 units, material cost per tonne will increase from last year's actual by ₹ 150, but it is proposed to maintain the consumption efficiency of 2008 as budgeted. Labour efficiency will be lower by 1% and labour rate will be ₹ 44 per hour. Variable and fixed overheads will go up by 20% over 2008 actuals.

Prepare the Production Cost budget for the period April-September, 2009 giving all the workings.
(6 Marks)(Nov., 2008)

Answer

Production Cost Budget
(for 6 months ending 30th September, 2009)

	30,000 units	
	Cost per unit	Total
	₹	₹
Material cost	180	54,00,000
Labour cost	115.21	34,56,420
Variable overhead	23.65	7,09,500
Fixed overhead	<u>23.2</u>	<u>6,96,000</u>
	<u>342.06</u>	<u>1,02,61,920</u>

Assumption : Here, difference in actual and standard time is also considered for calculating the lower efficiency i.e. $3.74\% + 1\% = 4.74\%$

Working Notes:

I. Material cost

$$\text{Material consumption per unit} = \frac{1,600 \text{ MT}}{16,000} = 0.10 \text{ MT}$$

Consumption for 30,000 units = 3,000 MT.

Cost of 3,000 MT @ ₹ 1,800 per MT = ₹ 54,00,000.

II. Labour cost can be calculated as follows:

Time required for 30,000 units = 75,000 hours

Add: $*(3.74\% + 1\%) = 4.74\%$ for lower efficiency = 3,555 hours

= 78,555 hours

$$*3.74\% = \frac{\text{Difference in actual and standard hours}}{\text{Actual hours}} \times 100$$

$$= \frac{1,360 \text{ hours}}{36,360 \text{ hours}}$$

$$\begin{aligned} \text{Labour cost} &= 78,555 \text{ hours} \times 44 \text{ per hour} \\ &= 34,56,420. \end{aligned}$$

III. Variable overhead

$$\text{Actual rate} = \frac{\text{₹ } 2,76,000}{14,000} = 19.71 \text{ per unit}$$

$$\text{Add: 20} = \underline{3.94}$$

$$\text{New rate} \quad \underline{23.65}$$

$$\begin{aligned} \text{Total variable overhead} &= 30,000 \times 23.65 \\ &= \text{₹ } 7,09,500 \end{aligned}$$

IV. Fixed overhead

$$\text{Actual} = \text{₹ } 5,80,000$$

$$\text{Add: 20\%} = \text{₹ } \underline{1,16,000}$$

$$= \text{₹ } \underline{6,96,000}$$

According to above the production cost budget will be as follows:

Alternative

Production Cost Budget (for 6 months ending 30th September, 2009)

	30,000 units	
	Cost per unit	Total
	₹	₹
Material cost	180	54,00,000
Labour cost	111.1	33,33,000
Variable overhead	23.65	7,09,500
Fixed overhead	<u>23.2</u>	<u>6,96,000</u>
	<u>337.95</u>	<u>1,01,38,500</u>

Working Notes:

I. Material cost

$$\text{Material consumption per unit} = \frac{1,600 \text{ MT}}{16,000} = 0.10 \text{ MT}$$

Consumption for 30,000 units = 3,000 MT.

Cost of 3,000 MT @ ₹ 1,800 per MT = ₹ 54,00,000.

II. Labour Cost:

$$2008 - \text{Total Budgeted Hour} = \frac{16,00,000}{40} = 40,000 \text{ hours}$$

$$\text{Labour hour budget for each unit} = \frac{40,000}{16,000} = 2.5$$

$$\text{Actual time paid} = \frac{15,99,840}{44} = 36,360 \text{ hours}$$

Less: Standard labour hours for 14,000 units (i.e. $14,000 \times 2.5$) = 35,000 hours

Difference in actual and standard hours = 1,360

Time required for 30,000 units ($30,000 \times 2.5$) = 75,000 hours

Add: 1% for lower efficiency = 750 hours

= 75,750 hours

Labour cost = 75,750 hours $\times$ 44 per hour = 33,33,000

III. Variable overhead

$$\text{Actual rate} = \frac{\text{₹ } 2,76,000}{14,000 \text{ units}} = 19.71 \text{ per unit}$$

Add: 20 = 3.94

New rate = 23.65

Total variable overhead = 30,000 $\times$ 23.65 = ₹ 7,09,500

IV. Fixed overhead

Actual = ₹ 5,80,000

Add: 20% = ₹ 1,16,000

= ₹ 6,96,000

Question 8

What are the various formulae used in calculating budget ratios? (3 Marks)(June, 2009)

Answer

Type of budgeted ratio used are:

1. Efficiency Ratio = $(\text{Standard hours} + \text{Actual hours}) \times 100$
2. Activity Ratio = $(\text{Standard hours} + \text{Budgeted hours}) \times 100$
3. Calendar Ratio = $(\text{Available working days} \div \text{budgeted working days}) \times 100$
4. Standard Capacity Usage Ratio $(\text{Budgeted hours} \div \text{Max. possible hours in the budgeted period}) \times 100$
5. Actual Capacity Usage Ratio = $(\text{Actual hours worked} + \text{Maximum possible working hours in a period}) \times 100$
6. Actual usage of Budgeted Capacity Ratio = $(\text{Actual working hours} \div \text{Budgeted hours}) \times 100$

Question 9

What are the steps involved in Zero-base budgeting? (5 Marks)(Nov.,2010)

Answer

Steps involved in the process of Zero Based Budgeting:

1. Determination of a set of objects is the pre-requisite and essential step in the direction of ZBB technique.
2. Deciding about the extent to which the technique of ZBB is to be applied whether in all areas of organization activities or only in few selected areas on trial basis.
3. Identify the areas where decisions are required to be taken.
4. Developing decision packages and ranking them in order of performance.
5. Preparation of budget that is translating decision packages into practicable units/items and allocating financial resources.

ZBB is simply an extension of the cost, benefit analysis method to the area of corporate planning and budgeting.

Question 10

The CEO of your company has been given the following statement showing the results for a recent month:

Particulars	Master Budget	Actual
Units produced & sold	10,000	9,000
	₹	₹
Sales	8,00,000	7,00,000
Direct material	2,00,000	1,84,000
Direct Wages	3,00,000	2,62,000
Variable overhead	1,00,000	94,000
Fixed overhead	1,00,000	98,000
Total Cost	7,00,000	6,38,000
Net Surplus	1,00,000	62,000

The standard cost of the product is as follows:

Direct material (1 kg @ ₹ 20/kg) ₹ 20.00 per unit

Direct Wages (1 hour @ ₹ 30/hour) ₹ 30.00 per unit

Variable overhead (1 hour @ ₹ 10/hour) ₹ 10.00 per unit

Actual results for the month revealed that 9,800 kg. of material was used and 8,800 labour hours were recorded.

(i) Prepare a flexible budget for the month and compare with the actual results. (6 Marks)

(ii) Calculate material volume and variable overhead efficiency variances. (2 Marks)

Answer

(i)

Particular	Master Budget		Flexible Budget	Actual	Variance	
Units	10,000		9,000	9,000		
	(₹) Total	(₹) Per Unit	(₹)	(₹)		
Sales	8,00,000	80	7,20,000	7,00,000	20,000	(A)
Direct Material	2,00,000	20	1,80,000	1,84,000	4,000	(A)
Direct Wages	3,00,000	30	2,70,000	2,62,000	8,000	(F)
Variable Overhead	1,00,000	10	90,000	94,000	4,000	(A)
Total Variable Cost	6,00,000	60	5,40,000	5,40,000	-	
Contribution	2,00,000	20	1,80,000	1,60,000	20,000	(A)
Fixed Overhead	1,00,000	10	1,00,000	98,000	2,000	(F)
Net Profit	1,00,000	10	80,000	62,000	18,000	(A)

(ii) Calculation of Variances:

Material Volume Variance: $SP (SQ - AQ) = 20 (9,000 - 9,800) = 16,000 (A)$

Variable Overhead efficiency variance $SR (SH - AH) = 10 (9,000 - 8,800) = 2,000 (F)$

Question 11

A Company is engaged in manufacturing two products A and B. Product A uses one unit of component X and two units of component Y. Product B uses two units of component X and one unit of component Y and two units of component Z. Component Z which is assembled in the factory uses one unit of component Y.

Components X and Y are purchased from the market. The company has prepared the following forecast of sales and inventory for the next year:

	Product A	Product B
	(Units)	(Units)
Sales	80,000	1,50,000
Stock at the end of the year	10,000	20,000
Stock at the beginning of the year	30,000	50,000

The production of both the products and the assembling of the component Z will be spread out uniformly throughout the year. The company at present orders its inventory of X and Y in quantities equivalent to 3 months production. The company has compiled the following data related to the two components:

	X	Y
Price per unit (₹)	20	8
Order placing cost per order (₹)	1,500	1,500
Carrying cost per annum	20%	20%

Required:

- (i) Prepare a budget for production and requirements of components for the next year.
 (ii) Suggest the optimal order quantity of components X and Y. (7 Marks)(May, 2010)

Answer

(i) Production Budget

	Product "A"	Product "B"
	Units	Units
Sales	80000	150000

Closing stock	10000	20000
Opening stock	30000	50000
Production Budget	60000	120000

Budget of Component Requirements

Components	X	Y	Z
Product A: Production 60000 units	60000	120000	
Product B: Production 120000 units	240000	120000	240000
Component Z : 240000 units		240000	
Total	300000	480000	240000

(ii) Optimal order quantity of components X and Y

Components	X	Y
Order placing costs ₹	1500	1500
Price of the component ₹	20	8
Carrying cost @ 20% ₹	4	1.60

$$\text{EOQ} = \sqrt{\left(\frac{(2 * 300000 * 1500)}{4}\right)}$$

$$= 15000 \text{ components}$$

$$\sqrt{\left(\frac{(2 * 480000 * 1500)}{1.60}\right)}$$

$$= 30000 \text{ components}$$

Question 12

PQR Ltd is considering introducing a new product at a price of ₹ 105 per unit. 'PQR Ltd's controller has compiled the following incremental cost information based on an estimate of 1,20,000 units of sales annually for the new product:

Direct material cost	₹ 36,00,000
Direct Labour cost	₹ 24,00,000
Flexible manufacturing support	₹ 12,00,000
Sales commission	10% of sales
Capacity- related cost	₹ 20,00,000

The average inventory levels for the new product are estimated as follows:

Raw materials: 2 months' production

Work-in-progress (100% complete for

Materials and 50% complete for labour and

Flexible manufacturing support) 1 month production

Finished goods 2 months' production

Annual inventory carrying costs not included in the flexible manufacturing support listed earlier are estimated to be 12% of inventory value. In addition, the sales manager expects the introduction of new product to result in a reduction in sales of existing product from 3,00,000 to 2,40,000 units. The contribution margin for the existing product is ₹20 per unit.

Prepare a statement showing the budgeted impact on PQR's profits on the introduction of the new product. Should the new product be introduced? (8 Marks)(May, 2012)

Answer

Budgeted production = 120,000 per annum (10,000 units per month)		
	₹ per unit	Total ₹
Sales Value	105.00	1,26,00,000
Less: Variable Cost		
Direct material	30.00	36,00,000
Direct Labour	20.00	24,00,000
Flexible mfg. support	10.00	12,00,000
Commission 10% of sales	10.50	12,60,000
Total Variable Cost	70.50	84,60,000
Contribution	34.50	41,40,000
Fixed mfg. cost (Capacity related cost)		20,00,000
Inventory carrying cost (Refer working)		2,70,000
Profit from new product		18,70,000
Less: Loss of contribution due to lower sale of existing product 60,000 units * ₹20		12,00,000
Net incremental profit		6,70,000

(Decision: Recommend new product)

Value of Inventory

Raw materials (36,00,000 /6)		6,00,000
Work in progress		
Materials (36,00,000/ 12)	3,00,000	
Labour (24,00,000/ 24)	1,00,000	

Flexible Manufacturing support (12,00,000 / 24)	50,000	4,50,000
Finished Goods		
(Raw materials + Labour + Flexible manufacturing support) / 6		12,00,000
Total Inventory Value		22,50,000
Inventory Carrying cost - 12%		2,70,000

Question 13

Define the following:

(i) *maximum capacity (theoretical capacity)*

(ii) *practical capacity*

(iii) *normal capacity*

(iv) *principal budget factor*

(The first three relate to a manufacturing plant)

(4 Marks)(May, 2012)

Answer

(i) Maximum Capacity = Maximum no. of days in a period x no. of workers or
Maximum no. of hours x no. of workers
or

The maximum no. of units that can be produced by a manufacturing facility in a certain period.

(ii) Practical Capacity = Maximum capacity (minus) Sundays, holidays, normal maintenance & idle time

(iii) Normal Capacity = Average of past 3 years' normal performance excluding abnormal data.

(iv) Principal budget factor = The factor that limits the activities of the functional budgets of the organization.

Question 14

Discuss the characteristics of zero base budgeting.

(4 Marks)(Nov, 2012)

Answer

Zero base budgeting (ZBB) is defined as method of budgeting which requires each cost element to be specifically justified, as though the activities to which the budget relates were

being undertaken for the first time. ZBB is prepared and justified from scratch (zero). Without approval, the budget allowance is zero.

Characteristics of ZBB:

- (i) Manager of a decision unit has to completely justify why there should be any budget allotment for his decision unit.
- (ii) Activities are identified in decision packages.
- (iii) Decision packages are ranked in order of priority
- (iv) Packages are evaluated by systematic analysis.
- (v) Decision packages are linked with corporate objectives, which are clearly laid down.
- (vi) Available resources are directed towards alternatives in order to prioritize to ensure optimal results.

Question 15

KG Ltd. is engaged in the production of two products K and G. One unit of product K requires two units of material A and four units of material B. Each unit of product G needs four units of material A, two units of material B and four units of material C. Material C is locally produced in the factory of the company by using two units of material B for each unit of C.

Material A and B are purchased in the open market. Production of products K, G and C is carried out evenly throughout the year. At present the company has purchased its 3 months requirements of A and B in one purchase. That is four purchases per annum. The other particulars provided by the company are:

	Products	
	K Units	G Units
Budgeted sales for the next year	40,000	75,000
Desired stock at the end of the year	5,000	10,000
Expected stock at the beginning of the year	15,000	25,000
	Products	
	A	B
Purchase price p.u. (₹)	15	25
Ordering cost per order (₹)	1,000	1,000
Carrying cost p.a.	10%	10%

You are required to:

- (i) Prepare a production budget and a material requirement budget for the next year.

- (ii) Calculate the number of material purchases to be made, if the company wants to purchase materials in optimal quantity. (8 Marks)(May, 2013)

Answer

Production Budget for Product K and G

Particulars	'K' Units	'G' Units
Desired Inventory at the end of the year	5,000	10,000
Sales Forecast	<u>40,000</u>	<u>75,000</u>
Total Requirements	45,000	85,000
Less: Expected Inventory at beginning of the year	<u>15,000</u>	<u>25,000</u>
Budgeted Production	30,000	60,000

Budgeted Requirements of Material 'A', 'B' and 'C'

Particulars	'A' Units	'B' Units	'C' Units
For Product 'K': Production 30,000 units			
'A': 30,000 × 2 per unit	60,000	–	–
'B': 30,000 × 4 per unit	–	1,20,000	–
For Product 'G': Production 60,000 units			
'A': 60,000 × 4 per unit	2,40,000	–	–
'B': 60,000 × 2 per unit	–	1,20,000	–
'C': 60,000 × 4 per unit	–	–	2,40,000
For Material 'C': Production 2,40,000 units			
'B': 2,40,000 × 2 per unit	–	4,80,000	–
Total Requirements	3,00,000	7,20,000	2,40,000

Optimum Order Quantity:

A	B
$EOQ = \sqrt{\frac{2 \times 3,00,000 \times 1,000}{15 \times 10\%}} = 20,000 \text{ Units}$	$EOQ = \sqrt{\frac{2 \times 7,20,000 \times 1,000}{25 \times 10\%}} = 24,000 \text{ Units}$

No. of Purchases:

A	B
$= \frac{\text{Total Requirements}}{\text{Optimum Order Quantity}} = \frac{3,00,000}{20,000}$	$= \frac{\text{Total Requirements}}{\text{Optimum Order Quantity}} = \frac{7,20,000}{24,000}$
= 15 Purchases	= 30 Purchases

Question 16

The PLN Co. presents the following static budgets for 4,000 units and 6,000 units activity levels for October 2013:

	4,000 units activity level	6,000 units activity level
Overhead A ` 12/hr. x 2 hr. /unit	96,000	1,44,000
Overhead B	1,40,000	1,90,000

Overhead C was omitted to be listed out. It is a fixed plant overhead, estimated at ₹ 12.5/hr. at 4,000 units activity level. This has to also feature in the flexible budget. The actual production was 5,000 units and 9,600 hours were needed for production.

You are required to present the flexible budget amount of each overhead to enable appropriate comparison with the actual figures. (5 Marks)(Nov, 2013)

Answer

Statement Showing Flexible Budget for 5,000 units Activity Level

Particulars	Amount (₹)
Overhead A (₹12.00 per hour × 2 hrs. per unit × 5,000 units)	1,20,000
Overhead B* (₹ 40,000 + ₹25 × 5,000 units)	1,65,000
Overhead C (₹12.50 per hour × 2 hrs. per unit × 4,000 units)	1,00,000
Total	3,85,000

Working Note (*)

Overhead B

$$\text{Variable Cost (per unit)} = \frac{\text{Change in Overhead Cost}}{\text{Change in Production Units}}$$

$$= \frac{\text{₹ 1,90,000} - \text{₹ 1,40,000}}{6,000 \text{ units} - 4,000 \text{ units}}$$

$$= \frac{\text{₹ 50,000}}{2,000 \text{ units}}$$

$$= \text{₹ 25}$$

$$\text{Fixed Cost} = \text{₹ 1,40,000} - 4,000 \text{ units} \times \text{₹ 25}$$

$$= \text{₹ 40,000}$$

Question 17

In each of the following independent situations, state with a brief reason whether 'Zero Base Budgeting' (ZBB) or 'Traditional Budgeting' (TB) would be more appropriate for year II.

- (i) A company producing a certain product has done extensive ZBB exercise in year I. The activity level is expected to marginally increase in year II.*
- (ii) The sales manager of a company selling three products has the intuitive feeling that in year II, sales will increase for one product and decrease for the other two. His expectation cannot be substantiated with figures.*
- (iii) The top management would like to delegate responsibility to the functional managers for their results during year II.*
- (iv) Resources are heavily constrained and allocation for budget requirements is very strict.*

(4 Marks)(Nov, 2013)

Answer

- (i)** The company has done extensive exercise in year-I that can be used as a basis for budgeting in year-II by incorporating increase in costs / revenue at expected activity level. Hence, **Traditional Budgeting** would be more appropriate for the company in year-II.
- (ii)** In **Traditional Budgeting** system budgets are prepared on the basis of previous year's budget figures with expected change in activity level and corresponding adjustment in the cost and prices. But under **Zero Base Budgeting (ZBB)** the estimations or projections are converted into figures. Since, sales manager is unable to substantiate his expectations into figures so **Traditional Budgeting** would be preferred against **Zero Base Budgeting**.
- (iii)** **Zero Base Budgeting** would be appropriate as ZBB allows top-level strategic goals to be implemented into the budgeting process by tying them to specific functional areas of the organization, where costs can be first grouped, then measured against previous results and current expectations.
- (iv)** **Zero Base Budgeting** allocates resources based on order of priority up to the spending cut-off level (maximum level upto which spending can be made). In an organisation where resources are constrained and budget is allocated on requirement basis, **Zero Base Budgeting** is more appropriate method of budgeting.

Standard Costing

Question 1

C Preserves produces Jams, Marmalade and Preserves. All the products are produced in a similar fashion; the fruits are cooked at low temperature in a vacuum process and then blended with glucose syrup with added citric acid and pectin to help setting.

Margins are tight and the firm operates, a system of standard costing for each batch of Jam.

The standard cost data for a batch of raspberry jam are

<i>Fruits extract</i>	<i>400 kgs @ ₹ 16 per kg.</i>
<i>Glucose syrup</i>	<i>700 kgs @ ₹ 10 per kg.</i>
<i>Pectin</i>	<i>99 kgs. @ 33.2 per kg.</i>
<i>Citric acid</i>	<i>1 kg at ₹ 200 per kg.</i>
<i>Labour</i>	<i>18 hours @ ₹ 32.50 per hour.</i>

Standard processing loss 3%.

The climate conditions proved disastrous for the raspberry crop. As a consequence, normal prices in the trade were ₹ 19 per kg for fruits abstract although good buying could achieve some savings. The impact of exchange rates for imported sugar plus the minimum price fixed for sugarcane, caused the price of syrup to increase by 20%.

The retail results for the batch were –

<i>Fruit extract</i>	<i>428 kgs at ₹ 18 per kg.</i>
<i>Glucose syrup</i>	<i>742 kgs at ₹ 12 per kg.</i>
<i>Pectin</i>	<i>125 kgs at ₹ 32.8 per kg.</i>
<i>Citric acid</i>	<i>1 kg at ₹ 95 per kg.</i>
<i>Labour</i>	<i>20 hrs. at ₹ 30 per hour.</i>

Actual output was 1,164 kgs of raspberry jam.

You are required to:

- (i) Calculate the ingredients planning variances that are deemed uncontrollable.*
- (ii) Calculate the ingredients operating variances that are deemed controllable.*

(iii) Calculate the mixture and yield variances.

(iv) Calculate the total variances for the batch.

(11 Marks) (May, 2005)

Answer

Details of original and revised standards and actual achieved

	Original standards		Revised standards		Actual	
Fruit	400 Kgs × ₹ 16	₹ 6,400	400 Kgs × ₹ 19	₹ 7,600	428 Kgs × ₹ 18	₹ 7,704
Glucose	700 Kgs × ₹ 10	₹ 7,000	700 Kgs × ₹ 12	₹ 8,400	742 Kgs × ₹ 12	₹ 8,904
Pectin	99 Kgs × ₹ 33.2	₹ 3286.8	99 Kgs × ₹ 33.2	₹ 3286.8	125 Kgs × ₹ 32.8	₹ 4,100
Citric acid	1 Kg × ₹ 200	₹ 200	1 Kg × ₹ 200	₹ 200	1 Kg × ₹ 95	₹ 95
	1,200 kgs	₹ 16,886.8	1,200 kgs	₹ 19,486.8	1,296 kgs	₹ 20,803
Labour		₹ 585.0		₹ 585.0		₹ 600
	1,200 kgs	17,471.8	1,200 kgs	20,071.8	1,296 kgs	21,403
Loss	36 kgs		36 kgs		132	
	1,164 kgs	₹ 17,471.8	1,164 kgs	₹ 20,071.8	1,164 Kgs	₹ 21,403

(i) Planning variances

* Fruit extract (6,400 less 7,600) ₹ 1,200(Adverse)

Glucose syrup (7,000 less 8,400) ₹ 1,400(Adverse)

Total ₹ 2,600(Adverse)

* (Std qty × Std price less Std qty × Revised Std price)

(ii) Ingredients operating variances

Total (19,486.8 less 20,803) = ₹ 1,316.2(Adverse)

Ingredients Price variance

(Revised Material Price – Actual Material Price) × (Actual Qty Consumed)

		Variance in ₹
Fruit extract	(19 – 18) × 428	428(F)
Glucose syrup		Nil
Pectin	(33.2 – 32.8) × 125	50(F)
Citric acid	(200 – 95) × 1	<u>105(F)</u>
		<u>583(F)</u>

Usage variance

(Std Qty on Actual Production less Actual Qty on Actual Production) $\times$ Revised Std Price/Unit

	₹	Variance in ₹
Fruit extract	$(400 - 428) \times 19$	532(A)
Glucose syrup	$(700 - 742) \times 12$	504(A)
Pectin	$(99 - 125) \times 33.2$	863.2(A)
Citric acid		<u>Nil</u>
		<u>1,899.2(A)</u>

(iii) Mix Variance

(Actual usage in std mix less Actual usage in actual mix) $\times$ std price

		Variance in ₹
Fruit extract	$(432 - 428) \times 19$	76(F)
Glucose syrup	$(756 - 742) \times 12$	168 (F)
Pectin	$(106.92 - 125) \times 33.2$	600.3(A)
Citric acid	$(1.08 - 1) \times 200$	16(F)
		340.3 (A)

Yield variance

(Actual yield – Std yield from actual output) $\times$ Std cost per unit of output

$$= (1,164 - 1,296 \times 0.97) \times \frac{19486.8}{1164} = 1,558.9(A)$$

Labour operating variance

$$585 - 600 = 15(A)$$

(iv) Total variance = Planning variance + Usage Variance + Price Variance + labour operating Variance.

$$\text{Or Total Variance} = (2,600) + (1,899.2) + 583 + (15) = 3931.2 (A).$$

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.
-----	-----

Raw Material - 1

Beg. Balance	0		18,000
		Closing Balance	6,000

Raw Material - 2

Beg. Balance	18,000		
		Closing Balance	41,400

Work in Progress

Beg. Balance	0		
Raw Material -2	72,000	Closing Balance	0

Sundry Creditors

			1,27,200
--	--	--	----------

Wages outstanding

	51,750		
--	--------	--	--

Quantity Variance-Material-1

	1,200		
--	-------	--	--

Price Variance-Material-2

			6,600
--	--	--	-------

Efficiency Variance-Labour

			7,200
--	--	--	-------

Other information's are: standard cost of Material – 2 is ₹ 180 per litre and standard quantity is 5 litres. Standard wages rate is ₹ 24 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.
(11 Marks) (Nov, 2005)

Answer

Material – 1 Rate Variance = Standard cost of material purchased – Actual cost
= ₹24, 000 – ₹21, 600 = ₹2, 400 (F)

Material – 2 Quantity Variance	= SR × SQ – SR × AQ
	= ₹ 900 × 80 units – ₹ 75, 600
	= ₹ 3, 600 (A)
Labour Spending Variance	= SR × AH – AR × AH
	= ₹ 24/per hour × 2300 hours – ₹ 51, 750
	= ₹ 3, 450 (A)
Labour Efficiency Variance	= SR × (SH – AH)
– 7200	= 24 (SH – 2300)
SH	= 2000 Hrs.

	₹
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 = ₹ 72, 000 (Given)
- Standard cost of Material – 2 per unit: 5 litres × ₹ 180 = ₹ 900
- ∴ No of units produced = ₹ 72, 000 / ₹900 = 80 units
- Total material – 1 used in production = ₹ 18, 000 (Given)
- Add Closing Inventory = ₹ 6, 000 (Given)
- Less Opening Inventory = 0
- Hence Standard Cost of Material – 1 purchased = ₹ 24, 000
- (2) Standard Rate of Material -1 = ₹24, 000 / 1,000kg = ₹ 24 per kg
- Standard Cost of Material – 1 = ₹ 18, 000
- Add favourable Quantity Variance = ₹ 1, 200
- Material – 1 allowed = ₹ 19, 200
- Standard quantity of Material – 1 allowed = ₹19, 200/₹24= 800 Kg.
- Standard quantity per unit = 800kg/80units = 10 kg
- Standard purchase price for Material – 2 = (550liters × ₹180)= ₹ 99, 000
- Add unfavourable Rate Variance = ₹ 6, 600
- Actual cost Price of Material – 2 = ₹ 1, 05, 600

(3) Opening balance of Material – 2	= ₹ 18, 000
Add Standard Cost of Purchase (550 litres × ₹180)	= ₹ 99, 000
Less Closing Balance	= ₹ 41, 400
Material-2 Consumed at Standard cost	= ₹ 75, 600

Question 3

“Overhead variances should be viewed as interdependent rather than independent”. Explain.

(6 Marks) (May, 2006)

Answer

The operations of a firm are so inter linked that the level of performance in one area of operation will affect the performance in other areas. Improvements in one area may lead to improvements in other areas. A sub-standard performance in one area may be compensated by a favourable performance in another area. Because of such interdependency among activities in the firm, the managers should not jump to conclusions merely based on the label of variances namely favourable or unfavourable. They should remember that there is a room for trade off amongst variances. Hence, variances need to be viewed as ‘attention directors’ rather than problem solvers. Thus, a better picture will be captured when overhead variance are not viewed in isolation but in an integrated manner.

Question 4

The following figures are available. Find out the missing figures, giving appropriate formulae:

		₹
Budgeted profit		15,000
Less: Adverse variances:		
Contribution price variance	10,600	
Direct materials variance	1,000	
Fixed overhead variance	<u>600</u>	<u>(12,200)</u>
		2,800
Add: Favourable variances		
Contribution quantity variance	1,800	
Direct wages variance	600	
Variable overhead variance	<u>1,800</u>	<u>4,200</u>
Actual profit		<u>7,000</u>

There is no inventory

Production units = Sales units for both actual and budget.

Standard selling price	₹18/unit
Standard variable cost	₹15/unit
Standard contribution	₹3/unit
Actual selling price	₹17/unit
Budgeted sales	10,000 units

Standard material cost p.u. = ₹1 (which is 5 kg. @ ₹20 Paise/kg.).

Material usage variance = 400 (Adv.)

Actual labour hours @ actual rate = ₹63,000

Actual labour hours @ standard rate = ₹61,950

Variable overhead standard rate = ₹2

Standard hours of production = 4 per unit

Variable overhead at standard rate = ₹84,800.

Variable overhead expenditure variance = 400 (A).

Budgeted fixed overhead = ₹15,000.

Find out the following:

- (i) Actual sales units
- (ii) Actual sales rupees
- (iii) Actual quantity of raw materials used
- (iv) Labour efficiency variance
- (v) Actual variable overhead in rupees
- (vi) Variable overhead efficiency variance
- (vii) Actual fixed overheads
- (viii) Operating profit variance.

(8 Marks) (Nov, 2006)

Answer

	₹
(1) Budgeted contribution = Budgeted Profit + Budgeted Fixed Cost	15,000 + 15,000 = 30,000
Plus Contribution quantity variance	1,800

Total Standard contribution	31,800
Standard Contribution per unit	3
Actual Sales Volume	10,600 units
(2) Actual Sales Volume $10,600 \times 17$	1,80,200
(3) Actual quantity of Raw Materials used	
Standard consumption $10,600 \times 5$	53,000 Kgs.
Add: Material Usage Variance $\frac{400}{.2}$	2,000 kgs.
Actual consumption	55,000 Kgs.
(4) Labour Efficiency variance	
Standard labour cost for Standard hours $(63,000 + 600)$	63,600
Standard labour cost for actual hours	61,950
Labour efficiency variance	1,650 F
(5) Actual variable overhead	
Variable OH at Std. Rate – Variable OH Variance	₹ 84,800 – ₹ 1,800 = ₹ 83,000
(6) Variable Overhead efficiency variance	
Actual hours (AH) $\frac{61,950}{15}$	41,300 hours
Standard hours (SH) $10,600 \times 4$	42,400 hours
Standard rate per hour (SR) $\frac{63,600}{10,600 \times 4}$	₹ 1.5
Efficiency variance $SR (SH - AH) = 2 (42,400 - 41,300) = 2,200F$	
(7) Actual fixed overheads: Budgeted Overhead - Fixed Overhead variance = $15,000 - 600 (A) = ₹ 15,600$.	
(8) Operating profit variance	
If budgeted profit is considered $(15,000 - 7,000) = ₹ 8,000$ adverse	
If standard profit is considered $(16,800 - 7,000) = ₹ 9,800$ adverse	

Question 5

A company following standard marginal costing system has the following interim trading statement for the quarter ending 30th June, 2005, which reveals a loss of ₹ 17,000, detailed below:

		₹
Sales		4,99,200
Closing stock (at prime cost)		<u>18,000</u>
		5,17,200

Costs:		
Direct material	1,68,000	
Direct labour	1,05,000	
Variable overhead	<u>42,000</u>	
	3,15,000	
Fixed overhead	1,20,000	
Fixed Admn. Overhead	40,000	
Variable distribution Overhead	19,200	
Fixed selling Overhead	<u>40,000</u>	
	<u>2,19,200</u>	
Total costs		<u>5,34,200</u>
Loss		<u>17,000</u>

Additional information is as follows:

- (i) Sales for the quarter were 1,200 units. Production was 1,400 units, of which 100 units were scrapped after complete manufacture. The factory capacity is estimated at 2,000 units.
- (ii) Because of low production, labour efficiency during the quarter is estimated to be 20% below normal level.

You are required to analyse the above and report to the management giving the reasons for the loss. (13 Marks) (Nov., 2006)

Answer

(i)

Details	Working	Amount (₹)
(1) Selling price	<u>4,99,200</u> 1,200	416
(2) Raw materials	<u>1,68,000</u> 1,400	120
Labour	<u>1,05,000</u> 1,750	60
[Equivalent units (1,400/80%)]		
Variable overhead	<u>42,000</u> 1,400	30

Total manufacturing cost		210
Distribution overheads	<u>19,200</u>	16
	1,200	
Total cost		226
Contribution		190
Total fixed cost: factory	1,20,000	
Administration	40,000	
Selling	40,000	2,00,000

(ii) Standard Profit for 1,200 units sold:

	₹	
Contribution	$1,200 \times 190$	2,28,000
Less: Fixed costs		<u>2,00,000</u>
Profit		<u>28,000</u>

(iii) Reconciliation

	₹	
Budgeted profit	$(2,000 \times 190 - 2,00,000)$	1,80,000
Less: Volume variance	800×190	1,52,000
Standard profit		28,000
Factors causing loss:		
Units scrapped	100×210	21,000
Labour inefficiency	350×60	21,000
Undervaluation of closing stock	$100 \times (210 - 180)$	3,000
Actual profit		<u>-17,000</u>

Question 6

Under the single plan, record the journal entries giving appropriate narration, with indication of amounts of debits or credits alongside the entries, for the following transactions using the respective control A/c.

(i) Material price variance (on purchase of materials)

(ii) Material usage variance (on consumption)

(iii) Labour rate variance.

(6 Marks) (Nov, 2006)

Answer

- (i) Dr. Material Control A/c
 Dr. or Cr. Material Price Variance A/c
 Cr. Creditors A/c
 (Being price variance during purchase of materials)
-
- (ii) Dr. WIP Control A/c
 Dr. or Cr. Material Usage Variance A/c
 Cr. Material Control A/c
 (Being recording of usage variance at Standard cost of excess/under utilized quantity)
-
- (iii) Dr. Wages Control A/c
 Dr. or Cr. Labour Rate Variance A/c
 Cr. Cash
 (Being entry to record wages at standard rate)
-

Question 7

A company produces a product X, using raw materials A and B. The standard mix of A and B is 1 : 1 and the standard loss is 10% of input.

You are required to compute the missing information indicated by “?” based on the data given below:

	A	B	Total
Standard price of raw material (₹/kg.)	24	30	
Actual input (kg.)	<u>?</u>	70	
Actual output (kg.)			<u>?</u>
Actual price ₹/kg.	30	<u>?</u>	
Standard input quantity (kg.)	<u>?</u>	<u>?</u>	
Yield variance (sub usage)	<u>?</u>	<u>?</u>	270(A)
Mix variance	<u>?</u>	<u>?</u>	<u>?</u>
Usage variance	<u>?</u>	<u>?</u>	<u>?</u>
Price variance	<u>?</u>	<u>?</u>	<u>?</u>
Cost variance	0	<u>?</u>	1300(A)

(14 Marks) (May 2007)

Answer

Computation of Yield Variance for 'A' and 'B'

DM yield variance for 'A' =

$$\text{DM yield variance for 'A'} = \left[\begin{array}{c} \text{Std qty of} \\ \text{all DM} \\ \text{allowed} \\ \text{for actual} \\ \text{output} \end{array} - \begin{array}{c} \text{Actual} \\ \text{total qty} \\ \text{of all DM} \\ \text{used} \end{array} \right] \times \begin{array}{c} \text{Std} \\ \text{Mix} \\ \text{\%age} \\ \text{of 'A'} \end{array} \times \text{Std price of 'A'}$$

$$= [SQ_A - RSQ_A] \times \text{Std price of 'A'}$$

Where RSQ_A = Revised Standard Quantity of 'A' = (Actual total qty of all DM used) $\times$ Std Mix %age of 'A' and

SQ_A = Standard Quantity of DM 'A' for Actual Production = Standard quantity of all DM allowed for actual output $\times$ Std Mix %age of 'A'

$$\text{DM yield variance for 'B'} = \left[\begin{array}{c} \text{Std qty of} \\ \text{all DM} \\ \text{allowed} \\ \text{for actual} \\ \text{output} \end{array} - \begin{array}{c} \text{Actual} \\ \text{total qty} \\ \text{of all DM} \\ \text{used} \end{array} \right] \times \begin{array}{c} \text{Std} \\ \text{Mix} \\ \text{\%age} \\ \text{of 'B'} \end{array} \times \text{Std price of 'B'}$$

$$= [SQ_B - RSQ_B] \times \text{Std price of 'B'}$$

Where RSQ_B = Revised Standard Quantity of 'B' = (Actual total qty of all DM used) $\times$ Standard Mix %age of 'B' and

SQ_B = Standard quantity of DM 'B' for Actual Production = Standard quantity of all DM allowed for actual output $\times$ Standard Mix %age of 'B'

Since Standard Mix %age is the same for both 'A' and 'B' (1:1) we have,

Total Yield variance for 'A' and 'B' = $T \times (\text{Std price of 'A'} + \text{Std price of 'B'})$

Where $T = (\text{Std qty of all DM allowed for actual output} - \text{Actual total qty of all DM used}) \times 0.5$

As Total Yield variance for 'A' and 'B' is given as – ₹ 270, we have

$$- ₹ 270 = T \times ₹ 24 + T \times ₹ 30$$

$$\text{Or } T = - 5$$

Hence Yield Variance for 'A' = $- 5 \times 24 = - ₹ 120$ and

Yield variance for 'B' = $- 5 \times 30 = - ₹ 150$.

Also

$$(SQ_A - RSQ_A) \times 24 = -120 \text{ or } SQ_A - RSQ_A = -5$$

Similarly

$$(SQ_B - RSQ_B) \times 30 = -150 \text{ or } SQ_B - RSQ_B = -5$$

Alternative 1

Let total actual quantity consumed; X kg.

Then, Quantity of A = X – 70

$$RSQ = \frac{X}{2} \text{ of A \& } \frac{X}{2} \text{ of B. (Since the Mix ratio is 1:1)}$$

The Standard input for both 'A' and 'B' will be $0.5X - 5$

Since Cost Variance for 'A' is given to be nil, we have,

$$(SP_A \times SQ_A) - (AQ_A \times AP_A) = 0$$

$$\text{i.e. } 24 \times (0.5X - 5) - (X - 70) \times 30 = 0$$

$$\text{or } X = 110 \text{ Kgs}$$

Therefore Actual Input for 'A' = $110 - 70 = 40$ Kgs

Also, Standard Input for 'A' and 'B' will be $\left(\frac{110}{2} - 5\right) = 50$ Kgs. Using this quantity in the Cost

Variance of 'B', the actual price per kg of 'B' (AP_B) will be ,

$$50 \times 30 - 70 \times AP_B = -1,300$$

$$\text{Or } AP_B = ₹ 40.$$

Alternative 2

Let the standard input of 'A' = X kg. Therefore, the total standard input for 'A' + 'B' = $2X$

Actual input = $(2X + 10)$ Kgs. $\therefore$ Actual input for 'A' = $(2X + 10 - 70) = (2X - 60)$ Kgs

Forming the equation for nil cost variance of 'A'.

$$₹ 24 \times X - ₹ 30 \times (2X - 60) = 0$$

Or $X = 50$ Kgs. Using this quantity in the Cost Variance of 'B', the actual price per kg. of 'B' (AP_B) will be ,

$$50 \times 30 - 70 \times AP_B = -1,300$$

$$\text{Or } AP_B = ₹ 40.$$

Alternative 3

Let the actual input of 'A' = X

Then the total actual input = (X + 70). Therefore, RSQ of 'A' and 'B' each = $0.5X + 35$ and Standard Input of 'A' and 'B' each = $0.5X + 30$.

Forming the equation for nil cost variance of 'A', we have,

$$24 \times (0.5X + 30) - 30 \times X = 0$$

Or X = 40 Kgs.

∴ Standard Input will be 50 Kgs. Using this, quantity in the Cost Variance of 'B', the actual price per kg. of 'B' (AP_B) will be,

$$50 \times 30 - 70 \times AP_B = -1,300$$

Or AP_B = ₹ 40.

Substituting various values for quantity and price, we get the following table.

	(1)	(2)	(3)	(4)
	Std. Price × SQ	Std. Price × RSQ	Std. Price × Actual Qty.	Actual Price × Actual Qty.
A	$24 \times 50 = 1200$	$24 \times 55 = 1320$	$24 \times 40 = 960$	$30 \times 40 = 1200$
B	$30 \times 50 = \underline{1500}$	$30 \times 55 = \underline{1650}$	$30 \times 70 = \underline{2100}$	$40 \times 70 = \underline{2800}$
	<u>2700</u>	<u>2970</u>	<u>3060</u>	<u>4000</u>

	(1) – (2)	(2) – (3)	(1) – (3)	(3) – (4)	(1) – (4)
	Yld variance	Mix variance	Usage variance	Price variance	Cost variance
A	$1200 - 1320 =$ $120(A)$	$1320 - 960 =$ $360(F)$	$1200 - 960 =$ $240(F)$	$960 - 1200 =$ $240(A)$	$1200 - 1200 =$ 0
B	$1500 - 1650 =$ $150(A)$	$1650 - 2100 =$ $450(A)$	$1500 - 2100 =$ $600(A)$	$2100 - 2800 =$ $700(A)$	$1500 - 2800 =$ $1300(A)$
	<u>270A</u>	<u>90A</u>	<u>360A</u>	<u>940A</u>	<u>1300A</u>

Actual Output = 90 Kgs.

(Actual output and standard output are always equal numerically in any material variance analysis)

Standard output = Standard input – Standard loss or $100 - 10 = 90$ Kgs.

Question 8

The working results of a Software Company for two corresponding years are shown below:

	Amount (₹ in lakhs)	
	Year 2005	Year 2006
Sales (A)	600	770
Cost of Sales:		
Direct materials	300	324
Direct wages and variable overheads	180	206
Fixed overheads	<u>80</u>	<u>150</u>
Total (B)	<u>560</u>	<u>680</u>
Profit (A – B)	<u>40</u>	<u>90</u>

In year 2006, there has been an increase in the selling price by 10 per cent. Following are the details of material consumption and utilization off direct labour hours during the two years:

	Year 2005	Year 2006
Direct material consumption (M. tons)	5,00,000	5,40,000
Direct labour hours	75,00,000	80,00,000

Required:

- (i) Taking year 2005 as base year, analyse the variances of year 2006 and also workout the amount which each variance has contributed to change in profit.
- (ii) Find out the breakeven sales for both years.
- (iii) Calculate the percentage increase in selling price in the year 2006 that would be needed over the sale value of year 2006 to earn margin of safety of 45 per cent. (19 Marks)(Nov 2007)

Answer

Working Notes:

- (i) Budgeted sales in year 2006 = $(100/110) \times 770 = ₹ 700$ lakhs
- (ii) Budgeted direct material cost = $(300/600) \times 700 = ₹ 350$ lakhs
- (iii) Budgeted direct wages and variable overheads = $(180/600) \times 700 = ₹ 210$ lakhs
- (iv) Rate per M. ton of direct material: Year 2005 = $(300/5) = ₹ 60$
: Year 2006 = $(324/5.40) = ₹ 60$
- (v) Material usage budget for the year 2006 = $(5/600) \times 700 = 5.83333$ lakhs
- (vi) Direct labour hours budget for the year 2006 = $(75/600) \times 700 = 87.50$ lakhs
- (vii) Direct labour and variable overheads rate per hour: Year 2005 = $(180/75) = ₹ 2.40$

$$\text{Year 2006} = (206/80) = ₹ 2.575$$

- (viii) Material price variance = $(₹ 60 - ₹ 60) \times 5,40,000 = \text{zero}$
- (ix) Material usage variance = $(5.83333 - 5.40) \times ₹ 60 = ₹ 26 \text{ lakhs (F)}$
- (x) Labour and variable overheads rate variance = $(2.40 - 2.575) \times 80 = ₹ 14 \text{ lakhs (A)}$
- (xi) Labour and variable overheads efficiency variance = $(87.50 - 80.00) \times ₹ 2.40$
 $= ₹ 18 \text{ lakhs (F)}$
- (xii) Fixed overheads expenditure variance = $(150 - 80) = ₹ 70 \text{ lakhs (A)}$

(xiii) **Statement of working results of the company**

	Actuals	Amount ₹ in lakhs	
		Budget	Variance
	2006	2006	
Sales	<u>770</u>	<u>700</u>	<u>70(F)</u>
Less: Direct material	324	350	26(F)
Direct wages and variable overheads	<u>206</u>	<u>210</u>	<u>4(F)</u>
Contribution	240	140	100(F)
Less: Fixed overheads	<u>150</u>	<u>80</u>	<u>70(A)</u>
Profit	<u>90</u>	<u>60</u>	<u>30(F)</u>

I **Reconciliation statement showing variances contribution to change in profit (₹ in lakhs)**

	Favourable	Adverse
Increase in contribution due to volume	20	—
Sales price variance	70	—
Material usage variance	26	—
Material price variance	—	—
Direct labour and variable overheads rate variance	—	14
Direct labour and variable overheads efficiency variance	18	—
Fixed overheads expenditure variance	—	<u>70</u>
	<u>134</u>	<u>84</u>
Total change in profit (increase)	<u>50</u>	

II **Break-even point**

$$\text{Year 2005 : } (80/120) \times 600 = ₹ 400 \text{ lakhs}$$

Year 2006 : $(150/240) \times 770 = ₹ 481.25$ lakhs

- III Required percentage increase in selling price in the year 2006 to earn a margin of safety of 45%.

Break-even sales = $(1 - 0.45)$ or 55 per cent of total sales.

Contribution at 55% sales = Fixed overheads = ₹ 150 lakhs.

Required contribution at total sales = ₹ $150/.55 = ₹ 272.73$ lakhs

Additional contribution required = $(272.73 - 240) = ₹ 32.73$ lakhs

Percentage increase in selling price required = $(32.73/770) \times 100 = 4.25\%$.

Question 9

The following information has been extracted from the books of Goru Enterprises which is using standard costing system:

Actual output	= 9,000 units
Direct wages paid	= 1,10,000 hours at ₹22 per hour, of which 5,000 hours, being idle time, were not recorded in production
Standard hours	= 10 hours per unit
Labour efficiency variance	= ₹ 3,75,000 (A)
Standard variable Overhead	= ₹ 150 per unit
Actual variable Overhead	= ₹ 16,00,000

You are required to calculate:

- (i) Idle time variance
- (ii) Total variable overhead variance
- (iii) Variable overhead expenditure variance
- (iv) Variable overhead efficiency variance.

(May, 2008) (6 Marks)

Answer

Actual output = 9,000 units

Idle time = 5,000 hours

Production time (Actual) = 1,05,000 hours

Standard hours for actual production = 10 hours / unit $\times$ 9,000 units = 90,000 hours.

Labour efficiency variance = 3,75,000 (A)

i.e. Standard rate $\times$ (Standard Production time – Actual production time) = 3,75,000(A).

SR $(90,000 - 1,05,000) = - 3,75,000$

$$SR = \frac{-3,75,000}{-15,000} = \text{Rs. } 25$$

(i) Idle time variance = 5,000 hours $\times$ 25 ₹ / hour = 1,25,000. (A)

(ii) Standard Variable Overhead = ₹ 150 / unit

Standard hours = 10 hours / unit

Standard Variable Overhead rate / hour = 150 / 10 = ₹ 15 / hour

Total Variable Overhead variance = Standard Variable Overhead – Actual
Variable Overhead

= Standard Rate $\times$ Standard hours – Actual
rate $\times$ Actual hours

= (15) $\times$ (10 $\times$ 9,000) – 16,00,000

= 13,50,000 – 16,00,000

Total Variable Overhead Variance = 2,50,000 (A)

(iii) Variable Overhead Expenditure Variance = (Standard Rate $\times$ Actual Hours) –
(Actual Rate $\times$ Actual Hours)

= (15 $\times$ 1,05,000) – 16,00,000

= 15,75,000 – 16,00,000

= 25,000 (A)

(iv) Variable Overhead Efficiency Variance = Standard Rate $\times$ (Standard Hours for actual
output – Actual hours for Actual output)

= 15 (90,000 – 1,05,000)

= 15 (–15,000)

= 2,25,000 (A)

Alternative Solution

Actual Output = 9,000 Units

Idle time = 5,000 hrs

Direct Wages Paid = 1,10,000 hours @ ₹ 22 out of which 5,000 hours being idle, were not recorded in production.

Standard hours = 10 per unit.

Labour efficiency variance = ₹ 3,75,000 (A)

or

Standard Rate (Standard Time – Actual Time) = – 3,75,000

$$\text{Or } (90,000 - 1,05,000) = \frac{-3,75,000}{\text{Standard Rate}}$$

Or Standard Rate = ₹ 25/-

(i) Idle time variance = Standard Rate × Idle time

$$25 \times 5,000 = ₹ 1,25,000 \text{ (A)}$$

(ii) Standard Variable Overhead / unit = 150

$$\text{Standard Rate} = \frac{150}{10} = ₹ 15/\text{hour}$$

Standard Quantity = 10 hours

Actual Variable Overhead = 16,00,000

Standard Variable Overhead = $150 \times 9,000 = 13,50,000$

Actual Variable Overhead = 16,00,000

Total Variable Overhead Variance = 2,50,000 (A)

(iii) Variable Overhead expenditure Variance = Standard Variable Overhead for actual hours – Actual Variable Overhead

$$= (150 \times 1,05,000) - 16,00,000$$

$$= 15,75,000 - 16,00,000$$

$$= 25,000 \text{ (A)}$$

(iv) Variable overhead efficiency variance = Standard Variable Overhead for actual output – Standard Variable Overhead for Actual hours)

$$= 15 (10 \text{ hours} \times 90,000 \text{ units} - 1,05,000)$$

$$= 15 (90,000 - 1,05,000)$$

$$= 15 (-15,000)$$

$$= 2,25,000 \text{ (A)}$$

Question 10

A manufacturing company has furnished the following financial data relating to the actual output of 9,600 units produced in the last quarter:

		₹
Sales		4,45,500
Costs:		

Direct Materials	59,400	
Direct Wages	89,400	
Variable Overheads	1,45,500	
Fixed Overheads	<u>78,000</u>	<u>3,72,300</u>
Profit		<u>73,200</u>

The standard wage rate is ₹ 4.50 per hour and the standard variable overhead rate is ₹ 7.50 per hour. The company uses a JIT system and the budgeted production and sales quantity is 10,000 units.

The following are the variances from standard costs recorded during the last quarter:

		₹
Direct materials	Price V	600 A
	Usage V	1,200 A
Direct Wages	Rate V	1,500 F
	Efficiency V	4,500 A
Variable Overheads	Expense V	6,000 F
	Efficiency V	7,500 A
Fixed Overheads	Expense V	3,000 A
Sales	Price V	13,500 F

You are required to:

- Prepare the Original budget and Standard cost sheet per unit of output;
- Produce a statement reconciling the budgeted profit with actual profit.

(11 Marks) (Nov., 2008)

Answer

Direct Materials:

SQ	AQ	SP	SQ × SP	AQ × SP	AP	AQ × AP
				59,400		
				Usage variance		Price variance
			1200 A			600 A

$$AQ \times SP = 58,800^1$$

$$SQ \times SP = 57,600^2$$

Standard cost of materials for actual output of 9,600 units = ₹ 57,600.

$$AQ \times SP = 4,32,000^5$$

Actual units = 9,600

Standard price is $4,32,000 / 9,600 = ₹ 45$ per unit.

Original Budget and Standard Cost Sheet:

	Budget	Standard Cost
Units budgeted	10,000	
Sales	<u>4,50,000</u>	<u>45.00</u>
Direct materials @ ₹ 6 per unit	60,000	6.00
Direct Wages	90,000	9.00
Variable Overheads @ ₹ 15 per unit	1,50,000	15.00
Fixed overheads @ ₹ 7.50 per unit	<u>75,000</u>	<u>7.50</u>
Total costs	<u>3,75,000</u>	<u>37.50</u>
Profit	<u>75,000</u>	<u>7.50</u>

Sales volume variance is $(9,600 - 10,000) \times 7.50 = ₹ 3,000$ A

Reconciliation Statement:

Budgeted Profit	75,000
Sales volume variance	3,000 A
Standard profit	72,000
Sales price variance	13,500 F
Total	85,500

Cost variances:

		F	A	
Materials:	Price		600	
	Usage		1,200	
Direct Labour:	Rate	1,500		
	Efficiency		4,500	
Variable Overhead:	Efficiency		7,500	
	Expense	6,000		
Fixed Overhead:	Volume		3,000	
	Expense		<u>3,000</u>	
Total variances		<u>7,500</u>	<u>19,800</u>	12,300 A

Actual profit 73,200

Working Notes:

- (1) Price Variance = $[SP - AP] AQ$
 $600 (A) = [SP \times AQ - 59,400]$
 $SP \times AQ = 58,800.$
- (2) Usage Variance = $[SQ \times SP] - [AQ \times SP]$
 $1200 (A) = SQ \times SP - 58,800$
 $SQ \times SP = 57,600.$
- (3) Rate Variance = $[SR - AR] AH$
 $1500 (F) = SR \times AH - 89,400$
 $SR \times AH = 90,900.$
- (4) Efficiency Variance = $[SH - AH] \times SR$
 $4500 (A) = SH \times SR - 90,900$
 $SH \times SR = 86,400.$
- (5) Price Variance = $(AP - SP) \times AQ$
 $13500 (F) = SP \times AQ - 4,45,500$
 $SP \times AQ = 4,32,000.$

Question 11

The following profit reconciliation statement has been prepared by the Cost Accountant of RSQ Ltd. for March, 2008:

	₹
Budget profit	2,40,000
Sales price variance	51,000 (F)
Sales volume profit variance	<u>42,000</u> (A)
	2,49,000
Material price variance	15,880 (A)
Material usage variance	3,200 (F)
Labour rate variance	78,400 (F)
Labour efficiency variance	32,000 (A)
Variable overhead expenditure variance	8,000 (F)
Variable overhead efficiency variance	12,000 (A)

Fixed overhead volume variance	1,96,000	(A)
Fixed overhead expenditure variance	<u>4,000</u>	(F)
Actual profit	<u>86,720</u>	

Budgeted production and sales volumes for Mach, 2008 were equal and the level of finished goods stock was unchanged, but the stock of raw materials decreased by 6,400 kg (valued at standard price) during the month.

The standard cost card is as under:

Material 4 kg @ ₹ 2.00	8.00
Labour 4 hours @ ₹ 32.00	128.00
Variable overhead	
4 hours @ ₹ 12.00	48.00
Fixed overheads	
4 hours @ ₹ 28.00	<u>112.00</u>
	296.00
Standard profit	<u>24.00</u>
Standard selling price	<u>320.00</u>

The actual labour rate was ₹ 2.24 lower than the standard hourly rate.

You are required to calculate:

- Actual quantity of material purchased
- Actual production and sales volume
- Actual number of hours worked
- Actual variable and fixed overhead cost incurred.

(11 Marks) (Nov., 2008)

Answer

$$\begin{aligned}
 \text{(i) Budgeted volume} &= \frac{\text{Budgeted profit}}{\text{Budgeted profit per unit}} \\
 &= \frac{2,40,000}{24.00} \\
 &= 10,000 \text{ units}
 \end{aligned}$$

$$\begin{aligned}
 \text{Difference between actual and budgeted volume} &= \frac{\text{Fixed overhead volume variance}}{\text{Standard fixed overhead rate}} \\
 &= \frac{1,96,000}{112} \\
 &= 1,750 \text{ units}
 \end{aligned}$$

Actual Production = Budgeted volume – Difference between actual and budget volume
 = 10,000 – 1,750
 = 8,250 units

(ii) Actual production = 8,250 units

Material quantity = 4 kg. × 8,250 = 33,000 kg.

Less: Difference in material use

Material = $\frac{\text{Usage variance}}{\text{Standard price}} = \frac{3,200}{2.00} = 1,600 \text{ kg.}$

Actual usages 31,400 kg.

Less: Decrease in stock 6,400 kg.

Actual purchases 25,000 kg.

(iii) Actual hours

8,250 units × 4 hours = 33,000 hours

Difference in actual and standard

$\frac{\text{Efficiency variance}}{\text{Standard rate}} = \frac{32,000 \text{ (A)}}{32.00} = 1,000 \text{ (A) hours}$

Actual hours 34,000 hours

(iv) Actual variable overhead incurred:

Standard cost of variable overhead = 8,250 × 48 = ₹ 3,96,000

Total variable overhead cost variance [8,000 (F) + 12,000 (A)] = ₹ 4,000 (A)

Actual variable overhead = ₹ 4,00,000

(v) Actual fixed overhead:

Budgeted fixed overhead =

Budgeted units × Budgeted rate = 10,000 × 112 = ₹ 11,20,000

Expenditure variance = ₹ 4,000 (F)

Actual fixed overhead = ₹ 11,16,000

It can also be calculated as below:

Actual fixed overhead:

Standard fixed overhead = (Actual output × Standard fixed overhead rate per unit) 8,250 × 112 = ₹ 9,24,000

Total fixed overhead variance [1,96,000 (A) + 4,000 (F)] = ₹ 1,92,000 (A)

Actual fixed overhead = ₹ 11,16,000

(vi) Actual sales volume:

Sales volume variance = Standard profit per unit (Actual quantity of sales – Standard quantity of sales)

42,000 (A) = 24 (Actual Quantity of sales – 10,000)

Actual quantity of sales = 8,250 units

Alternative for (iv) and (v) points

(1) Variable overhead cost variance = (Standard hours for actual output × Standard variable overhead rate per hour) – Actual variable overhead cost

4,000 (A) = (4 × 8,250 × 12) – Actual variable overhead

Actual variable overhead = ₹ 4,00,000.

(2) Fixed overhead cost variance = (Standard hours for actual output × Standard fixed overhead rate per hour) – Actual fixed overheads

1,92,000 (A) = (4 × 8,250 × 28) – Actual fixed overheads.

Actual fixed overhead = ₹ 11,16,000.

Question 12

The following information relates to labour of x Ltd.

Type of Labour	Skilled	Semi Skilled	Unskilled	Total
No. of workers in standard gang	4	3	2	9
Standard rate per hour (₹)	6	3	1	-
Number of workers in actual gang				9
Actual rate per hour (₹)	7	2	2	-

In a 40 hours week, the gang produced 270 standard hours.

The actual number of semi-skilled workers is two times the actual number of unskilled workers. The rate variance of semi-skilled workers is ₹ 160 (F).

Find the following:

- The number of workers in each category
- Total gang variance
- Total Sub-efficiency variance

(iv) Total labour rate variance

(v) Total labour cost variance

(10 Marks)(Nov., 2009)

Answer

	SR	SH		SR	RSH		SR	AH		AR	AH	
Skill	6×	120	720	6×	960	160	6×	120	120	7×	120	840
Semi-Skill	3×	90	270	3×	360	120	3×	160	480	2×	160	320
Unskilled	1×	60	<u>60</u>	1×	<u>80</u>	80	1×	80	<u>80</u>	2×	80	<u>160</u>
			<u>1050</u>		<u>1400</u>				<u>1280</u>			<u>1320</u>
	Sub-efficiency Variance					Gang Variance				Rate Variance		
	350 (A)					120 (F)				40 (A)		
	Cost Variance = 270 (A)											

Workings Note:

Standard hours produced = 270

Standard Mix : $270 \div 9 = 30$

	Skill	Semi-Skill	Unskilled
Ratio	4:	3:	2:
Hrs.	120	90	60

Actual hrs = $40 \times 9 = 360$ hrs.

Actual hrs in Standard Ratio = 360		
4:	3:	2:
$\frac{360}{9} \times 4 = 160$	$\frac{360}{9} \times 3 = 120$	$\frac{360}{9} \times 2 = 80$

[(Standard Rate - Actual Rate) Actual hrs.] = Rate Variance

Semi-skilled = 160

(3 - 2) Actual hrs = 160

Actual hrs = 160 (for semi-skilled)

Actual Semi-skilled = 2 (Unskilled actual)

160 = 2 (Unskilled)

Unskilled hrs (actual) = $\frac{160}{2} = 80$

Total Actual = 360

$$\begin{aligned}\therefore \text{Actual hrs} - \text{skilled} &= 360 - (160 + 80) \\ &= 360 - 240 = 120\end{aligned}$$

Actual Hrs.	Skilled	Semi-skilled	Unskilled
40 hr week	120	160	80
$\therefore$ No. of Workers	$\frac{120}{40} = 3$	$\frac{160}{40} = 4$	$\frac{80}{40} = 2$
(i)	3	4	2

(ii) Gang Variance:

$$\begin{aligned}&= (\text{Actual Hrs in Standard Ratio} - \text{Actual Hrs in Actual Ratio}) \times \text{Standard Rate} \\ &= 1400 - 1280 = 120 \text{ (F)}\end{aligned}$$

(iii) Sub-efficiency Variance:

$$\begin{aligned}&= \text{Standard Rate} (\text{Standard Hrs} - \text{Actual Hrs in Standard Ratio}) \\ &= 1050 - 1400 = 350 \text{ (A)}\end{aligned}$$

(iv) Total Labour Rate Variance:

$$\begin{aligned}&= \text{Actual Hrs} (\text{Standard Rate} - \text{Actual Rate}) \\ &= 1280 - 1320 = 40 \text{ (A)}\end{aligned}$$

(v) Labour Cost Variance:

$$\begin{aligned}&= (\text{Standard Rate} \times \text{Standard Hrs} - \text{Actual Rate} \times \text{Actual Hrs.}) \\ &= 1050 - 1320 = 270 \text{ (A)}\end{aligned}$$

Question 13

X Ltd. produces and sells a single product. Standard cost card per unit of the product is as follows

	₹.
Direct materials :A 10 kg @ ₹5 per kg	50.00
B 5 kg @ ₹ 6 per kg	30.00
Direct wages 5 hours @ ₹ 5 per hour	25.00
Variable production overheads 5 hours @ 12 per hour	60.00
Fixed production overheads	<u>25.00</u>
Total Standard cost	<u>190.00</u>
Standard gross profit	<u>35.00</u>

Standard selling price

225.00

A fixed production overhead has been absorbed on the expected annual output of 25,200 units produced evenly throughout the year. During the month of December, 2009, the following were the actual results for an actual production of 2,000 units:

	₹
Sales 2,000 units @ ₹ 225	<u>4,50,000</u>
Direct materials :A 18,900 kg	99,225
B 10,750 kg	61,275
Direct Wages 10,500 hours (actually worked 10,300 hours)	50,400
Variable production overheads	1,15,000
Fixed production overheads	<u>56,600</u>
Total	<u>3,82,500</u>
Gross profit	<u>67,500</u>

The material price variance is extracted at the time of receipt of materials. Material purchase were a 20,000 kg. @ ₹ 5.25 per kg; B 11,500 kg @ ₹ 5.70 per kg.

Required:

- Calculate all variances.
- Prepare an operating statement showing Standard gross profit, Variances and Actual gross profit.
- Explain the reason for the difference in actual gross profit given in the question and calculated in (ii) above. (12 Marks)(May 2010)

Answer

- Material Price variance = (SP-AP) AQ

A = (5-5.25) x 20000 = 5000(A)

B (At the time of receipt of Materials) = (6.0-5.70) x 11500 = 3450(F)

= 1550 (A)

Material usage variance = (SQ – AQ) * SP

A = (20000 – 18900) x 5 = 5500 (F)

B = (10000 – 10750) x 6 = 4500 (A)

= 1000 (F)

Standard quantity for actual output for

A = 2000 x 10 = 20000 kg

B	= 2000 x 5 = 10000 kg
Material Mix variance = SP (RSQ –AQ)	
A	= (19766.67 – 18900) x5 = 4333.33 (F)
B	= (9883.33 – 10750) x6 = 5200.00 (A)
	= 866.67 (A)
Revised standard quantity	
A	= 20000/30000 x 29650 = 19766.67
B	= 10000/30000 x 29650 = 9883.33
Material yield variance	= SR (AY- SY) (2000- 1976.67) x 80
	= 1866.67 (F)
SY	= (2100/31500) x 29650 = 1976.67
Labour rate variance	= (SR- AR) AH = (5-4.8) x 10500
	= 2100 (F)
Labour efficiency variance	= SR(SH – AH) = (10000- 10300) x 5
	= 1500(A)
Labour idle time variance	= Idle hours x SR = 200 x 5 = 1000 (A)
Variable overhead cost variance	= Recovered overhead – Actual overhead
	= (2000 x 60 – 115000) = 5000(F)
Variable overhead exp. Variance	= Standard variable overhead – Actual variable overhead
	= 10300 x 12 – 115000 = 8600 (F)
Variable overhead efficiency variance	= Recovered – Standard variable overhead
	= 120000 – 123600 = 3600(A)
Fixed overhead cost variance	= Recovered overhead – actual overhead
	= (2000 x25 – 56600) = 6600 (A)
Fixed overhead exp. Variance	= Budgeted overhead – Actual overhead
	= (25200 /12 x 25) – 56600) = 4100(A)
Fixed overhead volume variance	= Recovered – Budgeted overhead
	= (50000 – 52500) = 2500 (A)

(ii)

Reconciliation Statement

	(₹)	(₹)	
--	------	------	--

Standard Profit (35 * 2000)			
Variances		Favourable	Adverse
Material : Price (at the time of receipt)			1550
	Yield		866.67
		1866.67	
Labour :	Rate	2100	
	Efficiency		1500
	Idle time		1000
Variable overheads	Expenditure	8600	
	Efficiency		3600
Fixed overheads	Expenditure		4100
	Volume		2500
		<u>12566.67</u>	<u>15116.67</u>
Actual Profit			<u>67450</u>

- (iii) Actual gross profit given in the question is ₹ 67500 while calculated operating profit in statement is ₹ 67450. The difference amount is due to material price variance that is calculated at the time of receipt of material instead of consumption of material.

$$\text{MPV A} = 18900 \times (5 - 5.25) = 4725 \text{ (A)}$$

$$\text{B} = 10750 \times (6 - 5.70) = 3225 \text{ (F)}$$

$$\underline{1500 \text{ (A)}}$$

Over recovery in the operating statement is $(1550 - 1500) = 50$, should be added in actual profit $67450 + 50 = ₹ 67500$.

Question 14

A company is engaged in manufacturing of several products. The following data have been obtained from the record of a machine shop for an average month:

Budgeted

No. of working days	24
Working hours per day	8
No. of direct workers	150
Efficiency	One standard hour per clock hour
Down time	10%
Overheads	
Fixed	₹ 75,400

Variable ₹ 90,720

The actual data for the month of August 2010 are as follows:

Overheads

Fixed ₹ 78,800

Variable ₹ 70,870

Net operator hours worked 20,500

Standard hours produced 22,550

There was a special holiday in August 2010.

Required :

- (i) Calculate efficiency, activity, calendar and standard capacity usages ratio.
- (ii) Calculate all the relevant fixed overhead variances.
- (iii) Calculate variable overheads expenditure and efficiency variance. (10 Marks) (Nov., 2010)

Answer

Ratio	Working	Result	
Efficiency Ratio	$\frac{\text{Output expressed in Standard Hours}}{\text{Actual Hours Worked}}$	$(22550/20500) \times 100$	= 110%
Activity Ratio	$\frac{\text{Output expressed in Standard Hours}}{\text{Budgeted output in standard hours}}$	$(22550/25920) \times 100$	= 87% or 86.99 %
Calendar Ratio	$\frac{\text{Actual Working days in a period}}{\text{No. of working days in related budget period}}$	$(23/24) \times 100$	= 96%
Standard Capacity usage ratio	$\frac{\text{Budget Hours}}{\text{Maximum No. of hours in related period}}$	$(25920/28800) \times 100$	= 90%

Workings

Maximum Hours	= $24 \times 8 \times 150$	28,800
Budgeted Hours	= 28800 less 10%	25,920
Actual Hours (given)		20,500
Standard Hours (produced)		22,550
Budgeted Working days		24
Actual Working days		23

Standard Rate X Standard Hours	Standard Rate X Actual Hours	Actual Hours X Actual Rate
(1)	(2)	(3)
(90720/25920)*22550 ₹ 78925	(90720/25920)*20500 ₹ 71750	Given ₹ 70870

Variable Overhead Efficiency Variance (1) - (2) ₹ 7175 (F)

Variable Overhead Expenditure Variance (2) - (3) ₹ 880 (F)

Variable Overhead Variance (1) - (3) ₹ 8055 (F)

Standard Rate X Standard Hours	Standard Rate X Actual Hours	Standard Rate X Revised Budgeted Hours	Standard Rate X Budgeted Hours	Actual Overheads
(1)	(2)	(3)	(4)	(5)
2.91 X 22550 = 65621	2.91 X 20500 = 59655	2.91 X 24840 = 72284	Given = 75400	Given = 78800

Fixed Overhead Efficiency Variance (1) - (2) ₹ 5,966(F)

Fixed Overhead Capacity Variance (2) - (3) ₹ 12,629(A)

Fixed Overhead Calendar Variance (3) - (4) ₹ 3,116(A)

Fixed Overhead Volume Variance (1) - (4) ₹ 9,779(A)

Fixed Overhead Expenditure Variance (4) - (5) ₹ 3,400(A)

Fixed Overhead Variance (1) - (5) ₹ 13,179(A)

Question 15

A company actually sold 8000 units of A and 10,000 units of B at ₹ 12 and ₹ 16 per unit respectively against a budgeted sale of 6000 units of A at ₹ 14 per unit and 9000 units of B at ₹ 13 per unit. The standard costs of A and B are ₹ 8 and ₹ 10 per unit respectively and the corresponding actual costs are ₹ 5.5 and ₹ 14.5 per unit.

Compute the product wise sales margin mix and sales margin price variances, indicating clearly, whether the variances are favorable or adverse. (5 Marks)(May, 2011)

Answer

	BQ	RBQ	AQ	AP	BP	BC	BM	AM
A	6000	7200	8000	12	14	8	6	4
B	<u>9000</u>	<u>10800</u>	10000	16	13	10	3	6

	<u>15000</u>	<u>18000</u>						
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Sales Margin Mix Variance:

(Actual Qty in Budgeted Mix – Actual Qty in Actual Mix) x Budgeted Margin

$$A : (7,200 - 8,000) \times 6 = -4,800 \text{ (Fav)}$$

$$B : (10,800 - 10,000) \times 3 = \underline{2,400} \text{ (Adv)}$$

$$\text{Total Mix Variance} = \underline{-2,400} \text{ (Fav)}$$

Sales Margin Price Variance = Actual Qty (Budgeted Margin – Actual Margin)

$$A \quad 8,000 (6 - 4) = 16,000 \text{ (A)}$$

$$B \quad 10,000 (3 - 6) = \underline{30,000} \text{ (F)}$$

$$\text{Total Price Variance} = \underline{14,000} \text{ (F)}$$

Question 16

The budget and actual operating data for 2010-11 pertaining to 4 products in a store are given below:

Product	Budgeted data for 2010-11			Actual operating results in 2010-11		
	Gallons	Selling price ₹ per gallon)	Variable costs (₹ per gallon)	Gallons	Selling price (₹ per gallon)	Variable costs (₹ per gallon)
V	2,50,000	1.2	0.5	1,80,000	1.00	0.45
C	3,00,000	1.5	0.6	2,70,000	1.35	0.50
S	2,00,000	1.8	0.7	3,30,000	2.00	0.75
A	50,000	2.5	1.00	1,80,000	3.00	1.20

You are required to compute for the individual products and in total:

- the sales margin price variance
- the sales margin mix variance and
- the sales margin volume variance

Indicate whether the variances are favorable (F) or unfavorable (A or U)

(10 Marks)(Nov.,2011)

Answer

Working Notes:

Product	Budget Margin (BM)		Actual Margin (AM)	
	Budgeted Price – Budgeted Variable Cost		Actual Price – Budgeted Variable Cost	
V	1.2 – 0.5	= 0.7	1 – 0.5	= 0.5

C	1.5 – 0.6 = 0.9	1.35 – 0.6 = 0.75
S	1.8 – 0.7 = 1.1	2.0 – 0.7 = 1.3
A	2.5 – 1.0 = 1.5	3.0 – 1.0 = 2.0
	Actual Quantity x Actual Margin (1)	Actual Quantity x Budgeted Margin (2)
V	1,80,000 x 0.5 = 90,000	1,80,000 x 0.7 = 1,26,000
C	2,70,000 x 0.75 = 2,02,500	2,70,000 x 0.9 = 2,43,000
S	3,30,000 x 1.3 = 4,29,000	3,30,000 x 1.1 = 3,63,000
A	1,80,000 x 2.0 = 3,60,000	1,80,000 x 1.5 = 2,70,000
	9,60,000 = 10,81,500	9,60,000 = 10,02,000
	Actual Qty in Budgeted mix x Budgeted Margin (3)	Budgeted Quantity x Budgeted Margin (4)
V	3,00,000 x 0.7 = 2,10,000	2,50,000 x 0.7 = 1,75,000
C	3,60,000 x 0.9 = 3,24,000	3,00,000 x 0.9 = 2,70,000
S	2,40,000 x 1.1 = 2,64,000	2,00,000 x 1.1 = 2,20,000
A	60,000 x 1.5 = 90,000	50,000 x 1.5 = 75,000
	9,60,000 8,88,000	8,00,000 = 7,40,000
	Sales Margin – Price Variance (5) = (1) – (2)	Sales Margin Mix Variance (6) = (2) – (3)
V	36,000 (A)	84,000 (A)
C	40,500 (A)	81,000 (A)
S	66,000 (F)	99,000 (F)
A	90,000 (F)	1,80,000 (F)
	79,500 (F)	1,14,000 (F)
		Sales Margin Volume Variance (7) = (2) – (4)
		49,000 (A)
		27,000 (A)
		1,43,000 (F)
		1,95,000 (F)
		2,62,000 (F)

Question 17

The standard set for a chemical mixture of a company is as under:

Material	Standard Mix(%)	Standard Price `/Kg
A	80	50
B	20	100

Standard yield in production is 75 %.

The actual quantity produced was 1800 kg of output from the following:

Material	Quantity (kg)	Actual Price
A	1400	60
B	600	90

Calculate the total material price, mix and yield variances, indicating whether they are favorable (F) or adverse (A or U). (6 Marks)(May,2012)

Answer

	(I) SP x SQ	(II) SP x RSQ	(III) SP x AQ	(IV) AQ x AP
A	50*1920 =	50*1600 =	50*1400 =	1400*60=
B	100*480 =	100*400 =	100*600 =	600*90 =
TOTAL	1,44,000	1,20,000	1,30,000	1,38,000

SP- Standard Price per Kg, SQ- Standard Quantity for actual production

RSQ- Revised Standard Quantity, AQ- Actual Quantity used, AP- Actual Price per kg.

Variances : (Figures ₹)

Variances	Material Yield Variance (I-II)	Material Mix Variance (II-III)	Material Price Variance (III-IV)
A	16,000 F	10,000 F	14,000 A
B	8,000 F	20,000 A	6,000 F
TOTAL	24,000 F	10,000 A	8,000 A

Note : Standard Input = $1800 / 0.75 = 2,400$ kgs. Hence Standard quantity of A is $2,400 * 0.8 = 1920$ kgs and B = $2400 * 0.2 = 480$ kgs.

Question 18

Sunglow Limited manufactures and sells a single product. From the records of the company the following information is available for November 2012:

The standard cost comprises the following:

Direct material	Unit	₹
X	8	320
Y	24	1,680
Z	16	<u>400</u>
		2,400
Direct wages (₹ 40 per hour)		1,600
Variable overhead (25% of direct wages)		400

Fixed overhead (based on budgeted production of 10,000 units of the final product per month)		600
		<u>5,000</u>

The budgeted selling price is ₹ 700 each and the budgeted sales for the month were 14,000 units.

The following were the transactions for the month:

Direct material:	Units	Purchased Price per unit	Issued unit
X	44,000	42	82,400
Y	1,40,000	71	2,46,400
Z	60,000	24	1,64,000
Direct Wages:	₹ 90,00,000 (3,98,000 hours)		
Overheads:			
Variable	₹ 2,00,000		
Fixed	₹ 3,00,000		
Production:	11,000 units		
Sales:	9,000 units at ₹ 700 each and 3,500 units at ₹ 750 each		

Required:

Calculate (i) Material price variance; (ii) Material mix variance; (iii) Labour rate variance (iv) Labour efficiency variance (v) Variable overhead efficiency variance; and (vi) Fixed overhead efficiency variance.
(9 Marks)(Nov., 2012)

Answer

(a) Statement showing 'Standard Cost of Material' and 'Actual Cost of Material'-
Production 11,000 units

Direct Material Type	Standard Cost			Actual Cost			Revised Actual Quantity*
	Quantity	Rate	Amount	Quantity Consumed	Rate	Amount	
X	88,000 Units (11,000 x 8)	₹ 40 (320/8)	₹ 35,20,000	44,000 Units 38,400 Units	₹ 42 ₹ 40	₹ 33,84,000	82,133 Units [4,92,800 / 5,28,000 x 88,000]

Y	2,64,000 Units (11,000 x 24)	₹ 70 (1,680/24)	₹ 1,84,80,000	1,40,000 Units 1,06,400 Units	₹ 71 ₹ 70	₹ 1,73,88,000	2,46,400 Units [4,92,800 / 5,28,000 x 2,64,000]
Z	1,76,000 Units (11,000 x 16)	₹ 25 (400/16)	₹ 44,00,000	60,000 Units 1,04,000 Units	₹ 24 ₹ 25	₹ 40,40,000	1,64,267 Units [4,92,800 / 5,28,000 x 1,76,000]
Total	5,28,000 Units		₹ 2,64,00,000	4,92,800 Units		₹ 2,48,12,000	4,92,800 Units

* Actual Quantity in Standard Proportion.

**Statement showing 'Standard Cost of Wages' and 'Actual Cost of Wages'-
Production 11,000 units**

Standard Cost			Actual Cost		
Hours	Rate	Amount	Hours	Rate	Amount
4,40,000 hrs [11,000 x (1,600/40)]	₹ 40	₹ 1,76,00,000	3,98,000 hrs	₹ 22.613 (Appx.)	₹ 90,00,000

- (i) **Material Price Variance** = Actual Quantity x Std. Price – Actual Cost
- Material 'X' = 82,400 Units x ₹ 40 – ₹ 33,84,000
= ₹ 88,000 (A)
- Material 'Y' = 2,46,400 Units x ₹ 70 – ₹ 1,73,88,000
= ₹ 1,40,000 (A)
- Material 'Z' = 1,64,000 Units x ₹ 25 – ₹ 40,40,000
= ₹ 60,000 (F)
- Total = ₹ 88,000 (A) + ₹ 1,40,000 (A) + ₹ 60,000 (F)
= ₹ 1,68,000 (A)
- (ii) **Material Mix Variance** = Std. Price x (Revised Actual Quantity – Actual Quantity)
- Material 'X' = ₹ 40 x (82,133 units – 82,400 units)
= ₹ 10,680 (A)
- Material 'Y' = ₹ 70 x (2,46,400 units – 2,46,400 units)
= ₹ 0
- Material 'Z' = ₹ 25 x (1,64,267 units – 1,64,000 units)

- $$= 6,675 \text{ (F)}$$
- Total $= ₹ 10,680 \text{ (A)} + ₹ 0 + ₹ 6,675 \text{ (F)}$
 $= ₹ 4,005 \text{ (A)}$
- (iii) Labour Rate Variance $= \text{Actual hours} \times (\text{Std. Rate} - \text{Actual Rate})$
 $= 3,98,000 \text{ hrs} \times (₹ 40 - ₹ 22.613)$
 $= ₹ 69,20,000 \text{ (F)}$
- (iv) Labour Efficiency Variance $= \text{Std. Rate} \times (\text{Standard hours} - \text{Actual hours})$
 $= ₹ 40 \times (4,40,000 \text{ hrs.} - 3,98,000 \text{ hrs.})$
 $= ₹ 16,80,000 \text{ (F)}$
- (v) Variable Overhead Efficiency Variance
 $= \text{Std. Rate per Hour} \times (\text{Standard Hours for Actual Production} - \text{Actual Hours})$
 $= (₹ 400/40 \text{ hrs.}) \times [(11,000 \text{ units} \times 40 \text{ hrs.}) - 3,98,000 \text{ hrs.}]$
 $= ₹ 4,20,000 \text{ (F)}$
- (vi) Fixed Overhead Efficiency Variance
 $= \text{Std. Rate per Hour} \times (\text{Standard Hours for Actual Production} - \text{Actual Hours})$
 $= (₹ 600/40 \text{ hrs.}) \times [(11,000 \text{ units} \times 40 \text{ hrs.}) - 3,98,000 \text{ hrs.}]$
 $= ₹ 6,30,000 \text{ (F)}$

 It is assumed that Opening Inventory is valued at Standard Cost.

Question 19

The following are the information regarding overheads of a company:

- (a) Overheads cost variance = ₹ 2,800 (A)
- (b) Overheads volume variance = ₹ 2,000 (A)
- (c) Budgeted overheads = ₹ 12,000
- (d) Actual overhead recovery rate = ₹ 8 per hour
- (e) Budgeted hours for the period = 2,400 hours

You are required to compute the following:

- (i) Overheads expenditure variance.
- (ii) Actual incurred overheads.
- (iii) Actual hours for actual production.

(iv) Overheads capacity variance.

(v) Overheads efficiency variance.

(vi) Standard hours for actual production. (8 Marks)(May, 2013)

Answer

Overheads Cost Variance = ₹ 2,800 (A)

Overheads Volume Variance = ₹ 2,000 (A)

Budgeted Overheads = ₹ 12,000

Actual Overhead Recovery Rate = ₹ 8 per hour

Budgeted Hours for the period = 2,400 hours

(i) Overheads Expenditure Variance = Overheads Cost Variance (-)

Overheads Volume Variance

= ₹ 2,800 (A) - ₹ 2,000 (A)

= ₹ 800 (A)

(ii) Overheads Expenditure Variance = Budgeted Overheads (-) Actual Overheads

⇒ ₹ 800(A) = ₹ 12,000 (-) Actual Overheads

Therefore, Actual Overheads = ₹ 12,800

(iii) Actual hours for actual production = $\frac{\text{Actual Overheads}}{\text{Actual Overhead Recovery Rate Per Hour}}$

$$= \frac{\text{₹ 12,800}}{\text{₹ 8}}$$

= 1,600 hours

For (iv), (v) & (vi) refer Working Note

(iv) Overheads Capacity Variance = $\frac{\text{Budgeted Overheads for Actual Hours} (-)}{\text{Budgeted Overheads}}$

$$= ₹ 5 \times 1,600 \text{ hrs.} - ₹ 12,000$$

$$= ₹ 8,000 - ₹ 12,000$$

$$= ₹ 4,000 (A)$$

(v) Overheads Efficiency Variance = Absorbed Overheads (-) Budgeted Overheads for Actual Hour

$$= ₹ 10,000 - ₹ 5 \times 1,600 \text{ hours} = ₹ 2,000 (F)$$

(vi) Standard hours for actual production

$$= \frac{\text{Absorbed Overheads}}{\text{Standard Overhead Rate per hour}}$$

$$= \frac{\text{₹ } 10,000}{\text{₹ } 5} = 2,000$$

Working Notes:

$$\begin{aligned} \text{Overhead Cost Variance} &= \text{Absorbed Overheads (-) Actual Overheads} \\ &\Rightarrow \text{₹ } 2,800 \text{ (A)} = \text{Absorbed Overheads (-) ₹ } 12,800 \end{aligned}$$

$$\text{Therefore, Absorbed Overheads} = \text{₹ } 10,000$$

$$\text{Standard Rate per hour} = \frac{\text{Budgeted Overheads}}{\text{Budgeted Hours}} = \frac{\text{₹ } 12,000}{2,400 \text{ hours}} = \text{₹ } 5$$

Question 20

The following information relates to the labour element of X Ltd.

Type of labour	Skilled	Semi-skilled	Unskilled	Total
No. of workers in the standard gang	4	3	2	9
Standard rate per hour (₹)	6	3	1	
Number of workers in actual gang				9
Actual rate per hour (₹)	7	2	2	

In a 40 hour week, the gang produced 270 standard hours. The actual number of semi-skilled workers is two times the actual number of unskilled workers.

The rate variance of semi-skilled workers is ₹ 160 (F).

Find the following:

- The number of workers in each category
- Total gang variance
- Total sub-efficiency variance
- Total labour rate variance

Indicate if the variances are Favourable (F) or Adverse (A or U). (8 Marks)(Nov., 2013)

Answer

Working Note

Computation of Standard Hours Category Wise

Category	No. of Workers	Standard Hours
Skilled	4	120

		$\left(270 \text{ hrs.} \times \frac{4 \text{ workers}}{9 \text{ workers}} \right)$
Semi-Skilled	3	90 $\left(270 \text{ hrs.} \times \frac{3 \text{ workers}}{9 \text{ workers}} \right)$
Un-Skilled	2	60 $\left(270 \text{ hrs.} \times \frac{2 \text{ workers}}{9 \text{ workers}} \right)$
Total	9	270

Computation of Actual Hours Category Wise

Semi-Skilled Workers

$$\begin{aligned}
 \text{Labour Rate Variance} &= \text{Standard Cost of Actual Time} - \text{Actual Cost} \\
 \text{Or} &= \text{Standard Rate} \times \text{Actual Hours} - \text{Actual Rate} \times \text{Actual Hours} \\
 \text{Or} &= \text{Actual Hours} \times (\text{Standard Rate} - \text{Actual Rate}) \\
 \Rightarrow ₹ 160 \text{ (F)} &= \text{Actual Hours} \times (₹ 3 - ₹ 2) \\
 \Rightarrow \text{Actual Hours} &= 160 \text{ Hours}
 \end{aligned}$$

(i) Computation of Total No. of Workers in Each Category

Category	No. of Workers	Actual Hours
Skilled	3 $\left(\frac{120 \text{ hrs.}}{40 \text{ hrs.}} \right)$	120 (Balancing Figure)
Semi-Skilled	4 $\left(\frac{160 \text{ hrs.}}{40 \text{ hrs.}} \right)$	160 (Working Note)
Un-Skilled	2 $\left(\frac{80 \text{ hrs.}}{40 \text{ hrs.}} \right)$	80 $\left(\frac{160 \text{ hrs.}}{2} \right)$
Total	9	360*

(*) Total No. of Actual Hours is 360 hrs. (40 hrs. x 9 workers)

(ii), (iii), & (iv)

Computation of Variances

Statement Showing Standard & Actual Cost

Category	Standard Cost			Actual Cost			Revised Actual Hrs. (In Std. Proportion)
	Hrs.	Rate	Amt.	Hrs.	Rate	Amt.	
Skilled	120	6	720	120	7	840	160 $\left(360\text{hrs.} \times \frac{120\text{hrs.}}{270\text{hrs.}} \right)$
Semi-Skilled	90	3	270	160	2	320	120 $\left(360\text{hrs.} \times \frac{90\text{hrs.}}{270\text{hrs.}} \right)$
Un-Skilled	60	1	60	80	2	160	80 $\left(360\text{hrs.} \times \frac{60\text{hrs.}}{270\text{hrs.}} \right)$
Total	270		1,050	360		1,320	360

Total Gang Variance = Total Actual Time Worked (hours) × {Average Standard Rate per hour of Standard Gang

Less Average Standard Rate per hour of Actual Gang@}

@on the basis of hours worked

$$= 360 \text{ hrs.} \times \left(\frac{\text{₹}1,050}{270 \text{ hrs.}} - \frac{\text{₹} 6 \times 120 \text{ hrs.} + \text{₹} 3 \times 160 \text{ hrs.} + \text{₹} 1 \times 80 \text{ hrs.}}{360 \text{ hrs.}} \right)$$

$$= \text{₹}120 \text{ (F)}$$

Alternate Formula

Gang Variance = Standard Cost of Actual Time Worked in Standard Proportion – Standard Cost of Actual Time Worked

Or = Revised Actual Hours × Standard Rate – Actual Hours × Standard Rate

Or = Standard Rate × (Revised Actual Hours - Actual Hours)

Skilled Workers = ₹6 × (160 hrs. – 120 hrs)

$$= \text{₹}240 \text{ (F)}$$

Semi-Skilled Workers = ₹3 × (120 hrs. – 160 hrs)

$$= \text{₹}120 \text{ (A)}$$

Skilled Workers = ₹1 × (80 hrs. – 80 hrs)

$$= ₹ 0$$

$$\begin{aligned}\text{Total} &= ₹ 240 (F) + ₹ 120 (A) + ₹ 0 \\ &= ₹ 120 (F)\end{aligned}$$

Total Sub- Efficiency Variance

$$\begin{aligned}&= \text{Average Standard Rate per hour of Standard Gang} \times \{\text{Total Standard Time (hours)} - \text{Total Actual Time Worked (hours)}\} \\ &= \left(\frac{₹ 1,050}{270 \text{ hrs.}} \right) \times (270 \text{ hrs.} - 360 \text{ hrs.}) \\ &= ₹ 350 (A)\end{aligned}$$

Alternate Formula**Sub- Efficiency Variance**

$$= \text{Standard Cost of Standard Time for Actual Production} - \text{Standard Cost of Actual Time Worked in Standard Proportion}$$

$$\text{Or} \quad = \text{Standard Hours} \times \text{Standard Rate} - \text{Revised Actual Hours} \times \text{Standard Rate}$$

$$\text{Or} \quad = \text{Standard Rate} \times (\text{Standard Hours} - \text{Revised Actual Hours})$$

$$\begin{aligned}\text{Skilled Workers} &= ₹ 6 \times (120 \text{ hrs.} - 160 \text{ hrs.}) \\ &= ₹ 240 (A)\end{aligned}$$

$$\begin{aligned}\text{Semi-Skilled Workers} &= ₹ 3 \times (90 \text{ hrs.} - 120 \text{ hrs.}) \\ &= ₹ 90 (A)\end{aligned}$$

$$\begin{aligned}\text{Skilled Workers} &= ₹ 1 \times (60 \text{ hrs.} - 80 \text{ hrs.}) \\ &= ₹ 20 (A)\end{aligned}$$

$$\begin{aligned}\text{Total} &= ₹ 240 (A) + ₹ 90 (A) + ₹ 20 (A) \\ &= ₹ 350 (A)\end{aligned}$$

Labour Rate Variance

$$= \text{Standard Cost of Actual Time} - \text{Actual Cost}$$

$$\text{Or} \quad = \text{Standard Rate} \times \text{Actual Hours} - \text{Actual Rate} \times \text{Actual Hours}$$

$$\text{Or} \quad = \text{Actual Hours} \times (\text{Standard Rate} - \text{Actual Rate})$$

Skilled Workers	= 120 hrs. × (₹6 – ₹7)
	= ₹120 (A)
Semi- Skilled Workers	= 160 hrs. × (₹3 – ₹2)
	= ₹160 (F)
Skilled Workers	= 80 hrs. × (₹1 – ₹2)
	= ₹80 (A)
Total	= ₹120 (A) + ₹160 (F) + ₹80 (A)
	= ₹40 (A)

Costing of Service Sector

Question 1

A Multinational company runs a Public Medical Health Centre. For this purpose, it has hired a building at a rent of ₹ 10,000 per month with 5% of total taking. Health centre has three types of wards for its patients namely. General ward, Cottage ward and Deluxe ward. State the rent to be charged to each bed-day for different type of ward on the basis of the following informations:

- (i) The number of beds of each type are General ward 100, Cottage ward 50, Deluxe ward 30.
- (ii) The rent of Cottage ward bed is to be fixed at 2.5 times of the General ward bed and that of Deluxe ward bed as twice of the Cottage ward bed.
- (iii) The occupancy of each type of ward is as follows:
General ward 100%, Cottage ward 80% and Deluxe ward 60%. But, in general ward there were occasions when beds are full, extra beds were hired at a charges of ₹ 20 per bed. The total hire charges for the extra beds incurred for the whole year amount to ₹ 12,000.
- (iv) The Health Centre engaged a heart specialist from outside and on an average fees paid to him was ₹ 15,000 per trip. He makes three trips in the whole year.
- (v) The other expenses for the year were as under:

	₹
Salary of Supervisors, Nurses, Ward boys	4,25,000
Repairs and maintenance	90,000
Salary of doctors	13,50,000
Food supplied to patients	40,000
Laundry charges for their bed linens	80,500
Medicines supplied	74,000
Cost of oxygen, X-ray etc. other than directly borne for	
Treatment of patients	49,500
General administration charges	63,000

(vi) Provide profit @ 20% on total taking.

(vii) The Health Centre imposes 8% service tax on rent received.

(viii) 360 days may be taken in a year.

(12 Marks) (Nov.,2006)

Answer

(a) Statement of Total Cost

Total cost	Amount (₹)	
Salary of Supervisor , Nurses, Ward boys	4,25,000	
Repairs and Maintenance	90,000	
Salary of doctors	13,50,000	
Food supplied to patients	40,000	
Laundry charges for their bed linens	80,500	
Medicines supplied	74,000	
Cost of oxygen, X ray etc, other than directly borne for treatment of patients	49,500	
General administration charges	63,000	₹ 21,72,000
Building rent	(10 × 12,000)	₹ 1,20,000
Additional building rent on takings		5% on Total Taking
Hire charges extra beds		₹ 12,000
Fees to heart specialists	(3 × 15,000)	₹ 45,000
Total cost		₹ 23,49,000 + 5% on Total Taking
Profit		20% on Total Taking
Total takings		₹ 23,49,000 + 25% of Total Taking
Total taking(assuming X to be the rent per day)		1,05,000 × X
Rent to be charged		
$1,05,000 \times X = 23,49,000 + 25\% (1,05,000 \times X) = 78750 X = 23,49,000$ or $X = 29.83$ (Rounded Off)		

No of beds with Equivalent Rent

Nature of wards	Occupancy	Weight of rent	Ward Days
General ward	100 × 360 × 100%	36,000 × 1	36,000

Additional general ward	$\frac{12,000}{20}$	600×1	600
Cottage ward	$50 \times 360 \times 80\%$	$14,400 \times 2.5$	36,000
Deluxe ward	$50 \times 360 \times 60\%$	$6,480 \times 5$	32,400
Total			1,05,000

Rent to be charged

Particulars	Basic	Service tax	Total
General ward	29.83	2.39	32.22
Cottage ward	74.58	5.97	80.55
Deluxe ward	149.15	11.93	161.08

Note : You may assume Total Taking to include Service Tax also.

$$\text{Rent} = 23,49,000 + 25\% \times (1,05,000 \times 1.08) + 0.08 \times (1,05,000 \times X) = 1,05,000 \times 1.08 \\ = 23,49,000 + 28350X + 8400X = 1,13,400X$$

Therefore $X = ₹ 30.65$

Rent to be charged

Particulars	Basic	Service tax	Total
General ward	30.65	2.45	33.10
Cottage ward	76.63	6.13	82.76
Deluxe ward	153.25	12.26	165.51

Question 2

Discuss with examples, the basic costing methods to assign costs to services.

(5 Marks) (May, 2007)

Answer

- Job costing method:** The cost of a particular service is obtained by assigning costs to a distinct identifiable service.
e.g. Job Costing method is used in service sectors – like Accounting Firm, Advertisement campaign.
- Process Costing method:** Cost of a service is obtained by assigning costs to masses of similar unit and then computing cost / unit on an average basis.
e.g. Retail banking, postal delivery, credit card etc.
- Hybrid method:** Combination of both (i) & (ii) above.

Question 3

A city health centre provides health and other related services to the citizens who are covered under insurance plan. The health centre receives a payment from the insurance company each time any patient attends the centre for consultation as under:

Consultations involving	Payment from Insurance company ₹
No treatment	60
Minor treatment	250
Major treatment	500

In addition, the adult patients will have to make a co-payment which is equivalent to the amount of payment for the respective category of treatment made by the insurance company. However, children and senior citizens are not required to make any such co-payment.

The health centre will remain open for 6 days in a week for 52 weeks in a year. Each physician treated 20 patients per day although the maximum number of patients that could have been treated by a physician on any working day is 24 patients.

The health centre received a fixed income of ₹ 2,25,280 per annum for promotion of health products from the manufacturers.

The annual expenditure of the health centre is estimated as under:

Materials and consumable (100% variable) ₹ 22,32,000

Staff salaries per annum per employee (fixed):

Physician ₹ 4,50,000

Assistants ₹ 1,50,000

Administrative staff ₹ 90,000

Establishment and other operating costs (fixed) ₹ 16,00,000

The non-financial information is as under:

(i) Staff:

Number of physicians employed	6
Assistants	7
Administrative staff	2

(ii) Patient Mix:

Adults	50%
Children	40%
Senior Citizens	10%

(iii) Mix of patient appointments (%)

Consultation requiring no treatment	70%
Minor treatment	20%
Major treatment	10%

Required:

- (i) Calculate the Net income of the city health centre for the next year;
 (ii) Determine the percentage of maximum capacity required to be utilized next year in order to break even. (8 Marks) (Nov 2008)

Answer

1. (1) Total number of patients attended

Number of patients attended per day by a physician:	20
Number of physicians employed	6
Number of days in week	6
Number of weeks in a year	52

Total number of patients attended = $20 \times 6 \times 6 \times 52 = 37,440$.

(2) Patient Mix:

Adults (50%)	$37,440 \times 50/100$	=	18,720
Children (40%)	$37,440 \times 40/100$	=	14,976
Senior Citizens (10%)	$37,440 \times 10/100$	=	<u>3,744</u>
			<u>37,440</u>

(3) Patient Appointments:

No treatment required (70%)	$37,440 \times 70/100$	=	26,208
Minor treatment (20%)	$37,440 \times 20/100$	=	7,488
Major treatment (10%)	$37,440 \times 10/100$	=	<u>3,744</u>
			<u>37,440</u>

(4) Income from Insurance Companies:

	Number of patients	₹	₹
	(A)	(B)	(A × B)
No treatment patients	26,208	60	15,72,480
Minor treatment patients	7,488	250	18,72,000

Major treatment patients	3,744	500	<u>18,72,000</u>
	Total		<u>53,16,480</u>

(5) Co-payment from adult patients:

	<i>Number of patients</i>	<i>Payment (₹)</i>	<i>Total payment (₹)</i>
Total number of adult patients	18,720		
No treatment patients (70%)	13,104	60	7,86,240
Minor treatment (20%)	3,744	250	9,36,000
Major treatment (10%)	1,872	500	<u>9,36,000</u>
Total			<u>26,58,240</u>

(6) Net income:

	₹	₹
Payment from Insurance companies	53,16,480	
Co-payment from adult patients	<u>26,58,240</u>	
Total	79,74,720	
Other Income (fixed)	<u>2,25,280</u>	
Total Income (A)		82,00,000
Less: Expenditure		
Variable expenses:		
Material and consumables	22,32,000	
Fixed expenses:		
Physician's salary (6 × 4,50,000)	27,00,000	
Assistants salary (7 × 1,50,000)	10,50,000	
Administrative staff's salary (2 × 90,000)	1,80,000	
Establishment and other operating costs	16,00,000	<u>55,30,000</u>
Total Expenditure (B)		<u>77,62,000</u>
Net Income (A – B)		<u>4,38,000</u>

(ii) 1. Contribution Analysis:

	(₹)
Total Fees from Insurance Companies and adult patients	79,74,720

Less: Variable costs	22,32,000
Contribution	57,42,720
Average contribution per patient	$\frac{57,42,720}{37,440} = 153.38$

2. Break-even patients:

	(₹)
Fixed costs	55,30,000
Less: Fixed income	2,25,280
Net Fixed costs	53,04,720
Break-even patients = $\frac{\text{Net fixed costs}}{\text{Contribution per patient}}$	$\frac{53,04,720}{153.38} = 34,585$

3. Percentage of maximum capacity required to be utilized in order to break-even

$$\text{Present utilization} = \frac{20 \text{ patients}}{24 \text{ patients}} = 83.33\% = 37,440$$

$$100\% \text{ patient capacity is } \frac{37,440}{0.8333} = 44,930 \text{ patients}$$

Percentage of maximum capacity required to be utilized in order to break-even

$$= \frac{\text{Break - even patients}}{100\% \text{ patient capacity}} \times 100$$

$$= \frac{34,585}{44,930} \times 100 = 76.98\% \text{ say } 77\%.$$

Assumption: Patient mix and mix of patient appointments will be same in the next year.

Question 4

Give an appropriate cost unit for each of the following service sectors:

- (i) Hotel
- (ii) School
- (iii) Hospital
- (iv) Accounting firm
- (v) Transport

(vi) Staff Canteen

(vii) Machine maintenance

(viii) Computer Department

(4 Marks) (June, 2009)

Answer

Service Sector		Cost Unit
(i)	Hotel	Bednights available or occupied
(ii)	School	Student hours or no. of full time students
(iii)	Hospital	Patient-day / Room-day
(iv)	Accounting firm	Client hours
(v)	Transport	Passenger-Kms, or Quintal km or tonne-km
(vi)	Staff Canteen	No. of meals provided or no. of staff
(vii)	Machine maintenance	Maintenance hours to user departments
(viii)	Computer Department	Computer time to user departments.

Question 5

"Customer profile is important in charging cost." Explain this statement in the light of customer costing in service sector.

(4 Marks)(Nov., 2010)

Answer

Customer costing in the service sector: The customer costing is a new approach to management. The central theme of this approach is customer satisfaction. In some service industries, such as public relations, the specific output of industry may be difficult to identify and even more difficult to quantify. Further there are multiple customers, identifying support activities i.e. common costs with particular customer may be more problematic. In such cases it is important to cost customer. An ABC analysis of customers profitability provides valuable information to help management in pricing customer. Consider a banking sector. A bank's activities for customer will include the following types of activities. These are:

- i. Stopping a cheque
- ii. Withdrawal of cash
- iii. Updation of pass book
- iv. Issue of duplicate pass book
- v. Returning a cheque because of insufficient funds
- vi. Clearing of a customer cheque.

Different customers or categories of customers use different amount of these activities and so

customer profiles can be built up and customer can be charged according to the cost to serve them.

Customer profile is important in analyzing cost under the following categories

1. Customer specific costs: These are the direct and indirect cost of providing service to customer plus customer related cost assigned to each customer.

For example: cost of express courier service to a client who requests over-night delivery of some agreement.

2. Customer – line categories: These are the costs which are broken into broad categories of customers and not individual customers.

Question 6

Suggest suitable cost units for the following services:

(i) Hospital

(ii) Hotel

(iii) Transport

(iv) Staff canteen

(4 Marks)(May, 2012)

Answer

- | | |
|--------------------|--|
| (i) Hospital | Patient days, or room days or patient nights |
| (ii) Hotel | Room nights/ Room days |
| (iii) Transport | Passenger – km or Tonne- km or quintal – km |
| (iv) Staff canteen | No. of meals or no. of staff |

Question 7

XY Hotel has 40 bed rooms with a maximum occupancy of 490 sleeper nights per week. Average occupancy is 60% throughout the year. Meals provided to guests have been costed and the average food cost per person per day is as follows:

	₹
Breakfast	72.00
Lunch	220.00
Dinner	<u>268.00</u>
	<u>560.00</u>

Direct wages and staff meals per week are as under:

	₹
Housekeeping	39,040.00

Restaurant and kitchen	68,600.00
General	35,200.00

Direct expenses per annum are ₹ 9,15,200 for house keeping and ₹ 10,40,000 for restaurant. Indirect expenses amount to ₹ 68,22,400, which should be apportioned on the basis of floor area. The floor areas are as follows:

	Sq. Mt.
Bed rooms	3,600
Restaurant	1,200
Service Area	600

A net profit of 10% must be made on the restaurant taking and also on accommodation takings.

Required:

Calculate what inclusive term per person should be charged per day and also show the split between meals and accommodation charges. (7 Marks)(Nov, 2012)

Answer

Statement showing the charges per person per day

Particulars	Total (₹)	House keeping (₹)	Restaurant (₹)	General & Services (₹)
Direct Wages and Staff Meal per week	1,42,840	39,040	68,600	35,200
Other Direct Expenses per week [₹9,15,200/52; ₹10,40,000/52]	37,600	17,600	20,000	–
Sub Total – Direct Expenses	1,80,440	56,640	88,600	35,200
Direct Expenses per week (General)* [39,040:68,600]	–	12,767	22,433	(35,200)
Indirect Expenses per week (Based on floor area) [3,600:1,200]	1,31,200	98,400	32,800	–
Total	3,11,640	1,67,807	1,43,833	–
Average Occupancy (490 x 60% = 294 Sleeper nights per week)				

Particulars	Total (₹)	House keeping (₹)	Restaurant (₹)
Cost per person per day [₹1,67,807/294; ₹1,43,833/294]	1,060.00	570.77	489.23
Food Cost per person per day	560.00	—	560.00
Total Cost per person per day	1,620.00	570.77	1,049.23
Add: 1/9th of Cost	180.00	63.42	116.58
Charges per person per day	1,800.00	634.19	1,165.81

* may be apportioned to house-keeping and restaurant on any other alternative logical basis.

Question 8

Flyway Ltd. has hired an aircraft to specially operate between cities A and B. All the seats are economy class.

The following information is available:

Seating capacity of the aircraft	:	260 passengers
Average number of passengers per flight	:	240 passengers
Average one-way fare from A to B	:	₹5,000 per passenger
Fuel costs per flight from A to B	:	₹90,000
Food cost (A to B sector) (no charge to passenger)	:	₹300 per passenger
Commission to travel agents (All tickets are through agents)	:	10% of the fare
Annual lease costs allocated to each flight	:	₹2,00,000
Ground services, baggage handling/checking in service costs per flight A to B	:	₹40,000
Flight crew salaries per flight A to B	:	₹48,000

There is an offer from another airlines operator, Haltgo Ltd. for a stop-over at destination D, which is on the way from A to B. Due to this, the flight will operate from A to D, then from D to B.

The following terms are considered for the stop-over:

50 seats from D to B will be booked by Haltgo at ₹2,700 per ticket, whether or not Haltgo is able to sell them to its customers. No agents' commission is payable on these tickets.

However, Snacks must be provided to these passengers also by Flyway Ltd. at no further charge to Haltgo or the passengers.

A maximum of 60 tickets can be sold by Flyway's travel agents for the A to D sector at a fare of ₹ 3,000 per passenger.

Since the stop-over wastes more time, 25 of Flyway's original passengers in the A to B sector will voluntarily drop out in favour of other airlines offering direct flights between A and B.

Due to the stop-over, fuel costs will increase from ₹ 90,000 to ₹ 1,35,000. Additional airport landing/baggage handling charges of ₹ 19,000 per stop-over will have to be incurred by Flyway Ltd.

Flyway Ltd. will have to serve snacks to all the passengers in the D to B sector at no charge to passengers. Each snack will cost Flyway ₹ 200. This will be in addition to the original food at ₹ 300 served in the A to D sector.

You may assume that fuel costs are not affected by the actual number of passengers in the flight, ignore non-financial considerations, additional wear and tear to aircraft due to extra landing/take-off.

Without considering Haltgo's offer,

- (i) What is the profit earned by Flyway Ltd. per flight from A to B?
 - (ii) What is the Break-even number of passengers for each flight from A to B?
- Considering the effects of Haltgo's offer,
- (iii) Evaluate whether Flyway should accept the offer.

(A detailed profitability statement is not essential. Only figures relevant for the cost-revenue analysis are required.)

(12 Marks)(Nov., 2013)

Answer

Statement Showing Allocation of Seats in the Aircraft

Existing Situation	
For Destination A to B	
Seating Capacity of the Aircraft	260 passengers
Average Number of Passengers per flight	240 passengers
Proposed Situation	
For Destination D to B	
Seats Booked by Haltgo Ltd.	50 Seats
For Destination A to B	
Seats Available	210 Seats

{260 (capacity) – 50 (booked by Haltgo Ltd. for destination D to B)}	
Requirement of Regular Passengers {240 (original no. of passengers) – 25 (no. of passengers drop out due to wastage of time)}	215 Seats
Possible Allocation of Seats to Regular Passengers	210 Seats
For Destination A to D	
Seats Available {260 (capacity) – 210 (seats allocated to regular passengers of destination A to B)}	50 Seats
Requirement of Agents (tickets can be sold by Flyway's travel agents)	60 Seats
Possible Allocation to Agents of Flyway Ltd.	50 Seats

Existing Situation**Profit per Flight**

	₹	₹
Revenue <i>per passenger</i> (Gross Fare)		5,000
Less: Total Variable Cost <i>per passenger</i> :		
10% Commission on Fare	500	
Food	300	800
Contribution <i>per passenger</i>		4,200
Contribution <i>per flight</i> (Contribution for 240 Passengers)		10,08,000
Less: Fixed Costs <i>per flight</i>		
Fuel Cost	90,000	
Annual Lease Cost	2,00,000	
Ground Service, Baggage Handling / Checking in	40,000	
Flight Crew Salaries	48,000	3,78,000
Profit <i>per flight</i>		6,30,000

Break-even Point

Break-even Number of Passengers@ $\left(\frac{₹ 3,78,000}{₹ 4,200} \right)$	90 Passengers
--	---------------

$$(\textcircled{a}) \text{ Break-even Number of Passengers} = \frac{\text{Total Fixed Cost per Flight}}{\text{Contribution per Passenger}}$$

Proposed Situation

Contribution per Passenger (A to D)

	₹	₹
Revenue per passenger (Gross Fare)		3,000
Less: Total Variable Cost per passenger:		
10% Commission on Fare	300	
Food [#]	300	600
Contribution per passenger		2,400

Statement Showing Additional Revenue / Expenditure from Haltogo Ltd.'s Offer

	Additional	
	Cost (₹)	Revenue (₹)
Revenue from Destination D to B (50 Seats × ₹2,700)		1,35,000
Contribution from Destination A to D (50 Seats × ₹2,400)		1,20,000
Contribution Lost for Destination A to B (30 Seats* × ₹4,200)	1,26,000	
Snacks (260 Passengers × ₹ 200)	52,000	
Fuel Cost	45,000	
Airport Landing / Baggage Handling Charges	19,000	
Total	2,42,000	2,55,000

(*) 240 Seats (existing) Less 210 Seats (proposed)

([#]) All the passengers booked for destination A to D are also served food free of cost.

Flyway Ltd. will gain ₹13,000 (₹2,55,000 – ₹2,42,000) per flight if it accepts Haltgo's offer.

Decision: Accept Haltgo's offer.

Question 9

Discuss briefly two methods of costing in the service sector and give examples.

(4 Marks)(Nov., 2013)

Answer

Methods of Costing in the service sector are as follows:

- (i) **Job costing method:** In job costing method the cost of a particular service is obtained by assigning costs to a distinct identifiable service. In service sector like Accounting firm, Advertising campaigns etc. job costing method is used. For assigning indirect costs (overheads) models such as Activity Based Costing may be used.
- (ii) **Process costing method:** In process costing system the cost of a service is obtained by assigning costs to masses of similar unit and then computing unit cost on an average basis. Retail banking, Postal delivery, Credit card etc. uses process costing method.
- (iii) **Hybrid costing method:** Many companies uses a method of costing which is neither job costing nor process costing method. They in fact uses a hybrid costing method which combines elements of both job costing and process costing methods.

Transfer Pricing

Question 1

Tycon Ltd. has two manufacturing departments organized into separate profit centres known as Textile unit and Process House. The Textile unit has a production capacity of 5 lacs metres cloth per month, but at present its sales is limited to 50% to outside market and 30% to process house.

The transfer price for the year 2004 was agreed at ₹ 6 per metre. This price has been fixed in line with the external wholesale trade price on 1st January, 2004. However, the price of yarn declined, which was the raw material of textile unit, with effect, that wholesale trade price reduced to ₹ 5.60 per metre with effect from 1st June, 2004. This price was however not made applicable to the sales made to the processing house of the company. The textile unit turned down the processing house request for revision of price.

The Process house refines the cloth and packs the output known as brand Rayon in bundles of 100 metres each. The selling price of the Rayon is ₹ 825 per bundle. The process house has a potential of selling a further quantity of 1,000 bundles of Rayon provided the overall prices is reduced to ₹ 725 per bundle. In that event it can buy the additional 1,00,000 metres of cloth from textile unit, whose capacity can be fully utilised. The outside market has no further scope.

The cost data relevant to the operations are:

	Textile unit ₹	Process house ₹
Raw material (per metre) on 1 st June, 2004	3.00	Transfer price
Variable cost	1.20 (per metre)	80 (per bundle)
Fixed cost (per month)	4,12,000	1,00,000

You are required to:

- (i) Prepare statement showing the estimated profitability for June, 2004 for Textile unit and Process house and company as a whole on the following basis:
 - (a) At 80% and 100% capacity utilisation of the Textile unit at the market price and the transfer price to the Processing house of ₹ 6 per metre.

- (b) At 80% capacity utilisation of the Textile unit at the market price of ₹ 5.60 per metre and the transfer price to the Processing house of ₹ 6 per metre.
- (c) At 100% capacity utilisation of the Textile unit at the market price of ₹ 5.60 per metre and the transfer price to the Processing house of ₹ 5.60 per metre.
- (ii) Comment on the effect of the company's transfer pricing policy on the profitability of Processing house.
(11 Marks)(Nov., 2004)

Answer

- (i) (a) At 80% level (in ₹)

-Textile unit		-Process house	
Sales (4,00,000 × 6)	24,00,000	Sales(1,50,000/100) × 825	12,37,500
Less		Less	
Raw material (4,00,000 × 3)	12,00,000	Transfer Price (1,50,000 × 6)	9,00,000
Variable cost (4,00,000 × 1.2)	4,80,000	Variable cost (1,500 × 80)	1,20,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	3,08,000	Profit	1,17,500

Overall profit = 3,08,000 + 1,17,500 = ₹ 4,25,500

At 100% level

Sales (5,00,000 × 6)	30,00,000	Sales (2,50,000/100) × 725	18,12,500
Less		Less	
Raw material (5,00,000 × 3)	15,00,000	Transfer Price (2,50,000 × 6)	15,00,000
Variable cost (5,00,000 × 1.2)	6,00,000	Variable cost	2,00,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	4,88,000	Profit	12,500

Overall profit = 4,88,000+12,500 = ₹ 5,00,500

- (b) At 80% level (market price 5.60 and transfer price 6/-) (in ₹)

Textile unit		Process house	
Sale (2,50,000 × 5.6)	1400000		
(1,50,000 × 6.0)	900000		
	23,00,000		
Less			
Raw material (4,00,000 × 3)	12,00,000		
Variable cost (4,00,000 × 1.2)	4,80,000		
Fixed cost	4,12,000		
Profit	2,08,000	Profit	1,17,500

Overall profit = 2,08,000+1,17,500 = ₹ 3,25,500

(c) Sales 100% level at (5.60) (in ₹)

Sale (5,00,000 × 5.6)	28,00,000	Sales (2,50,000 × 725)	18,12,500
Less		Less	
Raw material (5,00,000 × 3)	15,00,000	Transfer Profit (2,50,000 × 5.6)	14,00,000
Variable cost (5,00,000 × 1.20)	6,00,000	Variable cost (2,500 × 80)	2,00,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	2,88,000	Profit	1,12,500

Overall profit = 2,88,000 + 1,12,500 = 4,00,500

(ii) Comments on the profitability of processing units:-

	Transfer price (₹)	Profit (₹)
(a) 80% capacity	6.00	1,17,500
100% capacity	6.00	12,500
(b) 80% capacity	6.00	1,17,500
(c) 100% capacity	5.60	1,12,500

Processing house will not be interested to buy more than 1,50,000 meters from textile units.

Question 2

AB Cycles Ltd. has 2 divisions, A and B which manufacture bicycle. Division A produces bicycle frame and Division B assembles rest of the bicycle on the frame. There is a market for sub-assembly and the final product. Each division has been treated as a profit centre. The transfer price has been set at the long-run average market price. The following data are available to each division:

Estimated selling price of final product	₹ 3,000 p.u.
Long run average market price of sub-assembly	₹ 2,000 p.u.
Incremental cost of completing sub-assembly in division B	₹ 1,500 p.u.
Incremental cost in Division A	₹ 1,200 p.u.

Required:

- If Division A's maximum capacity is 1,000 p.m. and sales to the intermediate are now 800 units, should 200 units be transferred to B on long-term average price basis.
- What would be the transfer price, if manager of Division B should be kept motivated?
- If outside market increases to 1,000 units, should Division A continue to transfer 200 units to Division B or sell entire production to outside market? (9 Marks)(May 2005)

Answer

- (i) In this case there are two options available –

	₹
(a) Sell at the sub assembly stage (after completion of Div. A) @ ₹ 2000/-	
Incremental cost in Div. A	1,200/-
Contribution	800/-
(b) Sell at the final product stage	3,000
Cost at Div. A and Div. B (1200+1500)	2,700
Contribution	300

Therefore it is profitable to sell at the subassembly stage because of higher contribution, provided there is a market.

Hence, if there is market at intermediate stage, first priority is to sell intermediary (sub assembly). Therefore, 800 units should be sold as sale of intermediary.

The balance capacity available of $(1000 - 800) = 200$ units should be transferred to B and B should complete the assembly and sell as final product, since the company can earn ₹ 300 per unit for each unit of such sale.

- (ii) If B Div. receives the subassembly at market price of ₹ 2,000, plus its own incremental cost of ₹ 1,500 will give total cost of ₹ 3,500, thereby yielding a loss of ₹ 3500 – ₹ 3000 = ₹ 500 per unit, whereas the company makes a profit of ₹ 300 per unit.

In order to keep the manager of Div. B motivated, the profit earned of ₹ 300 per unit should be shared between A and B. Hence transfer price will be variable cost of Div. A + 50% of profit earned in the final product = $1200 + 150 = ₹ 1,350$

- (iii) Both Div. A and the Company make higher contribution by selling to intermediate market. If the market demand increases to 1,000 units, the full quantity should be sold outside as intermediary and nothing should be transferred to Div. B.

Question 3

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 ₹ 540 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 ₹ 256.50.

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 ₹ 297, however division Y can buy the component from outside the market at ₹ 270 each. The variable cost of division Y in manufacturing the final product by using the component is ₹ 202.50 (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 ₹ 270 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 ₹ 50,625 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 ₹ 20.25, should division Y purchase from outside supplier?
- (iv) What transfer price would be fixed for the component in each of the above circumstances?

(12 Marks)(Nov. 2005)

Answer

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

	₹	(₹)
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		<u>Nil</u>
Total contribution		<u>1,68,750</u>

- (b) When component is purchased from division X

	(₹)	(₹)
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	<u>1,01,250</u>
Total contribution		<u>2,02,500</u>

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

		(₹ .)
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		<u>1,68,750</u>
Company's total contribution		<u>2,19,375</u>

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

		₹
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. ₹ 256.50 per component will be charged
- If facilities of division X can be put to alternative use then variable cost ₹ 256.50 + opportunity cost ₹ 20.25 = ₹ 276.75 will be transfer price.
- If market price gets reduced to ₹ 249.75 and there is no alternative use of facilities of Division X the variable cost ₹ 256.50 per component should be charged.

Question 4

What are some goals of a 'transfer-pricing' system in an organization? (4 Marks)(May 2006)

Answer

The goals of transfer pricing are that it should:

- provide information that motivates divisional managers to take good economic decisions which will improve the divisional profits and ultimately the profits of the company as a whole.
- provide information which will be useful for evaluating the divisional performance.
- seek to achieve goal congruence.
- ensure that divisional autonomy is not undermined.

Question 5

Hardware Ltd. Manufactures computer hardware products in different divisions which operate as profit centres. Printer Division makes and sells printers. The Printer Division's budgeted income statement, based on a sales volume of 15,000 units is given below. The Printer Division's Manager believes that sales can be increased by 2,400 units, if the selling price is reduced by ₹ 20 per unit from the present price of ₹ 400 per unit, and that, for this additional volume, no additional fixed costs will be incurred.

Printer Division presently uses a component purchased from an outside supplier at ₹ 70 per unit. A similar component is being produced by the Components Division of Hardware Ltd. And sold outside at a price of ₹ 100 per unit. Components Division can make this component for the Printer Division with a small modification in the specification, which would mean a reduction in the Direct Material cost for the Components Division by ₹ 1.5 per unit. Further, the Component Division will not incur variable selling cost on units transferred to the Printer Division. The Printer Division's Manager has offered the Component Division's Manager a price of ₹ 50 per unit of the component.

Component Division has the capacity to produce 75,000 units, of which only 64,000 can be absorbed by the outside market.

The current budgeted income statement for Components Division is based on a volume of 64,000 units considering all of it as sold outside.

	Printer Division	Component Division
	₹ '000	₹ '000
Sales revenue	<u>6,000</u>	<u>6,400</u>
Manufacturing cost:		
Component	1,050	—
Other direct materials, direct labour and variable OH	1,680	1,920
Fixed OH	<u>480</u>	<u>704</u>
Total manufacturing cost	<u>3,210</u>	<u>2,624</u>
Gross margin	2,790	3,776
Variable marketing costs	270	384
Fixed marketing and Admn. OH	<u>855</u>	<u>704</u>
Non-manufacturing cost	<u>1,125</u>	<u>1,088</u>
Operating profit	<u>1,665</u>	<u>2,688</u>

- (i) Should the Printer Division reduce the price by ₹ 20 per unit even if it is not able to procure the components from the Component Division at ₹ 50 per unit?

- (ii) Without prejudice to your answer to part (i) above, assume that Printer Division needs 17,400 units and that, either it takes all its requirements from Component Division or all of it from outside source. Should the Component Division be willing to supply the Printer Division at ₹50 per unit?
- (iii) Without prejudice to your answer to part (i) above, assume that Printer Division needs 17,400 units. Would it be in the best interest of Hardware Ltd. for the Components Division to supply the components to the Printer Division at ₹50?

Support each of your conclusions with appropriate calculations. (12 Marks) (May, 2007)

Answer

Particulars	Printer Division		If component is purchased internally	Components Division	
	Existing price	Reduction in selling price		Existing	If transfer is effected
Selling price	400	380	380	100	50
Component cost	70	70	50		
Other direct materials, labour and Variable overhead	112	112	112	30	28.50
Variable marketing cost	18	18	18	6	
Contribution	200	180	200	64	21.50
Volume units	15,000	17,400	17,400	64,000	17,400
Total contribution ('000)	3,000	3,132	3,480	4,096	374.10
Volume lost in the market					6,400 units
Contribution lost					$6,400 \times 64 = 409.60$

- (i) Yes, Printer Division should institute the ₹ 20 price reduction on its printer units because net income would increase by ₹ 1,32,000 (₹ 31,32,000 – ₹ 30,00,000).

Alternatively by incremental approach the net increase can be computed as follows:

	₹.
Contribution margin of sales increase ($₹ 180 \times 2,400$)	4,32,000
Loss in contribution margin on original volume arising from decrease in selling price ($15,000 \times ₹ 20$)	3,00,000
Increase in operating profit	1,32,000

- (ii) No, the Component Division should not sell all 17,400 units to Printer Division for ₹ 50. If the Component Division does sell all 17,400 units to Printer, Component Division will only be able to sell 57,600 units to outside customers instead of 64,000 units due to the capacity restrictions. This would decrease Component Division's profit before taxes by ₹ 35,500. Supporting calculations are as follows:

	₹.
Contribution from sales to printer ($₹ 21.50 \times 17,400$)	3,74,100
Loss in contribution from loss of sales to outsiders ($₹ 64 \times 6,400$)	<u>4,09,600</u>
Decrease in operating profit	<u>35,500</u>

- (iii) Yes, it would be in the best interest of Hardware Ltd. for the Component Division to sell the units to the Printer division at ₹ 50 each. The net advantage to the Hardware Ltd. is ₹ 3,12,500 as shown below. The net Advantage is the result of the cost savings from purchasing the Component unit internally and the contribution margin lost from 6,400 units that the Component Division otherwise would sell to outsiders.

	Total Company
	₹ '000s
Incremental contribution – if the component is transferred within (₹ '000) ($3,480 - 3,132$)	348.00
Contribution to the Component Division	374.10
Total incremental contribution	722.10
Less: Contribution lost by the Component Division	409.60
Net contribution gain	312.50

Question 6

X Ltd. has two divisions, A and B, which manufacture products A and B respectively. A and B are profit centres with the respective Divisional Managers being given full responsibility and credit for their performance.

The following figures are presented:

	Division A	Division B	
	₹ Per Unit	₹ Per Unit	
Direct material cost	50	24*	*(other than A)
Material A, if transferred from Division A	—	144	
Material A, if purchased from outside	—	160	
Direct labour	25	14	
Variable production overhead	20	2	
Variable selling overhead	13	26	
Selling price in outside market	160	300	
Selling price to B	144	—	
Selling price to S Ltd.	—	250	

Other Information:

To make one unit of B, one unit of component A is needed. If transferred from A, B presently takes product A at ₹ .144 per unit, with A not incurring variable selling overheads on units transferred to B.

Product A is available in the outside market at ₹ 160 per unit from competitors.

B can sell its product B in the external market at ₹ 300 per unit, whereas, if it supplied to X Ltd.'s subsidiary, S Ltd., it supplies at ₹ 250 per unit, and need not incur variable selling overhead on units transferred to S Ltd. S Ltd. requires 6,000 units and stipulates a condition that either all 6,000 units be taken from B or none at all.

	A(units)	B(units)	
Manufacturing capacity	20,000	28,000	
Demand in external market	18,000	26,000	
S Ltd.'s demand	—	6,000	or zero

Assume that Divisions A and B will have to operate during the year.

What is the best strategy for:

- Department A?
- Department B, given that A will use its best strategy?
- For X Ltd. As a whole?

(14 Marks) (May 2008)

Answer

	Div A	B	B
	₹ / unit	₹ / unit	₹ / unit
Direct Material (Other than A)	50	24	
Direct Labour	25	14	
Variable Overhead (Production)	<u>20</u>	<u>2</u>	
Variable Production Cost (excl. A)	95	40	40
From A		144	
From Outside		<u>160</u>	<u>160</u>
Variable production Cost / unit		184	200
Selling Price			
From outside	160	300	
Less: Selling Overhead	<u>13</u>	<u>26</u>	
Net Selling Price (outside)	<u>147</u>	<u>274</u>	
Net Selling Price to B	<u>144</u>		
Net Selling Price to S		<u>250</u>	
Net Selling Price (outside)	147	274	274
Variable Production Cost	<u>-95</u>	<u>-184</u>	<u>-200</u>
Contribution / unit (outside)	52	90	74
(Sale to B & S respectively)	144	250	250
Variable Production Cost	<u>-95</u>	<u>-184</u>	<u>-200</u>
Contribution / unit	<u>49</u>	<u>66</u>	<u>50</u>

Best strategy for A:

A = Maximise Production; Sell maximum no. of units @ 18,000 × 52 = 9,36,000
52 / unit (outside)

(To B) remaining units 2,000 × 49 = 98,000

Total Contribution for A 10,34,000

Best strategy for B:

Maximise contribution / unit by selling outside and procuring from A 90 / unit

Contribution × 2,000 units

Balance units can yield contribution of either 74/ unit for outside or ₹ 50 / unit to S Ltd.

Production Capacity = 28,000.

Option I			Option II
Outside Sales	Sales to S		Outside Sales × contribution / unit
$20,000 \times 74 = 14,80,000$	$6,000 \times 50 = 3,00,000$		$24,000 \times 74 = 17,76,000$
$2,000 \times 90 = 1,80,000$			$2,000 \times 90 = 1,80,000$
16,60,000	3,00,000		
Total Contribution	(16,60,000 + 3,00,000)	19,60,000	19,56,000

(B) Choose Option I i.e. get 2,000 units from A, sell 6,000 units to S and 20,000 to outside. Make 28,000 units @ full capacity. Total Contribution ₹ 19,60,000.

If A and B are allowed to act independent of the group synergy,

₹.

Total contribution	A – 10,34,000
	B – <u>19,60,000</u>
Total contribution for X Ltd.	<u>29,94,000</u>

Cost from X Ltd.'s Perspective

Variable Cost of production	Div A	₹ 95
	Div B	
Variable cost of production other than A	40	40
A supplied by Division	95	
A – Variable Cost		
A purchased	<u>135</u>	<u>160</u>
	<u>135</u>	<u>200</u>

Option I		Outside 26,000 units	Option II
Outside $20,000 \times (274 - 135)$	27,80,000	$20,000 (274 - 135)$	27,80,000
<u>$2,000 \times (274 - 200)$</u>	1,48,000	$6,000 (274 - 200)$	<u>4,44,000</u>
22,000			
S Ltd. 6,000 units $(250 - 200)$	<u>3,00,000</u>		
	<u>32,28,000</u>		<u>32,24,000</u>

Choose Option I

Contribution = ₹ 32,28,000 for X Ltd. as a whole

Transfer (2,000 units)

Make A transfer all output to B. Sell 6,000 units of B to S and 22,000 units to outside market.

This will make X Ltd. better off by $32,28,000 - 29,94,000 = ₹ 2,34,000$

(i.e. 18,000 units of A sold to outside increases contribution to A by 3 ₹ / unit and decreases contribution to B by 16 ₹ / unit Net negative effect = $13 \times 18,000 = ₹ 2,34,000$).

Question 7

A large business consultancy firm is organized in to several divisions. One of the divisions is the Information Technology (IT) division which provides consultancy services to its clients as well as to the other divisions of the firm. The consultants in the IT divisions always work in a team of three professional consultants on each day of consulting assignment. The external clients are charged a fee at the rate of ₹ 4,500 for each consulting day. The fee represents the cost plus 150% profit mark up. The break up of cost involved in the consultancy fee is estimated at 80% as being variable and the balance is fixed.

The textiles division of the consultancy firm which has undertaken a big assignment requires the services of two teams of IT consultants to work five days in a week for a period of 48 weeks. While the director of the textiles division intends to negotiate the transfer price for the consultancy work, the director of IT division proposes to charge the textiles division at ₹ 4,500 per consulting day.

In respect of the consulting work of the textiles division, IT division will be able to reduce the variable costs by ₹ 200 per consulting day. This is possible in all cases of internal consultations because of the use of specialized equipment.

You are required to explain the implications and set transfer prices per consulting day at which the IT division can provide consultancy services to the textiles division such that the profit of the business consultancy firm as a whole is maximized in each of the following scenarios:

- (i) *Every team of the IT division is fully engaged during the 48 week period in providing consultancy services to external clients and that the IT division has no spare capacity of consultancy teams to take up the textiles division assignment.*
- (ii) *IT division will be able to spare only one team of consultants to provide services to the textiles division during the 48 week period and all other teams are fully engaged in providing services to external clients.*
- (iii) *A new external client has come forward to pay IT division a total fee of ₹ 15,84,000 for engaging the services of two teams of consultants during the aforesaid period of 48 weeks.*

(11 Marks) (Nov., 2008)

Answer

Transfer Price is ₹ 4,500 for each consulting day.

Profit mark-up = 150%

Let cost = x

$$\begin{aligned}\text{Profit} &= x \times \frac{150}{100} \\ &= 1.5x\end{aligned}$$

$$\text{Cost + profit} = \text{Transfer price}$$

$$\Rightarrow x + 1.5x = 4,500$$

$$\Rightarrow 2.5x = 4,500$$

$$\Rightarrow x = \frac{4,500}{2.5} = 1,800$$

$$\therefore \text{Cost} = ₹ 1,800$$

$$\begin{aligned}\text{and profit} &= 1.5x = 1.5 \times 1,800 \\ &= ₹ 2,700\end{aligned}$$

$$\begin{aligned}\text{Variable cost (80\%)} &= ₹ 1,800 \times 80\% \\ &= ₹ 1,440\end{aligned}$$

$$\begin{aligned}\text{Fixed cost (20\%)} &= ₹ 1,800 \times 20\% \\ &= ₹ 360.\end{aligned}$$

Scenario (i):

Every consultancy team is fully engaged. There is no idle time or spare capacity.

Hence, transfer price = Marginal cost plus opportunity cost

$$\text{Marginal cost} = ₹ 1,440$$

$$\text{Saving for internal work} = ₹ 200$$

$$\text{Net Marginal Cost} = ₹ 1,240$$

Opportunity cost is the lost contribution.

$$\begin{aligned}\text{Lost contribution} &= \text{Contribution from external client} \\ &= \text{Fee charged from external client} - \text{Variable cost} \\ &= ₹ (4,500 - 1,440) \\ &= ₹ 3,060.\end{aligned}$$

$$\begin{aligned}\therefore \text{Transfer price} &= ₹ 1,240 + 3,060 \\ &= ₹ 4,300 \text{ per consulting day per team.}\end{aligned}$$

Scenario (ii):

One team is idle. Idle time has no opportunity cost. Variable cost for internal work is ₹ 1,240

per consulting day. Second team is busy. Hence opportunity cost is relevant in case of second team. Hence charge of second team is ₹ 4,300 per consulting day per team.

Average of charge of two teams = ₹ (1,240 + 4,300) / 2

= ₹ 2,770 per consulting day per team.

Scenario (iii):

New client offers a fee of ₹ 15,84,000

Duration: 5 days of 48 weeks × 2 teams = 480 days

Fee per day 15,84,000 / 480 = ₹ 3,300

Variable cost = ₹ 1,440

Contribution ₹ (3,300 – 1,440) = ₹ 1,860

Fee for consulting day for internal work:

Variable cost = ₹ 1,240

Contribution lost = ₹ 1,860

Fee to be charged = ₹ 3,100 per consulting day per team.

Question 8

Tripod Ltd. has three divisions – X, Y and Z, which make products X, Y and Z respectively. For division Y, the only direct material is product X and for Z, the only direct material is product Y. Division X purchases all its raw material from outside. Direct selling overhead, representing commission to external sales agents are avoided on all internal transfers. Division Y additionally incurs ₹ 10 per unit and ₹ 8 per unit on units delivered to external customers and Z respectively. Y also incurs ₹ 6 per unit picked up from X, whereas external suppliers supply at Y's factory at the stated price of ₹ 85 per unit.

Additional information is given below:

	Figures ₹/unit		
	X	Y	Z
Direct materials (external supplier rate)	40	85	135
Direct labour	30	50	45
Sales Agent's commission	15	15	10
Selling price in external market	110	170	240
Production capacity	20,000	30,000	40,000 units
External demand	14,000	26,000	42,000 units

You are required to discuss the range of negotiation for Managers X, Y and Z, for the number of units and the transfer price for internal transfers. (11 Marks) (Nov. 2008)

Answer

Analysis of range of negotiation for Manager of Division X

(Figures in ₹)

	Division X			
	Outside sales	Sales to Y (Range)		
Selling Price	110	70	—	79
(–) Commission	<u>15</u>	<u>—</u>		<u>—</u>
Net Selling Price	95	70	—	79
Variable Cost	<u>70</u>	<u>70</u>	—	<u>70</u>
Contribution per unit	25	0		9
Units	14,000	6,000		6,000
Total contribution				
(Units × Contribution per unit)	<u>3,50,000</u>	0		54,000

Analysis of Range of negotiation for Manager of Division Y

(Figures in ₹)

	Division Y					
	Outside Sales			Sale to Z		
	From X	From outside		From X	From outside	
Price range	<u>70</u>	79	85	70	79	85
Add: Transport	<u>6</u>	<u>6</u>	<u>—</u>	<u>6</u>	<u>6</u>	<u>—</u>
	76	85	85	76	85	85
Add: Direct Labour	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>
	126	135	135	126	135	135
Add: Delivery cost	<u>10</u>	<u>10</u>	<u>10</u>	<u>8</u>	<u>8</u>	<u>8</u>

	136	145	145	134	143	143
Add: Sales Commission	<u>15</u>	<u>15</u>	<u>15</u>	<u>—</u>	<u>—</u>	<u>—</u>
Total Cost	151	160	160	134	143	143
Selling Price	<u>170</u>	<u>170</u>	<u>170</u>	<u>135</u>	<u>135</u>	<u>135</u>
Contribution	19	10	10	<u>+1</u>	<u>(-) 8</u>	<u>(-) 8</u>

Range of Negotiations:

Manager of division X will sell 14,000 units outside at 110 ₹ per unit and earn contribution of ₹ 3.50 lakhs.

Excess capacity of 6,000 units can be offered to Y at a price between 70 (the variable manufacturing cost at X) and ₹ 95 (the maximum amount to equal outside contribution). But Y can get the material outside @ 85. So, y will not pay to X anything above (₹ 85 – 6) = ₹ 79 to match external available price.

X will be attracted to sell to Y only in the range of 71 – 79 ₹ per unit at a volume of 6,000 units.

At ₹ 70, X will be indifferent, but may offer to sell to Y to use idle capacity.

Z will not buy from Y at anything above 135. If X sells to Y at 70 per unit, Y can sell to Z at 134 and earn no contribution, only for surplus capacity and if units transferred by X to Y at ₹ 70 per unit.

	Y	Z
Provided X sells to Y at ₹ 70 per unit	Sell 4,000 units to Z at 134 (Indifferent) Sell 4,000 units to Z at 135 (willingly for a contribution of Re. 1)	Buy 4,000 units from y at 134 (attracted) Indifferent, since market price is also 135

For buying from X at 71 – 79 price range, Y will be interested in selling to Z only at prices 136 – 143, which will not interest Z.

Thus Y will sell to Z only if X sells to Y at ₹ 70 per unit and Y will supply to Z maximum 4,000 units.

Question 9

Bearings Ltd. makes three products, A, B and C in Divisions A, B and C respectively. The following information is given:

	A	B	C	
Direct Materials (excluding	4	15	20	₹/u

<i>material A for Divisions B and C)</i>				
<i>Direct Labour</i>	2	3	4	₹/u
<i>Variable overhead</i>	1	1	1	₹/u
<i>Selling price to outside customers</i>	15	40	50	₹/u
<i>Existing Capacity</i>	5,000	2,500	2,500	(No. of units)
<i>Maximum External demand</i>	3,750	5,000	4,000	(No. of units)
<i>Additional fixed costs that would be incurred to install additional capacity</i>	24,000	6,000	18,700	₹
<i>Maximum Additional units that can be produced by additional capacity</i>	5,000	1,250	2,250	(No. of units)

B and C need material A as their input. Material A is available outside at ₹ 15 per unit. Division A supplies the material free from defects. Each unit of B and C requires one unit of A as the input material.

If B purchases from outside, it has to pay ₹ 15 per unit. If B purchases from A, it has to incur in addition to the transfer price, ₹ 2 per unit as variable cost to modify it.

B has sufficient idle capacity to inspect its inputs without additional costs.

If C gets material from A, it can use it directly, but if it gets material from outside, which is at ₹ 15, it has to do one of the following:

(i) Inspect it at its own shop floor at ₹ 3 per unit

Or

(ii) Get the supplier to supply inspected products and pay the supplier ₹ 2 p. u. as inspection charges.

Or

(iii) A has enough idle labour, which it can lend to C to inspect at Re. 1 p.u. even though C purchases from outside.

A has to fix a uniform transfer price for both B and C. The transfer price will not be known to outsiders and is at the discretion of the Divisional Managers.

What is the best strategy for each division and the company as a whole?

(12 Marks)(June, 2009)

Answer

B will not pay A anything more than 13, because at 13, it will incur additional cost of ₹ 2/- to modify it, $13 + 2 = 15$, the outside cost.

	A		B	C
	Outside sale	Transfer to B & C		
Divisional variable cost of production	7	7	19	25
Transfer from A			13	13
Modification			2	
Total Variable Cost of production	7	7	34	38
Selling Price	15	13	40	50
Contribution	8	6	6	12

Option for C, Purchase all units from A @ 13: Any other option is costlier.

	A	B	C
Maximum external demand	3,750	5,000	4,000
Existing capacity	5,000	2,500	2,500
Maximum capacity that can be added	5,000	1,250	2,250
Total maximum that can be produced	10,000	3,750	4,750
Additional fixed cost on expansion	24,000	6,000	18,700
Units that must be sold/transfer to get this amount as contribution	$\frac{24,000}{6} = 4,000$	$\frac{6,000}{6} = 1,000$	$\frac{18,700}{6} = 1,558.33$
External demand not covered by existing capacity	-	2,500	1,500
Decision	Expand make 10,000 units 3,750 – outside 3,750 – B 2,500 – C	Expand make 2,500 + 1,250 = 3,750 units	Do not expand make only 2,500 units.

	A	B	C
--	---	---	---

	Outside sale	Transfer to B & C		
Units	3,750	$3,750 + 2,500 = 6,250$	3,750	2,500
Contribution / unit	8	6	6	12
Contribution (₹)	30,000	37,500	22,500	30,000
		67,500	22,500	30,000
Additional Fixed Cost		24,000	6,000	-
Net revenue addition		43,500	16,500	30,000

Individual strategy is the Company's best strategy.

Question 10

Optically Ltd. makes two kinds of products, P (lenses) and Q (swimming goggles) in divisions P and Q respectively. P is an input for Q and two units of P are needed to make one unit of Q.

The following data is given to you for a period :

	P ₹/u of P	Q ₹/u of Q
Direct Materials	20	25 (excluding P)
Direct Labour	30	35
Variable Overhead	10	20
External Demand (units)	3,000	3,000
Capacity (units)	7,000	2,500
Selling Price ₹/u (outside market)	100	410

If Q buys P from outside, it has the following costs:

For order quantity 2,499 or less ₹ 90 per unit for the entire quantity ordered.

For order quantity 2,500 – 5,000 ₹ 80 per unit for the entire quantity ordered.

For order quantity more than 5,000 ₹ 70 per unit for the entire quantity ordered.

You are required to:

(i) *Evaluate the best strategies for Division P and Q.*

(ii) *Briefly explain the concept of goal congruence.*

(12 Marks)(Nov., 2009)

Answer

(i) Optically Ltd manufactures P (lenses) and Q (swimming goggles).

Division P has option to supply to Division Q or sell to outside market.

Division Q has option to buy from Division P or purchase from outside market.

However, both divisions have to work within their individual capacity.

Variable Cost for product P in Division P = ₹ 60.

Variable cost for product Q in Division Q (excluding 2 Nos P's) = ₹ 80.

Division P has better market price of its product P than the market price offered to Q division.

For maximizing profit of the organization :	₹
P division should optimise its profit by selling maximum units to outside market.	
Contribution per unit for sale to outside for division P	40
Contribution per unit for Div Q as follows :	
Sale price - Variable cost (excluding lenses)	330
Max Contribution per unit (if procured from P div at its variable cost i.e ₹ 60)	210
Min Contribution per unit (if procured at ₹ 90 per unit from outside)	150
Contribution per unit at transfer price of ₹ 70 i.e minimum market price	190

Option 1 : Division Q buys 5001 units from market @ ₹ 70 and meets its capacity.
Division P sells 3000 units to outside market @ ₹ 100

Sale / Transfer	Contrib. /unit	Contribution in thousand rupees		
	₹	P Div	Q Div	Total
DivP :Sale of 3000 units to outside market @ ₹ 100	40	120		120
DivQ: Sale of 2500 units with P from market @ ₹ 70	190		475	475
Less : cost of rejection of one unit of product P			-0.07	-0.07
			474.9	
Total		120	3	594.93

Option 2 : Division P sells 3000 units to outside market, transfer 4000 units to div Q and Division Q buys 1000 units from outside market to work within the capacity

P Division agrees to a transfer price so that profitability of Q is not affected. To maintain the same profitability of Q, contribution required from 2000 units for Div Q is ₹ 400,000

i.e contribution per unit ₹ 200 i.e transfer price per unit of P is ₹ 65 per unit to make cost of lences ₹ 130

Sale / Transfer	Contrib. /unit	Contribution in thousand rupees		Total
		P Div	Q Div	
Div P : Sale of 3000 units to outside market	40	120		120
Div P : Transfer of 4000 units to div Q at ₹ 65	5	20		20
Div Q : Sale of 2000 units with P from P div @ ₹ 65	200		400	400
Div Q : Sale of 500 units with P from market @ ₹ 90	150		75	75
Total		140	475	615

Under Option 1, both divisions worked dis-jointly without caring for capacity utilization resulting lower profitability of the organization.

Under Option 2, both divisions worked with mutual advantages for optimizing their individual profits and overall profit for the organization has gone up by effective utilization of capacity.

Product P from Division P fetches higher price from open market indicating good quality of product. Moreover, supply from P division is well assured in the long run which is the justification of establishment of two parallel divisions.

Hence, Option 2 is suggested.

- (ii) Division functioning as profit centers strive to achieve maximum divisional profits, either by internal transfers or from outside purchase. This may not match with the organisation's objective of maximum overall profits. Divisions may be commercial to advice overall objects objectives, where divisional decisions are in line with the overall best for the company, and this is goal congruence. Divisions at a disadvantage may be given due weightage while appraising their performance. Goal incongruence defeats the purpose of divisional profit centre system.

Question 11

In a company, division A makes product A and Division B makes product B.

One unit of A needs one unit of B as input. State the unit transfer price to be adapted by the transferring Division A to B in each of the following independent situations:

- (i) *There is a ready market for A. There are no constraints for production or demand for A and A does not incur any external selling cost.*

- (ii) Supply is more than demand for A. External market resorts to distress price for A and this is expected to last for a temporary period. The product cannot be stocked until better times.
- (iii) Product A is highly specialized. Internal specifications are too many that B has to only buy from A.
- (iv) A has excess capacity. It can transfer any quantity to B. Goal congruence is to be achieved.
- (v) A has no spare capacity, has adequate demand in a competitive market.
- (vi) A has no spare capacity and has adequate demand in a competitive market. But on units transferred to B, it incurs ₹ 10 per unit as additional transport cost and ₹ 10,000 as fixed expenses irrespective of the number of units transferred.

(8 Marks)(Nov., 2011)

Answer

Transfer Price

- (i) Market Price = Transfer price
- (ii) For any quantity that the market can absorb, Price offered by B or Market price whichever is higher
For quantity that the market can no longer absorb, any price that B may offer
- (iii) Maximum Transfer price = Total Cost + Profit subject to maxim price B can pay to keep its ultimate product profitable.
Minimum transfer price = variable cost
- (iv) Transfer Price = Variable Cost to A
- (v) Transfer price = Either Market Price or Variable Cost + Opportunity Cost of diverting market sale
- (vi) Transfer price = Variable Cost + Opportunity Cost + specific cost + (fixed cost/units transferred)
Transfer Price/unit = (Market Price + 10) + (10,000/units transferred)

The question has an error. It says "one unit of A needs one unit of B". Hence students can assume B transfers to A. Then, considering each sub division independently,

- (i) B will offer A at market price of B less any avoidable selling expenses on units transferred to A.
- (ii) A will stop buying from B since stock already exists.
- (iii) Maximum Transfer price = Total Cost + Profit subject to maxim price B can pay to keep its ultimate product profitable.
Minimum transfer price = variable cost

- (iv) Transfer Price = Variable Cost to A
 (v) A will pay up to market price of B, less any avoidable selling expenses for transfers to A
 (vi) Transfer price = Variable Cost + Opportunity Cost + specific cost + (fixed cost/units transferred)

$$\text{Transfer Price/unit} = (\text{Market Price} + 10) + (10,000/\text{units transferred})$$

Question 12

AB Ltd. makes component 'C' and billing machines. Division A makes component 'C' that is used in the final assembly of the machine in Division B.

(One unit of Component 'C' is used per machine). Component C has an outside market also. A and B operate as profit centres and each can take its own decisions. The following data is given in the existing scenario for Divisions A and B, under which Division A has enough special and external demand to use its capacity and hence is offering B rates of 800 ₹/Unit for quantity up to 750 units and 900 ₹/unit for more than 750 units, so that its outside contribution is not affected by transfers to B. A and B can sell any quantity up to the maximum indicated under 'units sold', without affecting their future demands.

	Division A		Division B	
	External Market (normal sales)	Special sales	External Market (normal sales)	
Selling Price (₹/u)	1,000	800	4,000	
Variable manufacturing cost (₹/u)	600	600	1,500*	(*excluding component C)
Variable selling cost (₹/u)	100**	--	200**	(** Not incurred on inter division transfers)
Total variable cost (₹/unit)	700	600	1,700*	(*excluding component C)
Contribution (₹/unit)	300	200		
Units Sold	1,250	750	900	
Production capacity	2,000 units		900 units	

For the next period, A requires for its own use in its selling outlets, 50 units of billing machines produced by B. B's manager proposes as follows:

Option I - B will supply 50 machines to A on its variable manufacturing cost basis provided A supplies to B, 500 units of Component C at A's variable manufacturing cost basis.

Option II - Both A and B resort to total variable cost per unit basis applicable to normal external sale, though neither A nor B incurs any selling cost on inter division transfers. A will be given 50 machines for its use. A will have to supply B all the 900 units that B requires.

Option III - Both A and B use the external market selling price (i.e. 1,000 and 4,000 ₹/Unit for 900 units of Component 'C' and 50 machines respectively).

From a financial perspective, advise Division A's manager what he should choose. Support your advice with relevant figures.

What is the change in the rate of discount per unit given by B to A (based on unit transfer price to market price ratio) from option I to option II ?

(Note: Students need not work out the total cost statements. Steps showing relevant figures for evaluation are sufficient).
(10 Marks)(May, 2012)

Answer

Note : The basic strategy for division A is to first divert the Special Sales and then the Normal Sales in the external market to minimize the opportunity loss. The analysis is done on this basis.

	Option 1	Option 2	Option 3
Opportunity Lost (Units)			
Special Sales	500	750	750
External Market	-	150	150
Agreed Selling Price by Division A	600	700	1,000
Agreed Selling Price by Division B (Including the Transfer price of Division A)	2,100	2,400	4,000
Contribution (Lost) / Gain ₹ per unit			
Special Sales	(200)	(100)	200
External Market	-	(200)	100
Total Contribution (Lost) / Gain (₹)			
Special Sales	(1,00,000)	(75,000)	1,50,000
External Market	-	(30,000)	15,000
Total	(1,00,000)	(1,05,000)	1,65,000
Contribution Gain per unit by buying from B (₹/u)	1,900	1,600	-
Total Contribution Gained (50 Machines) ₹	95,000	80,000	-
Net Contribution Gained (50 Machines) ₹	(5,000)	(25,000)	165,000

Decision : Option 3 is preferred.

Rate of change in discount $(1900 - 1600)/4000 = 7.5\%$

Question 13

PEX is a manufacturing company of which division PQR manufactures a single standardized product. Some of the output is sold externally whilst the remainder is transferred to division RPQ where it is a subassembly in the manufacture of that division's product. PQR has the capacity (annual) to produce 30,000 units of the product. The unit costs of division PQR's product are as under:

	₹
Direct material	40
Direct labour	20
Direct expenses	20
Variable manufacturing overheads	20
Fixed manufacturing overheads	40
Sells and packaging expenses-variable	<u>10</u>
	<u>150</u>

Annually 20,000 units of the product are sold externally at the standard price of ₹300 per unit.

In addition to the external sales, 10,000 units are transferred annually to division RPQ at an internal transfer price of ₹290 per unit. This transfer price is obtained by deducting variable selling and packing expenses from the external price since those expenses are not incurred for internal transfers.

Division RPQ incorporates the transferred-in goods into a more advanced product. The unit costs of this product are as follows:

	₹
Transferred-in-item (from division PQR)	290
Direct material and components	230
Direct labour	30
Variable overheads	120
Fixed overheads	120
Selling and packing expenses-variable	<u>10</u>
	<u>800</u>

Division RPQ's manager disagrees with the basis used to set the transfer price. He argues that the transfers should be made at variable cost plus an agreed (minimal) mark up because his division is taking output that division PQR would be unable to sell at the price of ₹300.

Partly because of this disagreement, a study of the relationship between selling price and demand has recently been carried out for each division by the company's sales director. The study has brought out the following demand schedule:

Division PQR

Selling price (₹)	200	300	400
Demand (units)	30,000	20,000	10,000

Division RPQ

Selling price (₹)	800	900	1,000
Demand (units)	14,400	10,000	5,600

The manager of the division RPQ claims that this study supports his case. He suggests that a transfer price of ₹ 120 would give division PQR a reasonable contribution to its fixed overheads while allowing division RPQ to earn a reasonable profit. He also believes that it would lead to an increase of output and an improvement in the overall level of company profits.

Required:

- Calculate the effect of the transfer price of ₹ 290 per unit on company's operating profit. Calculate the optimal product mix.
- Advise the company on whether the transfer price should be revised to ₹ 120 per unit.

(11 Marks)(Nov, 2012)

Answer

Contribution Analysis of Divisions:

(i) Contribution – Division PQR

Selling Price (₹)	200	300	400
Variable Cost (₹)	110	110	110
Contribution per Unit (₹)	90	190	290
Demand (units)	30,000	20,000	10,000
Total Contribution(₹)	27,00,000	38,00,000*	29,00,000

*Optimal

The above table shows ₹ 300 price to be the most profitable and that cutting prices would not result in increased profits.

(ii) Contribution – Division RPQ (transfer price at ₹ 290)

Selling Price (₹)	800	900	1,000
Variable Cost (₹)	680	680	680

Contribution per Unit (₹)	120	220	320
Demand (units)	14,400	10,000	5,600
Total Contribution (₹)	17,28,000	22,00,000*	17,92,000

*Optimal

(iii) Contribution – Division RPQ (at alternative transfer price ₹ 120)

Selling Price (₹)	800	900	1,000
Variable Cost (₹)	510	510	510
Contribution per Unit (₹)	290	390	490
Demand (units)	14,400	10,000	5,600
Total Contribution (₹)	41,76,000*	39,00,000	27,44,000

*Optimal

The maximum capacity of the PQR division is given as 30,000 units. Hence there is no question of internal transfer if the entire 30,000 units are sold by PQR in the external market. However, from the above computations it is clear that Division PQR would sell 20,000 units in external market to optimize its profit and therefore the maximum transfer to division RPQ is 10,000 units only. The question of transferring 14,400 units would arise as an alternative to analyze the overall profitability only when PQR sells 10,000 units in the external market. Based on the demand projection of RPQ, the demand level of 5,600 units is not relevant. It can be further noted from the question that Division RPQ will purchase the entire quantity only from Division PQR and not externally. Hence the various options would be as follows.

	Option-1	Option-2	Option-3
PQR External Sales (units)	20,000	10,000	10,000
Transfer to RPQ (units)	10,000	14,400	10,000

Overall Profitability of the Company:

(iv) Transfer Price at ₹ 290

PQR External Sales (units)	20,000	10,000	10,000
Transfer to RPQ (units)	10,000	14,400	10,000
	₹	₹	₹
Contribution PQR (External) [Refer computation (i) above]	38,00,000	29,00,000	29,00,000
Contribution PQR (Transfer) @ ₹ 190	19,00,000	27,36,000	19,00,000

[₹ 290 less ₹ 100 Variable cost [#]]			
Contribution RPQ [Refer computation (ii) above]	22,00,000	17,28,000	22,00,000
Total Contribution for the Company	79,00,000*	73,64,000	70,00,000
Fixed Costs [PQR 30,000 units x ₹40 + RPQ 10,000 units x ₹120]	24,00,000	24,00,000	24,00,000
Total Company Profit (Contribution-Fixed costs)	55,00,000	49,64,000	46,00,000

*Optimal

(v) Transfer Price at ₹ 120

PQR External Sales (units)	20,000	10,000	10,000
Transfer to RPQ (units)	10,000	14,400	10,000
	₹	₹	₹
Contribution PQR (External) [Refer computation (i) above]	8,00,000	29,00,000	29,00,000
Contribution PQR (Transfer) @ ₹ 20 [₹ 120 less ₹ 100 Variable cost [#]]	2,00,000	2,88,000	2,00,000
Contribution RPQ [Refer computation (iii) above]	39,00,000	41,76,000	39,00,000
Total Contribution for the Company	79,00,000*	73,64,000	70,00,000
Fixed Costs [PQR 30,000 units x ₹40 + RPQ 10,000 units x ₹120]	24,00,000	24,00,000	24,00,000
Total Company Profit (Contribution-Fixed costs)	55,00,000	49,64,000	46,00,000

*Optimal

The revision of transfer price has no impact on the overall profitability of the company. However, it will alter the profitability of the Divisions.

*The optimal level is 30,000 of PQR of which 20,000 units are for external sale and 10,000 units are transferred to RPQ under both the transfer prices.

[#]On internal transfers, PQR's variable cost per unit is ₹ 100, since the ₹ 10 on selling is not incurred.

Question 14

Enumerate the expected disadvantages in taking divisions as profit centres. (4 Marks)(May, 2013)

Answer

The expected disadvantages of taking divisions as profit centres are as follows:

- Divisions may compete with each other and may take decisions to increase profits at the expense of other divisions thereby overemphasizing short term results.
- It may adversely affect co-operation between the divisions and lead to lack of harmony in achieving organizational goals of the company. Thus it is hard to achieve the objective of goal congruence.
- It may lead to reduction in the company's overall total profits.
- The cost of activities, which are common to all divisions, may be greater for decentralized structure than centralized structure. It may thus result in duplication of staff activities.
- Top management loses control by delegating decision making to divisional managers. There are risks of mistakes committed by the divisional managers, which the top management, may avoid.
- Series of control reports prepared for several departments may not be effective from the point of view of top management.
- It may under utilize corporate competence.
- It leads to complications associated with transfer pricing problems.
- It becomes difficult to identify and define precisely suitable profit centres.
- It confuses division's results with manager's performance.

Question 15

B Ltd. makes three products X, Y and Z in Divisions X, Y and Z respectively. The following information is given:

	X	Y	Z
<i>Direct Material (₹ / Unit) (excluding material X for Divisions Y and Z)</i>	8	22	40
<i>Direct Labour (₹ / Unit)</i>	4	6	8
<i>Variable Overhead (₹ / Unit)</i>	2	2	2
<i>Selling price to outside customers (₹ / Unit)</i>	25	65	90
<i>Existing capacity (no. of units)</i>	6,000	3,000	3,000
<i>Maximum external Market demand (no of units)</i>	5,000	5,500	5,000

Additional fixed cost that would be incurred to install additional capacity (₹)	45,000	9,000	23,100
Maximum additional units that can be produced by additional capacity	6,000	2,000	2,250

Y and Z need material X as their input. Material X is available in the market at ₹ 23 per unit. Defectives can be returned to suppliers at their cost. Division X supplies the material free from defects and hence is able to sell at ₹ 25 per unit. Each unit of Y and Z require one unit of X as input with slight modification.

If Y purchases from outside at ₹ 23 per unit, it has to incur ₹ 3 per unit as modification and inspection cost. If Y purchases from Division X, it has to incur, in addition to the transfer price, ₹ 2 per unit to modify it.

If Z gets the material from Division X, it can use it after incurring a modification cost, of ₹ 1 per unit. If Z buys material X from outside, it has to either inspect and modify it at its own shop floor at ₹ 5 per unit or use idle labour from Division X at ₹ 3 per unit. Division X will lend its idle labour as per Z's requirement even if Z purchases the material from outside.

The transfer prices are at the discretion of the Divisional Managers and will remain confidential. Assume no restriction on quantities of inter-division transfers or purchases.

Discuss with relevant figures the best strategy for each division and for the company as a whole. (12 Marks)(Nov., 2013)

Answer

Statement Showing Contribution per unit

(₹)

Particulars	Division X			Division Y		Division Z
	Sale to	Internal Transfer to		Purchase from	Transfer from	Transfer from
	Outside	Y	Z	Outside	X	X
Selling Price	25.00	---	---	65.00	65.00	90.00
Transfer Price	---	24.00*	25.00#	---	---	---
Direct Material (Excluding Material 'X')	8.00	8.00	8.00	22.00	22.00	40.00
Direct Labour	4.00	4.00	4.00	6.00	6.00	8.00
Variable Overhead	2.00	2.00	2.00	2.00	2.00	2.00
Purchase Price 'X'	---	---	---	23.00	---	---
Transfer Price 'X'	---	---	---	---	24.00	25.00
Modification Cost	---	---	---	3.00	2.00	1.00
Contribution	11.00	10.00	11.00	9.00	9.00	14.00

- (*) Division 'Y' will not pay Division 'X' anything more than ₹ 24, because at 24, it will incur additional cost of ₹ 2 per unit to modify it, ₹ 23 + ₹ 3 = ₹ 26, the outside cost.
- (#) To purchase material X from outside is costly for Division 'Z' as after modification at own shop floor, cost of the same comes to Division 'Z' is ₹ 28 (₹ 23 + ₹ 5).

If Division 'X' goes to utilize its full capacity in that case labour would not be available for modification to Department 'Z'.

Accordingly Division 'Z' may purchase material X at ₹ 25 from Division 'X' i.e. market price to outsiders.

Statement Showing Internal Transfer Decision (units)

Particulars	X	Y	Z
Existing Capacity ... (A)	6,000 units	3,000 units	3,000 units
Maximum Capacity that can be added ... (B)	6,000 units	2,000 units	2,250 units
Total Maximum that can be produced ... (C)=(A)+(B)	12,000 units	5,000 units	5,250 units
Maximum External Demand ... (D)	5,000 units	5,000 units	5,000 units
Balance ... (C) – (D)	7,000 units	---	250 units
Internal Transfer to Other Divisions	5,000 units to Z* 2,000 units to Y	N.A.	N.A.
Internal Transfer from Other Divisions	N.A.	2,000 units transfer from X (material X)	5,000 units transfer from X (material X)

- (*) Division 'X' will supply its production to Division 'Z' first (after meeting its external requirement) as contribution from product Z is high.

Statement Showing Decision Whether to Expand or Not

Particulars	X	Y	Z
Additional Fixed Cost on Expansion	₹ 45,000	₹ 9,000	₹ 23,100
Contribution that can be earned by expansion	₹ 64,000 (4,000 units × ₹ 11 + 2,000 units × ₹ 10)	₹ 18,000 (2,000 units × ₹ 9)	₹ 28,000 (2,000* units × ₹ 14)
Net Benefit from Expansion	₹ 19,000	₹ 9,000	₹ 4,900
Decision	Expansion	Expansion	Expansion

- (*) As maximum demand of product Z is 5,000 units which Division 'Z' first complete with existing capacity of 3,000 units. Balance 2,000 units from expansion.

Statement Showing Net Revenue Addition

(₹)

Particulars	X	Y	Z	Total
Contribution	55,000	45,000	70,000	1,70,000
– External Sales	(5,000 units × ₹11)	(5,000 units × ₹ 9)	(5,000 units × ₹14)	
Contribution	75,000	---	---	75,000
– Internal Transfer	(2,000 units × ₹10 + 5,000 units × ₹11)			
Additional Fixed Cost	45,000	9,000	23,100	77,100
Net Revenue Addition				1,67,900

Strategy for Company & Divisions

- (i) Division 'X' will transfer maximum possible material to Division 'Z' as Division 'Z' is offering maximum transfer price to Division 'X'. At the same time Division 'Z' is fetching maximum contribution for the organisation so it is beneficial for both the Divisions as well as organisation as a whole.
- (ii) As shown above all the three Divisions are getting net benefit when they are taking decision to expand and hence, all the three Divisions should expand there activity by incurring additional fixed cost on expansion.

Uniform Costing and Inter Firm Comparison

Question 1

What is uniform costing? Why is it recommended?

(4 Marks)(June, 2009)

Answer

Uniform Costing: It is not a distinct method of costing when several undertakings start using the same costing principles or practices, they are said to be following uniform costing. Different concerns in an industry should adopt a common method of costing and apply uniformly the same principles and techniques for better cost comparison and common good and helps in mutual cost control and cost reduction. Hence, it is recommended that a uniform method of costing should be adopted by the member units of an industry.

Question 2

What are the essential requisites for the installation of Uniform costing system?

(4 Marks)(May, 2011)

Answer

Essential Requisites for Installation of Uniform Costing System:

- A. Firms should be willing to share or furnish relevant data /information.
- B. Spirit of mutual trust and co-operation should prevail among participating firms.
- C. Mutual exchange of ideas, methods used, special achievements made, research and know – how should be frequent.
- D. Bigger firms should lead in sharing their experience to enable smaller firms to improve their performance.
- E. Uniformity should be established with regard to the size of units, production methods, accounting methods, procedures and principles used.

Question 3

Discuss the essential requisites for installation of uniform costing system. (4 Marks)(Nov, 2012)

Answer

The following are the essential requisites for the installation of uniform costing system

- (i) Firms in the industry should be willing to share/furnish relevant data/information.
- (ii) A spirit of collaboration and mutual trust should prevail among the participating firms.
- (iii) Mutual exchange of ideas, methods, special achievements, research and knowhow should be frequent.
- (iv) Larger firms should take the lead towards sharing their experience and knowhow with smaller firms to enable the latter to improve their performance.
- (v) Uniformity must be established with regard to the following before introducing uniform costing:
 - ✓ Size of various units covered by uniform costing
 - ✓ Production method
 - ✓ Accounting principles, methods and procedures

Question 4

State the advantages available in inter-firm comparison. (5 Marks)(May, 2013)

Answer

Advantages of Inter-firm comparison: The main advantages of inter-firm comparison are:

- Such a comparison gives an overall view of the industry as a whole to its members– the present position of the industry, progress made during the past and the future of the industry.
- It helps a concern in knowing its strengths or weaknesses in relation to others so that remedial measures may be taken.
- It ensures an unbiased specialized reporting on particular problems of the concern.
- It develops cost consciousness among members of the industry.
- It helps Government in effecting price regulation.
- It helps to improve the quality of products manufactured and to reduce the cost of production. It is thus advantageous to the industry as well as to the society.

Question 5

What are the limitations of Uniform Costing?

(4 Marks)(Nov., 2013)

Answer

Limitations of Uniform Costing

- (i) Sometimes it is not possible to adopt uniform standards, methods and procedures of costing in different firms due to differing circumstances in which they operate. Hence, the adoption of uniform costing becomes difficult in such firms.
- (ii) Disclosure of cost information and other data is an essential requirement of a uniform costing system. Many firms do not wish to share such information with their competitors in the same industry.
- (iii) Small firms in an industry believe that uniform costing system is only meant for big and medium size firms, because they cannot afford it.
- (iv) It induces monopolistic trend in the business, due to which prices may be increased artificially and supplies withheld.

Cost Sheet, Profitability Analysis and Reporting

Question 1

"Balanced score card and performance measurement system endeavours to create a blend of strategic measures, outcomes and drive measures and internal and external measures". Discuss the statement and explain the major components of a balanced score card.

(4 Marks)(May, 2005)

Answer

The balanced score card translates an organization's mission and strategy into a comprehensive set of performance measures that provides the framework for implementing its strategy. The balanced score card does not focus solely on achieving financial objectives. It is an approach, which provides information to management to assist in strategic policy formulation and achievement. It emphasizes the need to provide the user with a set of information, which addresses all relevant areas of performance in an objective and unbiased manner. As a management tool it helps companies to assess overall performance, improve operational processes and enables management to develop better plans for improvements.

Major components of a balanced scorecard - The components of balanced score cards varies from business to business. A well designed balanced scorecard combines financial measures of past performance with measures of firm's drivers of future performance. The specific objectives and measures of an organization-balanced scorecard can be derived from the firm's vision and strategy. Generally, balanced score card has the following four perspectives from which a company's activity can be evaluated.

- (i) **Financial perspective:** Financial perspective measures the results that the organization delivers to its stakeholders. The measures are: operating income, revenue growth, revenues from new products, gross margin percentage, cost reduction in key areas, economic value added, return on investment.
- (ii) **Customer perspective:** The customer perspective considers the business through the eyes of customers, measuring and rejecting upon customer satisfaction.

The measures are: - market share, customer satisfaction, customer retention percentage, time taken to fulfil customer's requests.

- (iii) *Internal business perspective*: The internal perspective focuses attention on the performance of the key internal processes, which drive the business such as innovative process, operation process and post-sales services.
- (iv) *Learning & growth perspective*: The measure are:- employee education & skills levels, employee turnover ratio, information system availability, percentage of employee suggestion implemented etc.

Question 2

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 of maharaja produced and sold	40,000	42,000
2. Selling Price per unit in ₹.	1,000	1,100
3. Total Direct Material (Square feet)	1,20,000	1,23,000
4. Direct material cost per square feet in ₹.	100	110
5. Manufacturing Capacity (in units)	50,000	50,000
6. Total Conversion cost in ₹.	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 customer	290 customer
9. Total selling and customer service cost in ₹.	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

- Describe briefly key elements that would include in Kitchen King's Balance Score Card.
- Calculate the Growth, Price-recovery and productivity component that explain the change in operating income from 2003 to 2004. (18 Marks)(Nov., 2005)

Answer

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 Perspective – Increase in operating income by charging higher margins on Maharaja.
- ◆ Customer Perspective – 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 Perspective: Development time for designing new end product and improvement in manufacturing process.

Operative Income:

	<i>(Amount in 000 ₹.)</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

$$(a) \text{ Revenue effect} = \text{Output Price in 2003} \{ \text{Actual units sold in 04} - \text{Actual units sold in 03} \} \\ = ₹1, 000 (42,000 \text{ units} - 40,000 \text{ units}) = ₹20, 00,000 (F)$$

(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 }

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

(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 ₹14, 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]

$$= 42,000 \text{ units } (\text{₹}1, 100 - \text{₹}1, 000) = \text{₹}42, 00,000 \text{ (F)}$$

- (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) Direct material = 1, 26,000sqft (₹100/sqft – ₹110/sqft)=₹12, 60,000 (A)

(b) Conversion Cost = 50,000 units (₹200/unit – ₹220/unit)
= ₹10, 00,000(A)

(c) S & Custr Service = 300 customers (₹24, 000 – ₹25,000)
= ₹3,00,000 (A) = ₹ 25, 60,000 (A)

Increase in Operating income due to Price Recovery is ₹16, 40,000 (F)
{₹42, 00,000 – ₹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: ₹110/sqft (1, 26,000 units – 1, 23,000 units) = ₹3, 30,000(F)

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

(iii) Selling & Customer = ₹25, 000 (300 customers – 290 customers) = ₹2,50,000 (F)
= ₹ 5,80,000 (F)

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

(Amount in 000 ₹.)					
	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 3

What are the elements of a Balanced Score card? Also explain how it can be used as a Financial Planning model.
(4 Marks)(May, 2006)

Answer

The elements of a balanced score card are:

- (i) Financial perspective
- (ii) Customer perspective
- (iii) Internal business process perspective
- (iv) Learning and growth perspective.

The objective of the balanced score card is to provide a comprehensive framework for translating the company's strategic objectives into a coherent set of performance measures. It emphasizes the use of financial and non-financial measures as part of the programme to achieve future financial performance. It helps in planning, setting targets and aligning strategic initiatives.

To evaluate the success of the implementation of the strategy, the company can assess the change in the operating income by comparing the targeted operating income with the actual operating income. The change in the operating income may arise due to growth factor, change in the price of inputs and outputs and productivity factor. The company is said to be successful in implementation of strategy only if the change in the operating income closely aligns with that strategy.

Question 4

Explain briefly the major components of a balanced score card. (4 Marks) (May, 2007)

Answer

An ideal Balanced score card combines financial measures of past performance with measures of the firm's drivers of future performance. The following perspectives are evaluated:

- (i) Customer perspective – Measures of price / delivery / quality / support.
- (ii) Internal perspective – Measures of efficiency / sales penetration and new product introduction.
- (iii) Innovation and learning perspective – Measures of technology / cost leadership.
- (iv) Financial perspective – Sales / Cost of sales / Return on capital employed etc.

Question 5

"In many organisations, initiatives to introduce balanced score card failed because efforts were made to negotiate targets rather than to build consensus."

Required:

Elucidate the above statement.

(8 Marks) (Nov., 2007)

Answer

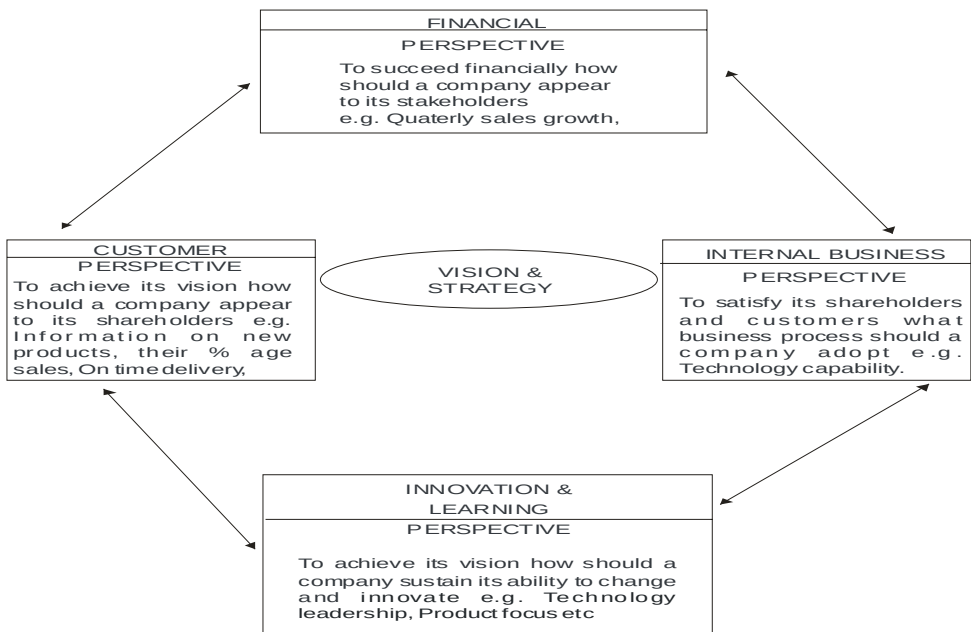
Balanced score card is a set of financial and non-financial measures relating to a company's critical success factors. It is an approach which provides information to management to assist in strategy implementation. Therefore, the components to be included in the balanced score card must flow from strategy. The targets should be measurable and must flow from strategy and corporate plan of the company. It is necessary that managers should agree to the components and targets because in absence of a consensus, managers may not commit to the targets established by the top management / the board of directors. Moreover, the functions are interdependent and results in one functional area/perspective (e.g. innovation and learning) have direct bearing on the results in other functional area / perspective (e.g. customer perspective). Therefore, it is not sufficient that individual managers agree to their targets. Successful implementation requires that the top management builds an overall consensus on the components and targets of the balanced score card. Negotiation undermines the fundamental principle that the components and targets should flow from strategy. As a result, an approach to establish targets through negotiation defeats the very purpose of balanced score card.

Question 6

Explain the features of a balanced scored card.

(4 Marks)(May, 2012)

Answer



A Balanced score card includes information, both financial and non-financial elements under 4 perspectives with a long term goal of improved financial performance.

Perspective	Parameters
Customer	Sales % Delivery time New product information
Internal business perspective	Business process to be adopted Technological capability Internal efficiency parameters
Innovation/ learning perspective	How a company should sustain its ability to change and innovate Technology leadership Product focus Kaizen approach
Financial perspective	Sales growth How the company should appear to its shareholders Operating income by segments

Question 7

What do you mean by DPP? What are its benefits?

(4 Marks)

Answer

Direct Product Profitability (DPP) is 'Used primarily within the retail sector, and involves the attribution of both the purchase price and other indirect costs *such as distribution, warehousing, retailing* to each product line. Thus a net profit, as opposed to a gross profit, can be identified for each product. The cost attribution process utilises a variety of measures *such as warehousing space, transport time* to reflect the resource consumption of individual products.'

Benefits of Direct Product Profitability:

- Better Cost Analysis - Cost *per product* is analysed to know the profitability of a particular product.
- Better Pricing Decision- It helps in price determination as desired margin can be added with the actual cost.
- Better Management of Store and Warehouse Space- Space Cost and Benefit from a product can be analysed and it helps in management of store and warehouse in profitable way.
- The Rationalisation of Product Ranges etc.

Linear Programming

Question 1

A manufacturing company produces two types of product the SUPER and REGULAR. Resource requirements for production are given below in the table. There are 1,600 hours of assembly worker hours available per week. 700 hours of paint time and 300 hours of inspection time. Regular customers bill demand at least 150 units of the REGULAR type and 90 units of the SUPER type.

Table				
Product	Profit/contribution Rs.	Assembly time Hrs.	Paint time Hrs.	Inspection time Hrs.
REGULAR	50	1.2	0.8	0.2
SUPER	75	1.6	0.9	0.2

Formulate and solve the given Linear programming problem to determine product mix on a weekly basis. (8 Marks) (Nov., 2004)

Answer

Let x_1 and x_2 denote the number of units produced per week of the product 'REGULAR' and 'SUPER' respectively.

$$\text{Maximise } Z = 50x_1 + 75x_2$$

Subject to

$$1.2x_1 + 1.6x_2 \leq 1,600 \text{ or } 12x_1 + 16x_2 \leq 16,000 \quad \text{-(i)}$$

$$0.8x_1 + 0.9x_2 \leq 700 \text{ or } 8x_1 + 9x_2 \leq 7,000 \quad \text{-(ii)}$$

$$0.2x_1 + 0.2x_2 \leq 300 \text{ or } 2x_1 + 2x_2 \leq 3,000 \quad \text{-(iii)}$$

$$x_1 \geq 150 \quad \text{-(iv)}$$

$$x_2 \geq 90 \quad \text{-(v)}$$

Let

$$x_1 = y_1 + 150$$

$$x_2 = y_2 + 90 \text{ where } y_1, y_2 \geq 0$$

$$\text{Maximize } Z = 50(y_1 + 150) + 75(y_2 + 90) \text{ or, } Z = 50y_1 + 75y_2 + 14,250$$

Subject to :

$$12(y_1 + 150) + 16(y_2 + 90) \leq 16,000$$

$$8(y_1 + 150) + 9(y_2 + 90) \leq 7,000$$

$$2(y_1 + 150) + 2(y_2 + 90) \leq 3,000$$

$$\text{and } y_1, y_2 \geq 0$$

Adding slack variables s_1, s_2, s_3 , we get

$$\text{Maximize } Z = 50y_1 + 75y_2 + 14,250 + 0s_1 + 0s_2 + 0s_3 \text{ subject to}$$

$$12y_1 + 16y_2 + s_1 = 12,760$$

$$8y_1 + 9y_2 + s_2 = 4,990$$

$$2y_1 + 2y_2 + s_3 = 2,520; \quad y_1, y_2, s_1, s_2, s_3 \geq 0$$

Table -1

C_j			50	75	0	0	0	
			y_1	y_2	s_1	s_2	s_3	
C_b								
0	s_1	12,760	12	16	1	0	0	12760/16
0	s_2	4,990	8	9	0	1	0	4990/9
0	s_3	2,520	2	2	0	0	1	2520/2
			-50	-75	0	0	0	
Δ_j								

Table II

C_j			50	75	0	0	0
C_b			y_1	y_2	s_1	s_2	s_3
0	s_1	3889	-20/9	0	1	-16/9	0
75	y_2	554.44	8/9	1	0	1/9	0
0	s_3	1411	2/9	0	0	-2/9	1
Δ_j			50/3	0	0	75/9	0

Since all the elements in the index row are either positive or equal to zero, table II gives an optimum solution which is $y_1 = 0$ and $y_2 = 554.44$

Substituting these values we get

$$x_1 = 0 + 150 = 150$$

$$x_2 = 90 + 554.44 = 644.44 \text{ and the value of objective function is}$$

$$\begin{aligned} Z &= 50 \times 150 + 75 \times 644.44 \\ &= ₹ 55,833 \end{aligned}$$

Question 2

A company manufactures two products A and B, involving three departments – Machining, Fabrication and Assembly. The process time, profit/unit and total capacity of each department is given in the following table:

	Machining (Hours)	Fabrication (Hours)	Assembly (Hours)	Profit (Rs).
A	1	5	3	80
B	2	4	1	100
Capacity	720	1,800	900	

Set up Linear Programming Problem to maximise profit. What will be the product Mix at Maximum profit level ?
(9 Marks)(May,2005)

Answer

$$\begin{aligned} \text{Maximize } z &= 80x + 100y \text{ subject to} & x + 2y &\leq 720 \\ & & 5x + 4y &\leq 1800 \\ & & 3x + y &\leq 900 \\ & & x \geq 0, y &\geq 0 \\ \text{where} & & x &= \text{No. of units of A} \\ & & y &= \text{No. of units of B} \end{aligned}$$

By the addition of slack variables s_1 , s_2 and s_3 the inequalities can be converted into equations. The problems thus become

$$\begin{aligned} z &= 80x + 100y + 0s_1 + 0s_2 + 0s_3 \text{ subject to} & x + 2y + s_1 &= 720 \\ & & 5x + 4y + s_2 &= 1800 \\ & & 3x + y + s_3 &= 900 \\ \text{and } x &\geq 0, & y &\geq 0, & s_1 &\geq 0, & s_2 &\geq 0, & s_3 &\geq 0 \end{aligned}$$

Table 1:

			80	100	0	0	0	
	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃	
S ₁	0	720	1	2	1	0	0	$\frac{720}{2} = 360$
S ₂	0	1800	5	4	0	1	0	$1800/4 = 450$
S ₃	0	900	3	1	0	0	1	$900/1 = 900$
Net evaluation row			80	100	0	0	0	
$1800 - 720 \times 4/2 = 360$			$900 - 720 \times 1/2 = 540$					
$5 - 1 \times 2 = 3$			$3 - 1 \times \frac{1}{2} = 5/2$					
$4 - 2 \times 2 = 0$			$1 - 2 \times 1/2 = 0$					
$0 - 1 \times 2 = -2$			$0 - 1 \times 1/2 = -1/2$					
$1 - 0 \times 2 = 1$			$0 - 0 \times 1/2 = 0$					
$0 - 0 \times 2 = 0$			$1 - 0 \times 1/2 = 1$					

Table 2:

			80	100	0	0	0	
Program	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃	
Y	100	360	$\frac{1}{2}$	1	$\frac{1}{2}$	0	0	$360 \div 1/2 = 720$
S ₂	0	360	3	0	-2	1	0	$360 \div 3 = 120$
S ₃	0	540	$5/2$	0	-1/2	0	1	$540 \div 5/2 = 216$
Net evaluation row			30	0	-50	0	0	

$$360 - 360 \times 1/6 = 300$$

$$\frac{1}{2} - 3 \times 1/6 = 0$$

$$1 - 0 \times 1/6 = 1$$

$$\frac{1}{2} - -2 \times 1/6 = 5/6$$

$$0 - 1 \times 1/6 = -1/6$$

$$0 - 0 \times 1/6 = 0$$

$$540 - 360 \times 5/6 = 240$$

$$5/2 - 3 \times 5/6 = 0$$

$$0 - 0 \times 5/6 = 0$$

$$-1/2 - -2 \times 5/6 = 7/6$$

$$0 - 1 \times 5/6 = -5/6$$

$$1 - 0 \times 5/6 = 1$$

Table 3:

			80	100	0	0	0
Program	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃
Y	100	300	0	1	5/6	-1/6	0
X	80	120	1	0	-2/3	1/3	0

S3	0	240	0	0	7/6	-5/6	1
Net evaluation row			0	0	-500/6	+100/6	
					+160/3	-80/3	0
					$= \frac{180}{6}$	$= -\frac{60}{6}$	

All the values of the net evaluation row of Table 3 are either zero or negative, the optimal program has been obtained.

Here $X = 120$, $y = 300$ and the maximum profit

$$= 80 \times 120 + 100 \times 300 = 9600 + 30,000$$

$$= ₹ 39,600.$$

Question 3

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 ₹ (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. (11 Marks)(Nov.,2005)

Answer

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

$$\text{Maximize } Z = 12 X_1 + 15X_2 + 14 X_3$$

Subject to the constraints:

$$- X_1 + X_2 \leq 0$$

$$- X_2 + 2X_3 \leq 0$$

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

$$X_1, X_2, X_3 > 0$$

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

			12	15	14	0	0	0
C_b	X_b	X_b	X_1	X_2	X_3	X_4	X_5	X_6
0	X_4	0	-1	1*	0	1	0	0
0	X_5	0	0	-1	2	0	1	0
0	X_6	100	1	1	1	0	0	1
	Z		-12	-15	-14	0	0	0
C_b	X_b	X_b	X_1	X_2	X_3	X_4	X_5	X_6
15	X_2	0	-1	1	0	1	0	0
0	X_5	0	-1	0	2	1	1	0
0	X_6	100	2*	0	1	-1	0	1
	Z		-27		-14	15	0	0
C_b	X_b	X_b	X_1	X_2	X_3	X_4	X_5	X_6
15	X_2	50	0	1	1/2	1/2	0	1/2
0	X_5	50	0	0	5/2*	1/2	1	1/2
12	X_1	50	1	0	1/2	-1/2	0	1/2
	Z		0	0	-1/2	3/2	0	27/2
C_b	X_b	X_b	X_1	X_2	X_3	X_4	X_5	X_6
15	X_2	40	0	1	0	2/5	-1/5	2/5
14	X_3	20	0	0	1	1/5	2/5	1/5
12	X_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 $Z = 1360$.

Question 4

What are the practical applications of Linear programming?

(7 Marks) (May, 2007)

Answer

Linear programming can be used to find optional solutions under constraints.

In production:

- pdt. mix under capacity constraints to minimise costs / maximise profits along with marginal costing.
- Inventory management to minimise holding cost, warehousing / transporting from factories to warehouses etc.

Sensitivity Analysis: By providing a range of feasible solutions to decide on discounts on selling price, decisions to make or buy.

Blending: Optional blending of raw materials under supply constraints.

Finance: Portfolio management, interest/receivables management.

Advertisement mix: In advertising campaign – analogous to pdn. management and pdt. mix.

Assignment of personnel to jobs and resource allocation problems.

However, the validity will depend on the manager's ability to establish a proper linear relationship among variables considered.

Question 5

Transport Ltd. Provides tourist vehicles of 3 types – 20-seater vans, 8-seater big cars and 5-seater small cars. These seating capacities are excluding the drivers. The company has 4 vehicles of the 20-seater van type, 10 vehicles of the 8-seater big car types and 20 vehicles of the 5-seater small car types. These vehicles have to be used to transport employees of their client company from their residences to their offices and back. All the residences are in the same housing colony. The offices are at two different places, one is the Head Office and the other is the Branch. Each vehicle plies only one round trip per day, if residence to office in the morning and office to residence in the evening. Each day, 180 officials need to be transported in Route I (from residence to Head Office and back) and 40 officials need to be transported in Route II (from Residence to Branch office and back). The cost per round trip for each type of vehicle along each route is given below.

You are required to formulate the information as a linear programming problem, with the objective of minimising the total cost of hiring vehicles for the client company, subject to the constraints mentioned above. (only formulation is required. Solution is not needed).

Figs. – ₹/round trip			
	20-seater vans	8-seater big cars	5-seater small cars
Route I – Residence – Head Office and Back	600	400	300
Route II – Residence – Branch Office and Back	500	300	200

(8 Marks) (May, 2008)

Answer

Type	I	II	III	Total no. of passengers
	20 – Seater vans	8 – Seater Big cars	5 – Seater Small cars	
Route I Residence H.O. Residence	600	400	300	180
Route II Residence Br. Residence	500	300	200	40
No. of vehicles	4	10	20	220
Max. capacity	80	80	100	
No. of passengers				260

Let i be the i th route,

and j be the type of vehicle, so that

S_{11} = no. of 20 seater vans on Route I

S_{12} = no. of 8 seater cars on Route I

S_{13} = no. of 5 seater cars on Route I

S_{21} = no. of 20 seater vans on Route II

S_{22} = no. of 8 seater cars on Route II

S_{23} = no. of 5 seater cars on Route II

Objective:

Minimise

$$\text{Cost } Z = 600 S_{11} + 400 S_{12} + 300 S_{13} + 500 S_{21} + 300 S_{22} + 200 S_{23}$$

Subject to

$$20 S_{11} + 8 S_{12} + 5 S_{13} = 180$$

$$20 S_{21} + 8 S_{22} + 5 S_{23} = 40$$

$$S_{11} + S_{21} \leq 4$$

$$S_{12} + S_{22} \leq 10$$

$$S_{13} + S_{23} \leq 20$$

$$\text{All } s_{ij} \geq 0$$

Question 6

The costs and selling prices per unit of two products manufacturing by a company are as under:

Product	A (Rs.)	B (Rs.)
Selling Price	500	450
Variable costs:		
Direct Materials @ ₹ 25 per kg.	100	100
Direct Labour @ ₹ 20 per hour	80	40
Painting @ ₹ 30 per hour	30	60
Variable overheads	190	175
Fixed costs @ ₹ 17.50/D.L.Hr.	70	35
Total costs	470	410
Profit	30	40

In any month the maximum availability of inputs is limited to the following:

Direct Materials	480 kg.
Direct Labour hours	400 hours
Painting hours	200 hours

Required:

- Formulate a linear programme to determine the production plan which maximizes the profits by using graphical approach.
- State the optimal product mix and the monthly profit derived from your solution in (i) above.
- If the company can sell the painting time at ₹ 40 per hour as a separate service, show what modification will be required in the formulation of the linear programming problem. You are required to re-formulate the problem but not to solve. (Nov 2008, 11 Marks)

Answer

Contribution analysis:

Products	A	B
	(Rs.)	(Rs.)
Selling price (A)	<u>500</u>	<u>450</u>
Variable costs:		
Direct Materials	100	100
Direct Labour	80	40
Painting	30	60
Variable Overheads	<u>190</u>	<u>175</u>
Total variable costs (B)	<u>400</u>	<u>375</u>
Contribution (A – B)	<u>100</u>	<u>75</u>

Direct Material per unit	$100/25 = 4 \text{ kg.}$	$100/25 = 4 \text{ kg.}$
Direct Labour hour per unit	$80/20 = 4 \text{ hours}$	$40/20 = 2 \text{ hours}$
Painting hour per unit	$30/30 = 1 \text{ hour}$	$60/30 = 2 \text{ hours}$

Let A be the units to be produced of product A and B be the units to be produced of product B.

LP Problem formulation:

Z Max $100A + 75B$

Maximisation of contribution

Subject to:

$$4A + 4B \leq 480$$

Raw material constraint

$$4A + 2B \leq 400$$

Direct Labour hour constraint

$$A + 2B \leq 200$$

Painting hour constraint

$$A, B \geq 0$$

Non negativity constraint

Raw Material Constraint : Put B = 0, A = 120

Put A = 0, B = 120

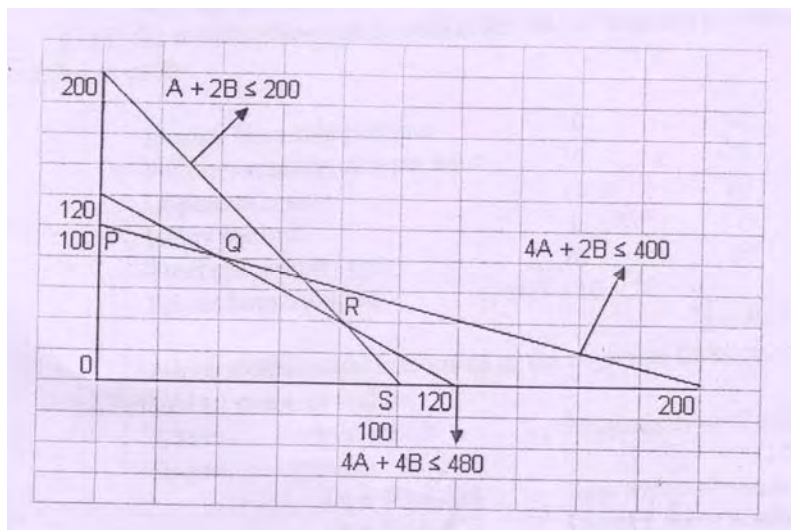
Direct Labour Constraint : Put B = 0, A = 100

Put A = 0, B = 200

Painting Constraint : Put B = 0, A = 200

Put A = 0, B = 100

The graphical representation will be as under:



Q Intersects $4A + 2B = 400$

(1)

and $4A + 4B = 480$

(2)

Subtracting (2) from (1), we get $-2B = -80$

$$\Rightarrow B = 80/2 = 40$$

Putting value of B in (1), we get $4A + 2 \times 40 = 400$

$$\Rightarrow A = \frac{400 - 80}{4} = 80$$

R Intersects $4A + 4B = 480$ (3)

and $A + 2B = 200$ (4)

Multiplying (4) by (2) and then subtracting from (3), we get

$$2A = 80$$

$$\Rightarrow A = 40$$

Putting the value of A in (4), we get $2B = 200 - 40$

$$\Rightarrow B = 80.$$

Evaluation of corner points:

Point	Products		Contribution		Total Contribution
	A	B	A (Rs.)	B (Rs.)	Rs.
P	0	100	100 per unit 0	75 per unit 7,500	7,500
Q	80	40	8,000	3,000	11,000
R	40	80	4,000	6,000	10,000
S	100	0	10,000	0	10,000

Optimal product mix is Q

Product	Units	Contribution
		Rs.
A	80	8,000
B	40	3,000
Total contribution		11,000
Less: Fixed costs 400 D.L. Hrs. $\times$ ₹ 17.50		7,000
Optimal Profit		4,000

(iii) If the painting time can be sold at ₹ 40 per hour the opportunity cost is calculated as under:

	A	B
	(Rs.)	(Rs.)
Income from sale per hour	40	40
Painting variable cost per hour	30	30
Opportunity cost	10	10
Painting hours per unit	1	2
Opportunity cost	10	20
Revised contribution	$100 - 10 = 90$	$75 - 20 = 55$

Hence, modification is required in the objective function.

Re-formulated problem will be:

Z Max.	$90A + 55B$	Maximisation of contribution
Subject to:		
	$4A + 4B \leq 480$	Raw Material constraint
	$4A + 2B \leq 400$	Direct Labour hour constraint
	$A + 2B \leq 200$	Painting hour constraint
	$A, B \geq 0$	Non-negativity constraint

Question 7

Formulate the dual for the following linear program:

Maximise : $100x_1 + 90x_2 + 40x_3 + 60x_4$

Subject to

$$6x_1 + 4x_2 + 8x_3 + 4x_4 \leq 140$$

$$10x_1 + 10x_2 + 2x_3 + 6x_4 \leq 120$$

$$10x_1 + 12x_2 + 6x_3 + 2x_4 \leq 50$$

$$x_1, x_2, x_3, x_4 \geq 0$$

(Only formulation is required. Please do not solve.)

(6 Marks)(June, 2009)

Answer

Dual:

Minimise $140u_1 + 120u_2 + 50u_3$

S.T. $6u_1 + 10u_2 + 10u_3 \geq 100$

$$4u_1 + 10u_2 + 12u_3 \geq 90$$

$$8u_1 + 2u_2 + 6u_3 \geq 40$$

$$4u_1 + 6u_2 + 2u_3 \geq 60$$

$$u_1, u_2, u_3, u_4 \geq 0$$

Question 8

The following is a linear programming problem. You are required to set up the initial simplex tableau. (Please do not attempt further iterations or solution):

Maximise

$$100x_1 + 80x_2$$

Subject to

$$3x_1 + 5x_2 \leq 150$$

$$x_2 \leq 20$$

$$8x_1 + 5x_2 \leq 300$$

$$x_1 + x_2 \geq 25$$

$$x_1, x_2 \geq 0$$

(6 Marks)(Nov., 2009)

Answer

Under the usual notations where

S1, S2, S3 are slack Variables,

A4 = the artificial variable

S4 = Surplus Variable

We have,

$$\text{Max. } Z = 100x_1 + 80x_2 + 0S_1 + 0S_2 + 0S_3 + 0S_4 - M A_4.$$

S.t.

$$3x_1 + 5x_2 + S_1 = 150$$

$$x_2 + S_2 = 20$$

$$8x_1 + 5x_2 + S_3 = 300$$

$$x_1 + x_2 - S_4 + A_4 = 25$$

		x_1	x_2	S_1	S_2	S_3	S_4	A_4	
Basis	C_j	100	80	0	0	0	0	-M	
S_1	0	3	5	1	0	0	0	0	150
S_2	0	0	1	0	1	0	0	0	20

S_3	0	8	5	0	0	1	0	0	300
A_4	-M	1	1	0	0	0	-1	1	25
Z_j		-M	-M	0	0	0	M	-M	-25M
$C_j - Z_j$		100+M	80+M	0	0	0	-M	0	

Question 9

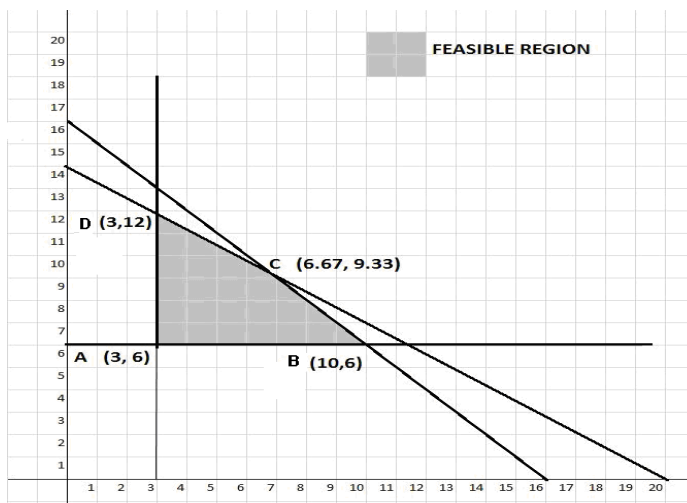
A firm makes two products X and Y, and has a total production capacity of 16 tonnes per day. X and Y are requiring the same production capacity. The firm has a permanent contract to supply at least 3 tonnes of X and 6 tonnes of Y per day to another company. Each tonne of X require 14 machine hours of production time and each tonne of Y requires 20 machine hours of production time. the daily maximum possible number of machine hours is 280. All the firm's output can be sold, and the profit made is ₹ 20 per tonne of X and ₹ 25 per tonne of Y.

Required:

Formulate a linear programme to determine the production schedule for maximum profit by using graphical approach and calculate the optimal product mix and profit. (6 Marks)(Nov., 2010)

Answer

Maximise Z $20x + 25y$
 Subject to $x + y \leq 16$
 $x \geq 3$
 $y \geq 6$
 $14x + 20y \leq 280$
 $x, y > 0$



Z =	20x +	25y	Total Contribution
Point	X	Y	
A	3	6	210
B	10	6	350
C	6.67	9.33	367- Optimal
D	3	12	360

The maximum value of objective function $Z = 370$ occurs at extreme point C (6.67, 9.33).

Hence company should produce $x_1 = 6.67$ tonnes of product X and $x_2 = 9.33$ tones of prod Y in order to yield a maximum profit of ₹ 367.

Question 10

The following matrix gives the unit cost of transporting a product from production plants P_1 , P_2 and P_3 to destinations D_1 , D_2 and D_3 . Plants P_1 , P_2 and P_3 have a maximum production of 65, 24 and 111 units respectively and destinations D_1 , D_2 and D_3 must receive at least 60, 65 and 75 units respectively:

To \ From	D_1	D_2	D_3	Supply
P_1	400	600	800	65
P_2	1,000	1,200	1,400	24
P_3	500	900	700	111
Demand	60	65	75	200

You are required to formulate the above as a linear programming problem. (Only formulation is needed. Please do not solve). (6 Marks) (Nov., 2008)

Answer

Let $p_i d_j$ be the variable to denote the number of units of product from the i th plant to the j th destination, so that

$P_1 d_1$ = transport from plant P_1 to D_1

$P_2 d_2$ = transport from plant P_2 to D_2 etc.

Objective function

$$\text{Minimize } z = 400 p_1 d_1 + 600 p_1 d_2 + 800 p_1 d_3 + 1000 p_2 d_1 + 1200 p_2 d_2 + 1400 p_2 d_3 \\ + 500 p_3 d_1 + 900 p_3 d_2 + 700 p_3 d_3.$$

Subject to:

$$\left. \begin{aligned} p_1d_1 + p_1d_2 + p_1d_3 &\leq 65 \\ p_2d_1 + p_2d_2 + p_2d_3 &\leq 24 \\ p_3d_1 + p_3d_2 + p_3d_3 &\leq 111 \end{aligned} \right\} \text{(Plant constraints)}$$

and

$$\left. \begin{aligned} p_1d_1 + p_2d_1 + p_3d_1 &\geq 60 \\ p_1d_2 + p_2d_2 + p_3d_2 &\geq 65 \\ p_1d_3 + p_2d_3 + p_3d_3 &\geq 75 \end{aligned} \right\} \text{(destination constraints)}$$

all $p_id_j \geq 0$

Question 11

Given below is the relevant portion of the first iteration of a linear program under the simplex method, using the usual notations.

			X_1	X_2	X_1	X_2	X_3
Quantity	Basic Variable	Contribution Per unit	50	40	0	0	0
150	S_1	0	3	5	1	0	0
20	S_2	0	0	1	0	1	0
296	S_3	0	8	5	0	0	1

(i) Write the initial liner program with the objective function and the in equations.

The following questions are to be answered independent of each other and based on the iteration given above:

(ii) What is the opportunity cost of bringing one unit of x_1 into the solution?

(iii) If we bring 4 units of x_1 into the solution, by how much will the basic variables changes?

(iv) What will be the change in the value of the objective function if 4 units of x_2 are brought into the solution?

(v) What will be the quantity of the incoming variable? (10 Marks)(Nov,2011)

Answer

(i) Maximize $Z = 50x_1 + 40x_2$

Subject to

$$3x_1 + 5x_2 \leq 150$$

$$x_2 \leq 20$$

$$8x_1 + 5x_2 \leq 296$$

$$x_1, x_2 \geq 0$$

- (ii) Opportunity Cost of bringing one unit of x_1 into the solution is ₹ 40, (i.e. the contribution lost on not bringing one unit of the next best choice, which is x_2).

(iii)

Change in basic variable per unit of x_1	Change in basic variables for 4 units of x_1	Implication
3	12	S_1 will be reduced by 12
0	0	S_2 will not be impacted
8	32	S_3 will be reduced by 32 units if we bring 4 units of x_1 into the solution

- (iv) Objective function value will increase by $4 \times 40 = ₹ 160$ if we bring in 4 units of x_2 into the solution.
- (v) x_1 having highest contribution will be the incoming variable. Maximum no of units of x_1 that can come in = Maximum ratio, which is minimum of (150/3, 20/0, 296/8) = Minimum of (50, ∞ , 37). Hence quantity of incoming variable x_1 is 37 units.

Question 12

The following linear program is presented to you:

Objective: Maximize $Z = 30x + 45Y$

Subject to: (i) $2x + 3y \leq 1,440$

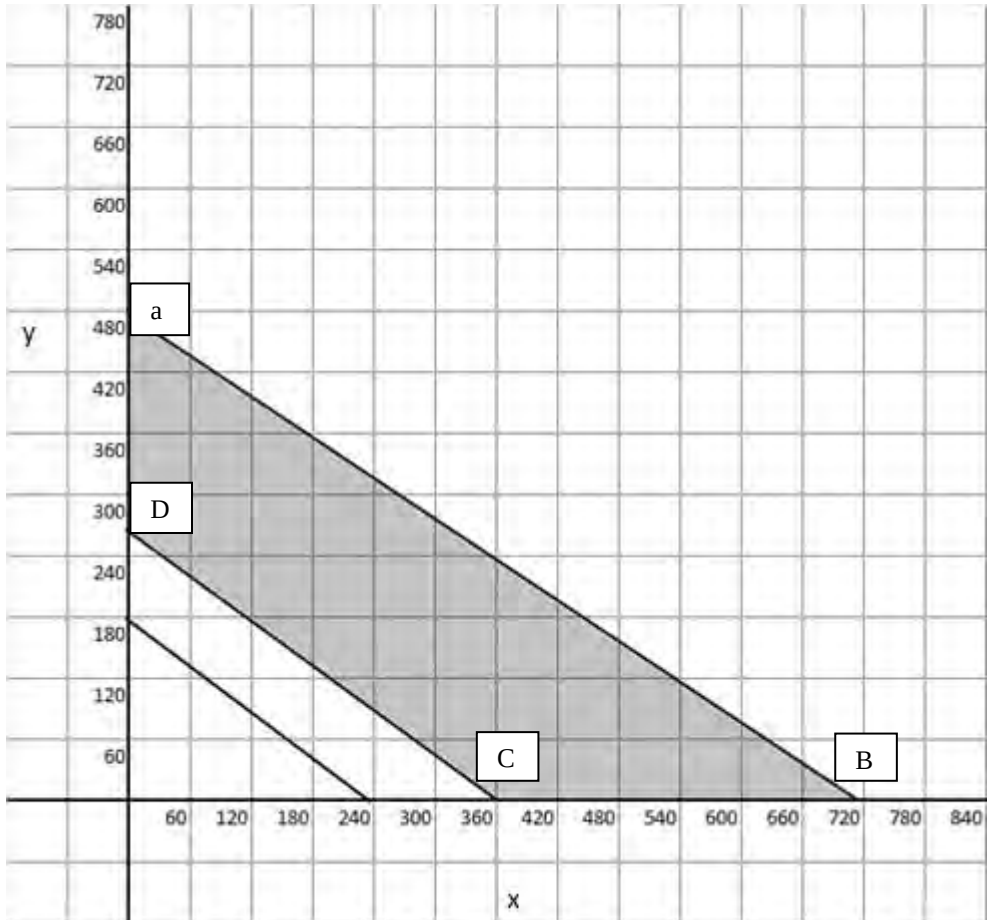
(ii) $9x + 12y \geq 2,160$

(iii) $3x + 4y \geq 1,080$

(iv) $x, y \geq 0$

You are required to draw the graph taking quantities of x and y in the respective axes in steps of 60 units (scale 1 cm. = 60 units), determine the optimality and offer your comments on the solution and the constraints. (8 Marks)

Answer



Boundary points

	x	y	Max Profit	
A	0	480	21,600	*
B	720	0	21,600	*
C	360	0	10,800	
D	0	270	12,150	
* Optimum profit.				

Comment: 1 – Solution – Multiple Optimal solution exists because the objective function line $30x + 45y$ falls on the constraint line $2x + 3y$ i.e., any point on the line will yield the same profit of ₹ 21,600/-.

Comment 2: - Constraint –Between Constraints (ii) $9x+12y \geq 2,160$ and (iii) $3x+4y \geq 1,080$ in the problem, constraint (iii) dominates constraint (ii).

Question 13

An investor is interested in investing ₹ 15,00,000 in a portfolio of investments. The investment choices and expected rates of return on each one of them are :

Investment	Projected Rate of Return
Mutual Fund 'XY'	15%
Mutual Fund 'HN'	9%
Money Market Fund	8%
Government Bonds	8.75%
Shares 'P'	17%
Share 'Q'	18%

The investor wants at least 40% of his investment in Government Bonds. Because of the higher perceived risk of the two shares, he has specified that the combined investment in these two shares not to exceed ₹ 2,60,000. The investor has also specified that at least 25% of the investment should be in the money market fund and that the amount of money invested in shares should not exceed the amount invested in Mutual Funds. His final investment condition is that the amount invested in mutual fund 'XY' should be no more than the amount invested in mutual fund 'HN'. The problem is to decide the amount of money to invest in each alternative so as to obtain the highest annual total return.

Required:

Formulate the above as a linear programming problem.

(5 Marks)(Nov., 2012)

Answer

Let

u = Investment in "Mutual Fund 'XY'"

v = Investment in "Mutual Fund 'HN'"

w = Investment in "Money Market Fund"

x = Investment in "Government Bonds"

y = Investment in "Share 'P'"

z = Investment in "Share 'Q'"

Maximize

$$Z = 0.15u + 0.09v + 0.08w + 0.0875x + 0.17y + 0.18z$$

₹ 15,00,000 to be invested -

$$u + v + w + x + y + z \leq 15,00,000$$

At least 40% of investment in Government Bonds-

$$x \geq (u + v + w + x + y + z) \times 0.40$$

Or

$$2u + 2v + 2w - 3x + 2y + 2z \leq 0$$

Combined Investment in two shares not to exceed ₹ 2,60,000-

$$y + z \leq 2,60,000$$

At least 25% of the investment in the money market fund-

$$w \geq (u + v + w + x + y + z) \times 0.25$$

Or

$$u + v - 3w + x + y + z \leq 0$$

Amount of money invested in shares should not exceed the amount invested in mutual funds-

$$y + z \leq u + v$$

Or

$$-u - v + y + z \leq 0$$

Amount invested in mutual fund 'XY' should be not be more than the amount invested in mutual fund 'HN'-

$$u \leq v$$

Or

$$u - v \leq 0$$

Maximize

$$Z = 0.15u + 0.09v + 0.08w + 0.0875x + 0.17y + 0.18z$$

Subject to:

$$u + v + w + x + y + z \leq 15,00,000$$

$$2u + 2v + 2w - 3x + 2y + 2z \leq 0$$

$$y + z \leq 2,60,000$$

$$u + v - 3w + x + y + z \leq 0$$

$$-u - v + y + z \leq 0$$

$$u - v \leq 0$$

$$u, v, w, x, y, z \geq 0$$

 This problem can be solved with the assumption of 'Investment Exactly ₹ 15,00,000'

Question 14

Write a short note on the characteristics of the dual problem.

(4 Marks)(Nov, 2012)

Answer

Characteristic of the dual problem:

- (i) For any linear programming model called primal model, there exists a companion model called the dual model.
- (ii) The number of constraints in the primal model equals the number of variables in the dual model.
- (iii) The number of variables in the primal model equals the number of constraints in the dual model
- (iv) If the primal model has a maximization objective then the dual model will have a minimization objective and vice-versa. Inequalities get reversed.
- (v) The solution of the primal model yields the solution of the dual model. Also, an optimal simplex table for the dual model yields the optimal solution to the primal model. Further, the objective functions of the two optimal tables will have identical values.
- (vi) Dual of the dual problem is the original primal itself.
- (vii) Feasible solutions to a primal and dual problem are both optimal if the complementary slackness conditions hold. If this relationship does not hold either the primal solution or the dual solution or both are not optimal.
- (viii) If the primal problem has no optimal solution due to infeasibility, then the dual problem will have no optimal solution due to unboundedness.
- (ix) If primal has no optimal solution due to unboundedness, then the dual will have no optimal solution due to infeasibility.

Question 15

A company manufactures two products A and B, involving three departments - Machining, Fabrication and Assembly. The process time, profit/unit and total capacity of each department is given in the following table :

	Machining (hours)	Fabrication (hours)	Assembly (hours)	Profit (₹)
A	1	5	3	80
B	2	4	1	100
Capacity	720	1,800	900	

Set up Linear Programming problem to maximize profits. What will be the product-mix at maximum profit level? What will be the profit?

(8 Marks)(May, 2013)

Answer

Let x and y denote the number of units produced for the product A & B respectively.

Maximize (Profit) $Z = 80x + 100y$

Subject to $x + 2y \leq 720$ (Machining Time)

$5x + 4y \leq 1,800$ (Fabrication Time)

$3x + y \leq 900$ (Assembly Time)

$x \geq 0, y \geq 0$

SIMPLEX METHOD

By introducing slack variables $s_1 \geq 0$, $s_2 \geq 0$ and $s_3 \geq 0$ the linear programming problem in standard form becomes –

Maximize $Z = 80x + 100y + 0s_1 + 0s_2 + 0s_3$

Subject to $x + 2y + s_1 = 720$ (Machining Time)

$5x + 4y + s_2 = 1,800$ (Fabrication Time)

$3x + y + s_3 = 900$ (Assembly Time)

$x, y, s_1, s_2, s_3 \geq 0$

We shall prepare the initial simplex tableau as follows:

SIMPLEX TABLEAU-I

C_j			80	100	0	0	0	Minimum Ratio
C_B	Basic Variable (B)	Value of Basic Variables $b(=X_B)$	x	y	s_1	s_2	s_3	
0	s_1	720	1	2	1	0	0	360
0	s_2	1,800	5	4	0	1	0	450
0	s_3	900	3	1	0	0	1	900
$Z_j = \sum C_{B_i} X_{j_i}$			0	0	0	0	0	
$C_j - Z_j$			80	100	0	0	0	

SIMPLEX TABLEAU-II

C_j			80	100	0	0	0	Minimum Ratio
C_B	Basic Variable (B)	Value of Basic Variables $b(=X_B)$	x	y	s_1	s_2	s_3	
100	y	360	1/2	1	1/2	0	0	720
0	s_2	360	3	0	-2	1	0	120

0	S_3	540	5/2	0	-1/2	0	1	216
$Z_j = \sum C_{B_i} X_j$			50	100	50	0	0	
$C_j - Z_j$			30↑	0	-50	0	0	

SIMPLEX TABLEAU-III

C_j			80	100	0	0	0
C_B	Basic Variable (B)	Value of Basic Variables $b(=X_B)$	x	y	S_1	S_2	S_3
100	y	300	0	1	5/6	-1/6	0
80	x	120	1	0	-2/3	1/3	0
0	S_3	240	0	0	7/6	-5/6	1
$Z_j = \sum C_{B_i} X_j$			80	100	30	10	0
$C_j - Z_j$			0	0	-30	-10	0

Since all numbers in the $C_j - Z_j$ row are either negative or zero, the optimum solution to the given problem has been obtained and is given by $x = 120$ units and 300 units

Maximum Profit = $80 \times 120 + 100 \times 300$

Hence, the optimum solution is to produce 120 units of product A and 300 units of product B to get maximum profit of ₹ 39,600

☞ The above solution can also be done through GRAPHICAL METHOD.

Solution by GRAPHICAL METHOD

Let x and y denote the number of units produced for the product A & B respectively.

Maximize (Profit) $Z = 80x + 100y$

Subject to $x + 2y \leq 720$ (Machining Time)

$5x + 4y \leq 1,800$ (Fabrication Time)

$3x + y \leq 900$ (Assembly Time)

$x \geq 0, y \geq 0$

Points to draw $x + 2y = 720$

If $x = 0$

$$2y = 720$$

$$y = 720/2 = 360$$

If $y = 0$

$$x = 720$$

$$(x, y) = (0, 360); (720, 0)$$

Points to draw $5x + 4y = 1,800$

$$\text{If } x = 0$$

$$4y = 1,800$$

$$y = 450$$

$$\text{If } y = 0$$

$$5x = 1,800$$

$$x = 360$$

$$(x, y) = (0, 450); (360, 0)$$

Points to draw $3x + y = 900$

$$\text{If } x = 0$$

$$y = 900$$

$$\text{If } y = 0$$

$$3x = 900$$

$$x = 300$$

$$(x, y) = (0, 900); (300, 0)$$

Intersection Point (R)

$$5x + 4y = 1,800 \text{ (Equation1)}$$

$$x + 2y = 720 \text{ (Equation2)}$$

Or

$$5x + 4y = 1,800$$

$$5x + 10y = 3,600 \text{ [(Equation 2) } \times 5]$$

$$\begin{array}{r} - \quad - \quad - \\ \hline \end{array}$$

$$- 6y = -1,800$$

$$y = 300$$

On putting value of y in any one of the above equation, the value of x = 120

Point R– (120, 300)

Intersection Point (Q)

$$5x + 4y = 1,800 \text{ (Equation1)}$$

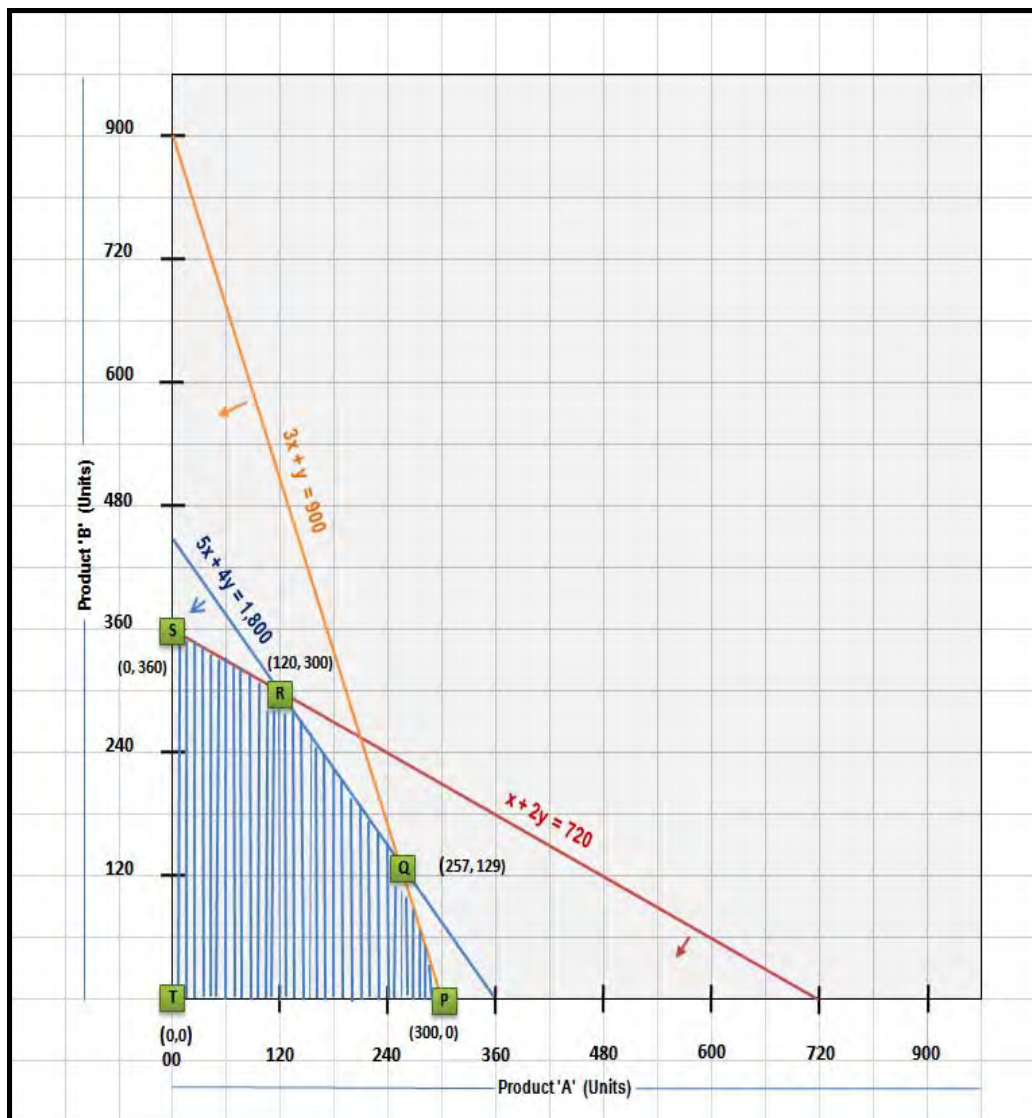
$$3x + y = 900 \text{ (Equation2)}$$

Or

$$\begin{array}{rcl}
 5x + 4y & = & 1,800 \\
 12x + 4y & = & 3,600 \quad [(Equation\ 2) \times 4] \\
 \hline
 -7x & = & -1,800 \\
 x & = & 257
 \end{array}$$

On putting value of x in any one of the above equation, the value of $y = 129$

Point Q – (257, 129)



The shaded portion in the diagram represents the feasible region.

Point	Co-Ordinates of the corner points of the feasible region (value of x and y)	Value of the objective function $Z = 80x + 100y$
P	(300,0)	₹ 24,000
Q	(257,129)	₹ 33,460
R	(120,300)	₹ 39,600
S	(0,360)	₹ 36,000
T	(0,0)	₹ 0

Since at Point R company makes *maximum profit* hence product mix at Point R i.e. 120 units of Product A and 300 units of product B should be produced.

Question 16

Given below is an iteration in a simplex table for a maximization objective linear programming product mix problem for products X_1 , X_2 and X_3 .

$C_j \rightarrow$			6	4	10	0	0	0
	Basic Variable	Quantity	X_1	X_2	X_3	S_1	S_2	S_3
0	S_1	400	0	$4/3$	0	1	$-1/3$	0
6	X_1	400	1	$2/3$	2	0	$1/3$	0
0	S_3	400	0	$5/3$	0	0	$-2/3$	1
Z_j		2,400	6	4	12	0	2	0
$C_j - Z_j$			0	0	-2	0	-2	0

Answer the following questions:

- Is the above solution feasible?
- Perform one more iteration with X_2 entering the solution to get a solution with the same value for the objective function.
- Indicate the shadow prices.
- If customer is prepared to pay higher price for product X_3 then by how much should the price be increased so that the company's profit remains unchanged?
- From the given table, derive any one original constraint inequality with the coefficients of variables in their simplest whole number forms. (8 Marks)(Nov., 2013)

Answer

C _j			6	4	10	0	0	0	Min.
C _B	Basic Variable	Quantity	X ₁	X ₂	X ₃	S ₁	S ₂	S ₃	Ratio
0	S ₁	400	0	4/3	0	1	-1/3	0	300
6	X ₁	400	1	2/3	2	0	1/3	0	600
0	S ₃	400	0	5/3	0	0	-2/3	1	240
$Z_j = \sum C_{Bi} X_j$			6	4	12	0	2	0	
$C_j - Z_j$			0	0	-2	0	-2	0	

(i) Yes, because the given solution has no artificial variables in the basic column.

(ii) Perform one more iteration with X₂:

C _j			6	4	10	0	0	0
C _B	Basic Variable	Quantity	X ₁	X ₂	X ₃	S ₁	S ₂	S ₃
0	S ₁	80	0	0	0	1	1/5	-4/5
6	X ₁	240	1	0	2	0	3/5	-2/5
4	X ₂	240	0	1	0	0	-2/5	3/5
$Z_j = \sum C_{Bi} X_j$			6	4	12	0	2	0
$C_j - Z_j$			0	0	-2	0	-2	0

(iii) Shadow Price is ₹0, ₹2 and ₹0 (or any other given monetary unit) for Constraint 1, Constraint 2 and Constraint 3 respectively and same has been obtained from row C_j - Z_j.

(iv) C_j - Z_j for X₃ being -2, production of each unit of X₃ would cause a reduction of ₹2 (or any other given monetary unit). Thus, the price for X₃ should be increased by at least two rupee *per unit* to ensure no reduction of profits.

(v) Original Constraint Inequality *with the coefficient of variables*:

Let us consider the given iteration is the 2nd one. The first iteration (I₁) must have had S₂ instead of X₁. Row X₁ of I₂ has been computed by dividing the S₂ row of I₁ by 3. S₂ of I₁ (in Identity Matrix) would have been 1. Now it is 1/3. Working backwards, we multiply row X₁ of I₂ by 3 to get Row S₂ of I₁.

Original Row S₂ [X₁ of I₂ × 3]:

$$(1X_1 + 2/3X_2 + 2X_3) \times 3 \leq 400 \times 3$$

Or

$$3X_1 + 2X_2 + 6X_3 \leq 1,200$$

Similarly Original Row S_1 [S_1 of $I_2 + X_1$ of I_2]:

$$(0X_1 + 4/3X_2 + 0X_3) + (1X_1 + 2/3X_2 + 2X_3) \leq 400 + 400$$

Or

$$X_1 + 2X_2 + 2X_3 \leq 800$$

Similarly Original Row S_3 [S_3 of $I_2 + 2 \times X_1$ of I_2]:

$$0X_1 + 5/3X_2 + 0X_3 + (1X_1 + 2/3X_2 + 2X_3) \times 2 \leq 400 + 400 \times 2$$

Or

$$2X_1 + 3X_2 + 4X_3 \leq 1,200$$



Original Constraint Inequality (with the coefficient of variables) can also be traced through algebraic method by solving through *system of equations*.

11

The Transportation Problem

Question 1

The initial allocation of a transportation problem, alongwith the unit cost of transportation from each origin to destination is given below. You are required to arrive at the minimum transportation cost by the Vogel's Approximation method and check for optimality.

(Hint : Candidates may consider $u_1 = 0$ at Row 1 for initial cell evaluation)

Requirement

11	2	8	8	6	2	4	18
9	10	9	12	9	6		10
7	6	3	8	7	7		8
9	2	3	5	6	2	11	4
<u>Availability</u>							
12	8	8	8	4			40

(May 2007, 6 marks)

Answer

The concept tested in this problem is Degeneracy with respect to the transportation problem. Total of rows and columns = $(4 + 5) = 9$. Hence, the number of allocations = $9 - 1 = 8$. As the actual number of allocation is 7, a 'zero' allocation is called for. To resolve this, an independent cell with least cost should be chosen. R4C2 has the least cost (cost = 3), but this is not independent. The next least cost cell R4C3 (cost = 5) is independent.

	9 C1	2 C2	5 C3	6 C4	2 C5	Total
0R1	11	2	8	6	2	18
0R2	9	9	12	9	6	10
-2R3	7	6	3	7	7	8
0R4	9	3	5	6	11	4
Total	12	8	8	8	4	40

Forming Equations through allocated cells

Basic equation	Setting R1 = 0 other values
$R1 + C2 = 2$	Setting $R1 = 0$, $C2 = 2$
$R1 + C4 = 6$	$C4 = 6$
$R1 + C5 = 2$	$C5 = 2$
$R2 + C1 = 9$	$R2 = 0$
$R3 + C3 = 3$	$R3 = -2$
$R4 + C1 = 9$	$C1 = 9$
$R4 + C3 = 5$	$C3 = 5$
$R4 + C4 = 6$	$R4 = 0$

Evaluate unallocated cells

$R1C1 = 11 - 0 - 9 = 2$	$R3C1 = 7 + 2 - 9 = 0$
$R1C3 = 8 - 0 - 5 = 3$	$R3C2 = 6 + 2 - 2 = 6$
$R2C2 = 9 - 0 - 2 = 7$	$R3C4 = 7 + 2 - 6 = 7$
$R2C3 = 12 - 0 - 5 = 7$	$R3C5 = 7 + 2 - 2 = 7$
$R2C4 = 9 - 0 - 6 = 3$	$R4C2 = 3 - 0 - 2 = 1$
$R2C5 = 6 - 0 - 2 = 4$	$R4C5 = 11 - 0 - 2 = 9$

Since all the evaluation is 0 or +ve, the optimal solution is obtained.

Optimal cost = $(8 \times 2) + (6 \times 6) + (4 \times 2) + (10 \times 9) + (8 \times 3) + (2 \times 9) + (0 \times 5) + (2 \times 6) =$

$$16 + 36 + 8 + 90 + 24 + 18 + 10 + 12 = \text{Rs. } 204.$$

Note: As regards allocation of the zero values, the solution to the above problem is also obtained by allocating the zero value in other independent cells such as R1C3, R2C2, R2C3, R3C1, R3C2, R3C4, R3C5. In such situation there will be one more iteration.

Question 2

Goods manufactured at 3 plants, A, B and C are required to be transported to sales outlets X, Y and Z. The unit costs of transporting the goods from the plants to the outlets are given below:

<i>Sales outlets \ Plants</i>	A	B	C	Total Demand
X	3	9	6	20
Y	4	4	6	40
Z	8	3	5	60
Total supply	40	50	30	120

You are required to:

- Compute the initial allocation by North-West Corner Rule.
- Compute the initial allocation by Vogel's approximation method and check whether it is optional.
- State your analysis on the optionality of allocation under North-West corner Rule and Vogel's Approximation method. (10 Marks) (May, 2008)

Answer

3	20	—	—	20
4	20	20	—	40
8	—	30	30	60
40	50	30	120	

- (i) Initial allocation under NW corner rule is as above.

$$\text{Initial cost : } 20 \times 3 = 60$$

$$20 \times 4 = 80$$

$$\begin{aligned}
 20 \times 4 &= 80 \\
 30 \times 3 &= 90 \\
 30 \times 5 &= \underline{150} \\
 &\underline{460}
 \end{aligned}$$

(ii) Initial solution by VAM:

3	20	9	6
4	20	4	6
8	3	50	10

40 50 30

1 1 1

4 1 1

1 1

20	3		
40	0	0	2
60	2	2	2

Initial solution:

$$\begin{aligned}
 20 \times 3 &= 60 \\
 20 \times 4 &= 80 \\
 50 \times 3 &= 150 \\
 20 \times 6 &= 120 \\
 10 \times 5 &= \underline{100} \\
 &\underline{460}
 \end{aligned}$$

Checking for optimality

3			$u_1 = 0$
4		6	$u_2 = 1$
	3	5	$u_3 = 0$

$v_1 = 3$ $v_2 = 3$ $v_3 = 5$

$u_i + v_j$

	3	5	0
	4		1
3			0
3	3	5	

$$\Delta_{ij} = c_{ij} - (u_i + v_j)$$

	6	1
	0	
5		

$$\Delta_{ij} \geq 0 \quad \therefore \text{Solution is optimal}$$

Conclusion:

The solution under VAM is optimal with a zero in R_2C_2 which means that the cell C_2R_2 which means that the cell C_2R_2 can come into solution, which will be another optimal solution. Under NWC rule the initial allocation had C_2R_2 and the total cost was the same Rs. 460 as the total cost under optimal VAM solution. Thus, in this problem, both methods have yielded the optimal solution under the 1st allocation. If we do an optimality test for the solution, we will get a zero for Δ_{ij} in C_3R_2 indicating the other optimal solution which was obtained under VAM.

Question 3

State the methods in which initial feasible solution can be arrived at in a transportation problem. (3 Marks) (Nov., 2008)

Answer

The methods by which initial feasible solution can be arrived at in a transportation model are as under:

- (i) North West Corner Method.
- (ii) Least Cost Method
- (iii) Vogel's Approximation Method (VAM)

Question 4

The cost per unit of transporting goods from the factories X, Y, Z to destinations. A, B and C, and the quantities demanded and supplied are tabulated below. As the company is working out the optimum logistics, the Govt.; has announced a fall in oil prices. The revised unit costs

are exactly half the costs given in the table. You are required to evaluate the minimum transportation cost. (6 Marks)(June, 2009)

Destinations Factories	A	B	C	Supply
X	15	9	6	10
Y	21	12	6	10
Z	6	18	9	10
Demand	10	10	10	30

Answer

The problem may be treated as an assignment problem. The solution will be the same even if prices are halved. Only at the last stage, calculate the minimum cost and divide it by 2 to account for fall in oil prices.

	A	B	C
X	15	9	6
Y	21	12	6
Z	6	18	9

Subtracting Row minimum, we get

	A	B	C
X	9	3	0
Y	15	6	0
Z	0	12	3

	A	B	C
X	9	3	0
Y	15	6	0
Z	0	12	3

Subtracting Column minimum,

No of lines required to cut Zeros = 3

		Cost / u	Units	Cost	Revised Cost
Allocation:	X → B	9	10	90	45
	Y → C	6	10	60	30
	Z → A	6	10	<u>60</u>	<u>30</u>
				<u>210</u>	<u>105</u>

Minimum cost = 105 Rs.

Alternative Solution I

Least Cost Method

	A	B Step V	C		Step I Diff.	Step III	
X	15	9 10	6 10	10	3	3	← Step IV
Y	21	12	5 10	10	6	6	
Z	5 10	18	9	10	3		
	10	10	10	30			
Step I Diff.	9	3	10				
Step III Diff.	Step II	3	10				

Initial Feasible solution

X – B

Y – C

Z – A

Test for optimality

No. of allocation = 3

No. of rows $m = 3$, no. of column = 3

$$m + n - 1 = 3 + 3 - 1 = 5$$

2 very small allocation are done to 2 cells of minimum costs, so that , the following table is got:

	A	B	C
X	15	10 9	e 6
Y	21	12	10 6
Z	10 6	18	e 9

$$m + n - 1 = 5$$

Now testing for optimality

			u_i
	9	e	0
		6	0
6		e	0
v_j	6	9	6
$u_i + v_j$ for unoccupied cells			

	A	B	C
X	6	-	-
Y	6	9	-
Z	-	9	-

$\text{Diff} = C_{ij} - (u_i + v_j)$

	A	B	C
X	9	-	-
Y	15	3	-
Z	-	9	-

All $\Delta_{ij} > 0$, Hence this is the optimal solution.

	Original Costs	Reduced Costs due to Oil Price	Qty.	Cost
X – B	9	4.5	10	45
Y – C	6	3	10	30
Z – A	6	3	10	<u>30</u>
				<u>105</u>

Total cost of transportation is minimum at Rs.105

Alternative Solution II

	A	B	C		Step I Diff.	Step III Diff.
X	7.5	4.5	3	10	1.5	1.5
Y	11.5	6	3	10	3	3
Z	3	9	1.5	10	1.5	
Qty.	10	10	10	30		
Step I Diff.	4.5	1.5	0			
Step III Diff.	Step II	1.5	0			

Step V arrow points to cell B (4.5) in the first table.

Step IV arrow points to cell Y (3) in the second table.

Initial Solution :

	A	B	C
X	7.5	4.5	3
Y	11.5	6	3
Z	3	9	4.5

No. of rows + no. of column - 1

$$m + n - 1 = 5$$

No. of allocation = 3

Hence add 'e' to 2 least cost cells so that

X	7.5	4.5	10	3	e
Y	11.5	6	3	10	
Z	3	10	9	4.5	e

Now $m + n - 1 = 5$

Testing for optimality,

u_i, v_j table

	A	B	C	u_i
X		4.5	e	0
Y			3	0
Z	3		e	0
v_j	3	4.5	3	

$u_i + v_j$ for unoccupied cells

	3	-	-
	3	4.5	-
	-	4.5	-

C_{ij}	$u_i + v_j$		
7.5	-	-	
11.5	6	-	
-	9	-	

3	-	-	
3	4.5	-	
-	4.5	-	

$\Delta_{ij} = C_{ij} - (u_i + v_j)$

4.5	-	-	
11.5	1.5	-	
8.5	4.5	-	

All $\Delta_{ij} > 0$. Hence the solution is optimal.

	Qty.	Cost/u	Total Cost
X – B	10	4.5	45
Y – C	10	3	30
Z – A	10	3	30
Total minimum cost at revised oil prices			105

Question 5

How do you know whether an alternative solution exists for a transportation problem?

(4 Marks)(Nov., 2009)

Answer

The Δ_{ij} matrix = $\Delta_{ij} = C_{ij} - (u_i + v_j)$

Where c_i is the cost matrix and $(u_i + v_j)$ is the cell evaluation matrix for allocated cell.

The Δ_{ij} matrix has one or more 'Zero' elements, indicating that, if that cell is brought into the solution, the optional cost will not change though the allocation changes.

Thus, a 'Zero' element in the Δ_{ij} matrix reveals the possibility of an alternative solution.

Question 6

A company has three plants located at A, B and C. The production of these plants is absorbed by four distribution centres located at X, Y, W and Z. the transportation cost per unit has been shown in small cells in the following table:

<i>Distribution Centres</i> <i>Factories</i>	X	Y	W	Z	Supply (Units)
A	6	9	13	7	6000
B	6	10	11	5	6000
C	4	7	14	8	6000
Demand (Units)	4000	4000	4500	5000	18000 17500

Find the optimum solution of the transportation problem by applying Vogel's Approximation Method.
(8 Marks)(Nov., 2010)

Answer

Step 1 : Initial Allocation based on Least cost cells corresponding to highest differences

	X	Y	W	Z	Dummy	Total
A		2,000	3,500		500	6,000
B			1,000	5,000		6,000
C	4,000	2,000				6,000
TOTAL	4,000	4,000	4,500	5,000	500	18,000

Step 2 : Δ_{ij} Matrix values for Unallocated cells

	X	Y	W	Z	Dummy
A	0			0	
B	2	3			2
C			3	3	2

All Δ_{ij} values ≥ 0 . Therefore initial allocation is optimal.

Step 3 : Optimal Transportation Cost

	Units	Costs involved	Total
A to Y	2,000	9	18,000
A to W	3,500	13	45,500
B to W	1,000	11	11,000
B to Z	5,000	5	25,000
C to X	4,000	4	16,000
C to Y	2,000	7	14,000
Total minimum cost			1,29,500

Note : Since there are zeroes in the Δ_{ij} Matrix alternate solutions exist.

Question 7

Will the initial solution for a minimization problem obtained by Vogel's Approximation Method and the Least Cost Method be the same ? Why? (4 Marks) (May, 2011)

Answer

The initial solution need not be the same under both methods.

Vogel's Approximation Method uses the differences between the minimum and the next minimum costs for each row and column.

This is the penalty or opportunity cost of not utilising the next best alternative. The highest penalty is given the 1st preference. This need not be the lowest cost.

For example if a row has minimum cost as 3, and the next minimum as 2, penalty is 1; whereas if another row has minimum 4 and next minimum 6, penalty is 2, and this row is given preference. But least cost given preference to the lowest cost cell, irrespective of the next cost.

Vogel's Approximation Method will result in a more optimal solution than least cost.

They will be the same only when the maximum penalty and the minimum cost coincide

Question 8

The following matrix is a minimization problem for transportation cost. The unit transportation costs are given at the right hand corners of the cells and the Δ_{ij} values are encircled.

	D1	D2	D3	Supply
F ₁	3	4	4	500
F ₂	9 (88)	6 300	7 (88)	300
F ₃	4 (88)	6 (88)	5 200	200
Deamnd	300	400	300	1000

Find the optimum solution (s) and the minimum cost.

(5 Marks) (May, 2011)

Answer

Δ_{ij} values are given for unallocated cells. Hece, no. of allocated cells = 5, which = $3 + 3 - 1$ = no. of columns + no of rows – 1.

Allocating in other than Δ_{ij} cells.

Factory	S1	D2	D3	Supply
	3 300	4 100	4 100	500
	9 (88)	6 300	7 (88)	300
	4 (88)	6 (88)	5 200	200
	300	400	300	1000

This solution is optional since Δ_{ij} are non-ve. For the other optional solution, which exists since $\Delta_{ij} = 0$ at $R_3 C_1$, this cell should be brought in with a loop : $R_3, C_1 - R_1 C_1 - R_1 C_3 - R_3 C_3$.

Working Notes:

Step I : $R_1 C_1$ (Minimum of 300, 500)

Step II : $R_2 C_2$ (Minimum of 300, 400)

Step III : $R_1 C_2$ balance of C_2 total : 100, R_1 Total = 100

Step IV : $R_1 C_3$ 100 (balance of C_3 total = 200)

Step V : $R_3 C_3$ 200

Solution I

-100				+100
	300	100	100	
		300		
+100	(88)		200	-100

Solution II

200	100	200
	300	
100		100

	Solution I	Solution II
Cost:	$3 \times 300 = 900$	$3 \times 200 = 600$
	$4 \times 100 = 400$	$4 \times 100 = 400$
	$4 \times 100 = 400$	$4 \times 200 = 800$
	$6 \times 300 = 1800$	$6 \times 300 = 1800$
	$5 \times 200 = 1000$	$5 \times 100 = 500$
		$4 \times 100 = 400$
Minimum Cost	<u>4500</u>	<u>4500</u>

Question 9

The following table gives the unit transportation costs and the quantities demanded/supplied at different locations for a minimization problem:

<i>Demand</i> <i>Supply</i>	C_1	C_2	C_3	C_4	<i>Total Units</i>
R_1	100	120	200	110	20000
R_2	160	80	140	120	38000
R_3	180	140	60	100	16000
<i>Total Units</i>	10000	18000	22000	24000	

You are required to find out which cell gets the 3rd allocation in the initial basic feasible solution under each of the following methods and to give the cell reference, cost per unit of that cell and the quantity allocated to that cell :

(i) North West Corner Rule

(ii) Vogel's Approximation Method

(iii) Least Cost Method

(Candidates may use the standard notation of $C_i R_j$ for cell reference. (e.g. $C_2 R_3$ means the cell at the intersection of Column 2 and Row 3)

(Note: The full solution is not required to be worked out).

(5 Marks)(May, 2012)

Answer

Sl. No	Method	Cell Reference	Cost/unit	Quantity
		I	II	III
i)	North West Corner Rule	$C_2 R_2$	80	8,000
ii)	Vogel's method	$C_3 R_2$	140	6,000
		or		
		$C_1 R_1$	100	10,000
iii)	Least Cost Method	$C_1 R_1$	100	10,000

Question 10

In a transportation problem for cost minimization, there are 4 rows indicating quantities demanded and this totals up to 1,200 units. There are 4 columns giving quantities supplied. This totals up to 1,400 units. What is the condition for a solution to be degenerate?

(3 Marks)(May, 2012)

Answer

The condition for degeneracy is that the number of allocations in a solution is less than $m+n-1$.

The given problem is an unbalanced situation and hence a dummy row is to be added, since the Column quantity is greater than that of the Row quantity. The total number of Rows and

Columns then = 9 i.e. (5+4). Therefore, $m+n-1 = 8$, i.e. if the number of allocations is less than 8, then degeneracy would occur.

Question 11

Explain the term 'Degeneracy' in the context of a transportation problem. How can this be solved?
(5 Marks)(Nov., 2012)

Answer

A transportation problem's solution has $m+n-1$ basic variables, (where m, n are the number of rows and columns) which means that the number of occupied cells in such a solution is one less than the number of rows and number of columns.

When the number of occupied cells in a solution is less than $m+n-1$, the solution is called a degenerate solution.

Such a situation is handled by introducing an infinitesimally small allocation 'e' in the least cost and independent cell.

If the number of occupied cells $< m+n-1$ by one, then only one 'e' needs to be introduced. If the number of occupied cells is less by more than one, to the extent of shortage, 'e's will have to be introduced till the condition that no. of occupied cells = $m+n-1$. For e.g. if no. of occupied cells in a solution is 7 and we have $m+n-1 = 9$, then, we have to introduce two quantities of 'e', say e_1 and e_2 in 2 of the least cost independent cells.

Degeneracy occurs because in any particular allocation (earlier than the last allocation), the row and column totals get simultaneously fulfilled. (In the last allocation, it is always that row and column get fulfilled). Then, we have a degeneracy by one number, i.e. no. of occupied cells $+1 = m+n-1$. We need to put one 'e'. In the subsequent allocation, if again row and column totals get fulfilled simultaneously, again there will be a shortage of occupied cells and another 'e' will be required.

Due to this concept, an assignment problem, solved by transportation technique taking demand quantity = supply quantity = 1 in every row and column will require an 'e' for each allocation other than the last one. For e.g. in a 5×5 assignment problem, there are 4 allocations other than the last one. therefore, 4 'e's will be required. i.e. $m + n - 1$ will be $5+5-1$, $=9$, whereas, the no. of occupied cells will be 5. To resolve the degeneracy, we will need 4 'e's.

The 'e' has to be placed in the least cost independent cell, for arriving at the optimal solution as early as possible. If, by mistake, we place 'e' in the second least cost but independent cell, after the u_i, v_j step, the 'e' will be shifted to the least cost independent cell, thereby necessitating one more iteration. This is similar to the simplex table. If we bring in a wrong variable by mistake, it will go out in the next iteration. The only thing is that the solution will be reached later.

Question 12

XYZ Company has three plants and four warehouses. The supply and demand in units and the corresponding transportation costs are given. The table below shows the details taken from the solution procedure of the transportation problem :

		WAREHOUSES								
		I		II		III		IV		Supply
Plants	A		5		10	10	4		5	10
	B	20	6		8		7	5	2	25
	C	5	4	10	2	5	5		7	20
Demand		25		10		15		5		

Answer the following questions. Give brief reasons:

- Is this solution feasible?
- Is this solution degenerate?
- Is this solution optimum?

(8 Marks)(May,2013)

Answer

- Is this solution feasible?

A necessary and sufficient condition for the existence of a feasible solution to the transportation problem is that

$$\sum_{i=1}^m a_i = \sum_{j=1}^n b_j$$

Where

a_i = quantity of product available at origin i.

b_j = quantity of product available at origin j.

In other words, the total capacity (or supply) must equal total requirement (or demand)

As the supply 55 units (10+25+20) equals demand 55 units (25+10+15+5), a feasible solution to the problem exists.

- Is this solution degenerate?

When the number of positive allocations at any stage of the feasible solution is less than the required number (rows + columns -1), the solution is said to be *degenerate solution*.

In given solution total allocated cells are 6 which are equal to $4+3-1$ (rows + columns -1). Therefore, the initial basic solution is not a degenerate solution.

(iii) Is this solution optimum?

Test of Optimality:

($u_i + v_j$) matrix for allocated cells

		4		u_i
				-1
6			2	2
4	2	5		0
v_j	4	2	5	0

($u_i + v_j$) matrix for unallocated cells

				u_i
3	1		-1	-1
	4	7		2
			0	0
v_j	4	2	5	0

$\Delta_{ij} = C_{ij} - (u_i + v_j)$ matrix

2	9		6
	4	0	
			7

Since, all cells values in $\Delta_{ij} = C_{ij} - (u_i + v_j)$ matrix are non-negative, hence the solution provided by XYZ Company is optimum.

It may be noted that zero opportunity cost in cell (B, III) indicates a case of alternative optimum solution.

Question 13

Define the following terms in relation to a transportation problem:

- (i) Degeneracy
- (ii) Prohibited routes

(4 Marks)(Nov., 2013)

Answer

- (i) **Degeneracy:** A transportation problem's solution has $m+n-1$ basic variables, (where m, n are the number of rows and columns) which means that the number of occupied cells in such a solution is one less than the number of rows and number of columns.

When the number of occupied cells in a solution is less than $m+n-1$, the solution is called a degenerate solution.

Such a situation is handled by introducing an infinitesimally small allocation 'e' in the least cost and independent cell.

- (ii) **Prohibited Routes:** Sometimes in a given transportation problem, some routes may not be available. There could be several reasons for this such as bad road conditions or strike etc. In such situations, there is a restriction on the route available for transportation. To handle such type of a situation, a very large cost (or a negative profit for the maximization problem) represented by ∞ or 'M' is assigned to each of such routes which are not available. Due to assignment of very large cost, such routes would automatically be eliminated in the final solution. The problem is solved in its usual way.

The Assignment Problem

Question 1

A Marketing Manager has 4 subordinates and 4 tasks. The subordinates differ in efficiency. The tasks also differ in their intrinsic difficulty. His estimates of the time each subordinate would take to perform each task is given in the matrix below. How should the task be allocated one to one man so that the total man-hours are minimised ?(7 Marks)(Nov. 2004)

	I	II	III	IV
1	16	52	34	22
2	26	56	8	52
3	76	38	36	30
4	38	52	48	20

Answer

	I	II	III	IV
1	16	52	34	22
2	26	56	8	52
3	76	38	36	30
4	38	52	48	20

Step 1:

Subtract the smallest element of each row from every element of the corresponding row

	I	II	III	IV
1	0	36	18	6
2	18	48	0	44
3	46	8	6	0
4	18	32	28	0

Step 2: Subtract the smallest element of each column from every element in that column

	I	II	III	IV
1	0	28	18	6
2	18	40	0	44
3	46	0	6	0
4	18	24	28	0

Step 3: Draw minimum number of horizontal and vertical lines to cover all the zeros

	I	II	III	IV
1	0	28	18	6
2	18	40	0	44
3	46	0	6	0
4	18	24	28	0

The optimal assignment is

1	—	I	=	16
2	—	III	=	8
3	—	II	=	38
4	—	IV	=	<u>20</u>
				<u>82 hours</u>

Minimum time taken = 82 hours

Question 2

A BPO company is taking bids for 4 routes in the city to ply pick-up and drop cabs. Four companies have made bids as detailed below:

Bids for Routes (₹)

Company/Routes	R_1	R_2	R_3	R_4
C_1	4,000	5,000	—	—
C_2	—	4,000	—	4,000
C_3	3,000	—	2,000	—
C_4	—	—	4,000	5,000

Each bidder can be assigned only one route. Determine the minimum cost that the BPO should incur. (6 Marks)(Nov., 2006)

Answer

Reducing minimum from each column element (figure in '000s)

Step 1

	R ₁	R ₂	R ₃	R ₄
C ₁	1	1	—	—
C ₂	—	0	—	0
C ₃	0	—	0	—
C ₄	—	—	2	1

Step 2

	R ₁	R ₂	R ₃	R ₄
C ₁	0	0	—	—
C ₂	—	0	—	0
C ₃	0	—	0	—
C ₄	—	—	1	0

Number of lines to connect all zeros nos. is 4 which is optional.

Alternatively you may also reduce the minimum from each row.

Step 1

	R ₁	R ₂	R ₃	R ₄
C ₁	0	1	—	—
C ₂	—	0	—	0
C ₃	1	—	0	—
C ₄	—	—	0	1

Step 2

	R ₁	R ₂	R ₃	R ₄
C ₁	0	1	—	—
C ₂	—	0	—	0
C ₃	0	—	0	—
C ₄	—	—	0	0

Number of lines to connect all zeros nos. is 4 which is optional.

All diagonal elements are zeros and are chosen. The minimum cost is ₹ 15,000 C₁ – R₁ 4,000; C₂ – R₂ 4,000; C₃ – R₃ 2,000; C₄ – R₄ 5,000; (Total) = 15,000.

Question 3

A company has four zones open and four marketing managers available for assignment. The zones are not equal in sales potentials. It is estimated that a typical marketing manager operating in each zone would bring in the following Annual sales:

Zones	₹
East	2,40,000
West	1,92,000
North	1,44,000
South	1,20,000

The four marketing managers are also different in ability. It is estimated that working under the same conditions, their yearly sales would be proportionately as under:

Manager M	:	8
Manager N	:	7
Manager O	:	5
Manager P	:	4

Required:

If the criterion is maximum expected total sales, find the optimum assignment and the maximum sales.
(11 Marks) (Nov., 2007)

Answer

Sum of the proportion = $(8 + 7 + 5 + 4) = 24$

Assuming ₹ 1,000 as one unit, the effective matrix is as follows:

Effective Matrix

Managers	Zones			
	East	West	North	South
M	$(8/24) \times 240 = 80$	$(8/24) \times 192 = 64$	$(8/24) \times 144 = 48$	$(8/24) \times 120 = 40$
N	$(7/24) \times 240 = 70$	$(7/24) \times 192 = 56$	$(7/24) \times 144 = 42$	$(7/24) \times 120 = 35$
O	$(5/24) \times 240 = 50$	$(5/24) \times 192 = 40$	$(5/24) \times 144 = 30$	$(5/24) \times 120 = 25$
P	$(4/24) \times 240 = 40$	$(4/24) \times 192 = 32$	$(4/24) \times 144 = 24$	$(4/24) \times 120 = 20$

Convert the maximization problem to minimization problem

The resultant loss matrix is as follows:

Loss Matrix

Managers	East	West	North	South
M	0	16	32	40
N	10	24	38	45
O	30	40	50	55
P	40	48	56	60

Row operation

Managers	East	West	North	South
M	0	16	32	40
N	0	14	28	35
O	0	10	20	25
P	0	8	16	20

Column operation

Managers	East	West	North	South
M	0	8	16	20
N	0	6	12	15
O	0	2	4	5
P	0	0	0	0

Managers	East	West	North	South
M	0	6	14	18
N	0	4	10	13
O	0	0	2	3
P	2	0	0	0

Managers	East	West	North	South
M	0	2	10	14
N	0	0	6	9
O	4	0	2	3
P	6	0	0	0

Managers	East	West	North	South
M	0	2	8	12
N	0	0	4	7
O	4	0	0	1
P	8	2	0	0

Assignment	Sales
	₹
M – East	80,000
N – West	56,000
O – North	30,000
P – South	<u>20,000</u>
	<u>1,86,000</u>

Question 4

The cost matrix giving selling costs per unit of a product by salesman A, B, C and D in regions R_1 , R_2 , R_3 and R_4 is given below:

	A	B	C	D
R_1	4	12	16	8
R_2	20	28	32	24
R_3	36	44	48	40
R_4	52	60	64	56

- (i) Assign one salesman to one region to minimise the selling cost.
- (ii) If the selling price of the product is ₹ 200 per unit and variable cost excluding the selling cost given in the table is ₹ 100 per unit, find the assignment that would maximise the contribution.
- (iii) What other conclusion can you make from the above? (8 Marks)(Nov., 2008)

Answer

(i)

4	12	16	8
20	28	32	24
36	44	48	40
52	60	64	56

Subtracting minimum element – each row.

0	8	12	4
0	8	12	4
0	8	12	4
0	8	12	4

Subtracting minimum element – each column,

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

Minimum no. of lines to cover all zeros = 4 = order of matrix. Hence optimal assignment is possible.

$$\text{Minimum cost} = 4 + 28 + 48 + 56 = 136.$$

$$= AR_1 + BR_2 + CR_3 + DR_4$$

Since all are zeros, there are 24 solutions to this assignment problem.

Viz.	A	B	C	D	
	R ₁	R ₂	R ₃	R ₄	
	R ₂	R ₃	R ₄	R ₁	
	R ₃	R ₄	R ₁	R ₂	
	R ₄	R ₁	R ₂	R ₃	
	R ₁	R ₃	R ₄	R ₂	etc.

A can be assigned in 4 ways, B in 3 ways for each of A's 4 ways.

(ii) $SP - VC = 100 \text{ ₹}$

	A	B	C	D
R ₁	96	88	84	92
R ₂	80	72	68	76
R ₃	64	56	52	60
R ₄	48	40	36	44

Subtracting the highest term

0	8	12	4
16	24	28	20
32	40	44	36
48	56	60	52

Subtracting minimum term of each row.

0	8	12	4
0	8	12	4
0	8	12	4
0	8	12	4

Which is the same as the earlier matrix

$$\text{Maximum contribution} = ₹ (96 + 72 + 52 + 44) = ₹ 264.$$

Alternative Solution:

Maximisation of contribution is same as minimizing cost. Hence, same assignments as in (i) will be the optimal solution.

Maximum Contribution ₹ $(400 - 136) = ₹ 264$

- (iii) (a) The relative cost of assigning person i to region r does not change by addition or subtraction of a constant from either a row, or column or all elements of the matrix.
- (b) Minimising cost is the same as maximizing contribution. Hence, the assignment solution will be the same, applying point (i) above.
- (c) Many zero's represent many feasible least cost assignment. Here, all zeros mean maximum permutation of a 4×4 matrix, viz. $4 \times 3 \times 2 \times 1 = 24$ solutions are possible.

Question 5

In an assignment problem to assign jobs to men to minimize the time taken, suppose that one man does not know how to do a particular job, how will you eliminate this allocation from the solution?
(4 Marks)(Nov., 2009)

Answer

In an assignment minimization problem, if one task cannot be assigned to one person, introduce a prohibitively large cost for that allocation, say M , where M has a high the value. Then, while doing the row minimum and column minimum operations, automatically this allocation will get eliminated.

Question 6

A manager was asked to assign tasks to operators (one task per operator only) so as to minimize the time taken. He was given the matrix showing the hours taken by the operators for the tasks.

First, he performed the row minimum operation. Secondly, he did the column minimum operation. Then, he realized that there were 4 tasks and 5 operators. At the third step he introduced the dummy row and continued with his fourth step of drawing lines to cover zeros. He drew 2 vertical lines (under operator III and operator IV) and two horizontal lines (aside task T_4 and dummy task T_5). At step 5, he performed the necessary operation with the uncovered element, since the number of lines was less than the order of the matrix. After this, his matrix appeared as follows:

Operators

Tasks	I	II	III	IV	V
T_1	4	2	5	0	0
T_2	6	3	3	0	3
T_3	4	0	0	0	1
T_4	0	0	5	3	0
T_5 (dummy)	0	0	3	3	0

- (i) What was the matrix after step II ? Based on such matrix, ascertain (ii) and (iii) given below.
- (ii) What was the most difficult task for operators I, II and V ?
- (iii) Who was the most efficient operators?
- (iv) If you are not told anything about the manager's errors, which operator would be denied any task? Why?
- (v) Can the manager go ahead with his assignment to correctly arrive at the optional assignment, or should he start afresh after introducing the dummy task at the beginning?

(10 Marks)(June, 2009)

Answer

	I	II	III	IV	V
(given)					
T ₁	4	2	5	0	0
T ₂	6	3	3	0	3
T ₃	4	0	0	0	1
T ₄	0	0	5	3	0
T ₅	0	0	3	3	0
(Dummy)					

Junction values at dummy = 3. 3 was the minimum uncovered element.

Previous step was

7	5	5	0	3
9	6	3	0	6
7	3	0	0	4
0	0	2	0	0
0	0	0	0	0

- (i) At step II the matrix was:

7	5	5	0	3
9	6	3	0	6
7	3	0	0	4
0	0	2	0	0

(ii) For Operator I, Most difficult task will be indicated by hours = T_2

Operator II T_2

Operator V T_2

(iii) Most efficient operator = Operator IV

(iv) If the Manager's mistake was not known,

4	2	5	0	0
6	3	3	0	3
4	0	0	0	1
0	0	5	3	0
0	0	3	3	0

We continue the assignment; $T_1 - V$,

$T_2 - IV$, $T_3 - III$ are fixed.

Between T_4 and T_5 , I or II Can be allotted.

So, other I or II Can be denied the job.

(v) Yes, the Manager can go ahead with the optimal assignment

Row minimum is not affected by when the dummy was introduced.

Column minimum was affected. But in the process, more zeros were generated to provide better solution.

Question 7

A city corporation has decided to carry out road repairs on 4 main roads in the city.

The Government has agreed to make a special grant of ₹ 50 lacs towards the cost with the condition that the repairs should be carried out at lowest cost. Five contractors have sent their bids. Only road will be awarded to one contractor. The bids are given below:

		Cost of Repairs (₹ in lacs)			
Contractors	Road	R_1	R_2	R_3	R_3
	C_1	9	14	19	15
	C_2	7	17	20	19
	C_3	9	18	21	18
	C_3	10	12	18	19
	C_4	10	15	21	16

You are informed that C_2 should get R_1 and C_4 should get R_2 to minimize costs.

(i) What is the minimum cost allocation?

- (ii) How much is the minimum discount that the eliminated contractor should offer for meriting a contract?
- (iii) Independent of (ii) above, if the corporation can negotiate to get a uniform discount rate from each contractor, what is the minimum rate of discount so that the cost is within the grant amount?
(6 Marks)(Nov., 2011)

Answer

- (i) There are 5 rows and 4 columns hence insert a dummy column R_5 .

- C_2 has been allocated to R_1
- C_4 has been allocated to R_2 . Hence the assignment is restricted to

	R_3	R_4	R_5
C_1	19	15	0
C_3	21	18	0
C_5	21	16	0

Column Minimum

	R_3	R_4	R_5
C_1	0	0	0
C_3	2	3	0
C_5	2	1	0

	R_3	R_4	R_5
C_1	0	0	1
C_3	1	2	0
C_5	1	0	0

Hence C_1 has been allotted to R_3 , C_3 to R_5 and C_5 to R_4 .

Hence the Minimum cost is $= 7+12+19+16+0 = 54$ Lacs

- (ii) C_3 should reduce 2 lacs for R_1 , 6lacs for R_2 , 2lacs for R_3 and 2 lacs for R_4

Minimum Discount = 2 Lacs for any of R_1 , R_3 , R_4

- (iii) Minimum rate of Discount $(54-50) = 4/54 = 7.41\%$

Question 8

The following matrix was obtained after performing row minimum operations on rows R_1 and R_2 in an assignment problem for minimization. Entries "xx" represent some positive numbers. (It is not meant that all "xx" numbers are equal). State two circumstances under which an optimal solution is obtained just after the row minimum and column minimum operations.

(Candidates may use cell references as $C_i R_j$ for uniformity. e.g. $C_1 R_1$ represents the cell at the intersection of Column1 (C_1) and Row 1 (R_1) etc.

	C_1	C_2	C_3
R_1	0	xx	xx
R_2	xx	0	xx
R_3	xx	xx	xx

(4 Marks)(May, 2012)

Answer

Situation 1 :On performing minimum operation in Row 3, if C_3R_3 is zero, the optimal solution is obtained.

0	xx	xx
xx	0	xx
xx	xx	0

Optimal solution = C_1R_1 , C_2R_2 & C_3R_3

Situation 2:On performing minimum operation in Row 3, if C_2R_3 is zero, then it necessitates the performance of minimum operation in C_3 . On account of this, if either C_3R_3 or C_3R_2 is zero then the optimal solution is obtained

0	xx	xx
xx	0	xx
xx	0	xx

And

0	xx	xx
xx	0	xx
xx	0	0

or

0	xx	Xx
xx	0	0
xx	0	Xx

Optimal = C_1R_1 , C_2R_2 & C_3R_3

OR

Optimal = C_1R_1 , C_2R_3 & C_3R_2

(i.e., C_2R_3 and C_3R_3 are zero after Row minimum and column minimum operation respectively) (or C_2R_3 and C_3R_2 are zero after Row minimum and column minimum operation respectively).

Situation 3 :On performing minimum operation in Row 3, if C_1R_3 is zero, then it necessitates the performance of minimum operation in C_3 . On account of this, if either C_3R_3 or C_3R_1 is zero

then the optimal solution is obtained.(i.e., C_1R_3 and C_3R_3 are zero after Row minimum and column minimum operation respectively).

0	xx	xx
xx	0	xx
0	xx	xx

and

0	xx	xx
xx	0	0
0	xx	0

or

0	xx	0
Xx	0	Xx
0	0	Xx

Optimal = C_1R_1 , C_2R_2 & C_3R_3

OR

Optimal = C_1R_3 , C_2R_2 & C_3R_1

(i.e., C_1R_3 and C_3R_3 are zero after Row minimum and column minimum operation respectively)
or C_1R_3 and C_3R_1 are zero after Row minimum and column minimum operation respectively).

Question 9

A production supervisor is considering how he should assign five jobs that are to be performed to five operators. He wants to assign the jobs to the operators in such a manner that the aggregate costs to perform the job is the least. He has the following information about the wages paid to the operators for performing these jobs.

Operators	Jobs				
	1	2	3	4	5
A	10	3	3	2	8
B	9	7	8	2	7
C	7	5	6	2	4
D	3	5	8	2	4
E	9	10	9	6	10

Required:

Assign the jobs to the operators so that the aggregate cost is the least. (8 Marks)(Nov., 2012)

Answer

The given problem is a minimization problem

Subtracting minimum element of each row from all the elements of that row, the given problem reduces to the following:

	Job1	Job2	Job3	Job4	Job5
A	8	1	1	0	6
B	7	5	6	0	5
C	5	3	4	0	2
D	1	3	6	0	2
E	3	4	3	0	4

Subtracting the minimum element of each column from all the elements of that column

	Job1	Job2	Job3	Job4	Job5
A	7	0	0	0	4
B	6	4	5	0	3
C	4	2	3	0	0
D	0	2	5	0	0
E	2	3	2	0	2

Since the minimum number of lines covering all zeros is equal to 4, which is less than the number of columns/rows(=5), the above table does not provide the optimal solution.

Subtracting the minimum uncovered element (=2) from all uncovered elements and adding the same to the elements lying at the intersection of two lines, we get the following matrix:

	Job1	Job2	Job3	Job4	Job5
A	9	0	0	2	6
B	6	2	3	0	3
C	4	0	1	0	0
D	0	0	3	0	0
E	2	1	0	0	2

Since the minimum number of horizontal and vertical lines to cover all zeros is equal to five, which is equal to the order of the matrix, the above table gives the optimal solution.

The optimal assignment is given below:

Operator	Job	Wages (`)
A	2	3
B	4	2
C	5	4
D	1	3
E	3	9
Total		21

Question 10

Prescribe the steps to be followed to solve an assignment problem. (5 Marks)(May, 2013)

Answer

The assignment problem can be solved by applying the following steps:

Step1: Subtract the minimum element after row operation of each row from all the elements in that row. From each column of the matrix so obtained, subtract its minimum element. The resulting matrix is the starting matrix for the following procedure.

Step2: Draw the minimum number of horizontal and vertical lines that cover all the zeros. If this number of lines is n , order of the matrix, optimal assignment can be made by skipping steps 3 and 4 and proceeding with step 5. If, however, this number is less than n , go to the next step

Step3: Here, we try to increase the number of zeros in the matrix. We select the smallest element out of these which do not lie on any line. Subtract this element from all such (uncovered) elements and add it to the elements which are placed at the intersections of the horizontal and vertical lines. Do not alter the elements through which only one line passes.

Step4: Repeat steps 1, 2 and 3 until we get the minimum number of lines equal to n .

Step5 (A): Starting with first row, examine all rows of matrix in step 2 or 4 in turn until a row containing exactly one zero is found. Surround this zero by $\square$, indication of an assignment there. Draw a vertical line through the column containing this zero. This eliminates any confusion of making any further assignments in that column. Process all the rows in this way.

Step5 (B): Apply the same treatment to columns also. Starting with the first column, examine all columns until a column containing exactly one zero is found. Mark $\square$ around this zero and draw a horizontal line through the row containing this marked zero. Repeat steps 5A and B, until one of the following situations arises:

- (i) No unmarked ($\square$) or uncovered (by a line) zero is left,
- (ii) There may be more than one unmarked zero in one column or row. In this case, put around one of the unmarked zero arbitrarily and pass 2 lines in the cells of the remaining zeros in its row and column. Repeat the process until no unmarked zero is left in the matrix.

Question 11

Answer the following independent situations relating to an assignment problem with a minimization objective:

- (i) *Just after row and column minimum operations, we find that a particular row has 2 zeroes. Does this imply that the 2 corresponding numbers in the original matrix before any operation were equal? Why?*
- (ii) *Under the usual notation, where a_{32} means the element at the intersection of the 3rd row and 2nd column, we have, in a 4×4 assignment problem, a_{24} and a_{32} figuring in the optimal solution. What can you conclude about the remaining assignments? Why?*

(5 Marks)(Nov., 2013)

Answer

- (i) Under the Hungarian Assignment Method, the prerequisite to assign any job is that each row and column must have a zero value in its corresponding cells. If any row or column does not have any zero value then to obtain zero value, each cell values in the row or column is subtracted by the corresponding minimum cell value of respective rows or columns by performing row or column operation. This means *if any row or column have two or more cells having same minimum value then these row or column will have more than one zero*. However, having two zeros does not necessarily imply two equal values in the original assignment matrix just before row and column operations. Two zeroes in a same row can also be possible by two different operations i.e. one zero from row operation and one zero from column operation.
- (ii) The order of matrix in the assignment problem is 4×4 . The total assignment (allocations) will be four. In the assignment problem when any allocation is made in any cell then the corresponding row and column become unavailable for further allocation. Hence, these corresponding row and column are crossed mark to show unavailability. In the given assignment matrix two allocations have been made in a_{24} (2nd row and 4th column) and a_{32} (3rd row and 2nd column). This implies that 2nd and 3rd row and 4th and 2nd column are unavailable for further allocation.

Therefore, the other allocations are at either at a_{11} and a_{43} or at a_{13} and a_{41} .

Critical Path Analysis

Question 1

The following table gives the activities in a construction project and the time duration of each activity:

Activity	Preceding activity	Normal Time (Days)
A	—	16
B	—	20
C	A	8
D	A	10
E	B, C	6
F	D, E	12

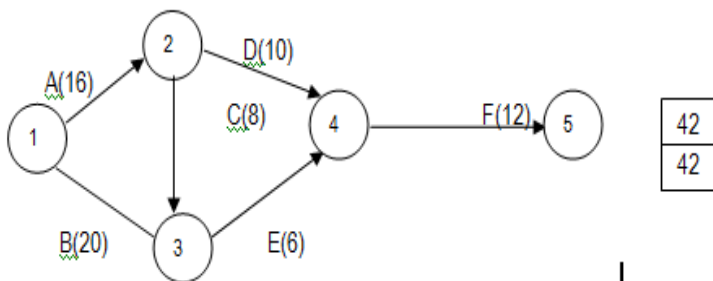
Required:

- Draw the activity network of the project.
- Find critical path.
- Find the total float and free-float for each activity.

(6 Marks) (Nov., 2007)

Answer

(i)



$$A \rightarrow D \rightarrow F = 16 + 10 + 12 = 38$$

$$B \rightarrow E \rightarrow F = 20 + 6 + 12 = 38$$

$$(ii) A - C - E - F = 16 + 8 + 6 + 12 = 42$$

Critical path

(iii) Total float and free float for each activity

Activity	Normal time (Days)	Earliest start	Time finish	Latest start	Time finish	Float total	Free
A	16	0	16	0	16	0	0
B	20	0	20	4	24	4	4
C	8	16	24	16	24	0	0
D	10	16	26	20	30	4	4
E	6	24	30	24	30	0	0
F	12	30	42	30	42	0	0

Question 2

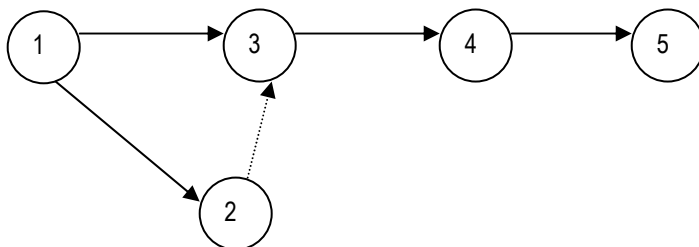
What do you mean by a dummy activity? Why is it used in networking? (4 Marks) (May, 2008)

Answer

Dummy activity is a hypothetical activity which consumes no resource or time. It is represented by dotted lines and is inserted in the network to clarify an activity pattern under the following situations.

- To make activities with common starting and finishing events distinguishable.
- To identify and maintain the proper precedence relationship between activities that are not connected by events.
- To bring all "loose ends" to a single initial and single terminal event.

e.g.



Dummy (2) – (3) is used to convey that can start only after events numbered (2) and (3) are over:

Question 3

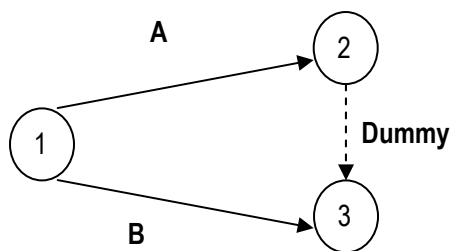
Explain the following in the context of a network:

- (i) Critical path
- (ii) Dummy activity.

(4 Marks)(June, 2009)

Answer

- (i) **Critical Path:** Critical Path is a chain of activities that begin with the starting event and ends with ending event of a particular project. It is that path that runs through a network with the maximum length of time or it indicates the maximum possible time required for completion of a project. Critical path indicates the minimum time that will be required to complete a project. It is determined after identifying critical events. Critical path goes through critical events.
- (ii) **Dummy Activities:** Dummy Activity is that activity which does not consume time or resources. It is used when two or more activities have same initial and terminal events. As a result of using dummy activities, other activities can be identified by unique end events. These are usually shown by arrows with dashed lines.



Question 4

A small project is composed of seven activities, whose time estimates are listed below. Activities are identified by their beginning (i) and ending (j) note numbers:

Activity	Estimated durations (in days)		
	Optimistic	Most likely	Pessimistic
(i-j)			
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

13.4 Advanced Management Accounting

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

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

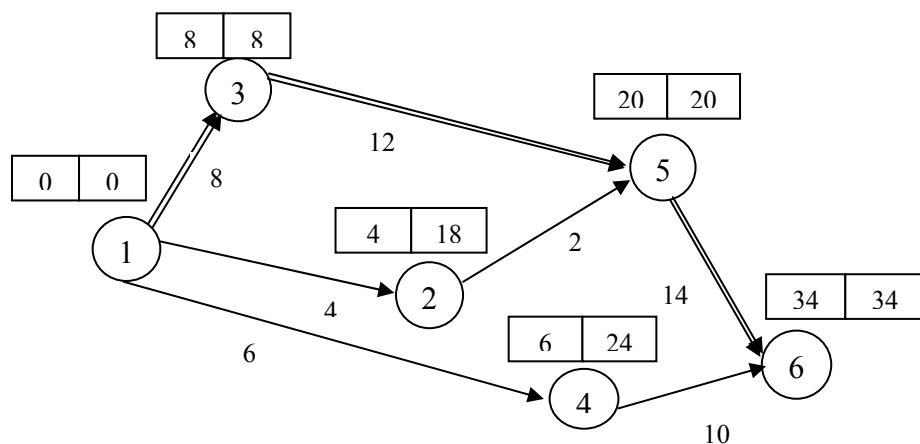
(4 Marks)(May, 2010)

Answer

Activity Estimated Durations :

Activity estimated durations (days) $t_e = \frac{(a + 4m + b)}{6}$ Duration

Activity	a	m	b	t_e	$\sigma = [(b - a)/6]^2$
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



Critical path is 1-3-5-6.

The expected project duration = $8+12+14 = 34$ days

Question 5

List the 5 steps involved in the methodology of critical path analysis. (4 Marks)(Nov., 2010)

Answer

Working Methodology of PERT:

The working methodology of PERT which includes both CPM and PERT, consists of following five steps:

1. Analyze and break down the project in terms of specific activities and/or events.
2. Determine the interdependence and sequence of specific activities and prepare a network.
3. Assign estimates of time, cost or both to all the activities of the network.
4. Identify the longest or critical path through the network.
5. Monitor, evaluate and control the progress of the project by re-planning, rescheduling and reassignment of resources.

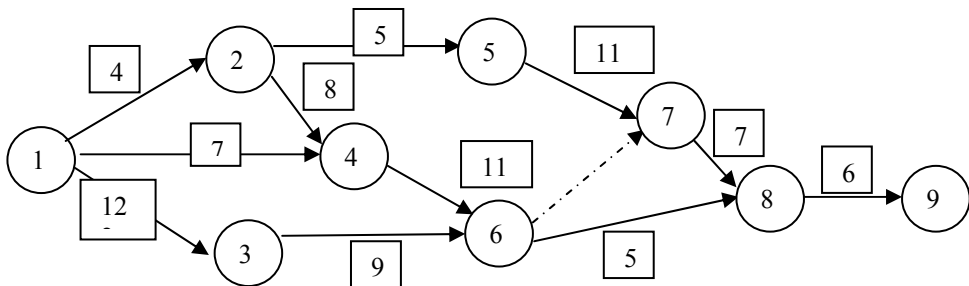
Question 6

The number of days of total float (TF), earliest start times (EST) and duration in days are given for some of the following activities.

Activity	TF	EST	Duration
1 – 2	0	0	5
1 – 3	0		
1 – 4	5		
2 – 4	0	4	
2 – 5	1		
3 – 6	2	12	6
4 – 6	0	12	
5 – 7	3		
6 – 7		23	
6 – 8	2		
7 – 8	0	23	6
8 – 9		30	

- Draw the network.
- List the paths with their corresponding durations and state when the project can be completed. (10 Marks)(Nov., 2011)

Answer



Network Diagram: 6-7 dummy

6-8-9 and 7-8-9

1-2-5-7 and 1-2-4-6

1-4-6 and 1-3-6

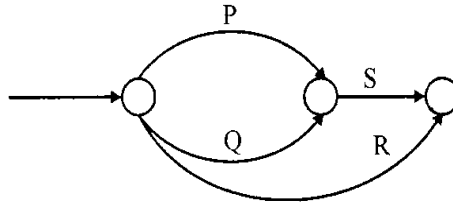
Activity	Duration	Early Start	Late Start	Late Finish	Total Float
1-2	4	0	0	4	0
1-3	12	0	2	14	0
1-4	7	0	5	12	5
2-4	8	4	4	12	0
2-5	5	4	8	13	1
3-6	9	12	14	23	2
4-6	11	12	12	23	0
5-7	11	9	12	23	3
6-7	0	23	23	23	0
6-8	5	23	25	30	2
7-8	7	23	23	30	0
8-9	6	30	30	36	0

PATH	DURATION	PATH	DURATION
1-2-5-7-8-9	32	1-4-6-8-9	29
1-2-4-6-7-8-9	36	1-3-6-7-8-9	34
1-2-4-6-8-9	34	1-3-6-8-9	32
1-4-6-7-8-9	31		

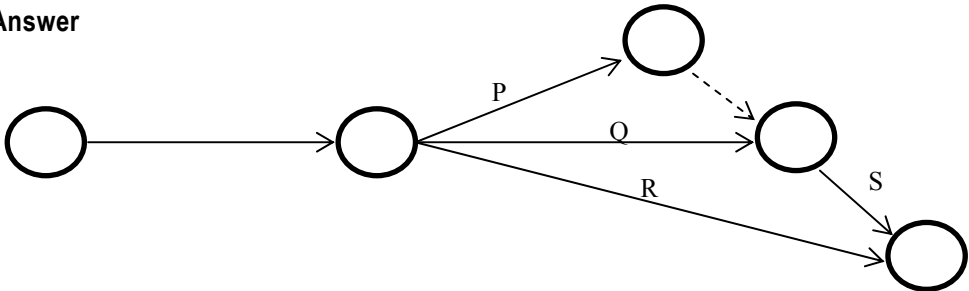
Note: Students may refer same chapter of Practice Manual for clear understanding of this problem and solution.

Question 7

The following is a part of a network.



What are activities P and Q called? How would you rectify the situation? (4 Marks)(May, 2012)

Answer

Activities P and Q are called duplicate activities (or parallel activities) since they have the same head and tail events. The situation may be rectified by introducing a dummy either between P and S or between Q and S or before P or before Q (i.e. introduce the dummy before the tail event and after the duplicate activity or Introduce the dummy activity between the head event and the duplicate activity).

14

Programme Evaluation and Review Technique

Question 1

A product comprised of 10 activities whose normal time and cost are given as follows:

Activity	Normal Time (days)	Normal cost
1-2	3	50
2-3	3	5
2-4	7	70
2-5	9	120
3-5	5	42
4-5	0	0
5-6	6	54
6-7	4	67
6-8	13	130
7-8	10	166

Indirect cost ₹9 per day.

(i) Draw the network and identify the critical path.

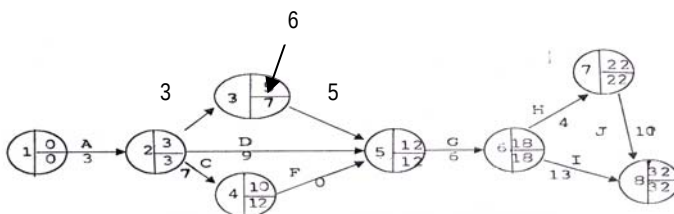
(ii) What are the project duration and associated cost ?

(iii) Find out the total float associated with each activity.

(6 Marks) (May, 2005)

Answer

(i)



Critical path A D G H J

1-----2-----5-----6-----7-----8

(ii) A D G H J is the critical path having normal project duration

$$3 + 9 + 6 + 4 + 10 = 32 \text{ days}$$

Normal project cost:- Direct cost	=	₹ 704
Indirect cost (32×9)	=	288
		992

(iii) Calculation of total float

Activity	Nt(days)	E_F	L_F	Float ($L_F - E_F$)
1-2	3	3	3	0
2-3	3	6	7	1
2-4	7	10	12	2
2-5	9	12	12	0
3-5	5	11	12	1
4-5	0	10	12	2
5-6	6	18	18	0
6-7	4	22	22	0
6-8	13	31	32	1
7-8	10	32	32	0

Question 2

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	Estimated durations (in days)		
(i-j)	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 ?

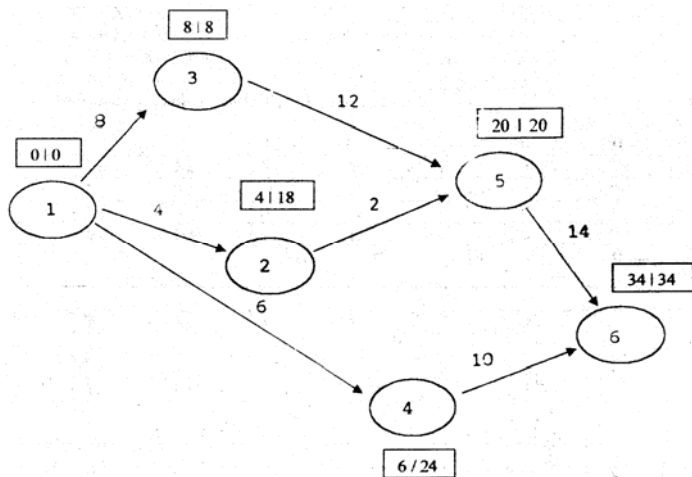
Given:	z	0.50	0.67	1.00	1.33	2.00
	P	0.3085	0.2514	0.1587	0.0918	0.0228

(7 Marks) (Nov., 2005)

Answer

(a)

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:

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

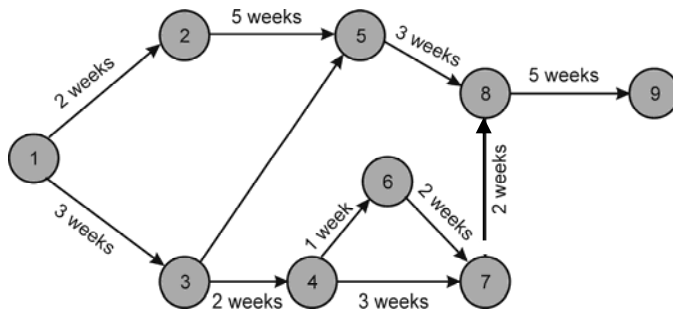
When due date is 38 days

$$Z = \frac{38 - 34}{6} = \frac{4}{6} = 0.67 \text{ Probability meeting the date is } 0.7486 \text{ or } 74.86\%.$$

Question 3

A network is given below:

- (i) Name the paths and give their total duration.
- (ii) Give three different ways of reducing the project above duration by four days.



(6 Marks) (Nov, 2006)

Answer

- (i) Assuming that the duration of activity 3 – 5 is 4 weeks.

The various critical paths are:

1-2-5-8-9	15 weeks
1-3-4-7-8-9	15 weeks
1-3-4-6-7-8-9	15 weeks
1-3-5-8-9	15 weeks

(ii) Note: Since the duration for activity 3-5 is not specified it is open for you to assume the duration. Depending upon the duration assume three possibilities emerge.

1. If the duration assumed is more than 4 weeks then that path (13, 35, 58, 89) alone will be critical. In that case you can choose any of the activity in the critical path.
2. If the duration assumed is exactly 4 weeks then it will be one of the 4 critical paths and the various possibilities are given below.
3. If the duration assumed is less than 4 weeks then the solution should be based on 3 of the critical paths namely 1-2-5-8-9, 1-3-4-6-7-8-9 and 1-3-4-7-8-9. This has 16 combinations.

Reduce in the following ways, the project duration is. Since all the paths are critical, reduction is possible by combining activities. The activities can be independent, common to few paths and common to all the paths. The various categories are as follows:

1. Common to all the paths. 8-9
2. Independent : Combination
 1. 1-2,3-5,4-6 and 4-7.
 2. 2-5,3-5,4-6 and 4-7.
 3. 1-2,3-5,4-7, 6-7.
 4. 2-5,3-5,4-7, 6-7.
3. Activities common to two of the paths.
 1. 1-2,1-3.
 2. 1-3,2-5.
 3. 3-4,5-8.
 4. 5-8,7-8.
4. Activities common to two of the paths and two independent activities.
 1. 1-2,3-4,3-5.
 2. 1-2,3-5,7-8.
 3. 2-5,3-4,3-5.
 4. 2-5,3-5,7-8.
 5. 4-6,4-7,5-8.
 6. 4-7,5-8,6-7.

(Any three of the above combination.)

Question 4

A company had planned its operations as follows:

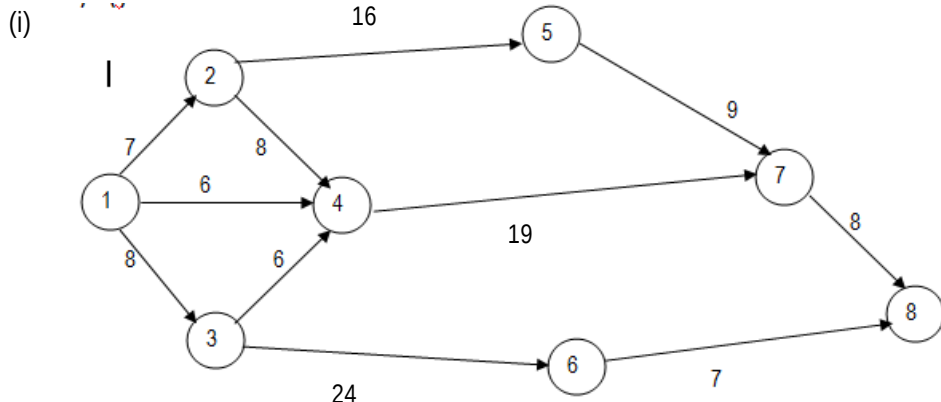
Activity	Duration (days)
1-2	7

2–4	8
1–3	8
3–4	6
1–4	6
2–5	16
4–7	19
3–6	24
5–7	9
6–8	7
7–8	8

- (i) Draw the network and find the critical paths.
- (ii) After 15 days of working, the following progress is noted:
- (a) Activities 1–2, 1–3 and 1–4 completed as per original schedule.
 - (b) Activity 2–4 is in progress and will be completed in 4 more days.
 - (c) Activity 3–6 is in progress and will need 17 more days to complete.
 - (d) The staff at activity 3–6 are specialised. They are directed to complete 3–6 and undertake an activity 6–7, which will require 7 days. This rearrangement arose due to a modification in a specialisation.
 - (e) Activity 6–8 will be completed in 4 days instead of the originally planned 7 days.
 - (f) There is no change in the other activities.

Update the network diagram after 15 days of start of work based on the assumption given above. Indicate the revised critical paths alongwith their duration. (11 Marks) (May 2007)

Answer

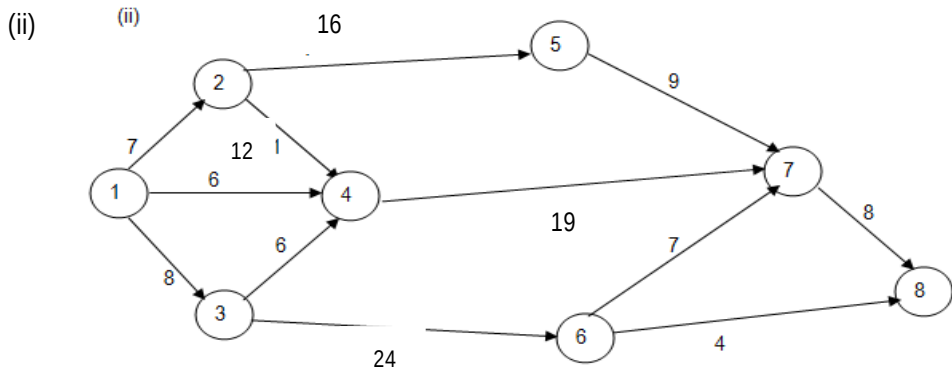


Paths	Duration
1 – 2 – 5 – 7 – 8	$7 + 16 + 9 + 8 = 40$
1 – 2 – 4 – 7 – 8	$7 + 8 + 19 + 8 = 42$
1 – 4 – 7 – 8	$6 + 19 + 8 = 33$
1 – 3 – 4 – 7 – 8	$8 + 6 + 19 + 8 = 41$
1 – 3 – 6 – 8	$8 + 24 + 7 = 39$

Critical path 1 – 2 – 4 – 7 – 8 = 42 days.

Revised Duration of activities 2 – 4 and 3 – 6 after 15 days for update.

Activity	Preceding Activity	Date of completion	Revised Duration
2 – 4	1 – 2	$15 + 4 = 19$ days	$19 - 7 = 12$ days
3 – 6	1 – 3	$15 + 17 = 32$ days	$32 - 8 = 24$ days
6 – 7 (new activity)	3 – 6		7 days
6 – 8	3 – 6		4 days



Paths	Duration
1 - 2 - 5 - 7 - 8	$7 + 16 + 9 + 8 = 40$
1 - 2 - 4 - 7 - 8	$7 + 12 + 19 + 8 = 46$
1 - 4 - 7 - 8	$6 + 19 + 8 = 33$
1 - 3 - 4 - 7 - 8	$8 + 6 + 19 + 8 = 41$
1 - 3 - 6 - 7 - 8	$8 + 24 + 7 + 8 = 47$
1 - 3 - 6 - 8	$8 + 24 + 4 = 36$

Critical path = 1 - 3 - 6 - 7 - 8 = 47 days.

Question 5

The following information is available:

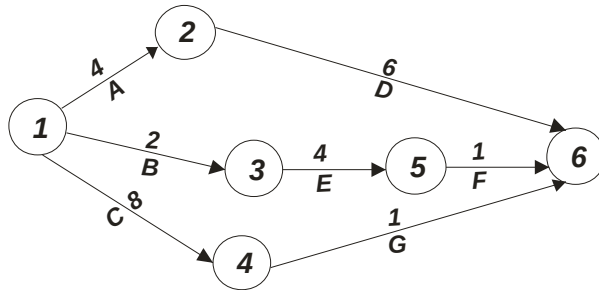
Activity		No. of days	No. of men required per day
A	1-2	4	2
B	1-3	2	3
C	1-4	8	5
D	2-6	6	3
E	3-5	4	2
F	5-6	1	3
G	4-6	1	8

(i) Draw the network and find the critical path.

(ii) What is the peak requirement of Manpower? On which day(s) will this occur?

(iii) If the maximum labour available on any day is only 10, when can the project be completed?
(9 Marks) (May, 2008)

Answer



Path	Days	
AD	10	CP →
BEF	7	
CG	9	

Critical Path = 1– 2 – 6

i.e. AD = 10 days.

Peak requirement is 11 men, required on days 7 and 9.

If only 10 men are available on any day, shift F,G to days 10 and 11 and the project can be completed in 11 days.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	A ₂	A ₂	A ₂	A ₂										
					D ₃	D ₃	D ₃	D ₃	D ₃	D ₃				
	B ₃	B ₃	E ₂	E ₂	E ₂	E ₂								
							F ₃							
	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅						
									G ₈					
	10	10	9	9	10	10	11	8	11	3				
If s/o shift									F ₃	G ₈				
New	10	10	9	9	10	10	8	8	3	6	8			

Question 6

A project consists of seven activities and the time estimates of the activities are furnished as under:

Activity	Optimistic Days	Most likely Days	Pessimistic Days
1-2	4	10	16
1-3	3	6	9
1-4	4	7	16
2-5	5	5	5
3-5	8	11	32
4-6	4	10	16
5-6	2	5	8

Required:

- Draw the network diagram.
- Identify the critical path and its duration.
- What is the probability that the project will be completed in 5 days earlier than the critical path duration?
- What project duration will provide 95% confidence level of completion ($Z_{0.95} = 1.65$) ?

Given

Z	1.00	1.09	1.18	1.25	1.33
Probability	0.1587	0.1379	0.1190	0.1056	0.0918

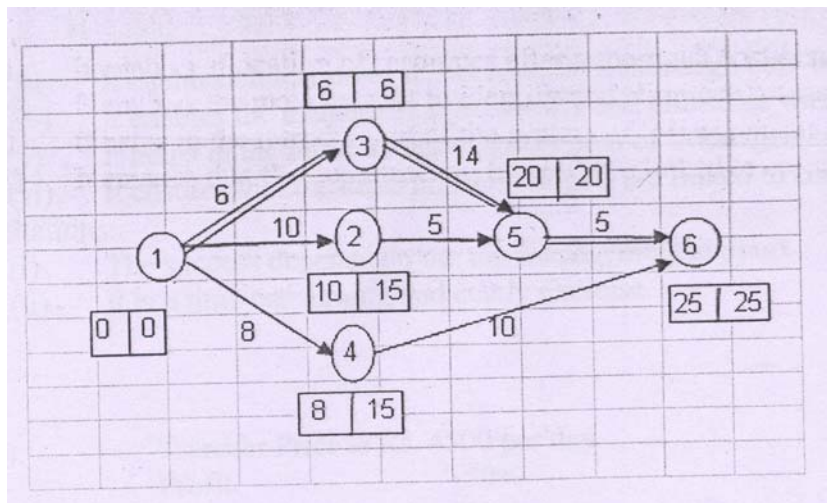
(11 Marks) (Nov., 2008)

Answer

Calculation of expected time and variance of each activity:

Activity	Optimistic Days	Most likely Days	Pessimistic Days	Expected Duration	Variance
1-2	4	10	16	10	4
1-3	3	6	9	6	1
1-4	4	7	16	8	4
2-5	5	5	5	5	0
3-5	8	11	32	14	16
4-6	4	10	16	10	4
5-6	2	5	8	5	1

The network diagram is as under:



Critical Path: 1-3 3-5 5-6

Duration (days) 6 14 5 = 25 days

Standard deviation: 1 + 16 + 1 = 18

$\sqrt{18} = 4.24$

Probability that the project will be completed five days earlier:

$$Z = \frac{20 - 25}{4.24} = -1.18.$$

According to probability values given in the question probability is 11.9%

To obtain 95% confidence level:

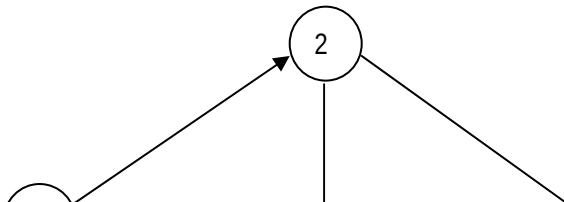
$$1.65 = \frac{X - 25}{4.24}$$

$$X - 25 = 6.996$$

$$X = 32 \text{ days}$$

Question 7

The normal time, crash time and crashing cost per day are given for the following network:



Activity	Normal time (days)	Crash time (days)	Crashing cost (Rs./day)
1–2	18	14	40
1–3	23	22	20
2–3	8	5	60
2–4	10	6	40
3–4	3	2	80
4–5	8	6	50

- (i) Crash the project duration in steps and arrive at the minimum duration. What will be the critical path and the cost of crashing?
- (ii) If there is an indirect cost of ₹ 70 per day, what will be the optimal project duration and the cost of crashing? (10 Marks) (Nov., 2008)

Answer

- (i) Critical path

1 – 2 – 3 – 4 – 5 37 days

Paths:

	Normal	Crash
1 – 2 – 4 – 5	36	26
1 – 2 – 3 – 4 – 5	37	27
1 – 3 – 4 – 5	34	30

	Crash Activity	Days,	Cost
Step I	1 – 2	1	40
II	1 – 2	1	40

III	4 – 5	1	50
IV	4 – 5	1	50
V	2 – 3	1	60
VI	1 – 2 & 1 – 3	<u>1</u>	<u>60</u> (40 + 20)
		<u>6</u>	<u>300</u>

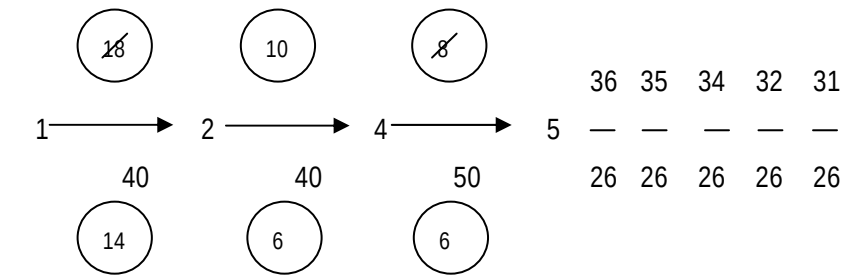
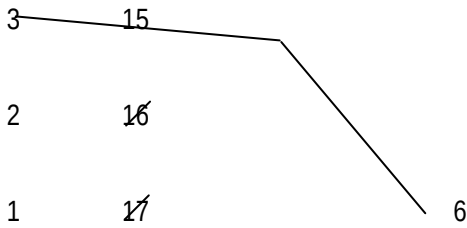
Revised critical paths : $\left. \begin{array}{l} 1-2-4-5 \\ 1-2-3-4-5 \\ 1-3-4-5 \end{array} \right\} 31 \text{ days}$

VII 1 – 2 & 3 – 4 (40 + 80) $\frac{120}{420}$ 30 days

But VII is not done if indirect cost = 70, which is < 120.

(ii) Project duration is 31 days and cost of crashing is 300.

Workings of Crashing:

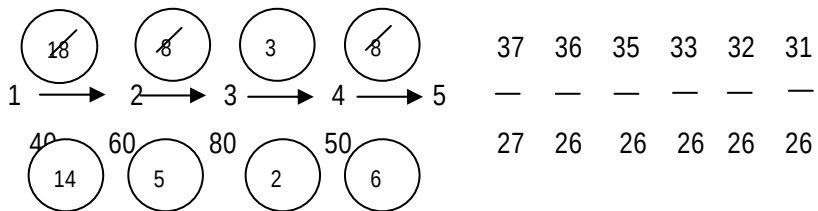


5 15

2 16

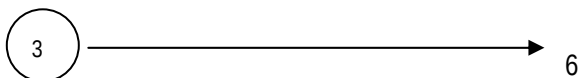
1 17

6

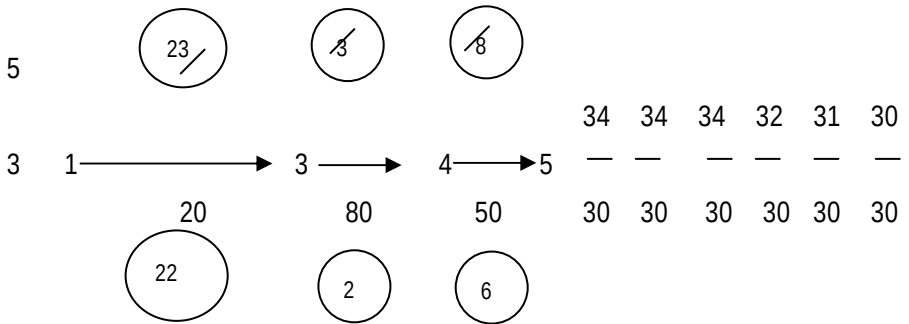


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2



6



Critical Path : 1 – 2 – 3 – 4 – 5 (37 days) Crashing cost

(1)	1 – 2	1 day	40
(2)	1 – 2	1 day	40
(3)	4 – 5	2 days	100
(4)	2 – 3	1 day	60
(5)	1 – 2 & 1 – 3	1 day (40 + 20)	<u>60</u>
			<u>300</u>

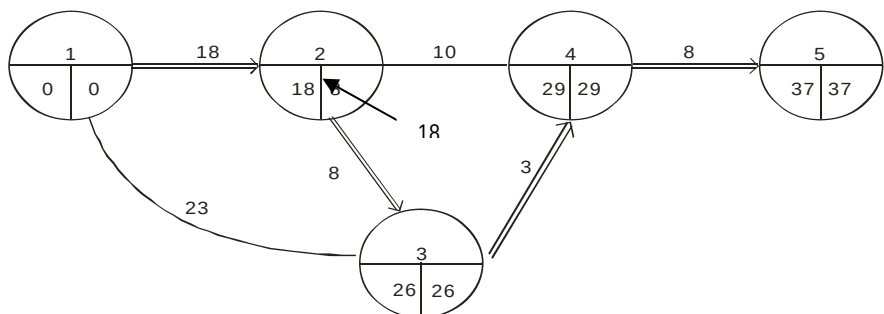
Revised critical Path : 1 – 2 – 4 – 5
 1 – 2 – 3 – 4 – 5
 1 – 3 – 4 – 5

Duration 31 days

(Note: After each crashing a networking diagram has to be drawn and critical path has to be decided).

Alternative Solution:

(i) Network Diagram:



Project duration = 37 days.

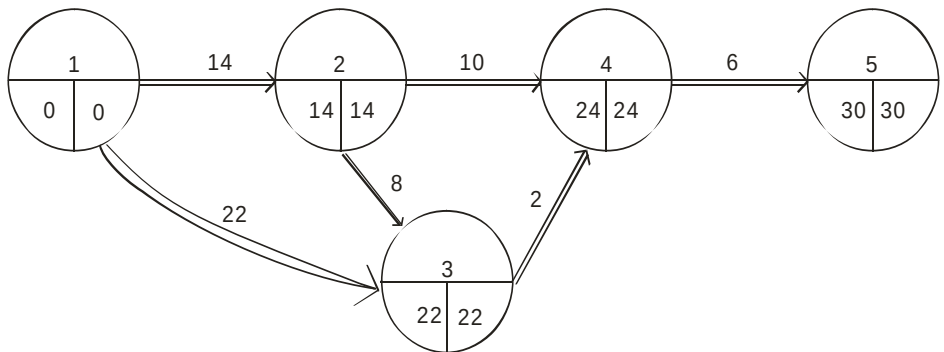
(i) $1 \rightarrow 3 \rightarrow 4 \rightarrow 5$

(ii) $1 - 2 - 3 - 4 - 5$ (Critical Path)

Crashing by Steps

Step : 1	Crash activity	Crashing No. of days	Crash cost per day (Rs.)	Crashing cost (Rs.)
	1-2	3	40	120
Step : 2	1-2	1	40	40
	1-3	1	20	20
Step : 3	4-5	2	50	100
Step : 4	3-4	1	80	<u>80</u>
				<u>360</u>

Revised Network



Effective crashing days = 7

Critical Paths:

(i) $1 - 2 - 4 - 5$

(ii) $1 - 3 - 4 - 5$

(iii) $1 - 2 - 3 - 4 - 5$

Project duration = 30 days

Crashing cost = ₹ 360

- (ii) For optimal project duration, we have to consider indirect cost per day i.e., ₹ 70. The crashing cost of activity 3-4 is ₹ 80 which is higher than indirect cost per day. Hence,

we may opt it out (Step 4).

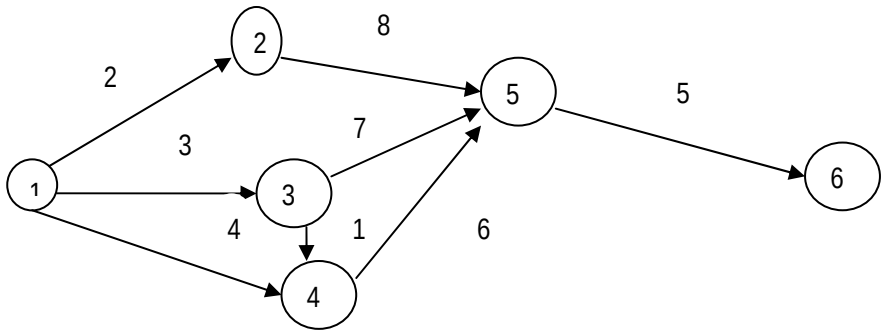
In that case, project duration = 31 days.

Crashing cost = ₹ 280.

Saving in indirect cost = $6 \times ₹ 70 = ₹ 420$.

Question 8

The following network gives the duration in days for each activity :



- (i) You are required to list the critical paths.
- (ii) Given that each activity can be crashed by a maximum of one day, choose to crash any four activities so that the project duration is reduced by 2 days. (6 Marks)(Nov.,2009)

Answer

Critical Paths:

All are critical paths:

- | | | | |
|-------|-------------------|---------------|------|
| (i) | 1 – 2 – 5 – 6 | 2 + 8 + 5 | = 15 |
| (ii) | 1 – 3 – 5 – 6 | 3 + 7 + 5 | = 15 |
| (iii) | 1 – 4 – 5 – 6 | 4 + 6 + 5 | = 15 |
| (iv) | 1 – 3 – 4 – 5 – 6 | 3 + 1 + 6 + 5 | = 15 |

- (i) Choose 5 – 6, common path;

Crash by 1 day

- (ii) Choose: 1 – 2, 1 – 3, 1 – 4

Or

- (iii) Choose: 1 – 2, 3 – 5, 4 – 5

Or

(iv) Choose: 2 - 5 , 3 - 5, 4 - 5

Or

(v) Choose: 1 - 3, 1 - 4, 2 - 5

Question 9

State any 5 limitations of the assumptions of PERT and CPM

(5 Marks)(Nov.,2011)

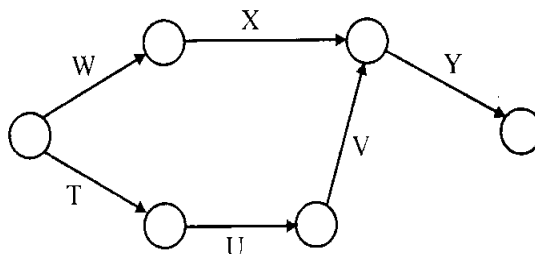
Answer

Limitations of the assumption of PERT and CPM

- (i) Beta distribution may not always be applicable
- (ii) The formulae for expected duration and standard deviation are simplification. In certain cases, errors due to these have been found up to 33 %
- (iii) The above errors may get compounded or may cancel each other
- (iv) Activities are assumed to be independent. But the limitations on the resources may not justify the assumption.
- (v) It may not always be possible to sort out completely identifiable activities and to state where they begin and where they end
- (vi) If there exist alternatives in outcome, they need to be incorporated by way of a decision tree analysis.
- (vii) Time estimates have a subjective element and to this extent, techniques could be weak. Contractors can manipulate and underestimate time in cost plus contract bids. In incentive contracts, overestimation is likely.
- (viii) Cost-time tradeoffs / cost curve slopes are subjective and even experts may be widely off the mark even after honest deliberations

Question 10

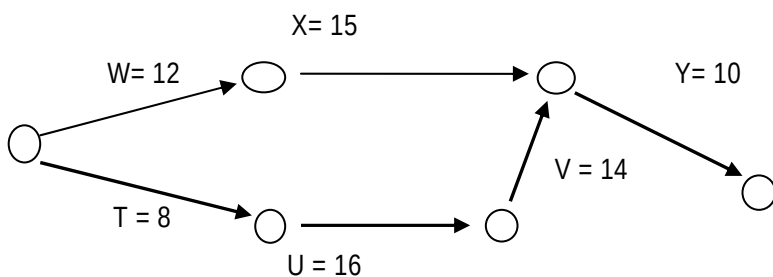
The following network and table are presented to you:



Activity	Normal Duration (Days)	Normal Cost (₹)	Crash Duration (Days)	Crash Cost (₹)
T	8	2,250	6	2,750
U	16	1,875	11	2,750
V	14	2,250	9	3,000
W	12	3,000	9	3,750
X	15	1,000	14	2,500
Y	10	2,500	8	2,860

Perform step by step crashing and reduce the project duration by 11 days while minimizing the crashing cost. What would be the cost of the crashing exercise? (8 Marks)(May, 2012)

Answer



Paths: TUVY 8+16+14+10 = 48 days (critical path)
 WXY 12+15+10 = 37 days

	T	U	V	Y
Crash days possible	2	5	5	2
Crash cost-normal cost	500	875	750	360
Crashing cost/day	250	175	150	180
Step I crash V – 5 days			750	
Step II crash U – 5 days		875		
Step III crash Y- 1 day				180
Minimum cost of crashing exercise (₹)	750+875+180 = 1805 (for 11 days)			

Question 11

Write a short note on the distinction between PERT and CPM.

(5 Marks)(Nov., 2012)

Answer

The PERT and CPM models are similar in terms of their basic structure, rationale and mode of analysis. However, there are certain distinctions between PERT and CPM networks which are enumerated below:

- (i) CPM is activity oriented, while PERT is event oriented
- (ii) CPM is a deterministic model. It completely ignores the probabilistic element of the problem. PERT is a probabilistic model. It uses three estimates of activity time. Optimistic, pessimistic and most likely, with a view to take into account time uncertainty.
- (iii) PERT is primarily concerned with time. It helps the manager to schedule and coordinate various activities so that the project can be completed on scheduled time. CPM places dual emphasis on time and cost and evaluates the trade-off between project cost and project time. By deploying additional resources, it allows the project manager to manipulate project duration within certain limits so that the project duration can be shortened at an optimal cost.
- (iv) CPM is commonly used for those projects which are repetitive in nature and where one has prior experience of handling similar projects. PERT is generally used for those projects where time required to complete various activities are not known as prior.

Question 12

The Noida Nirman Authority intends to install a road traffic regulating signal in a heavy traffic prone area. The total installation work has been broken down into six activities. The normal duration, crash duration and crashing cost of the activities are expected as given in the following table :

Activity	Normal Duration (Days)	Crash Duration (Days)	Crashing Cost per day (₹)
1-2	9	6	30,000
1-3	8	5	40,000
1-4	15	10	45,000
2-4	5	3	15,000
3-4	10	6	20,000
4-5	2	1	60,000

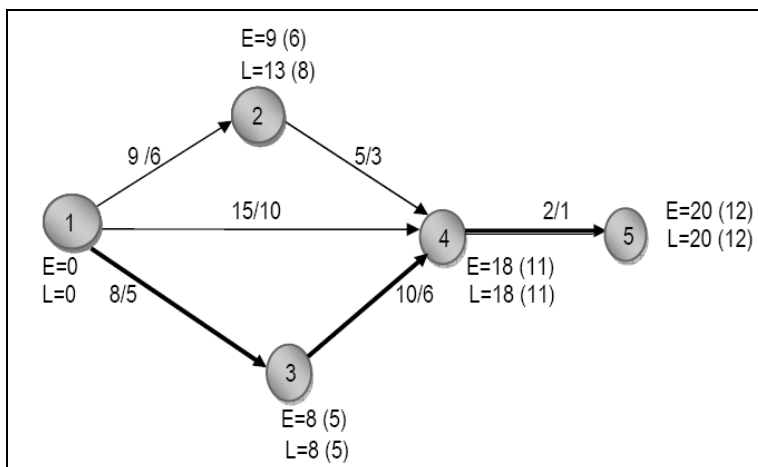
You are required to :

- (i) *draw the network and find the normal and minimum duration of the work.*
- (ii) *compute the additional cost involved if the authority wants to complete the work in the shortest duration.*

(7 Marks)(May, 2013)

Answer

(i)



The critical path is 1 – 3 – 4 – 5. The normal length of the project is 20 days and minimum project length is 12 days.

(ii) Statement showing Additional Crashing Cost:

Normal Project Length Days	Job Crashed	Crashing Cost
20	-	-
19	3-4	₹ 20,000 x 1 Day = ₹ 20,000
18	3-4	₹ 20,000 x 2 Days = ₹ 40,000
17	3-4	₹ 20,000 x 3 Days = ₹ 60,000
16	4-5	₹ 20,000 x 3 Days + 1 Day x ₹ 60,000 = ₹ 1,20,000
15	3-4, 1-4	₹ 20,000 x 4 Days + ₹ 60,000 x 1 Day + ₹ 45,000 x 1 Day = ₹ 1,85,000
14	1-3, 1-4, 2-4	₹ 1,85,000 + 1 Day x ₹ 40,000 + 1 Day x ₹ 45,000 + 1 Day x ₹ 15,000 = ₹ 2,85,000
13	1-3, 1-4, 2-4	₹ 2,85,000 + 1 Day x ₹ 40,000 + 1 Day x ₹ 45,000 + 1 Day x ₹ 15,000 = ₹ 3,85,000
12	1-3, 1-4, 1-2	₹ 3,85,000 + 1 Day x ₹ 40,000 + 1 Day x ₹ 45,000 + 1 Day x ₹ 30,000 = ₹ 5,00,000
Total Additional Cost (At shortest duration)		₹ 5,00,000/-

Question 13

Under what circumstance PERT is more relevant? How?

(4 Marks)(May, 2013)

Answer

PERT (Program Evaluation and Review Technique) is more relevant for handling such projects which have a great deal of uncertainty associated with the activity durations.

To take these uncertainty into account, three kinds of times estimates are generally obtained. These are:

- The Optimistic Times Estimate: This is the estimate of the shortest possible time in which an activity can be completed under ideal conditions. For this estimate, no provision for delays or setbacks are made. We shall denote this estimate by t_o .
- The Pessimistic Time Estimate: This is the maximum possible time which an activity could take to accomplish the job. If everything went wrong and abnormal situations prevailed, this would be the time estimate. It is denoted by t_p .
- The Most Likely Time Estimate: This is a time estimate of an activity which lies between the optimistic and the pessimistic time estimates. It assumes that things go in a normal way with few setbacks. It is represents by t_m .

Question 14

A project consists of seven activities whose time estimates (optimistic - t_o , pessimistic - t_p and most likely - t_m) in days are given below:

Activity	t_o	t_p	t_m
1-2	1	5	3
1-3	1	7	4
1-4	2	10	6
2-5	2	8	2
3-5	3	15	6
4-6	2	8	5
5-6	2	14	5

Required:

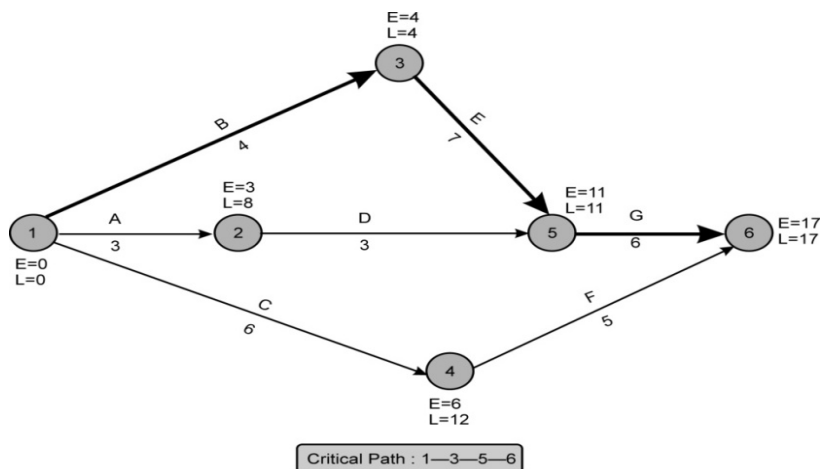
- (i) *Draw the network and find out the expected time and variance for each activity. What is the expected duration for completion of the project?*
- (ii) *IT the target time is 22 days, what is the probability of not meeting the target?*
- (iii) *Within how many days can the project be expected to be completed with 99 percent chance?*

Given $Z_{2.33} = 0.9901$ and $Z_{1.67} = 0.9525$

(8 Marks)(Nov., 2013)

Answer

(i) The network for the given problem



The Expected Time and Variance for each of the activities (in Days)

Activity	Time Estimates (Days)			Expected Time	Variance
	Optimistic (t_o)	Pessimistic (t_p)	Most Likely (t_m)	$t_e = \frac{t_o + 4t_m + t_p}{6}$	$S_t^2 = \left(\frac{t_p - t_o}{6} \right)^2$
A (1-2)	1	5	3	3	$\frac{4}{9}$
B (1-3)	1	7	4	4	1
C (1-4)	2	10	6	6	$\frac{16}{9}$
D (2-5)	2	8	2	3	1
E (3-5)	3	15	6	7	4
F (4-6)	2	8	5	5	1
G (5-6)	2	14	5	6	4

$$\text{Probability of Completing the Project by Schedule Time } T_s \text{ is given by } Z = \frac{T_s - T_e}{\sigma_e}$$

$$\text{Expected Project Length } (T_e) = 17 \text{ Days}$$

$$\text{Variance of the Critical Path } 1-3-5-6 \text{ } (\sigma_e^2) [1+4+4] = 9$$

$$\text{Standard Deviation of the Critical Path } (\sigma_e) [\sqrt{9}] = 3$$

(ii) Probability of not meeting the target time of 22 days

$$\text{Probability of Completing the Project by Schedule Time } T_s \text{ is given by } Z = \frac{T_s - T_e}{\sigma_e}$$

Accordingly probability of meeting the target time of 22 days is given by Z

$$= \frac{22 - 17}{3}$$

$$= 1.67^*$$

$$\text{Probability } (Z = 1.67) = 0.9525$$

$$\text{Probability of not meeting the target time of 22 days } [1 - 0.9525] = 0.0475$$

$$\text{Or} = 4.75\%$$

(iii) Expected Time if the project to be completed with 99% chance

$$\text{Probability of Completing the Project by Schedule Time } T_s \text{ is given by } Z = \frac{T_s - T_e}{\sigma_e}$$

Accordingly,

$$Z = \frac{T_s - 17}{3}$$

At 99% Chance Z equals to 2.33

Accordingly,

$$2.33 = \frac{T_s - 17}{3}$$

Or

$$T_s = 23.99$$

Hence, expected time of completing the project with 99% of chances is 23.99 or 24 Days.

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Simulation

Question 1

A company trading in motor vehicle spares wishes to determine the level of stock it should carry for the item in its range. Demand is not certain and replenishment of stock takes 3 days. For one item X, the following information is obtained:

Demand (unit per day)	Probability
1	.1
2	.2
3	.3
4	.3
5	.1

Each time an order is placed, the company incurs an ordering cost of ₹ 20 per order. The company also incurs carrying cost of ₹ 2.50 per unit per day. The inventory carrying cost is calculated on the basis of average stock.

The manager of the company wishes to compare two options for his inventory decision.

- (A) Order 12 units when the inventory at the beginning of the day plus order outstanding is less than 12 units.
- (B) Order 10 units when the inventory at the beginning of the day plus order outstanding is less than 10 units.

Currently (on first day) the company has a stock of 17 units. The sequence of random number to be used is 08, 91, 25, 18, 40, 27, 85, 75, 32, 52 using first number for day one.

You are required to carry out a simulation run over a period of 10 days, recommended which option the manager should chose. (7 Marks) (Nov., 2004)

Answer

Allocation of random numbers

Demand	Probability	Cumulative prob.	Random numbers
1	.1	.1	00-09
2	.2	.3	10-29

3	.3	.6	30-59
4	.3	.9	60-89
5	.1	1.0	90-99

Option I

Day	Random numbers	Opening Stock	Demand	Closing Stock	Order placed	Order in	Average stock
1	08	17	1	16	-	-	16.5
2	91	16	5	11	12	-	13.5
3	25	11	2	09	-	-	10.0
4	18	09	2	07	-	-	8.00
5	40	07	3	04	-	12	5.50
6	27	16	2	14	-	-	15.0
7	85	14	4	10	12	-	12.00
8	75	10	4	06	-	-	8.00
9	32	6	3	3	-	-	4.50
10	52	3	3	-	-	12	<u>1.50</u>
							<u>94.5</u>

Carrying cost (94.5×2.50) = ₹ 236.25

Ordering cost (2×20) = ₹ 40.00

₹ 276.25

Option 11

Day	Random no.	Opening Stock	Demand	Closing Stock	Order placed	Order in	Average stock
1	08	17	1	16	-	-	16.5
2	91	16	5	11	-	-	13.5
3	25	11	2	09	10	-	10.0
4	18	09	2	07	-	-	8.00
5	40	07	3	04	-	-	5.50
6	27	04	2	02	-	10	3.00
7	85	12	4	08	10	-	10.00
8	75	08	4	04	-	-	6.00

9	32	04	3	01	-	-	2.50
10	52	01	3	-	-	10	<u>0.50</u>
							<u>75.5</u>

Carrying cost (75.5×2.50) = ₹ 118.75

Ordering cost (2×20) = ₹ 40.00

₹ 228.75

Option II is better.

Question 2

A Publishing house has bought out a new monthly magazine, which sells at ₹ 37.5 per copy. The cost of producing it is ₹ 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 ₹ 4 per copy for handling charges.

The newsstand manager wants to simulate the demand and profitability. The 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 pattern forecast by the newsstand.
- Simulate twelve months sales and calculate the monthly and annual profit/loss.
- Calculate the loss on lost sales.

(8 Marks) (Nov., 2005)

Answer

- 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 (₹)</i>	<i>Loss on return (₹)</i>	<i>Net (₹)</i>	<i>Loss on lost units</i>
1	27	450	450	300	3375	1200	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	300
10	83	1050	750	--	5625	--	5625	900
11	96	1650	750	--	5625	--	5625	
12	69	750	750	--	5625		5625	
					54000	7200	46800	2100

(iii) Loss on lost sale $2100 \times 7.5 = ₹ 15750$.

Question 3

- (i) What is simulation? (1 Mark) (Nov., 2006)
- (ii) What are the steps in simulation? (4 Marks) (Nov., 2006)

Answer

- (i) Simulation is a quantitative procedure which describes a process by developing a model of that process and then conducting a series of organized trial and error experiments to

product the behaviour of the process over time.

(ii) Steps in the simulation process:

- (i) Define the problem and system you intend to simulate.
- (ii) Formulate the model you intend to use.
- (iii) Test the model, compare with behaviour of the actual problem environment.
- (iv) Identify and collect data to test the model.
- (v) Run the simulation.
- (vi) Analyse the results of the simulation and, if desired, change the solution you are evaluating.
- (vii) Rerun the simulation to tests the new solution.
- (viii) Validate the simulation i.e., increase the chances of valid inferences.

Question 4

How would you use the Monte Carlo Simulation method in inventory control?

(4 Marks) (May 2008)

Answer

The Monte Carlo Simulation:

It is the earliest mathematical Model of real situations in inventory control:

Steps involved in carrying out Monte Carlo simulation are:

- ◆ Define the problem and select the measure of effectiveness of the problem that might be inventory shortages per period.
- ◆ Identify the variables which influence the measure of effectiveness significantly for example, number of units in inventory.
- ◆ Determine the proper cumulative probability distribution of each variable selected with the probability on vertical axis and the values of variables on horizontal axis.
- ◆ Get a set of random numbers.
- ◆ Consider each random number as a decimal value of the cumulative probability distribution with the decimal enter the cumulative distribution plot from the vertical axis. Project this point horizontally, until it intersects cumulative probability distribution curve. Then project the point of intersection down into the vertical axis.
- ◆ Then record the value generated into the formula derived from the chosen measure of effectiveness. Solve and record the value. This value is the measure of effectiveness for that simulated value. Repeat above steps until sample is large enough for the

satisfaction of the decision maker.

Question 5

A single counter ticket booking centre employs one booking clerk. A passenger on arrival immediately goes to the booking counter for being served if the counter is free. If, on the other hand, the counter is engaged, the passenger will have to wait. The passengers are served on first come first served basis. The time of arrival and the time of service varies from one minute to six minutes. The distribution of arrival and service time is as under:

<i>Arrival / Service Time (Minutes)</i>	<i>Arrival (Probability)</i>	<i>Service (Probability)</i>
1	0.05	0.10
2	0.20	0.20
3	0.35	0.40
4	0.25	0.20
5	0.10	0.10
6	0.05	—

Required:

- (i) Simulate the arrival and service of 10 passengers starting from 9 A.M. by using the following random numbers in pairs respectively for arrival and service. Random numbers 60 09 16 12 08 18 36 65 38 25 07 11 08 79 59 61 53 77 03 10.
- (ii) Determine the total duration of
 - (1) Idle time of booking clerk and
 - (2) Waiting time of passengers.

(8 Marks) (Nov., 2008)

Answer

Random allocation tables are as under:

<i>Time (Mts)</i>	<i>Arrival (Probability)</i>	<i>Arrivals Cumulative Probability</i>	<i>Random No. allocated</i>	<i>Time (Mts)</i>	<i>Service (Probability)</i>	<i>Service Cumulative (Probability)</i>	<i>Random No. allocated</i>
1	0.05	0.05	00-04	1	0.10	0.10	00-09
2	0.20	0.25	05-24	2	0.20	0.30	10-29
3	0.35	0.60	25-59	3	0.40	0.70	30-69
4	0.25	0.85	60-84	4	0.20	0.90	70-89
5	0.10	0.95	85-94	5	0.10	1.00	90-99
6	0.05	1.00	95-99				

Simulation of ten trails:

R. No.	Arrival Mts.	Time	Start	R. No.	Time Mts.	Finish Time	Waiting Time	
							Clerk	Passanger
60	4	9.04	9.04	09	1	9.05	4	—
16	2	9.06	9.06	12	2	9.08	1	—
08	2	9.08	9.08	18	2	9.10	—	—
36	3	9.11	9.11	65	3	9.14	1	—
38	3	9.14	9.14	25	2	9.16	—	—
07	2	9.16	9.16	11	2	9.18	—	—
08	2	9.18	9.18	79	4	9.22	—	—
59	3	9.21	9.22	61	3	9.25	—	1
53	3	9.24	9.25	77	4	9.29	—	1
03	1	9.25	9.29	10	2	9.31	—	<u>4</u>
	Total						<u>6</u>	<u>6</u>

In the above ten trial, the clerk was idle for 6 minutes and the passengers had to wait for 6 minutes.

Question 6

ABC Cooperative Bank receives and disburses different amount of cash in each month. The bank has an opening cash Balance of ₹ 15 crores in the first month. Pattern of receipts and disbursements from past data is as follows:

Monthly Cash receipts		Monthly Cash disbursements	
₹ in Crores	Probability	₹ in Crores	Probability
30	0.20	33	0.15
42	0.40	60	0.20
36	0.25	39	0.40
99	0.15	57	0.25

Simulate the cash position over a period of 12 months.

Required:

- Calculate probability that the ABC Cooperative Bank will fall short in payments.
- Calculate average monthly shortfall.
- If ABC bank can get an overdraft facility of ₹ 45 crores from other Nationalized banks. What is the probability that they will fall short in monthly payments?

Use the following sequence (rowwise) of paired random numbers.

1778 4316 7435 3123 7244 4692 5158 6808 9358 5478 9654 0977

(7 Marks)(May, 2010)

Answer

Monthly Cash receipts (₹ crores)				Monthly Cash disbursements (₹ crores)			
Cash	Probability	Cumulative	R.N.	Cash	Probability	Cumulative	R.N.
30	0.20	0.20	00-19	33	0.15	0.15	00-14
42	0.40	0.60	20-59	60	0.20	0.35	15-34
36	0.25	0.85	60-84	39	0.40	0.75	35-74
99	0.15	1.00	85-99	57	0.25	1.00	75-99

	Opening	Receipt			Payment		Closing
Months	(₹ in Crores)	Random Number.	(₹ in Crores)	Total	Random Number.	(₹ in Crores)	(₹ in Crores)
1	15	17	30	45	78	57	-12
2	-12	43	42	30	16	60	-30
3	-30	74	36	06	35	39	-33
4	-33	31	42	09	23	60	-51
5	-51	72	36	-15	44	39	-54
6	-54	46	42	-12	92	57	-69
7	-69	51	42	-27	58	39	-66
8	-66	68	36	-30	08	33	-63
9	-63	93	99	36	58	39	-3
10	-3	54	42	39	78	57	-18
11	-18	96	99	81	54	39	42
12	42	09	30	72	77	57	15

(i) In 12 months, the bank falls short of cash in 10 months to meet payment.

Thus, probability of shortfall = $10/12 = 0.83$

(ii) Total short fall of ₹ 399 crores over 10 months

Average monthly shortfall during 10 months = ₹ 39.9 crores

(iii) With an overdraft facility of ₹ 45 crores is available, there will be a shortfall in 5 months (4,5,6,7,8).. Therefore, probability is = $5/12 = 0.42$

Question 7

What are the steps involved in carrying out Monte Carlo simulation model? (4 Marks)(Nov., 2010)

Answer

Steps involved in Monte Carlo simulation are:

- (i) To select the measure of effectiveness of the problem, that is, what element is used to measure success in improving the system modeled. This is the element one wants to maximize or minimize.
- (ii) Identifying the variables which influence the measure of effectiveness significantly.
- (iii) Determining the proper cumulative probability distribution.
- (iv) To get a set of random numbers.
- (v) Consideration of each random number as a decimal value of the cumulative probability distribution. With the decimal, enter the cumulative distribution plot from the vertical axis, Project this point horizontally, until it intersects cumulative probability distribution curve.
- (vi) Recording the value generated in step(v) into the formula derived from the chose measures of effectiveness. Solve and record the value.
- (vii) Repeating steps (V) and (VI) until sample is large enough for the satisfaction of the decision maker.

Question 8

A car rental agency has collected the following data on the demand for five-seater vehicles over the past 50 days.

Daily Demand	4	5	6	7	8
No. of Days	4	10	16	14	6

The agency has only 6 cars at present.

- (i) *Use the following 5 random numbers to generate 5 days of demand for the rental agency*
Random Nos 15, 48, 71, 56, 90
- (ii) *What is the average number of cars rented per day for the 5 days ?*
- (iii) *How many rentals will be lost over the 5 days? (5 Marks)(May, 2011)*

Answer

Daily demand	Days	Probability	Cumulative probability	Random No.	Day	Demand	Rented	Rental lost
4	4	0.08	0.08	00.07	1	5	5	

5	10	0.20	0.28	08-27	2	6	6	
6	16	0.32	0.60	28-59	3	7	6	1
7	14	0.28	0.88	60-87	4	6	6	
8	<u>6</u>	<u>0.12</u>	1.00	88-99	5	8	<u>6</u>	<u>2</u>
	<u>50</u>	<u>1.00</u>					<u>29</u>	<u>3</u>

$$\text{Average no. of cars rented} = \frac{29}{5} = 5.8$$

Rental lost = 3

Question 9

What are the steps involved in the simulation process?

(4 Marks)(Nov., 2011)

Answer

Steps in Simulation Process

1. Define the problem or system you intend to simulate.
2. Formulate the model you intend to use.
3. Test the model; compare its behavior with the behavior of the actual problem environment.
4. Identify and collect the data needed to test the model.
5. Run the simulation.
6. Analyse the results of the simulation and, if desired, change the solution you are evaluating.
7. Rerun the simulation to test the new solution.
8. Validate the simulation, that is, increase the chances that any inferences you draw about the real situation from running the simulation will be valid.

Question 10

A refreshment centre in a railway station has two counters - (i) self-service (opted by 60 % of the customers) and (ii) attended service (opted by 40 % of the customers). Both counters can serve one person at a time. The arrival rate of customers is given by the following probability distribution:

No. of arrivals	1	3	4	0	2
Probability	0.10	0.30	0.05	0.20	0.35

Formulate the associated interval of 2 digit random numbers for generating

(i) the type of service and

(ii) the arrival rate

(4 Marks)(May, 2012)

Answer

Type of Service	Probability	Cumulative Probability	Random No. Interval
Self- Service	0.60	0.60	00 - 59
Attended Service	0.40	1.00	60 - 99

Arrival Rate:

No. of arrivals	Probability	Cumulative Probability	Random Number Interval
0	0.20	0.20	00 - 19
1	0.10	0.30	20 - 29
2	0.35	0.65	30 - 64
3	0.30	0.95	65 - 94
4	0.05	1.00	95 - 99

Question 11

An international tourist company deals with numerous personal callers each day and prides itself on its level of service. The time to deal with each caller depends on the client's requirements which range from, say, a request for a brochure to booking a round-the-world cruise. If a client has to wait for more than 10 minutes for attention, it is company's policy for the manager to see him personally and to give him a holiday voucher worth ₹15.

The company's observations have shown that the time taken to deal with clients and the arrival pattern of their calls follow the following distribution pattern:

Time to deal with clients	Minutes	2	4	6	10	14	20	30
	Probability	0.05	0.10	0.15	0.30	0.25	0.10	0.05
Time between call arrivals	Minutes	1	8	15	25			
	Probability	0.2	0.4	0.3	0.1			

Required:

(i) Describe how you would simulate the operation of the travel agency based on the use of random number tables;

- (ii) Simulate the arrival and serving of 12 clients and show the number of clients who receive a voucher (use line 1 of the random numbers below to derive the arrival pattern and line 2 for serving times); and
- (iii) Calculate the weekly cost of vouchers; assuming the proportion of clients receiving vouchers derived from (ii) applies throughout a week of 75 operating hours.

Random Numbers

Line 1	03	47	43	73	86	36	96	47	36	61	46	98
Line 2	63	71	62	33	26	16	80	45	60	11	14	10

(7 Marks)(Nov., 2012)

Answer

Time to deal with clients

Time(Minutes)	Probability	Cumulative Probability	Assigned Numbers
2	0.05	0.05	00-04
4	0.10	0.15	05-14
6	0.15	0.30	15-29
10	0.30	0.60	30-59
14	0.25	0.85	60-84
20	0.10	0.95	85-94
30	0.05	1.00	95-99

Time between arrivals

Time(Minutes)	Probability	Cumulative Probability	Assigned Numbers
1	0.2	0.2	00-19
8	0.4	0.6	20-59
15	0.3	0.9	60-89
25	0.1	1.0	90-99

Simulation table for time between arrivals and service time

Client	Time Between Arrivals	Arrival Time	Time In	Serving Time	Time Out	Waiting Time	Voucher
1	1	1	1	14	15	-	
2	8	9	15	14	29	6	
3	8	17	29	14	43	12	Yes
4	15	32	43	10	53	11	Yes

5	15	47	53	6	59	6	
6	8	55	59	6	65	4	
7	25	80	80	14	94	-	
8	8	88	94	10	104	6	
9	8	96	104	14	118	8	
10	15	111	118	4	122	7	
11	8	119	122	4	126	3	
12	25	144	144	4	148	-	

Total Clients in a Week of 75Hours = 75 Hours x 60 minutes / 10.4[#] minutes = 433

[#]Average time between arrivals = $0.2 \times 1 + 0.4 \times 8 + 0.3 \times 15 + 0.1 \times 25 = 10.4$ minutes

2 out of the 12 clients receive ₹ 15 voucher. So the cost will be ₹ 1,082.50 or ₹ 1,083 [(2/12 x 433) x ₹15].

☞ Taking cycle time as 148 minutes, voucher cost can be computed as follows:

₹ 15 per Client x [(75 Hours x 60 minutes / 148 minutes) no. of cycles x 2 Clients per Cycle Time]

So, Voucher Cost will be ₹ 912.16

Question 12

Brief the reasons for using simulation technique to solve problems. (4 Marks)(May, 2013)

Answer

Reasons for using simulation technique to solve problems:

- It is not possible to develop a mathematical model and solutions without some basic assumptions.
- It may be too costly to actually observe a system.
- Sufficient time may not be available to allow the system to operate for a very long time.
- Actual operation and observation of a real system may be too disruptive.

Question 13

A bakery sells a popular brand of bread. Cost price per bread is ₹ 16 and selling price per bread is ₹ 20. Shelf life of the bread is 2 days and if it is not sold within two days, then it has no sale value at the end of second day. Daily demand based on past experience is as under:

Daily Demand	0	20	25	35	40	45
Probability	.01	.15	.30	.40	.10	.04

Consider the following sequence of random numbers:

58, 80, 51, 09, 47, 26, 64, 43, 86, 35

Using the sequence, simulate the demand for the next 10 days and find out the total profit or loss for 10 days assuming 35 breads are purchased every day in the morning and there is an opening stock of 5 breads (purchased the previous day) on the 1st day morning. Assume LIFO basis (Last In First Out basis - where the fresh bread is sold first). (8 Marks)(Nov., 2013)

Answer

The demand patterns yield the following probability distribution. The numbers 00–99 are allocated in proportion to the probabilities associated with each event.

Random No. Coding for Demand

Demand	Prob.	Cum Prob.	Random Numbers
0	0.01	0.01	00 – 00
20	0.15	0.16	01 – 15
25	0.30	0.46	16 – 45
35	0.40	0.86	46 – 85
40	0.10	0.96	86 – 95
45	0.04	1.00	96 – 99

Let us simulate the supply and demand for the next ten days using the given random numbers / information in order to find the profit if

- the cost of the bread is ₹16,
- the selling price is ₹20 and
- unsold bread after the end of the 2nd Day have no saleable value.

Simulation Sheet for Finding Profit

Day	Random No	Op. Stock (In No.)	Demand (In No.)	Supply (In No.)	Waste (In No.)	Cl. Stock (In No.)	Loss on Waste (In ₹)	Profit on Sale (In ₹)	Net Profit (In ₹)
1	58	5	35	35	5	0	80 (5b×₹16)	140 (35b×₹4)	60
2	80	0	35	35	0	0	0	140 (35b×₹4)	140
3	51	0	35	35	0	0	0	140 (35b×₹4)	140

4	09	0	20	35	0	15	0	80 (20b×₹4)	80
5	47	15	35	35	15	0	240 (15b×₹16)	140 (35b×₹4)	-100
6	26	0	25	35	0	10	0	100 (25b×₹4)	100
7	64	10	35	35	10	0	160 (10b×₹16)	140 (35b×₹4)	-20
8	43	0	25	35	0	10	0	100 (25b×₹4)	100
9	86	10	40	35	5	0	80 (5b×₹16)	160 (40b×₹4)	80
10	35	0	25	35	0	10	0	100 (25b×₹4)	100

*b refers to no. of breads

Profit on Sale of one Bread ₹4 (₹20 – ₹16).

Total Profit for 10 Days is ₹680.

(₹60 + ₹140 + ₹140 + ₹80 – ₹100 + ₹100 – ₹20 + ₹100 + ₹80 + ₹100)

Cost of Bread in Stock at the end of the 10th Day is ₹160 (10 Breads × ₹16).

Learning Curve Theory

Question 1

An electronics firm which has developed a new type of fire-alarm system has been asked to quote for a prospective contract. The customer requires separate price quotations for each of the following possible orders:

Order	Number of fire-alarm systems
First	100
Second	60
Third	40

The firm estimates the following cost per unit for the first order:

Direct materials	₹. 500
Direct labour	
Deptt. A (Highly automatic) 20 hours at ₹. 10 per hour	
Deptt. B (Skilled labour) 40 hours at ₹. 15 per hour	
Variable overheads	20% of direct labour
Fixed overheads absorbed:	
Deptt. A	₹. 8 per hour
Deptt. B	₹. 5 per hour

Determine a price per unit for each of the three orders, assuming the firm uses a mark up of 25% on total costs and allows for an 80% learning curve. Extract from 80% Learning curve table:

X	1.0	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
Y%	100.0	91.7	89.5	87.6	86.1	84.4	83.0	81.5	80.0

X represents the cumulative total volume produced to date expressed as a multiple of the initial order.

Y is the learning curve factor, for a given X value, expressed as a percentage of the cost of the initial order.

(8 Marks) (May, 2005); (11 Marks) (May, 2010)

Answer

(i) Price per unit for first order of 100 units

	₹	₹
Direct material		500.00
Direct labour	Dept A 20 Hrs @ 10 = 200 Dept B 40 Hrs @ 15 = 600	800.00
Variable Overhead	20% of ₹ 800	160.00
Fixed Overhead	Dept A 20 Hrs @ 8 = 160 Dept B 40 Hrs @ 5 = 200	360.00
Total cost		1,820.00
Profit 25%		455.00
Selling price per unit		2,275.00

(ii) Price per unit for second order of 60 units

Learning will be applicable only in department B.

Cumulative output becomes 100 units + 60 units = 160 units i.e 1.6 times for which learning is 86.1 % from the tables.

Therefore Total Hrs for 160 units = 160 units $\times$ 40 $\times$.861 = 5,510.4 Hrs

Therefore Hrs for 60 units = Hrs for 160 units less Hrs for 100 units

Or 5510.4 less 40 $\times$ 100 = 1510.4 Hrs

Therefore Hrs per unit = $\frac{1510.4}{60} = 25.17$

Calculation of selling price per unit

		₹
Direct materials		500.00
Direct labour	Dept A 20 Hrs @ 10 = 200 Dept B 25.17 Hrs @ 15 = 377.55	577.55
Variable Overhead	20% of 577.55	115.51
Fixed Overhead	Dept A 20 Hrs @8= 160 Dept B 25.17 Hrs @5=125.85	285.85
Total cost		1,478.91
Profit 25%		369.73
Selling price per unit		1,848.64

(iii) Price per unit for third order of 40 units

Cumulative output becomes $100 + 60 + 40 = 200$ units i.e. 2 times for which learning is 80% from the table

Total Hrs for 200 units = $200 \times 40 \times .80 = 6,400$ Hrs

Hrs for 40 units = Hrs for 200 units less Hrs for 160 units

Or $6,400$ less $5510.4 = 889.6$ Hrs

Therefore Hrs per unit = $\frac{889.6}{40} = 22.24$

Calculation of selling price per unit

		₹
Direct materials		500.00
Direct labour	Dept A 20 Hrs @ 10 = 200.00	533.60
	Dept B 22.24 @ 15 = 333.60	
Variable Overhead	20% of 533.60	106.72
Fixed Overhead	Dept A 20 Hrs @ 8 = 160	271.20
	Dept B 22.24 Hrs @ 5 = 111.20	
Total cost		1,411.52
Profit 25%		352.88
Selling price per unit		1,764.40

Question 2

Explain the concept 'Learning curve'. How can it be applied for Cost management?

(4 Marks) (May, 2006)

Answer

The first time when a new operation is performed, both the workers and the operating procedures are untried. As the operation is repeated and the workers become more familiar with work, labour efficiency increases and the labour cost per unit declines. This process continues for some time and a regular rate of decline in cost per unit can be established. This rate can be used to predict future labour costs. The learning process starts from the point when the first unit comes out of the production line. In other words 'Learning curve' is a function that measures how labour hours per unit decline as units of production increase because workers are learning and becoming better at their jobs.

Cost Management Application:

1. Learning curve is useful in analysing cost volume profit relationship. The company can set low price of its product to generate high demand. As the production increases, cost per unit drops.
2. It helps in budgeting and profit planning.
3. It enables the company in price fixation. In particular, the company can fix a lower price for repeat orders.
4. It helps the design engineers to take suitable decisions based on expected rates of improvement.
5. It helps in price negotiations.
6. It is useful in setting standards and in performance evaluation.

Question 3

Discuss the application of the learning curve.

(4 Marks) (May, 2007)

Answer

Application of Learning curve: Learning curve helps to analyse cost-volume profit relationships during familiarisation phase of product or process to arrive at cost estimates.

It helps in budgeting and profit planning.

It helps in pricing and consequent decision making – e.g. acceptance of an order, negotiations in establishing contract prices etc. with the advantage of the knowledge of decreasing unit cost.

It helps in setting standards in the learning phase.

Question 4

What are the distinctive features of learning curve theory in manufacturing environment? Explain the learning curve ratio.

(9 Marks) (Nov., 2007)

Answer

As the production quantity of a given item is doubled, the cost of the item decreases at a fixed rate. This phenomenon is the basic premise on which the theory of learning curve has been formulated. As the quantity produced doubles, the absolute amount of cost increase will be successively smaller but the rate of decrease will remain fixed. It occurs due to the following distinctive features of manufacturing environment:

- (i) Better tooling methods are developed and used.
- (ii) More productive equipments are designed and used to make the product.

- (iii) Design bugs are detected and corrected.
- (iv) Engineering changes decrease over time.
- (v) Earlier teething problems are overcome.
- (vi) Rejections and rework tend to diminish over time.

In the initial stage of a new product or a new process, the learning effect pattern is so regular that the rate of decline established at the outset can be used to predict labour cost well in advance. The effect of experience on cost is summarized in the learning curve ratio or improvement ratio.

$$\text{Learning curve ratio} = \frac{\text{Average labour cost of first } 2N \text{ units}}{\text{Average labour cost of first } N \text{ units}}$$

For example, if the average labour cost for the first 500 units is ₹ 25 and the average labour cost for the first 1,000 units is ₹ 20, the learning curve ratio is (₹ 20/25) or 80%. Since the average cost per unit of 1,000 units is ₹ 20, the average cost per unit of first 2,000 units is likely to be 80% of ₹ 20 or ₹ 16.

Question 5

M Ltd. Manufactures a special product purely carried out by manual labour. It has a capacity of 20,000 units. It estimates the following cost structure:

Direct material 30 ₹/unit

Direct labour (1 hour / unit) 20 ₹/unit

Variable overhead 10 ₹/unit

Fixed overheads at maximum capacity is ₹1,50,000.

It is estimated that at the current level of efficiency, each unit requires one hour for the first 5,000 units. Subsequently it is possible to achieve 80% learning rate. The market can absorb the first 5,000 units at ₹ .100 per unit. What should be the minimum selling price acceptable for an order of 15,000 units for a prospective client?
(7 Marks) (May, 2008)

Answer

	5,000 units	20,000 units
Material	1,50,000	6,00,000
Direct Labour	1,00,000	2,56,000
		Refer to W Note i
Variable Overhead	<u>50,000</u>	<u>2,00,000</u>
Total Variable Cost	3,00,000	10,56,000
Fixed Cost	<u>1,50,000</u>	<u>1,50,000</u>

Total Cost	4,50,000	12,06,000
Total cost / unit	90	60.3
Sales $100 \times 5,000$	5,00,000	<u>5,00,000</u>
$15,000 \times x$ (assumed selling price)		$15,000 x$
(Total Sales less Total Cost) = Profit	50,000	$15,000 x - 7,06,000$

Or minimum selling price = 50.4 (refer to Working Note ii)

Working Note: I

Units	Hours
5,000	5,000
10,000	$10,000 \times 1 \times .8 = 8,000$ hours
20,000	$20,000 \times 1 \times .8 \times .8 = 12,800$ hours

Working Note: II

$$15,000 x - 7,06,000 > 50,000$$

$$15,000 x > 7,56,000$$

$$\text{or } x > 50.4$$

Alternative Solution:

$$\text{Total cost / unit of capacity } 20,000 = 60.3$$

$$\text{Weighted average selling price} > 80.4$$

$$\text{i.e. } \frac{5,000 \times 100 + 15,000 x}{20,000} > 60.3$$

$$= 5,00,000 + 15,000 x > 60.3 \times 20,000$$

$$= 15,000 x > 12,06,000 - 5,00,000$$

Or

$$15,000 x > 7,06,000$$

$$x > 47.06$$

$$\text{Minimum price to cover production Cost} = 47.06$$

$$\text{Minimum price to cover same amount of profit} = 50.40 \text{ (refer to Working Note 1)}$$

Working Note 1

$$(-47.06 + 50.04) \times 15,000 \text{ units} = ₹ 50,000$$

Question 6

A company which has developed a new machine has observed that the time taken to manufacture the first machine is 600 hours. Calculate the time which the company will take to manufacture the second machine if the actual learning curve rate is (i) 80% and (ii) 90%. Explain which of the two learning rates will show faster learning. (3 Marks) (Nov., 2008)

Answer

(i) Actual learning curve rate is 80%.

Time taken to produce the first machine = 600 hours

Average time taken to produce two machines = $600 \times 80\%$ hours
= 480 hours.

Cumulative time taken to produce two machines = 480×2 hours
= 960 hours.

Time taken to produce the second machine = $(960 - 600)$ hours
= 360 hours.

(ii) Actual learning curve rate is 90%.

Time taken to produce the first machine = 600 hours

Average time taken to produce two machines = $600 \times 90\%$ hours
= 540 hours.

Cumulative time taken to produce two machines = 540×2 hours
= 1080 hours.

Time taken to produce the second machine = $(1080 - 600)$ hours
= 480 hours.

The time taken to produce the second machine is lower at 80% learning rate and hence 80% learning rate shows faster learning rate.

Question 7

The Gifts Company makes mementos for offering chief guests and other dignitaries at functions. A customer wants 4 identical pieces of hand-crafted gifts for 4 dignitaries invited to its function.

For this product, the Gifts Company estimates the following costs for the 1st unit of the product

	₹/unit
Direct variable costs (excluding labour)	2,000

Direct labour (20 hours @ ₹ 50 hour)	1,000
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90 % learning curve ratio is applicable and one labourer works for one customer's order.

- (i) What is the price per piece to be quoted for this customer if the targeted contribution is ₹ 1,500 per unit?
- (ii) If 4 different labourers made the 4 products simultaneously to ensure faster delivery to the customer, can the price at (i) above be quoted? Why? (6 Marks)(Nov., 2009)

Answer

(i) ₹/u

	1 st unit	Avg/u after 4 th at
Variable Cost	2000	2000
Labour	1000	810
Target Contribution		1500
Price to be quoted		4310 (₹ /u)

- (ii) No, the company cannot quote this price for varying products because the learning curve Ratio does not apply to non-repeated jobs. Each product will carry a different price according to its direct labour hours.

Question 8

Explain distinctive features of learning curve theory in manufacturing environment.

(4 Marks)(Nov., 2010)

Answer

The production quantity of a given item doubled the cost of that item decrease at a fixed rate. This phenomenon is the basic premise on which the theory of learning curve has been formulated.

The distinctive features of a learning curve are:

1. Better tooling methods are developed and used
2. More productive equipments are designed and used to make the product.
3. Design bugs are detected and corrected.
4. Better design engineering reduces material and labour costs.
5. Early teething problems are overcome. As production progresses management is prompted to achieve better planning and better management.
6. Rejections and rework tend to diminish over time.
7. As quantity produced increases the Cost per unit decreases, since each unit entails:

(i) Lesser labour (ii) Greater productivity of material and labour (iii) Fewer delays and lesser time losses.

Question 9

What are the limitations of the learning curve theory ?

(4 Marks)(Nov., 2011)

Answer

Limitations of Learning Curve Theory

1. All activities of a firm are not subject to learning effect. (Activities that have not been performed in the present operational mode, those performed by new or unfamiliar employees are subjected to learning effect, while those performed by familiar or experienced workmen will not be subjected to learning effect)
2. It is correct that learning effect does take place and average time taken is likely to reduce. But in practice it is highly unlikely that there will be a regular consistent rate of decrease. Therefore any cost prediction based on conventional learning curves should be viewed with caution.
3. Considerable difficulty arises in obtaining valid data that will form basis for computation of learning effect.
4. Even slight change in circumstances quickly renders the learning curve obsolete. While the regularity of conventional learning curves can be questioned, it would be wrong to ignore learning effect altogether in predicting costs for decision purposes.

Question 10

What are the distinctive features of learning curve theory in manufacturing environment? Explain the learning curve ratio.

(4 Marks)(Nov, 2012)

Answer

Learning curve ratio:

$$= \frac{\text{Average Labour cost of first } 2N \text{ units}}{\text{Average Labour cost of first } N \text{ units}}$$

As the production quantity of a given item is doubled, the cost of the item decreases at a fixed rate. It occurs because of the following distinctive features of manufacturing environment.

- (i) Better tooling methods are developed and used
- (ii) Design bugs are detected and corrected
- (iii) More productive equipment is designed and used.
- (iv) Engineering changes decrease over time.

- (v) Earlier teething problems are overcome.
- (vi) Rejections and rework tend to diminish overtime.

Question 11

Bring out the main applications of Learning Curve.

(4 Marks)(May, 2013)

Answer

Knowledge of learning curve can be useful both in planning and control. Standard cost for new operations should be revised frequently to reflect the anticipated learning pattern. The main applications are summarised below:

- **Helps to analyse CVP relationship during familiarisation phase:** Learning curve is useful to analyse cost-volume-profit relationship during familiarisation phase of product or process and thus it is very useful for cost estimates. Learning curve can be used as a tool for forecasting.
- **Helps in budgeting and profit planning:** Budget manager should select those costs which reflect learning effect and then he should be able to incorporate this effect in process of developing budgets or in the exercises relating to project planning.
- **Helps in pricing:** The use of cost data adjusted for learning effect helps in development of advantageous pricing policy.
- **Design makers:** It helps design engineers in making decisions based upon expected (predictable from past experience) rates of improvement.
- **Helps in negotiations:** It is very useful to Government in negotiations about the contracts.
- **Helps in setting standards:** The learning curve is quite helpful in setting standards in learning phase.

Question 12

State whether the learning curve theory can be applied to the following independent situations briefly justifying your decision:

- (i) *A labour intensive sculpted product is carved from the metal provided to the staff. The metal is sourced from different suppliers since it is scarce. The alloy composition of the input metal is quite different among the suppliers.*
- (ii) *Pieces of hand-made furniture are assembled by the company in a far off location. The labourers do not know anything about the final product which utilizes their work. As a matter of further precaution, rotation of labour is done frequently.*
- (iii) *Skilled workers have been employed for a long time. The company has adequate market for the craft pieces done by these experts.*

- (iv) A company finds that it always has an adverse usage of indirect material. It wants to apply learning curve theory to improve the way standards have been set. **(4 Marks)(Nov., 2013)**

Answer

- (i) 'Learning Curve Theory' will not be applicable as *alloy combination of the input metal is quite different* among the suppliers hence learning experience with one type of metal may not be beneficial for the workers to deal with other metal with separate alloy composition.
- (ii) 'Learning Curve Theory' will not be applicable as in this situation *rotation of labour is done frequently*, labours will not be able to get the benefit of learning and apply their learning. Hence, learning curve theory can not be applied.
- (iii) 'Learning Curve Theory' will not be applicable as in this situation as *workers are skilled and employed for a long time*, they have already achieved maximum level of expertise by taking advantage of learning. Hence, at this point of time learning curve theory can not be applied.
- (iv) 'Learning Curve Theory' will not be applicable as indirect materials are the materials which are not used directly in the production (not directly proportionate with volume of output) and usually used machines (e.g. lubricants, spares parts etc.) with less human interactions. Adverse usage of indirect materials can be controlled through proper monitoring and appropriate standard settings and not from applying learning curve theory.