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Budget and Budgetary Control
(incl. Key factor analysis, Throughput A/cing & Synchronous Manufacturing)

Key Factor/Limiting Factor analysis & Product Mix Decision

A key factor is defined as the factor in the activities of an undertaking which, at a particular point of time or over a period, will limit the volume of output. Other variant terms are limiting factor, Principal Budget Factor & scarce factor. Limiting factors are governed by both internal & external factors. It may be actual or potential. If a factor of production is in short supply, then the best-paying product becomes that which yields the highest contribution per unit of limiting factor.

$$\text{Profitability} = \frac{\text{Contribution}}{\text{Key Factor}}$$

Thus, Contribution per unit of key factor may be ascertained & maximized according to priority (ranking). Some examples of key factors are:

- I. Materials-Scarce Raw Material; Restrictions by licenses, etc.
- II. Labour-General Shortage; Shortage of a particular type of labour.
- III. Plant-Imbalance; Insufficient capacity due to shortage of capital, supply, etc.
- IV. Management-Shortage of efficient staff; policy decisions.
- V. Capital-Shortage of capital; insufficient research activity
- VI. Sales-Market demand; insufficient advertisement.

Important Note 1: If no limiting factor is provided in question, but still we need to rank the products for better allocation, we shall take CONTRIBUTION PER UNIT as base for ranking.

Important Note 2: In case where there is more than one limiting factor, the technique of linear programming is applied. We can also apply concepts of Throughput Accounting for this purpose.

Question 1: A company manufactures and markets three products P, Q and R. All three products are made from the same set of machines. Production is limited by machine capacity.

From the data given below, indicate priorities of products P, Q and R with a view to maximizing profits:

	PRODUCT		
	P	Q	R
Raw material cost per unit	(₹)11.00	16.25	21.00
Direct labour cost per unit	(₹) 2.50	2.50	2.50
Other variable cost per unit	(₹)1.50	2.25	3.50
Selling price per unit	(₹)25.00	30.00	35.00
Standard machine time required per unit in minutes	40	20	25

[Ans.: P-III; Q-I; R-II]

Question 2: Jupiter Enterprises Ltd. is manufacturing three products A, B and C using the same raw materials. All the products pass through departments I, II and III. Relevant details of the current production plan are as follows:

Standard cost per unit	Products		
	A	B	C
Direct materials	₹40	₹50	₹64
Direct labour:			
Dept. I(Rate-₹10/hr)	1 hr	1.2 hrs.	1.5 hrs.
Dept. II(Rate-₹12/hr)	0.5 hr	1 hr	1 hr
Dept. III(Rate-₹15/hr)	0.8 hr	1 hr	1.2 hrs.
Variable overhead	₹12	₹11	₹16
Current annual production (units)	30,000	40,000	25,000
Selling price per unit	₹100	₹130	₹175
Forecast of sales (max. units)	50,000	40,000	30,000

Fixed overheads per annum – ₹25 lakhs.

The labour available in department II is in short supply and cannot be increased in the near future. The Managing Director has doubts about the correctness of the product mix proposed above. He has requested you to examine the current production plan and give your specific recommendation.

You are required:

- To state whether the suggested product mix is the optimum one in the circumstances stated above: if not, which is the optimum mix? Show workings;
- To indicate increase in profit, if any, if your suggestion is implemented.

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[Ans.: (a) Suggested product mix is not optimum; (b) Increase in profit is ₹2 lakhs]

Question 3: A company producing products "PIE" and "SIGMA" using a single production process, has the following cost data:

	PIE	SIGMA
Selling price per unit (₹)	20	30
Variable cost per unit (₹)	11	16
Machine hours required per unit production (hrs.)	1	2
Market limitation (units)	1 lakh	2.5 lakhs

Total machine hours available -4 lakhs.

Fixed cost per annum-₹26 lakhs

Considering the limiting factors of machine hours and market limitations, you are required to

- Indicate the best combination of products to give optimum contribution;
- Show the additional machinery requirement to be augmented on rental basis at an annual rent of ₹1.5 lakhs per machine to provide additional capacity of 30,000 hours per machine;
- Change in number of machines to be rented if the annual rental charges reduce to ₹1, 25,000 per machine.

[Ans.: (a) Pie: 100000 units; Sigma: 150000 units; (b) 6 machines are to be taken on rental (c) 6 machines are to be taken on rental]

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Question 4: Mega Corporation manufactures and sells three products to the automobile industry. All the products must pass through a matching process, the capacity of which is limited to 20,000 hours per annum, both by equipment design and government regulation. The following additional information is available:

	Product - X	Product - Y	Product - Z
Selling price ₹/unit	1,900	2,400	4,000
Variable cost ₹/unit	700	1,200	2,800
Machining requirement hrs/units	3	2	1
Maximum possible sales – units	10,000	2,000	1,000

Required : statement showing the best possible production mix which would provide the maximum profit for Mega Corporation together with supporting workings.

[Ans.: X :5000; Y: 2000; Z: 1000]

Question 5: A firm can produce three different products from the same raw material using the same production facilities. The requisite labour is available in plenty at ₹8 per hour for all products. The supply of raw materials, which is imported at ₹8 per kg. is limited to 10,400 kgs. for the budget period. The variable overheads are ₹5.60 per hour. The fixed overheads are ₹50,000. The selling commission is 10 per cent on sales.

a. From the following information, you are required to suggest the most suitable sales mix, which will maximize the firms profits. Also determine the profit that will be earned at that level:

Product	Market demand (units)	Selling price per Unit	Labour hours required per Unit	Raw Material required per Unit (Kgs)
X	8,000	30	1	0.7
Y	6,000	40	2	0.4
Z	5,000	50	1.5	1.5

b. Assume, in above situation, if additional 4,500 kgs of raw materials is made for production, should the firm go in for further production, if it will result in additional fixed overheads of ₹25,000 and 25% increase in the rates per hour for labour and variable overheads?

[Ans.: X : 8000, Y : 6000, Z : 1600 with Profit = 66160; Loss = 2300]

Question 6: Super Forging Ltd. is manufacturing three household products A, B and C and selling them in competitive market. Details of current demand, selling price and cost structure are given below:

Particulars	A	B	C
Expected demand (units)	10000	12000	20000
Selling price per unit (₹)	20	16	10
Variable cost per unit (₹)			
Direct Materials (₹10/kg)	6	4	2
Direct Labour (₹15/hr.)	3	3	1.50
Variable Overheads	2	1	1
Fixed Overhead per unit (₹)	5	4	2

The company is frequently affected by acute scarcity of raw material and high labour turnover. During the next period it is expected to have one of the following situations:

- (a) Raw materials available will be only 12100 kg.
- (b) Direct labour hours available will be only 5000 hrs.
- (c) It may be possible to increase sales of any one product by **25%** without any additional fixed costs but by spending ₹20000 on advertisement. There will be no shortage of materials or labour.

Suggest the best production plan in each case and the resultant profit that the company would earn according to your suggestion. ICWA-June/98

[Ans.: Net Profit (a) 117500 (b) 102000 (c) 165500]

[Hint: In part (c) of above mentioned question since we have been provided % increase in units we shall opt the product which is going provide us highest increment in total contribution.

Now since total increase in contribution is

$$A: 10000 \times 25\% \times 9 = ₹22500$$

$$B: 12000 \times 25\% \times 8 = ₹24000$$

$$C: 20000 \times 25\% \times 5.5 = ₹27500$$

Hence we are supposed to increase sales of Product C (P/V ratio is not supposed to be seen in such cases).

However, if inspite of % increase, absolute value of increase in unit would have been provided, we would choose Contribution per unit as our base of ranking. For example if in above it would have asked that "It may be possible to increase sales of any one product by 2500 units without any additional fixed costs but by spending ₹20000 on advertisement. There will be no shortage of materials or labour."

In such cases we will rank our products on the basis of contribution per unit, hence we are supposed to increase sales of Product A inspite of product C because, it is ultimately lead with highest increase in contribution.]

Question 7 [Sales mix with two key factors]: Arvind Electronics is a small scale unit manufacturing three standard electronic components A, B and C .Current selling price and costs are as follows:

	A	B	C
Selling price per unit	₹28	₹60	₹125
Direct materials	8	15	20
Direct labour (@ ₹10/hr.)	10	20	50
Variable overheads	5	10	25

Fixed overheads are budgeted at ₹25, 000 per annum. Direct labour availability is limited to 11,000 hours only per year. The company has agreed to supply a minimum of 500 units of each of these products. Current production plan of the company envisages supply of the minimum requirements and using the surplus labour hours for production and sale of 'C' which has the highest margin.

Required:

- Profit according to current plan.
- Alternative plan, if any, for maximum profit.
- Break-even point in terms of units and sales value based on our calculations in (b).
- Number of units and sales value required in respect of each of the above three products to earn 24% profit after tax on capital employed of ₹1,00,000. Tax rate applicable to the firm is 50%.

[Ans.: (a) ₹42000 (b) Profit will be ₹52500 (c) 1500 units & ₹106500 (d) A: 500 units & ₹14000; B: 3700 units & 222000; C: 500 & 62500] ICWA-Dec./97

Question 8: M/s Mars Ltd. is manufacturing three products. The cost details are as follows:

Particulars	Products					
	A		B		C	
	Units	₹	Units	₹	Units	₹
Direct Materials	4	12	5	15	6	18
Direct Labour		5		6		6
Direct Expenses		8		9		11
		25		30		35
Selling Price		35		40		50
		10		10		15
No. of Units sold	20,000		40,000		20,000	
Total Contribution	2,00,000		4,00,000		3,00,000	
Total		₹9, 00,000				
Less: Fixed Costs		₹7, 50,000				
		₹1, 50,000				

The direct materials were all imported. Due to foreign exchange restrictions, henceforth, *the company can import only 3,00,000 units of raw materials*. The company can produce in all 1,00,000 units maximum (all products). However, they can market only 20,000 units each of product A and C. There is a local substitute material which is available at a price of ₹3.75 per unit. Besides, the company has to spend ₹50, 000 on intermediaries and consumables, if local substitute material is used in the production process. There was also a third party who was willing to take a part of the plant on lease up to 50,000 units capacity of B and willing to pay lease charges of ₹2,75,000.

You are required to advise the management:

- (a) What should be the quantum of production/sales mix of products with existing import restrictions?
- (b) Whether the company can optimize production of 1,00,000 units with local substance materials?
- (c) Whether the company can enhance profits by leasing out a part of the plant to the third party and restricting its own production? CA (Inter)/99

[Ans.: (a) A - 20000 units, B - 20000 units, C - 20000 units; (b) Yes; (c) No]

Question 9: The following particulars are taken from the records of a company engaged in manufacturing two products, A and B, from a certain material:

	Product A (per unit) ₹	Product B (per unit) ₹
Sales	2,500	5,000
Material cost (₹50 per kg)	500	1,250
Direct labour (₹30 per hour)	750	1,500
Variable overhead	250	500

Total fixed overhead: ₹10, 00,000

Comment on the profitability of each product when:

- (i) Total sales in value is limited.
- (ii) Raw material is in short supply.
- (iii) Production capacity is the limiting factor.
- (iv) Total availability or raw materials is 20,000 kg. and maximum sales potential of each product is 1,000 units, find the product mix to yield maximum profits. CA (Inter) Nov/98

[Ans.: (i), (ii) & (iii) Product A is more profitable (iv) A: 1000 units; B: 400 units to yield a profit of ₹700000]

Question 10: A Company manufactures and sells three products A, B and C as per details given below:

	Products		
	A	B	C
Direct materials	₹20	₹16	₹18
Direct labour	12	14	12
Variable overheads	8	10	6
Fixed overheads	6	6	4
	46	46	40
Profit	18	14	12
Selling Price	64	60	52
Sales (Units)	10,000	5,000	8,000

- (a) Rank the products according the profitability. What is the profit currently earned by the company?
- (b) Production arrangements are such that if one of the products is discontinued, sales of the other two can be increased by 50%. Management wants to discontinue 'C' as its contribution is least. Do you agree? Present your recommendation supported by suitable analysis.
- (c) There is also a proposal to introduce a highly profitable product 'D' using the existing facilities, along with the two products retained at the original level of production. The details relating to product 'D' are as follows:

	Variable cost per unit(₹)	Selling price / unit
Direct Materials	12	₹48 (proposed)
Direct Labour	8	
Variable overheads	5	

Demand for 'D' is uncertain. Management wants to know the minimum sales that would ensure the maximum profit as per (b). Give your recommendation, supported by workings. ICWA-June/01

[Ans.: (a) A-I; B-III; C-II with Profit of 3.46 lakhs; (b) C should not be discontinued. Product B should be discontinued, then profit will improve to ₹430000 (c) Minimum Sales = 8000 units to ensure max. profit of ₹430000]

Question 11: A company engaged in the manufacture of sophisticated products uses high grade raw materials which are in short supply. During the year 1991, the company earned a profit of 12% before interest and depreciation on turnover of ₹10 crores. Interest & depreciation which are fixed amounted to ₹75 lakhs & ₹50 lakhs respectively. The product mix was as under:

Product Group	Mix % to total sales	P/V ratio (%)	Raw Material as % on sales value
A	30	30	40
B	20	40	50
C	50	25	36

During the year 1992, the price of the raw material is expected to increase by 10%. The company has been able to make arrangements for the procurement of raw materials of the total value of ₹561 lakhs at 1992 prices. The sales potential of each product group can be increased in 1992 by 50% of 1991 sales.

Required:

- Set the optimal product mix for 1992.
- What increase in overall price is required to raise sales value of 1992 to maintain the Margin of Safety at 10%. (ICWA-June/83), (ICWA-June/93), (May/85-[Adapted]), (12 Marks) Nov./10-N.C.[Adapted]

[Ans.: (i) A - ₹450 lakhs; B - ₹300 lakhs, C - ₹500 lakhs; (ii) 1.33%]

Question 12: A company manufactures and sells three products P,Q,R whose unit selling price and cost details are given below:

	P	Q	R
Selling price/unit (₹)	80	60	50
Direct materials /unit (₹)	32	25	20
Direct labour/unit (₹) (@ ₹10/hr.)	20	15	10
Variable overheads/unit (₹)	10	9	6
Total budgeted Fixed Overheads per annum			₹5,50,000
Current sales (Units)	15,000	20,000	10,000

Required:

- Profit earned by the company p.a. according to estimates.
- Assuming that the company has only 75,000 labour hours per year, is it advisable to increase production/sales of any one of the products by a maximum of 25% only by spending an additional amount of ₹30,000 on advertisement/if so, which product should be chosen and what would be the expected profit?
- A reduction of selling price by 5% will boost up sales of all products by 50%. But, direct labour hours would continue to be 75,000. What is the best product mix for this proposition? Would you recommend this option? Show workings. CA(Inter) Nov./01

[Ans.: (a) ₹80000 (c) No]

Question 13[Specific and avoidable fixed cost]: 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:

- (i) Advise the company about the best product mix during peak-season for maximum profit.
- (ii) What will be the maximum profit for the off-season? (12 Marks) Nov/08-N.C.

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

Question 14: A farmer asks your recommendation for optimal mix of production for the coming year. The current data is given below

	ITEMS PRODUCED			
	A	B	C	D
Area occupied (acres)	25	20	30	25
Yield per acre (tonnes)	10	8	9	12
Sales price per tonne (₹)	1,000	1,250	1,500	1350
Variable cost per (acre)				
Material (₹)	700	600	950	900
Labour (₹)	2,000	2,500	3,000	3,700
Variable overheads (₹)	2,000	2,000	2,000	2,000
Fixed overhead	₹			
Cultivation and growing	1,00,000			
Harvesting and transport	2,40,000			
Land revenue	90,000			
Administration	1,10,000			
Total	5,40,000			

The land which is being used for producing items A and B can be used for either of the items but not for items C and D. The land which is being used for producing items C and D can be used for either items but not for items A and B.

In order to provide adequate market service, the farmer must produce each year at least 40 tonnes each of A and B and 36 tonnes each of C and D.

You are required to calculate the following:

- The profit for the current year; and
- The profit for the production mix which you could recommend.

[Ans.: (a) ₹157000; (b) ₹216300]

C.S.- Dec./96 & (11 Marks) Nov./09-O.C.[Adapted]

Question 15: An agriculturist has 480 hectares of land on which he grows potatoes, tomatoes, peas and carrots. Out of the total area of land, 340 hectares are suitable for all the four vegetables but the remaining 140 hectares of land are suitable only for growing peas and carrots. Labour for all kinds of farm work is available in plenty.

The market requirement is that all the four types of vegetables must be produced with a minimum of 5000 boxes of any one variety. The farmer has decided that the area devoted to any crop should be in terms of complete hectares and not in fractions of a hectare. The only other limitation is that not more than 113750 boxes of any one vegetable should be produced.

The relevant data concerning production, market prices and costs are as under:

	Potatoes	Peas	Carrots	Tomatoes
Annual yield:				
Boxes per hectare	350	100	70	180
Costs:				
Direct material per hectare	₹952	₹432	₹384	₹624
Direct Labour:				
Growing per hectare	1792	1216	744	1056
Harvesting and packing per box	7.20	6.56	8.80	10.40
Transport per box	10.40	10.40	8.00	19.20
Market price per box	30.76	31.74	36.80	44.55

Fixed expenses per annum:

Growing	₹	124000
Harvesting		75000
Transport		75000
General administration		150000

It is possible to make the land presently suitable for peas and carrots, viable for growing potatoes and tomatoes if certain land development work is undertaken. This work will involve a capital expenditure of ₹6000 per hectare which a bank is prepared to finance at the rate of interest of 15% p.a. If such improvement is undertaken, the harvesting cost of the entire crop of tomatoes will decrease on an average by ₹2.60 per box.

Required:

- Calculate, within the given constraints, the area to be cultivated in respect of each crop to achieve the largest total profit and the amount of such total profit before land development work is undertaken.
- Assuming that the other constraint continues, advise the grower whether the land development scheme should be undertaken and if so the maximum total profit that would be achieved after the said development scheme is undertaken.

Nov./88

[Ans.: (i) Potatoes-312 hectares; Peas-50 hectares; Carrots-90 hectares; Tomatoes-28 hectares with profit of 20116240 (ii) Potatoes-325 hectares; Peas-50 hectares; Carrots-72 hectares; Tomatoes-33 hectares with profit of 22477260]

Question 16[Key factor with no sales mix]: Kumar Co. has two plants one at Sambalpur and the other at Bilaspur, where production of goods takes place. The basic raw material requirement is 80% of the finished product, by weight. Such materials are available locally, but are limited to 6000 MT at ₹1800 per MT at Sambalpur, and 16000 MT at ₹2000 per MT at Bilaspur. Any extra requirement will have to be procured from Jamshedpur at ₹2500 per MT. Other particulars are as under-

Particulars	For Sambalpur Unit	For Bilaspur Unit
Annual Output (MT)	12000	15000
Capacity Utilization	80%	60%
Other Variables (₹ Lakhs)	156	192
Fixed Costs (₹ Lakhs)	108	120

You are required to determine-

1. Cost break-up of each unit per MT of output.
2. Quantity of production at each unit of availability of local supplies of basic raw material only, by keeping the same total production of the Company, as a whole.
3. Cost savings, if any, as per revised schedule of production.

[Ans.: Cost per M.T. of output : Sambalpur – ₹3850; Bilaspur ₹3680; Quantity of production : Sambalpur – 7500 M.T., Bilaspur - 19500] (12 Marks) Nov./01 & (12 Marks) Nov./10 [Adapted]

Question 17 [Key factor with no sales mix]: X Ltd. has two factories, one at Lucknow and another at Pune producing 7,200 tonnes and 10,800 tonnes of a product against the maximum production capacity of 9,000 and 11,880 tonnes respectively at Lucknow and Pune.

10% of the raw material introduced is lost in the production process. The maximum quantity of raw material, available locally is 6,000 and 13,000 tonnes at ₹720 and ₹729 per tonne at Lucknow and Pune respectively. For the additional needs a supplier of Bhopal is ready to supply raw material at our factory site at ₹792 per tonne.

Other variable costs of the production process are ₹22.32 lacs and ₹32.94 lacs and fixed costs are ₹18 lacs and ₹24.84 lacs respectively for Lucknow and Pune factory.

The output is sold at a selling price of ₹1,450 and ₹1,460 per tonne by Lucknow and Pune factory respectively.

You are required to compute the cost per tonne and net profit earned in respect of each factory. Can you suggest any other alternative production plan for both the factories without any change in present total output of 18,000 tonnes whereby the company may earn optimum profit? (19 Marks) Nov./97

[Ans.: Cost per tonne – Lucknow – ₹1380; Pune ₹1345; Net Profit - Lucknow ₹5.04 lakhs & Pune ₹12.42 Lakhs; Alternative production plan – Lucknow 6120 tonnes & Pune 11880 tonnes.]

The theory of constraints and throughput accounting

During the 1980s Goldratt and Cox (1989) advocated a new approach to production management called optimized production technology (OPT). OPT is based on the principle that profits are expanded by increasing the throughput (***throughput: sales – direct materials***) of the plant. The OPT approach determines what prevents throughput being higher by distinguishing between bottleneck and non-bottleneck resources. This approach advocates that bottleneck resources/activities should be fully utilized while non bottleneck resources/activities should not be utilized to 100% of their capacity since it would result in increase in inventory.

A constraint is any thing that confines or limits a person's or machines, ability to perform a project or function. Delay in a production environment are caused by human and machine constraint. Human constraint can be caused by an inability to understand react or perform at some higher rate of speed. **Machine constraints are called bottlenecks**, are points at which processing levels are sufficiently slow to cause the other processing mechanism in the network to experience idle time.

OPT is based on the principle that profits are expanded by increasing throughput of the plant i.e. rate at which raw material are turned into sales. The most widely recognized management accounting system developed

for this purpose is known in USA as Theory of Constraints (TOC). The theory was picked up and inducted into an accounting system in the UK where it is known as Throughput Accounting (TA).

Instead of using marginal contribution to allocate resources to restricted resources, this theory uses the concept of throughput : sales – direct materials.

More importantly, the Theory of Constraints concludes that in many cases, resources should not be thrown heedlessly into production processes which are located before the bottleneck since this will only result in a build up of partially finished inventory waiting for processing which is more costly to accumulate than it is to underutilize the capacity. Traditional variance analysis focuses attention on underutilized capacity, e.g. unfavourable volume variances, which simply encourage plant managers to produce a backlog.

Basis of introducing TOC is to reduce inventory created by non-bottleneck machines in front of bottleneck machines.

The idea behind TOC is that raw materials is the only variable cost. Labour & variable overhead are considered as fixed cost, except specifically provided. In it we deduct only true unit-level variable costs such as material & power.

The theory of constraints (TOC) describes methods to maximize operating income under bottleneck situation. The three measurements:

1. Calculate **Throughput contribution** = sale - direct materials cost of the goods sold.
2. **Investments(inventory)** = Sum of materials costs in direct materials, work – in – process, and finished goods inventories; R & D costs; and costs of equipment and buildings.
3. **Operating costs** equal all costs of operations (other than direct materials) incurred to earn throughput contribution. Operating costs include salaries and wages, rent utilities, and depreciation.

The objective of TOC is to increase throughput contribution while decreasing investments and operating costs. TOC considers a short – run time and assumes that operating costs are fixed costs.

The important concept behind TOC is that the production rate of the entire factory is set at the pace of the bottleneck resource. Hence, in order to achieve the best result TOC emphasizes the importance of removing bottlenecks (or limiting factor).

Procedure of TOC (Theory of Constraints)

Step-1: Find the total requirement of resources i.e. S of units × resource required per unit. Compute it for each department separately.

Step-2: Throughput accounting Ratio (TA ratio) = $\frac{\text{Capacity required}}{\text{Capacity available}} \times 100$ for each department

Step-3: The highest among the TA ratio will be considered as the bottleneck factor (Other scarce resources will be ignored).

Step-4: To obtain optimum use of the bottleneck activity we calculate contribution per bottleneck factor (a.k.a. product return per time period on bottleneck activity) & rank accordingly.

Step-5: Prepare statement for optimum product mix for allocating the bottleneck factor.

Note: Some authors treat value derived in Step 2 as machine utilization ratio & calculates

$$\text{Throughput accounting ratio} = \frac{\text{Throughput contribution per time period}}{\text{Conversion cost per time period}}$$

Question 18: Explain the theory of constraint.

(4 Marks) Nov/03

Question 19: Explain the concept and aim of theory of constraints. What are the key measures of theory of constraints?

(7 Marks) May/08

Question 20: 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			Throughput accounting ratio
	A	B	C	
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 analyze the above information and apply theory of constraints process to remove the constraints. How many units of each product will be made? (6 Marks) Nov/08-N.C.

[Ans.: Units: A-100; B-500; C-500]

Question 21: A company produces 3 products A, B and C. The following information is available for a period.

	Production		
	A	B	C
Contribution (Sales – Direct Materials)	₹24	₹20	₹12
Machine hours required per unit:			
Machine 1	12	4	2
Machine 2	18	6	3
Machine 3	6	2	1
Estimated sales demand	200	200	200

It is given that machine capacity is limited to 3,200 hours for each machine, you are required to analyze the above information and apply TOC process to remove the constraint.

[Ans.: Units: A-77; B-200; C-200]

Question 22: 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.

[Ans.: Units: A-200; B-11; C-200; D-200]

(7 Marks) June/09-N.C.

Question 23: ABC Ltd makes and sells two products A and B, each of which passes through the same automated production operations. The following estimated information is available for period 1

(i) Product unit data:	A	B
Direct material cost (₹)	2	40
Variable production overhead cost (₹)	28	4
Overall hours per product unit (hrs)	0.25	0.15

(ii) Production/ sales of products A and B are 1,20,000 units and 45,000 units respectively. The selling prices per unit for A and B are ₹60 and ₹70 respectively.

(iii) Maximum demand for each product is 20% above the estimated sales levels.

(iv) Total fixed production overhead cost is ₹14,70,000. This is absorbed by products A and B at an average rate per hour based on the estimated production levels.

Required:

(a) Using net profit as the decision measure, show why the management of ABC Ltd argues that it is indifferent on financial grounds as to the mix of products A and B which should be produced and sold and calculate the total net profit for period 1.

(b) One of the production operations has a maximum capacity of 3,075 hours which has been identified as a bottleneck which limits the overall production/ sales of products A and B. The bottleneck hours required per product unit for product A and B are 0.02 and 0.015 respectively.

All other information detailed in (a) still applies.

Required: Calculate the mix (units) of products A and B which will maximize net profit and the value (₹) of the maximum net profit.

(c) The bottleneck situation detailed in (b) still applies. ABC Ltd has decided to determine the profit maximizing mix of products A and B based on the throughput accounting principle of maximizing the throughput return per production hour of the bottleneck resource. This may be measured as:

$$\text{Throughput return per production hour} = \frac{(\text{selling price} - \text{material cost})}{\text{Bottleneck hours per unit}}$$

All other information detailed in (a) and (b) still applies, except that the variable overhead cost as per (a) is now considered to be fixed for the short/intermediate term, based on the value (₹) which applied to the product mix in (a).

Calculate the mix (units) of products A and B which will maximize net profit and the value of that net profit.

[Ans.: (a) Profit per unit = ₹20 under both the products (b) Profit: ₹3331500; (c) A: 144000 units, B: 13000 units; Net profit: ₹3732000] (RTP-May/07)

[Note: Assumed that variable overheads (e.g. Direct labour) are fixed in short term. They are derived from part (a) as {120000×28 + 45000×4}]

SYNCHRONOUS MANUFACTURING

This concept of 'synchronous manufacturing' was started in 1984. It has been defined as: an all-encompassing manufacturing management philosophy that includes a consistent set of principles, procedures, and techniques where every action is evaluated in terms of the common global goal of the organisation.

A set of seven 'principles' are associated with synchronous manufacturing:

1. Do not focus on balance idle capacities; focus on synchronizing the production flow.
2. The marginal value of time at a bottleneck resource is equal to the throughput rate of the products processed by the bottleneck.
3. The marginal value of time at a non-bottleneck resource is negligible.
4. The level of utilization of a non-bottleneck resource is controlled by other constraints within the system.
5. Resources must be utilized, not simply activated.
6. A transfer batch may not, and many times should not, be equal to the process batch.

7. A process batch should be variable both along its route and over time.

According to synchronous manufacturing principles 2 and 3, the return on improvements at a bottleneck resource is very high. But the return on improvement made at non-bottlenecks is marginal at best.

The synchronous manufacturing philosophy required managers to focus on those areas of operations where there exist potential global improvements.

Question 24: Brief the principles associated with synchronous manufacturing. (5 Marks) May/10-N.C.

Budgeting Control & Performance Management

Budget is a financial and/or quantitative statement, prepared and approved prior to a defined period of time of the policy to be pursued during that period for the purpose of attaining a given objective. It may include income, expenditure and employment of capital.

Features:

1. Financial and/or Quantitative statement
2. Futuristic – prepared and approved prior to a defined period of time
3. Goal Oriented – for the purpose of attaining a given objective
4. Components – income, expenditure and employment of capital

The objective of budgeting are:

1. To encourage self-study in all aspects of a company's operations.
2. To get all members of management to “put their heads” to the basic question of how the business should be run to make them a co-ordinated team operating in unison towards clearly defined objectives.
3. To force a definition and crystallization of company policies and aims.
4. To increase the effectiveness with which people and capital are employed.
5. To disclose areas of potential improvement in the company's operations.
6. To stimulate study of relationship of the company to its external economic environment for improving the effectiveness of its direction.

Budgetary Control:

Definition: Budgetary Control is defined as “the establishment of budgets, relating the responsibilities of executives to the requirement of a policy, and the continuous comparison of actual with budgeted results either to secure by individual action the objective of that policy or to provide a base for its revision.”

Salient features:

- a) **Objectives:** Determining the objectives to be achieved, over the budget period, and the policy or policies that might be adopted for the achievement of these ends.
- b) **Activities:** Determining the variety of activities that should be undertaken for the achievement of the objectives.
- c) **Plans:** Drawing up a plan or a scheme of operation in respect of each class of activity in physical as well as monetary terms for the full budget period and its parts.
- d) **Performance evaluation:** Laying out a system of comparison of actual performance by each person, section or department with the relevant budget and determination of causes for the discrepancies, if any.
- e) **Control Action:** Ensuring that corrective action will be taken where the plan is not being achieved and, if that be not possible, for the revision of the plan.

Objectives of budgetary control system

The objectives of a budgetary control system are:

1. **Definition of Goals:** Portraying with precision, the overall aims of the business and determining targets of performance for each section or department of the business.
2. **Defining responsibilities:** Laying down the responsibilities of each of the executives and other personnel so that everyone knows what is expected of him and how he will be judged.
3. **Basis for performance evaluation:** Providing basis for the comparison of actual performance with the predetermined targets and investigation of deviation, if any, of actual performance and expenses from the budgeted figures. It helps to take timely corrective measures.
4. **Optimum use of resources:** Ensuring the best use of all available resources to maximize profit or production, subject to the limiting factors.

5. **Coordination:** Co-ordinating the various activities of the business and centralizing control, but also facility for management to decentralise responsibility and delegate authority.
6. **Planned action:** Engendering a spirit of careful forethought, assessment of what is possible and an attempt at it. It leads to dynamism without recklessness. It also helps to draw up long range plans with a fair measure of accuracy.
7. **Basis for policy:** Providing a basis for revision of current and future policies. Providing a yardstick against which actual results can be compared.

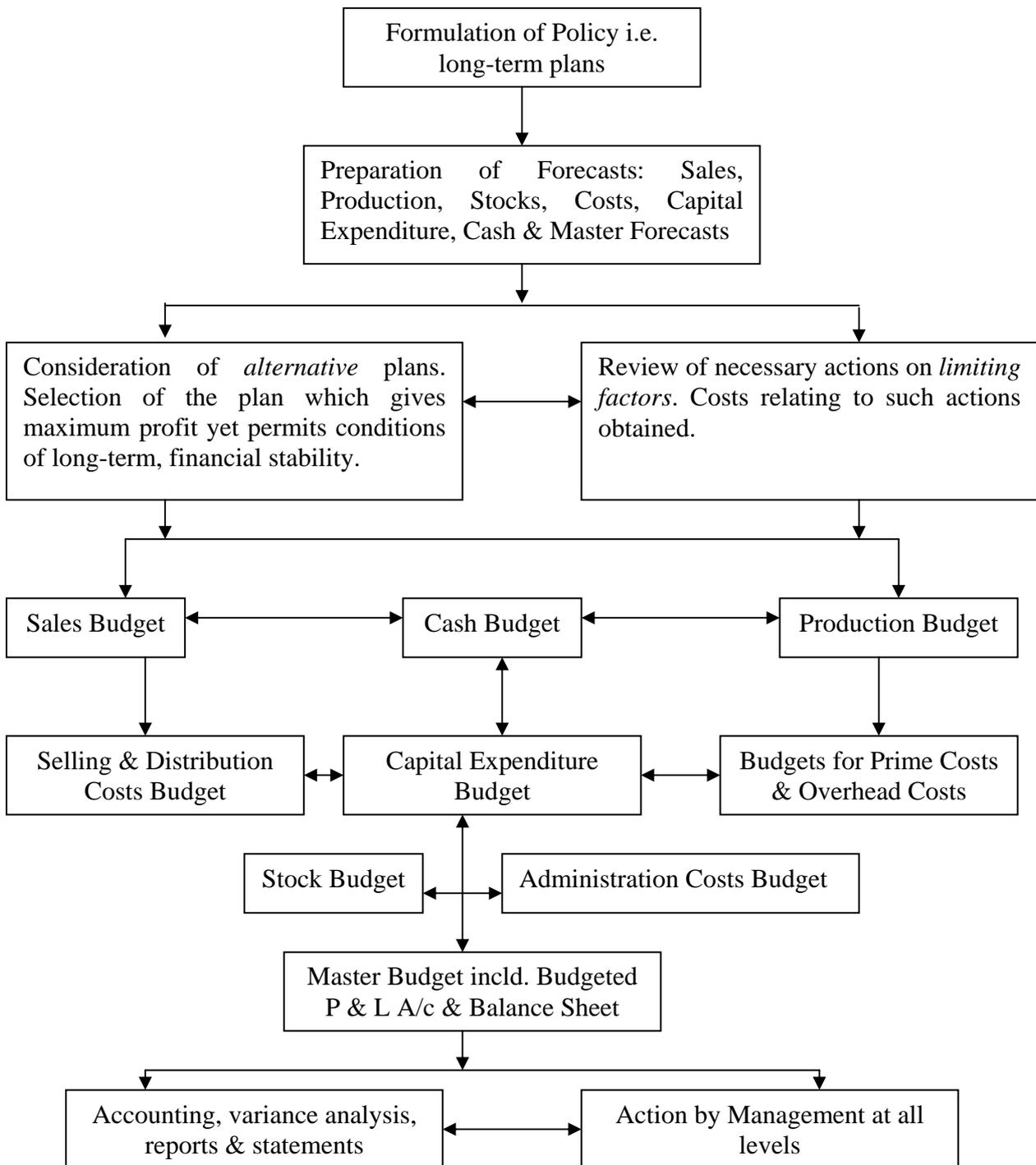


Fig. Budgetary Control: diagram of procedure

Role of a Budget Officer:

- Successful implementation of budgetary control system depends upon the Budget Committee.
- The Budget Committee would be composed of all functional heads and a member from the Board to preside over and guide the deliberations.
- The Budget Committee acts through the Budget Officer whose responsibilities include:
 1. **Functional Budget preparation:** To assist in the preparation of the various budgets by coordinating the work of the accounts department which normally compiles the budgets, with the relevant functional departments like Sales, Production, Plant maintenance etc.
 2. **Communication to Responsible Centres:** To forward the budget to the individuals who are responsible to adhere to them and to guide them in overcoming any practical difficulties in its working.
 3. **Coordination:** To prepare the periodical budget reports for circulation to the individuals concerned, coordinating with them in the formulation of budgets for subsequent periods.
 4. **Follow-up:** To determine the follow-up action to be taken on the budget reports.
 5. **Budget Committee Review:** To prepare an overall budget working report for discussion at the Budget Committee meetings and to ensure follow-up on the lines of action suggested by the Committee.
 6. **Board Review:** To prepare periodical reports for the Board meeting, comparing the budgeted Profit and Loss Account and the Balance Sheet with the actual results.

Advantages of Budgetary Control System

1. **Efficiency:** It enables the management to conduct its business activities in an efficient manner. Effective utilization of scarce resources, i.e. men, material, machinery, methods and money – is made possible.
2. **Cost Control:** It is powerful instrument used by business houses for the control of their expenditure. It inculcates the feeling of cost consciousness among workers.
3. **Performance evaluation:** It provides a yardstick for measuring and evaluating the performance of individuals and their departments.
4. **Standard Costing and Variance analysis:** It creates suitable conditions for the implementation of standard costing system in a business organization. It reveals the deviations to management from the budgeted figures after making a comparison with actual figures.
5. **Policy formulation:** It helps in the review of current trends and framing of future policies.

Limitations of Budgetary Control System

1. **Estimates:** Budgets may or may not be true, as they are based on estimates. The assumptions about future events may or may not actually happen.
2. **Rigidity:** Budgets are considered as rigid document. Too much emphasis on budgets may affect day-to-day operations and ignores the dynamic state of organization functioning.
3. **False Sense of Security:** Mere budgeting cannot lead to profitability. Budgets cannot be executed automatically. It may create a false sense of security that everything has been taken care of in the budgets.
4. **Lack of coordination:** Staff co-operation is usually not available during budgetary control exercise.
5. **Time and Cost:** The introduction and implementation of the system may be expensive.

The interrelationship of budgets:

The critical importance of the principal budget factor stems from the factor that all budgets are interrelated. For example, if sales are the principal budget factor this is the first budget to be prepared. This will then provide the basis for the preparation of several others budgets, including the selling expenses budget and the production budget.

However, the production budget cannot be prepared directly from the sales budget without a consideration of stockholding policy. For example, management may plan to increase finished goods stock in anticipation of a sales drive. Production quantities would then have to be higher than the budgeted sales level. Similarly, if a decision is taken to reduce the level of material stocks held, it would not be necessary to purchase all of the materials required for production.

Using spreadsheets in budget preparation:

It is clear from just this simple example that exchange in one budget can have a knock-on effect on several others budgets. For this reason spreadsheets are particularly useful in budget preparation. Budgetary planning is an iterative process. Once the first set of budgets has been prepared they will be considered by senior managers. They may require amendments to be made or they may wish to see the effect of changes in key decision variables.

A well-designed spreadsheet model can take account of all of the budget interrelationships. This means that it will not be an onerous task to alter decision variables and produce revised budgets for management's consideration.

Flexible Budget:

Meaning: It is a budget, which is designed to change in relation to level of activity by recognizing the difference between fixed, semi-variable and variable costs.

Need: The need for preparation of flexible budgets arises in the following circumstances

- Seasonal fluctuations in sales and/or production, for example in soft drinks industry. Introduction of new products, product design and versions on a frequent basis.
- Industries engaged in make-to-order business like shipbuilding;
- An industry which is influenced by changes in fashion; and General change in sales

Flexible budgeting may be resorted to in the following situations:

- **New Business:** In the case of new business venture due to its typical nature it may be difficult to forecast the demand of a product accurately.
- **Uncertain Environment:** Where the business is dependent upon the mercy of nature e.g. a person dealing in wool trade may have enough market if temperature goes below the freezing point.
- **Factor market conditions:** In the case of labour intensive industry where the production of the concern is dependent upon the availability of labour.

Steps involved in the preparation of budgets

Definition of Objectives: Objectives should be defined precisely. They should be written out; areas of control de-marketed and items of revenue and expenditure to be covered by the budget stated. This will give a clear understanding of the plan and its scope to all those who must cooperate to make it a success.

Identification of key (or budget) factor: A key factor represents source whose availability is less than its requirement. Such resource constraints put a limit on the organization objective of maximum profitability. Some examples are lack of sales demand, rationing of raw material, labour shortage, plant capacity etc. For proper budgeting, the key factor must be located and estimated properly.

Budget Committee and Controller: Formulation of a budget usually requires whole time services of a senior executive; he must be assisted in this work by a Budget Committee, consisting of all the heads of department along with the Managing Director as the Chairman. The Controller is responsible for coordination and development of budget programmes and preparing the Budget Manual .

Budget Manual: The Budget manual is a schedule, document or booklet, which shows in a written form, the budgeting organization and procedure. The manual should be well written and indexed so that a copy thereof may be given to each department head for guidance.

Budget period: The period covered by a budget is known as budget period. Normally a calendar year or a period coterminous with the financial year is adopted as the Budget Period. It is then sub-divided into shorter periods – it may be months or quarters or such period as coincide with period of trading activity.

Standard of activity or output: The standards of activity levels for future period should be laid down. These are generally based on past statistics, known market changes and current conditions and forecast of future situations. In a progressive business, the achievement of a year must exceed those of earlier years. In budgeting, fixing the budget of sales and capital expenditure are most important since these budgets determine the extent of development activity.

Specimen of Master Budget			
For the year ending.....			
Normal Capacity.....	standard hours (100%)		
Capacity Budgeted.....	standard hours		
	Budgeted Figures		Total (₹)
	Product A (₹)	Product A (₹)	
1. SALES			
Manufacturing Costs:			
Direct Labour			
Direct Material			
Factory Overhead			
Add Opening Stock			
Less Closing Stock			
2. COST OF GOODS SOLD			
3. Gross Profit (1 - 2)			
4. Selling & Distribution Costs			
5. Administration Costs			
6. NET PROFIT (3 – 4 & 5)			
7. Fixed Assets			
8. Current Assets			
9. CAPITAL EMPLOYED			
10. Ratio of Profit to Capital Employed			
11. Ratio of Sales to Capital Employed			
12. Current Ratio			
13. Quick Ratio			
14. PROFIT APPROPRIATIONS			
15. Net Profit (6 above)			
Less Dividends			
Transfer to General Reserve			
Transfer to Asset Replacement Reserve			
Taxation			
16. TOTAL APPROPRIATIONS			
17. PROFIT & LOSS BALANCE (15 – 16)			

The Budget Manual

Effective budgetary planning relies on the provision of adequate information to the individuals involved in the planning process.

Many of these information needs are contained in the budget manual. A budget manual is a collection of documents that contains key information for those involved in the planning process. Typical contents could include the following:

- a) An introductory explanation of the budgetary planning and control process, including a statement of the budgetary objective and desired results.
- b) A form of organisation chart to show who is responsible for the preparation of each functional budget and the way in which the budgets are interrelated.
- c) A timetable for the preparation of each budget. This will prevent the formation of a 'bottleneck' with the late preparation of one budget holding up the preparation of all others.
- d) Copies of all forms to be completed by those responsible for preparing budgets, with explanations concerning their completion.
- e) A list of the organization's account codes, with full explanations of how to use them.
- f) Information concerning key assumptions to be made by managers in their budgets, for example the rate of inflation, key exchange rates, etc.

ZERO BASE BUDGETING (ZBB):

Meaning: It is an expenditure control device where each divisional head has to justify the requirement of funds for each head of expenditure and prepare the budget accordingly, without reference to the past budget or achievements.

It is an operating planning and budgeting process, which requires each manager to justify his entire budget requests in detail from "scratch" (hence zero-base).

Features:

1. **Wholistic:** The technique deals practically with all the elements of budget proposals.
2. **Analytical:** A critical evaluation of all the ongoing activities is also done afresh together with new proposals. Each manager has to justify why he should spend any money at all.
3. **Priority Based:** This approach requires that all activities be identified as decision on packages, which would be evaluated by systematic analysis and ranked in order of importance.
4. **Review Based:** an organisation should not only make decisions about the proposed new-programmes but it should also from time to time, review the "utility" and "appropriateness" of the existing programmes.
5. **Rational:** It allows for budget reductions and expansions in a rational manner and allows re-allocation of resources from low to high priority programme.

Steps in Zero Base Budgeting (ZBB)

ZBB involves the following:

- **Objectives:** Determination of a set of objectives is one of pre-requisite and essential step in the direction of ZBB technique.
- **Coverage:** Deciding about the extent to which the technique of ZBB is to be applied, whether in all areas of organisation's activities or only in a few selected areas on trial basis.
- **Decision Areas :** Identify those areas where decisions are required to be taken.
- **Ranking:** Developing decision – package and ranking them in order of preference.
- **Budgeting:** Preparation of budget, that is translating decision packages into practicable units items and allocating financial resources.

Advantages of ZBB:

The advantages of zero-base budgeting are as follows.

1. **Priority allocation:** It provides a systematic approach for the evaluation of different activities and ranks them in order of preference for the allocation of scarce resource.
2. **Maximum Efficiency:** It ensures that the various functions undertaken by the organization are critical for the achievement of its objectives and are being performed in the best possible way.
3. **Cost Benefit Analysis:** It provides an opportunity to the management to allocate resource for various cost benefit analysis. The chances of arbitrary cuts and enhancement are thus avoided.
4. **Elimination of wasteful expenditure:** The areas of wasteful expenditure can be easily identified and eliminated.
5. **Goal Congruence:** Department budgets are closely linked with corporate objectives.
6. **Management by Objectives:** The technique can also be used for the introduction and implementation of the system of 'management by objective' Thus it cannot only be used for fulfillment of the objectives of traditional budgeting but it can also be used for a variety of other purposes.

Limitations of ZBB:

1. **Lack of Coordination:** Various operational problems are likely to be faced in implementing the technique of ZBB. It requires the wholehearted support from top management.
2. **Old is Gold Attitude:** Generally managers are reluctant to start afresh. They tend to plan for future just by reference to past actions and budgets.
3. **Time Consuming:** It is time consuming as well as costly.
4. **Lack of trained staff:** It needs properly trained managerial personnel to do the required job.

Performance Budgeting: Meaning:

It is the process of analysing, identifying, simplifying and crystallizing specific performance objectives, of a job to be achieved over a period, within the framework of organizational objectives, the purposes and objectives of the job.

The technique is characterised by its specific direction towards the business objectives of the organization.

Features and Advantages:

- Performance budgeting lays immediate stress on the achievement of specific goals over a period of time.
- It aims at a continuous growth of the organisation so that it continues to meet the dynamic needs of its growing clientele.
- It enables the organization to be sensitive and adaptive, preventing it from developing rigidities, which may retard the process of growth.
- It requires the preparation of periodic performance reports, which compare budget and actual performance to find out existing variances.

Important considerations in Performance Reporting:

The important considerations in drawing up of reports and determining their scope are the following:

Significance	<ul style="list-style-type: none"> • Reliability – Are the facts in the report reliable? • Cause or Effect – Does it either call for action or demonstrate the effect of action
Timeliness	<ul style="list-style-type: none"> • Latest time – How late can the information be and still be of use? • Earliest Time – What is the earliest moment at which it could be used if it were available? • Frequency – How frequently is it required?
Accuracy	<ul style="list-style-type: none"> • How small should be an inaccuracy, which does not alter the significance of the information. • What doubtful elements does it contain? Could any of them or all together make a material difference?
Appropriateness	<ul style="list-style-type: none"> • Receiver – is the recipient the right person to take any action that is needed? • Additional Information – Is there any other information which is required to support the information to anyone else jointly interested?
Discrimination	<ul style="list-style-type: none"> • Will anything be lost by omitting the item? • Will any of the items gain from the omission? • Is the responsibility for suppressing the item acceptable?
Presentation	<ul style="list-style-type: none"> • Clarity – Is the report clear and unbiased? • Form – Is the form suitable to the subject and to the recipient?

Performance Reports:

A. Top Management: (including Board of Directors and financial managers)

- Balance Sheet
- Profit & Loss Statement
- Position of Stock;
- Disposition of funds or working capital
- Capital expenditure and forward commitments together with progress of projects in hand. Cash flow statements;
- Sales, production, and other appropriate statistics

B. Sales Management

- Actual sales compared with budgeted sales to measure performance by (a) products; (b) territories; (c) individual salesmen; and (d) customers.
- Standard profit and loss, product-wise (a) for fixing selling prices and (b) to concentrate on sales of most profitable products.
- Selling expenses in relation to budget and sales value analysed by (a) products; (b) territories; (c) individual salesmen; and (d) customers

- Bad debts and accounts, which are slow and difficult in collection. Status reports on new or doubtful customers.

C. Production management

- To Buyer:
Price variations on purchases analysed by commodities.
- To Foreman
Operational Efficiency for individual operators duly summarized as departmental averages. Labour utilization report and causes of lost time and controllable time; Indirect shop expenses against the standard allowed; and Scrap report
- To Works Manager
 1. Departmental operating statement
 2. General works operating statements (Expenses relating to all works expenses not directly allocable or controllable by departments);
 3. Plant utilization report;
 4. Department scrap report; and
 5. Material usage report

Special Reports: These are prepared at the request of general management or at the initiative of the management accountant. Some examples are:

- Taxation legislation and its effect on profits Estimates of the earning capacity of a new project Break-even analysis
- Capital budgeting decisions
- Special pricing analysis
- Make or buy certain components

Question 25: What are the advantages and limitations of Zero base Budgeting? (4 Marks) Nov./04

Question 26: "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/05

Ans.: A single budget system may be conflicting in planning and motivation, and planning and performance evaluation roles as below:

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.

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 27: Write short note on 'Zero Base Budgeting' as an approach towards productivity improvement. (4 Marks) Nov./05

Question 28: Describe the process of zero-base budgeting. (4 Marks) May/07 & (5 Marks) Nov./10-N.C.

Question 29: A manufacturing company makes 4 products that are sold through 8 regional offices countrywide. The products pass through 3 production processes in a factory. A separate market research division monitors outside competition. This division is outside the sales management hierarchy.

As a management accountant, suggest some routine reports for performance measurement to be made to :

- (a) The Sales Management
- (b) The Works Manager

(9 Marks) Nov./10-O.C.

CONCEPTS RELATED TO CAPACITY (Refer CAS 2 & 3)

- '**Licensed Capacity**' is the production capacity of the plant for which license has been issued by an appropriate authority.
- '**Installed Capacity**' is the maximum productive capacity according to the manufacturers' specification of machines/equipment. In other words, it is only a theoretical capacity and is therefore, seldom achieved. In case a product passes through different production processes and each process is having different

capacity then the process which brings effective or ultimate production shall be considered for deciding installed capacity. It is a measure of maximum operating capacity based on 100% efficiency with no interruption for maintenance or other factors (i.e. Maximum no. of days in a period × No. of workers × Hours per day)

- **'Practical or Achievable Capacity'** is the maximum productive capacity of a plant reduced by the predictable and unavoidable factors of interruption pertaining to internal causes. Thus, practical capacity is the installed capacity (-) the inevitable interruptions due to time lost for preventive maintenance, repairs, set ups, normal delays, weekly off-days and holidays etc. It is defined as actually utilized capacity of a plant. Practical capacity does not consider the external factors causing reduction in production e.g. lack of orders.
- **'Normal capacity'** is determined based on the productive capacity achieved over a period of time, say average of three normal years out of preceding five years or expected to be achieved over a period of time, say next three to five years. The periods influenced by abnormalities should be excluded for this purpose. Unlike practical capacity, normal capacity allows for idleness both of plant and personnel caused due to lack of sales orders.

Note: Since practical capacity is based on possible production & normal capacity is based on production basing on possible sales, it is not tenable assumption that firm will produce without taking into account sales level, normal capacity is preferable measure to calculate factory overhead absorption rate.

- **'Expected or Short-run expectancy'** is the capacity of a plant utilized based on sales expectancy for next period/year (i.e. in a single year only). Thus, expected capacity differs from normal capacity in the length of time to determine capacity base. This measure doesn't smoothen out cyclic fluctuations in sales that are likely to occur over a period of time as it is guided by one year projection only. If there is no sales problem it is clear that the practical capacity & short term capacity will coincide.
- **'Actual Capacity Utilization'** is the volume of production achieved in relation to installed capacity.
- **'Idle Capacity'** is the difference between installed capacity and the actual capacity utilization when actual capacity utilization is less than installed capacity.
- **'Excess Capacity Utilization'** is the difference between installed capacity and the actual capacity utilization when actual capacity utilization is more than installed capacity.
- **'Abnormal idle capacity'** is the difference between practical capacity and normal capacity or actual capacity utilization whichever is higher

Note: Whenever question specifically provides budgeted capacity, we take the capacity so provided as budgeted capacity otherwise we take budgeted capacity as normal capacity, when sales remains reasonably constant although if sales fluctuate from one year to another, we take budgeted capacity as expected capacity. If normal/expected capacity is missing, we take it as practical capacity.

Remember, fixed overheads absorption rate is to be always calculated on Budgeted capacity i.e.

$$\frac{\text{Budgeted Fixed Overheads}}{\text{Budgeted Capacity}}$$

If a question provides us fixed overhead absorption rate along with budgeted as well as actual capacity, we will multiply it with budgeted capacity (not by actual capacity) to find Budgeted Fixed Overhead.

Question 30: Manufacturers' Specifications - capacity per hour	= 500 units
No of shifts (each shift 8 hours)	= 3 shifts
Holidays in a year:	
Sundays	= 52 days
Other holidays	= 13 days
Annual maintenance is done within these 13 holidays	
Preventive Weekly Maintenance for the machine on Sunday.	
Normal idle capacity for batch change over, lunch, personal need, etc.	= 1 hr per shift

Production (units) based on sales expectancy in past 5 years = 30.1, 26.9, 29.7, 24.4 and 30.2 lakh
Actual Production for the year = 30.1 lakh

[Ans.: Installed capacity = 43.8 lakh units; Practical capacity = 31.5 lakh units; Normal capacity = 30 lakh units; Actual capacity utilization = 68.7%; Idle capacity = 31.3%; Abnormal idle capacity = 1.4 lakh units]

[Hint: It is assumed that business cycle consists of 3 years]

Question 31: XYZ Ltd. wishes to determine various capacity levels both in terms of production units and machine-hours. One machine-hour produces 10 units of finished product. The production department in which the machine is located normally operates 6 days a week (except Sunday) on a single, eight hour shift. The plant is closed for 10 working days each year for holidays.

The plant is closed for 200 hours each year for its repairs and maintenance. Normal sales demand averages 20000 units a year over a 5-year period (extensive product changes are made every five years). The expected sales volume for the next year is 19000 units. Budgeted Fixed overhead costs are ₹6,00,000 & variable overhead costs at ₹100 per hour as the basis of determining factory overhead application rate.

Show the machine-hours and production capacity at four levels. Also calculate factory overhead application rate.

[Ans.: Maximum capacity: 2920 hours or 29200 units; Practical capacity: 2224 hours or 22240 units; Normal capacity: 2000 hours or 20000 units; Expected capacity: 1900 hours or 19000 units; Factory overhead application rate per hour: ₹400; Factory overhead application rate per unit: ₹40]

Question 32: 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
1	2.50	18	10
2	3.00	5	4
3	2.00	10	5
Variable overheads (₹/unit)	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./07

[Ans.: (i) Profit ₹399500 (ii) X 23400 units, Y 19500 units, Z 10585 units; optimal profit ₹406450]

Question 33 [Flexible Budget]: JBC Limited, a manufacturing company having a capacity of 60,000 units has prepared a following cost sheet:

Direct material per unit)	₹12.50
Direct wages (per unit.)	₹5.00
Semi-variable cost	₹30,000 fixed plus 0.50 per unit
Factory overhead (per unit)	₹10.00 (50% fixed)
Selling and administration overhead (per unit)	₹8.00 (25% variable)
Selling price (per unit)	₹40

During the year 2008, the sales volume achieved by the company was 50,000 units.

The company has launched an expansion program as under:

- The capacity will be increased to 1,00,000 units.
- The cost of investment on expansion is ₹5 lakhs which is proposed to be financed through financial institution at 12 per cent per annum.
- The depreciation rate on new investment is 10 per cent based on straight line.
- The additional fixed overheads will amount to ₹2.00 lakhs up to 80,000 units and will increase by ₹80,000 more beyond 80,000 units.

After the expansion, the company has two alternatives for operating the expanded plant as under:

- Sales can be increased up to 80,000 units by spending ₹50,000 on special advertisement campaign to explore new market.
- Sales can be increased up to 1,00,000 units subject to the following:
 - Reduction of selling price by ₹4 per unit on all the units sold.
 - The direct material cost would go down by 4 per cent due to discount on bulk buying.
 - By increasing the variable selling and administration expenses by 4 per cent.

Required:

- Construct a flexible budget at the level 50,000 units, 80,000 units and 1,00,000 units of production and select best profitable level of operation.
- Calculate break even point both before and after expansion.

ICWA June/84[Adapted] & (9 Marks) June./09-O.C.

[Ans.: (i) Profit: 50000 units – ₹60000; 80000 units – ₹150000; 100000 units – ₹62000; (ii) BEP: Before Expansion: 50000 units – 46000 units; 80000 units – 70000 units; After expansion: 100000 units – 94570 units]

Question 34 [Flexible Budget for overhead items – Variance- Overhead absorbed and overhead volume variance]: A manufacturing company has the following budgeted costs for one month which are based on a normal capacity level of 40,000 hours. A departmental overhead absorption rate of ₹4.40 per hour has been calculated as follows:

Overhead	Fixed (₹'000)	Variable per hour (₹)
Management and supervision	30	-
Shift premium	-	0.10
ESI and pension costs	6	0.22
Inspection	20	0.25
Consumable supplies	6	0.18
Power for machinery	-	0.20
Lighting and heating	4	-
Rates	9	-
Repairs and maintenance	8	0.15
Materials handling	10	0.30
Depreciation of machinery	15	-
Production administration	12	-
	120	
Overhead rate per hour:		
Variable		1.40
Fixed		<u>3.00</u>
Total		<u>4.40</u>

During the month of April, the company actually worked 36,000 hours producing **36,000 standard hours** of production and incurred the following overhead costs.

	₹'000
Management and supervision	30.0
Shift premium	4.0
ESI and pension costs	15.0
Inspection	28.0
Consumable supplies	12.7
Power for machinery	7.8
Lighting and heating	4.2
Rates	9.0
Repairs and maintenance	15.1
Materials handling	21.4
Depreciation of machinery	15.0
Production administration	11.5
Idle time	1.6
	175.3

You are required to:

- Prepare a statement showing the flexible budget for the month of April, the actual costs and the variance for each overhead item;
- Comment on each variance of ₹1,000 or more by suggesting possible reasons for the variances reported;
- State for control purposes, with reasons to support your conclusions:
 - Whether (b) above is adequate; and
 - Whether the statement prepared in request in (a) above could be improved, and if so, how:
- Calculate:
 - The overhead absorbed;
 - The total amount under/over-spent ; and
 - The overhead volume variance

ICWA-June/93

[Ans.: (a) Total overhead variance ₹4900A; (d) (i) ₹158400 (ii) ₹4900 (iii) ₹12000(A)]

Question 35 [Cash Budget]: Following budgeted sales values have been extracted from the budget of A.Z. limited for the year ending 31st December 1997:

April	₹4,00,000
May	4,50,000
June	5,20,000
July	4,20,000
August	4,80,000

The contribution/sales ratio is 40% Fixed costs are budgeted to be ₹12,00,000 for the year arising at a constant rate per month and including depreciation of ₹3,00,000 per annum.

40% of each month's sales are produced in the month prior to sale, and 60% are produced in the month of sale. 50% of the direct materials required for production are purchased in the month prior to their being used in production.

30% of the variable costs are labour costs, which are paid in the month they are incurred.

60% of the variable costs are direct material costs. Suppliers of direct materials are paid in the month after purchase.

The remaining variable costs are variable overhead costs. 40% of the variable overhead costs are paid in the month they are incurred, the balance being paid in the month after they are incurred. Fixed costs are paid in the month they incurred.

Capital expenditure expected in June is ₹1,90,000.

Sales receipts for the three months of May, June and July are budgeted as follows:

May	₹4,01,700
June	4,50,280
July	4,25,880

The bank balance on May 1, 1997 is expected to be ₹40,000.

Requirement:

Prepare a cash budget for A.Z. Limited.

Your budget should be in columnar format showing separately the receipts, payments and balances for each of the months of May, June and July 1997.

[Ans.: Closing Balance – May: ₹92428, June: (₹9860), July: 66844]

Question 36 [Production Cost budget]: The budgeted and actual cost data of M Ltd. for 6 months from April to September, 2008 are as under:

	Budget	Actual
Production units	16,000	14,000
Material cost	₹25,60,000 (1,600 MT @ ₹1,600)	₹41,60,000 (at ₹1,650)
Labour cost	₹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./08-N.C.

[Ans.: If difference in actual and standard time is also considered for calculating the lower efficiency then Total cost: ₹1,02,69,708; If lower efficiency of 1% is based on budgeted efficiency then Total Cost: ₹1,01,38,652; If lower efficiency of 1% is based on actual efficiency then Total Cost: ₹1,02,68,696]

[Hint.: We need to specifically mention in exam the assumption we are following regarding labour efficiency.]

[Note.: In Suggested answers by ICAI, while doing solution ICAI have assumed that decrease in efficiency means reduction in time for producing same units although we shall go by real meaning of decrease in efficiency i.e. decrease in productivity/output & if we want to know about the increase in time for same amount of output, then we can definitely derive it. (This logic is also substantiated by a solution by ICAI in a similar question in Study material of ICAI & also in Nov'95). In other words Reduction in Labour efficiency by 1% doesn't mean that you will be able to produce same amount of units (i.e. 30000) in 101% of original labour time, rather, it means that we will be able to make 29700 (30000×99%) units in original labour time i.e. 75000 hours or in other words we can produce 30000 units (units to be produced) in 101.01% of original labour time i.e. 75758 hours approx.]

Question 37 [Preparation of monthly cash budgets and budgeted income statement] On 30th September, 1990, the Balance Sheet of Melodies Pvt. Ltd. retailers of musical instruments was as under:

Ordinary Shares of ₹10 each fully paid	₹20,000	Equipment (at cost)	₹20,000
Reserves and Surplus	10,000	Less: Depreciation	5,000
Trade creditors	40,000	Stock	15,000
			20,000

Proposed Dividend	15,000	Trade Debtors	15,000
	85,000	Balance at Bank	35,000
			85,000

The company is developing a system of forward planning, and on 1st October, 1990 it supplies the following information:

Month	Credit Sales	Cash Sales	Credit Purchases
September 1990 (actual)	₹15,000	₹14,000	₹40,000
October 1990 (Budget)	18,000	5,000	23,000
November 1990 (Budget)	20,000	6,000	27,000
December 1990 (Budget)	25,000	8,000	26,000

All trade debtors are allowed one month's credit and are expected to settle promptly. All trade creditors are paid in the month following delivery.

On 1st October 1990, all the equipment was replaced at a cost of ₹30,000. ₹14,000 was allowed in exchange for the old equipment and a net payment of ₹16,000 was made. Depreciation is to be provided at the rate of 10% per annum.

The proposed dividend will be paid in December 1990

The following expenses will be paid:

Wages ₹3,000 per month

Administration ₹1,500 per month

Rent ₹3,600 for the year to 30th September 1991 (to be paid in October 1990).

The gross profit percentage on sales is estimated at 25%

You are required:

(a) to prepare a Cash budget for the month of October, November and December.

(b) To prepare Income Statement for the three months ended 31st December.

Nov./90

[Ans.: (a) Closing Balance (Overdraft) – October : (9100), November : (12600), December : (31100); (b) Net profit : ₹13350]

Question 38 [Production Budget]: Sportswear Ltd. manufactures sportswear shirts and shorts. The production budget for these two products has to be prepared for the next three months, November 2010, December 2010 and January 2010.

The following information is given :

(i) Sales volume every month will be 2% more than the previous month's volume for each product.

(ii) The company carries stock of finished garments sufficient to meet 40% of the next month's sale.

(iii) Closing stock for October 2010 was 6000 shirts and 8000 shorts.

You are required to prepare the production budget for each product for November, December 2010 and January 2011. (5 Marks) Nov./10-O.C.

[Ans.: Shirts: 15120, 15422, 15731; Shorts: 20160, 20563, 20975]

Question 39 [Production Budget & EOQ]: A firm is engaged in the manufacture of two products 'A' and 'B'. Product A used one unit of component 'P' and two units of components 'Q'. Product B 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'. Components 'P' and 'Q' are purchased from the market. The firm has prepared the following forecast of sales and inventory for the next year.

		Products	
		A	B
Sales	Units	8,000	15,000
Inventories:			
At the end of the year	Units	1,000	2,000

At the beginning of the year	Units	3,000	5,000
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The production of both the products and the assembling of the component 'R' will be spread out uniformly throughout the year.

The firm at present orders its inventory of components 'P' and 'Q' in quantities equivalent to 3 months' consumption. The firm has been advised that savings in the provisioning of components can arise by changing over to the ordering quantities. The firm has compiled the following data relating to the two Components:

		P	Q
Price per unit	₹	2.00	0.80
Order placing costs per order	₹	15.00	15.00
Carrying costs p.a.		20%	20%

Required:

- a) Prepare a budget of production and requirements of components for the next year.
- b) Find the economic order quantity.
- c) Based on the economic order quantity calculated in (b) above, calculate the savings arising from switching over to the new ordering system both in terms of cost and reduction in working capital.

(May 1989), (11 Marks) May/06-Adapted & (7 Marks) May/10-N.C.-Adapted

[Ans.: (a) Production: A-6000 units, B-12000 units; (b) P – 1500 components, Q – 3000 components]

Question 40 [Functional Budgets]: 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./04 & May/95-Adapted

[Ans.: (i) Material Purchase Budget: X - 117200 units, Y - 41480 units, Total cost of materials-₹358840, Material Usage Budget: X-108600 units at ₹217200; Y-38240 units at ₹114720 (ii) Production Budget: Product A – 5200 units, Product B – 11320 units (iii) Wages Budget: Total wages ₹697680]

Question 41 [Sales, Production, Material Usage, Purchase and Manpower Budgets]: ZED Ltd. manufactures three types of products, A,B and C and markets them at ₹450, ₹550 and ₹650 per unit respectively. The current ratio of sales in quantity of A, B and C is 1: 2: 4.

Relevant Data of A, B, and C (per unit)

Product	Quantity of parts required therein				Labour hours		Variable Overheads
	Frame	E	F	G	Skill	Unskilled	₹
A	1	10	2	8	6	8	9
B	1	2	14	10	4	6	11
C	1	6	10	2	3	6	7

The present purchase price per part is ₹45, ₹15, ₹15 and ₹5 for frame, E, F and G respectively. The wage rate per hour for skilled and unskilled workers is ₹6 and ₹5 respectively.

The opening stocks are as on 1.11.1995 stood at 500, 1,000, 3,000, 1,500, 1,000, 20,000 and 10,000 respectively for A,B,C frames, E,F and G. The company maintains closing stock of products and parts at 90% of the opening stocks.

The workers work for 8 hours a day for 25 days in a month.

The share of fixed overheads per month comes to ₹15,75,000; ₹5,80,000; and ₹8,45,000 for production, administration and selling and distribution respectively.

The yearly profit as projected up to October, 1996 is ₹120 lakhs.

You are required to present the following for November, 1995:

- Sales budget in quantity as well as in value for A, B and C.
- Production budget.
- Parts usage budget.
- Purchase budget in quantity as well as in value.
- Manpower budget showing labour hours and wages payable for both types of workers.

ICWA-June/95 & (19 Marks) Nov./95

[Ans.: (a) Sales value product A (2500 × ₹450), Product B (5000 × ₹550) & Product C (10000 × 650); (b) Production budget (in units) Product A, B & C – 2450, 4900 & 9700 respectively; (c) Parts usage budget (parts of total material required) Frame-17050, E-92500, F-170500, G-88000; (d) Purchase budget (in qty as well as value) Frame-(16900 × ₹45), E-(92400 × ₹15), F-(168500 × ₹15), G-(82100 × ₹5); (e) Wages payable to skilled worker ₹(63400 × ₹6) and unskilled worker (107200 × ₹5)]

Question 42 [Production, material purchase and direct wage cost budgets and budgeted income statement]: X Ltd. produces and markets three products- Chairs, Tables and Benches. The company is interested in presenting its budget for the next quarter ending 31st March, 1991. It expects to sell 4,200 chairs, 800 tables and 500 benches during the said period at the selling price of ₹50, ₹85 and ₹158 per unit respectively. The following information's are made available for the purpose:

(i) Material and labour requirements:

	Chairs	Tables	Benches
Timber per unit (in cu. Ft.)	0.50	1.2	2.5
Upholstery per unit (in sq. yds.)	0.25	-	-
Carpenter's time(minutes per unit)	45	60	75
Fixed and Finisher's time(minutes per unit)	15	15	30

Timber costs ₹50 per cu. Ft. and upholstery costs ₹20 per sq. yd. fixing and finishing material costs 5% of the cost of timber and upholstery. Carpenter gets ₹6 per hour while the fixer and finisher get ₹4.80 per hour.

(ii) Inventory levels planned:

	Timber (cu. ft)	Upholstery (sq. yds.)	Chairs (nos.)	Tables (nos.)	Benches (nos.)
Opening	600	400	400	100	50
Closing	650	260	200	300	50

(iii) Fixed overheads would be ₹8,000 per month.

You are required to:

- Prepare a production budget showing quantities to be manufactured.
- Prepare a raw materials purchase budget in quantities as well as in rupees.
- Draw a direct wage cost budget.
- Present a statement showing variable cost of manufacture per unit of all three products.
- Find out the budgeted net income for the said quarter.

(Nov./93)

[Ans.: (a) 4000, 1000, 5000; (b) 4500 cu ft of ₹225000, 860 sq yds of ₹17200; (c) ₹34950; (d) 37.20, 70.20, 141.15; (e) ₹50025]

Question 43 [Preparation of Production and Purchase Budget]: Manufacturers Ltd. produce three products from three basic raw materials in three departments. The company operates budgetary control system and makes its stock to finished goods on a total cost basis. From the following data, you are required to produce for the month of July 1986 the following budgets.

(a) Production	(b) Material usage		
(c) Purchases	(d) Profit and loss account for each product and in total		
	A	B	C
Sales	₹15,00,000	₹10,80,000	₹16,80,000
Stock of finished products at July 1, 1986 in units	3,000	2,000	2,500
	Department		
	I	II	III
Production overhead	₹2,39,000	₹2,01,300	₹3,91,200
Direct labour hours	47,800	67,100	65,200
	Direct Material		
	M ₁	M ₂	M ₃
Stock at July 1, 1986 in units	24,500	20,500	17,500

The company is introducing a new system of inventory control, which should reduce stock. The forecast is that stocks as at 31st July 1986 will be reduced as follows:
Raw materials by 10% and finished product by 20%.

Fixed production overhead is absorbed on a direct labour-hour basis. It is expected that there will be no work-in-progress at the beginning or end of the month. Administration cost is absorbed by products at a rate of 20% of production cost and selling and distribution cost is absorbed by products at a rate of 40% production cost.

Profit is budgeted as a percentage of total cost as follows:
Product A 25%, Product B 12½% and Product C 16⅔%

Standard cost data per unit of products:

		Product		
	Price per unit	A	B	C
Direct material	₹	Units	Units	Units
M ₁	2.00	5	-	12
M ₂	4.00	-	10	9
M ₃	1.00	5	5	-
Direct wages:	Rate per hour	A	B	C
	₹	Hrs.	Hrs.	Hrs.
Department I	2.50	4	2	2
Department II	2.00	6	2	3
Department III	1.50	2	4	6
Other variable costs		₹10	₹20	₹15

(May/86)

[Ans.: (a) A – 6900 units, B – 4600 units, C – 5500 units; (b) M₁ – 100500 units, M₂ -95500 units, M₃ – 57500 units; (c) M₁ – 98500 units of ₹196100, M₂ - 93450 units of ₹373800, M₃ – 55750 units of ₹55750; (d) A - ₹300000, B - ₹120000, C - ₹240000, D - ₹660000]

Responsibility Accounting

Each manager, regardless of level, is incharge of a responsibility center. A responsibility center is a segment of an organization whose manager is accountable for a specified set of activities. The higher the manager's level, the broader the responsibility center and generally, the larger the no. of his subordinates. Responsibility Accounting is a system that measures the plans (by budgets) and actions (by actual results) of each responsibility center. Responsibility accounting is concerned with designing reports that help motivate managers to make decisions and to take actions that are in the best interests of the overall organization. Four major types of responsibility centers are:

- Cost Centre - the manager is accountable for costs only. E.g. Maintenance Manager
- Revenue Centre - the manager is accountable for revenues only. E.g. Sales Manager
- Profit Centre - the manager is accountable for revenues & costs. E.g. Department/Segmental Manager
- Investment Centre - the manager is accountable for investments, revenues & costs. E.g. Regional Manager responsible for investment in new projects and for revenues & costs.

Type of responsibility center	Manager has control over	Principal performance measurement
Cost centre	Costs (only controllable cost items)	Variance analysis Efficiency measures
Profit centre	Costs (only controllable costs) Sales prices (including transfer prices) Output volumes	Profit
Investment centre	Costs (only controllable costs) Sales prices (including transfer prices) Output volumes Investment in fixed & current assets	Return on investment Residual income Other financial ratios

Manager's control over responsibility centre

Type of centre	Manager responsible for			
	Costs	Revenues	Profit/Loss	Investment
Cost Centre	Yes	No	No	No
Revenue Centre	No	Yes	No	No
Profit Centre	Yes	Yes	Yes	No
Investment Centre	Yes	Yes	Yes	Yes

Question 44 [Responsibility Accounting Reports + Budget Variance]: Nicefit manufactures ready made garments by a simple process of cutting the clothes in various shapes and then sewing the corresponding pieces together to form the finished product.

The sewing Department and the cutting department report to the production manager who along with Engineering Manager reports to the Director-Manufacturing. The Sales Manager, Publicity Manager and the Credit Manger report to the Director-Marketing, who along with Director-Manufacturing reports to the Managing Director of the company.

The Accounts Department reports the following for the last quarter of 1983:

	Budgeted (₹)	Actual (₹)
Bad debt Losses	5,000	3,000
Cloth used	31,000	36,000
Advertising	4,000	4,000
Audit fees	7,500	7,500
Credit reports	1,200	1,050
Sales representative travelling expenses	9,000	10,200
Sales commission	7,000	7,000
Cutting Labour	6,000	6,600
Thread	500	450
Sewing Labour	17,000	18,400
Credit Deptt. Salaries	8,000	8,000
Cutting utilities	800	700
Sewing utilities	900	950
Director Marketing salaries & Admn. Exp.	20,000	21,400
Production engineering expenses	13,000	12,200
Sales management office expenses	16,000	15,700

Production Manager office expenses	18,000	17,000
Director Mfg. Salaries & Admn. Expenses	21,000	20,100

Using the above data, prepare Responsibility Accounting reports for the director marketing, the Director-manufacturing and the production manager.

[Ans.: Production Manager- Budget: ₹56200, Actual: ₹63100, Direct Manufacturing- Budget: ₹87200, Actual: ₹92300, Direct Marketing- Budget: 50200, Actual: 48950]

Question 45 [Performance Budget & Summary Report]: The following data relate to a company which had a profit approved for selling 5000 units per month at an average selling price of ₹10 per unit and budgeted variable cost of production was ₹4 per unit and fixed costs were budgeted at ₹20,000. Planned income being ₹10,000 per month. Because of shortage of raw—materials the plant could produce only 4000 units and the cost of production was increased by 0.50 per unit. Consequently ₹1.00 raised the selling price per unit. To modify production processes in order to meet materials shortage, the Company incurred an expenditure of ₹1,000 in Research and Development. Set out a Performance budget and a summary report there.

[Ans.: Net Profit – Original Plan: ₹10000, Revised Budget: ₹4000, Actual Result: 5000]

6



Transfer Pricing

A transfer price is the amount of money that one subunit (segment, department, division and so on) of an organization charges for goods and services to another subunit of an organization.

The transfer price creates revenue for the selling subunit and purchase cost for the buying subunit, affecting each subunit's operating income. The product transferred between subunits of an organization is called an **intermediate product**. It can either be processed further by receiving subunit or, if transferred from production to marketing, resold to an external customer.

Organizations have a system of transfer pricing, therefore, in order to assess the efficiency and effectiveness of its department and divisional managers. This maybe in spite of the fact that transfer prices may be artificial in the sense that it is felt that there is no rationale for "selling" between departments and divisions.

Aims of a transfer pricing system

- To **encourage goal congruence**, whereby individual managers' own goals are the same as the goals of the company as a whole.
- To enable the **realistic measurement of divisional profit**.
- To sustain high level of **management efforts**.
- To give **autonomy** to managers.
- To ensure **profit maximization** for the company as a whole.

It may be difficult to reconcile all of these aims.

Transfer Pricing Methods

Market-based transfer prices. When there is a competitive outside market for the good or service transferred between the divisions, the market price is often used as a transfer price. This solution is reasonably easy to administer and provides a theoretically correct transfer price when there is no idle capacity. However, when there is idle capacity in the selling division, the transfer price will be too high and the buying division may inappropriately purchase from an outside supplier or cut back on volume.

The major merits of this method are:

- a) **Maximum Prices:** In a competitive market, goods/services cannot be transferred to its users at a higher price. Hence market prices constitute the basis for efficient production.
- b) **Demand and Supply Forces:** Market prices take into account, the forces of demand and supply. If intermediate products are freely saleable, in the long run, market prices will provide a good indicator of the overall efficiency of the various divisions.
- c) **Opportunity Cost Recovery:** Opportunity costs of transferring divisions are fully recovered. Hence there is sufficient incentive for internal transfer, for transferring divisions operating at full capacity.
- d) **Objective:** Market prices provide reliable measures of divisional income because these prices are established independently rather than by individuals who have an interest in the results.

The major demerits of this method are:

- a) **Availability of Market Prices:** There may be difficulty in obtaining just / fair market prices. Sometimes, the intermediate product may not be saleable; in other cases direct market substitutes may not be available for products, which are manufactured only for internal consumption.

- b) **Impact of S&D Costs:** There may be difficulties in determining the elements of Selling and Distribution costs such as commission, discounts, advertisement and sales promotion etc. so that necessary adjustment may be made in the market price to provide benefit of these expenses, to the recipient Division.
- c) **Unjust Enrichment:** Market Prices lead to unjust enrichment of the transferring division, particularly if the former has sufficient spare capacity and the intermediate is not freely saleable externally.

Negotiated transfer prices (a.k.a. Shadow Pricing). It refers to the determination of transfer prices based on active participation, involvement, co-ordination and agreement of the managers of the transferring and recipient division. In principle, if division managers understand their own businesses and are cooperative, negotiated transfer prices should work quite well. It is always possible in such a situation (barring externalities) to find a transfer price that would increase each participating division's profits. While negotiated transfer prices can work quite well under the right conditions, if managers are uncooperative and highly competitive, negotiations may go nowhere.

Advantages:

1. **Proper Decision Making:** Negotiated prices lead to business like attitude amongst divisions of the company. The buying division may purchase from outside sources if the outside prices are lower than the internal division's price.
2. **Autonomy and Motivation Value:** Each sub-unit is considered as an independent unit. Buyers and Sellers are completely free to deal outside the Company. This promotes sub-unit autonomy and motivates managers.
3. **Overall Company Profitability:** Through properly direct negotiations, managers will be able to determine the appropriate transfer prices that satisfy the requirements of the divisions and is in the best interest of the Company as a whole.

Limitations:

1. **Sub-optimal:** The agreed transfer price may depend on the negotiating skills and bargaining powers of the managers involved. The final result may not always be optimal.
2. **Conflicts:** Rather than agreement on transfer prices, negotiations can lead to conflict between divisions and may require top-management mediation.
3. **Defeat of Performance evaluation criteria:** Transfer prices dependent on manager's negotiation skills will defeat the very purpose of performance evaluation.
4. **Time and Cost:** Negotiations are time consuming for the manager involved, particularly when the number of transactions and interdependencies are large.

In order to have an effective system of transfer pricing; the following points should be kept in view;

- Price of all transfer in and out of a profit centre should be determined by negotiation between the buyer and the seller.
- Negotiations should have access to full data on alternative source and markets and to public and private information about market prices.
- Buyers and sellers should be completely free to deal outside the company.

Cost-based transfer prices. Transfer Price can be recorded at:

(i) Variable costs (ii) Full manufacturing cost (iii) Total Actual cost (iv) Standard Cost or at (v) Variable or Full cost plus some arbitrary mark-up.

- **Variable Manufacturing Costs:**

Merits	Demerits
<ul style="list-style-type: none"> • Simple to understand. • Easy To Operate • No Negative Contribution to Transferring Division • Suitable if Transferring Division has sufficient spare capacity and intermediate product is not marketable. 	<ul style="list-style-type: none"> • Cost and Prices fluctuate from time to time, Hence Transfer prices also vary. • No Contribution from transferring division, since only manufacturing cost is recouped. • Not suitable for performance evaluation. • Does not consider opportunity costs and losses. • Not suitable for transferring divisions which operate at full capacity.

• **Full Manufacturing Cost:**

Merits	Demerits
<ul style="list-style-type: none"> • Simple to understand. • Easy to Operate. • Guaranteed Contribution to transferring division, to the extent of fixed manufacturing cost. • Ideal if transferring division has sufficient spare capacity, and intermediate product is not marketable. 	<ul style="list-style-type: none"> • Cost and Prices fluctuate from time to time, Hence Transfer prices also vary. • Not suitable for performance evaluation. • Does not consider opportunity costs and losses. • Not suitable for transferring divisions which operate at full capacity.

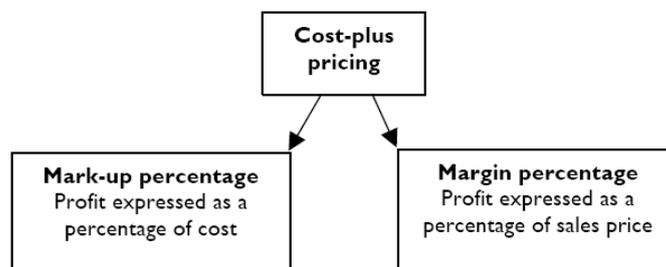
• **Total Actual Costs:**

Merits	Demerits
<ul style="list-style-type: none"> • Simple to understand. • Easy to Operate. • Guaranteed Contribution to transferring division, to the extent of fixed cost. Usable if transferring division has sufficient spare capacity, and intermediate product is not marketable. 	<ul style="list-style-type: none"> • Actual Cost and Prices fluctuate from time to time, • Not suitable for performance evaluation of transferring division. • Does not Consider Opportunity costs and losses. • Not suitable for transferring divisions which operate at full capacity. • Cost efficiency of transferring division may mean lower prices, hence no incentive for cost reduction.

• **Standard Costs:**

Merits	Demerits
<ul style="list-style-type: none"> • Simple and Easy to operate when compared with actual cost based methods. • Inventories are carried at standard costs in transferring and receiving divisions. 	<ul style="list-style-type: none"> • The Transferring divisions usually absorb variances and hence segment-wise performance evaluation is not possible. • Does not Consider Opportunity costs and losses.

- **Cost Plus mark-up:** Under this method, the transfers are made at Cost + Mark-up basis. Cost may be any variant i.e. Variable Manufacturing Costs or Full Manufacturing Costs or Total Cost (Actual) or Standard Costs. Mark-up added to cost may be expressed either (1) as a percentage of full cost or (2) as a percentage of capital employed.



Total Actual cost of the product includes all production costs plus cost from other business functions (R & D, design, marketing, distribution and customer service).

Dual Pricing: The dual pricing method uses two prices. The supplying division is credited with a price based on total cost plus a mark- up and the receiving division is debited with marginal cost. This means that the

selling division is allowed to earn a profit and the receiving division has the correct information in order to make the correct selling decision to maximize the group's profit. The difference between the two prices will be debited to a group account- a transfer price adjustment account. At the end of the year the profits of the two divisions, and hence of the group, will be overstated to the extent of the price difference. In order to correct this, the total amount in the transfer price adjustment account must be subtracted from the two profits to arrive at the correct profit for the group as a whole.

Dual pricing can also be used with market price in place of marginal cost for the receiving division. This can aid the supplying division in a particular circumstance. For example, where market prices are very volatile and the market price of the component suddenly collapses it may be unrealistic to expect the supplying division to cope with the decreases. Under the circumstances the receiving division would wish to buy elsewhere if the transfer price set was higher than the market price. So the supplying division could be credited with total cost plus and the receiving division debited with the much reduced market price. The receiving division would then be happy to continue to buy internally.

The dual pricing method can be effective in avoiding sub-optimal decisions but it can be administratively cumbersome.

Advantages:

1. **Incentive to Transferring Division:** The transfer price will meet the performance evaluation requirements of the transferring division since each unit transferred generates a profit (due to mark-up). Thus the supplying division manager is motivated to transfer the intermediate product internally.
2. **No unjust Enrichment:** If the transfer price is set at the transferring division's marginal cost of the intermediate product, it will not have any contribution from the internal transfers. All the total contribution from inter-divisional trading will be assigned to the Recipient division. Such unjust enrichment is avoided through the use of mark-up.
3. **Optimal Decisions:** Since relevant cost analysis is used as the second transfer price, the transfer pricing system automatically promotes goal congruence by leading to optimal decisions.

Disadvantages:

1. **Confusing:** The use of different transfer prices causes confusion, particularly when more than two divisions are involved.
2. **Artificial:** Dual Transfer Prices are considered to be artificial.
3. **No incentive:** Fixed price with mark-up protects transferring divisions from competition. It reduces divisional incentives to compete effectively and give them little incentive to improve their productivity.
4. **Misleading:** Dual Transfer prices can result in misleading information and create a false impression of divisional profits. There is a possibility of double-counting of profits. At the extreme, all divisions may report profits when the company as a whole is losing money.

Two-part transfer pricing: To avoid the sub-optimal decisions that may occur when the fixed costs of one division are perceived as variable costs by another division, a two part transfer price might be used.

Under this method, Transfer price = Marginal Cost + **Lump-sum** Fixed Fee

- This method is most suited when there is no market for the intermediate product, and the transferring division has no capacity constraints.
- The Transferring Division is provided with sufficient incentive for internal transfer, since marginal costs are fully recovered and the lump-sum fee received will reduce its losses by recovering fixed costs.
- The Recipient Division is also interested in the internal procurement since the transfer price will be less than market price or cost of alternative option like outsourcing etc.
- This system also has a drawback the supplying division has no incentive to supply units swiftly, as each unit does not generate a profit. The profit is made whenever the fixed fee is transferred.

Moreover, the lump-sum fixed fee constitutes a commitment if the divisions to utilize a portion of the capacity of the transferring divisions, for an agreed compensation.

General guidelines for setting Transfer Prices:

Minimum Transfer Price: The selling division would like for the transfer price to be as high as possible. The manager of selling division will not agree to a transfer price that is less than his or her "cost." But what cost? If

the manager is rational, then the manager should realize that any transfer price that covers variable cost plus fixed costs specific to such decision plus opportunity cost will result in an increase in segment profits. The opportunity cost is the contribution margin that is lost on units that cannot be produced and sold as a result of the transfer. Therefore, the lowest acceptable transfer price as far as the selling division is concerned is: When there is idle capacity, there are no lost sales and so the total contribution margin of lost sales is zero.

$$\text{Transfer Price} \geq \text{Incremental Costs (i.e. Variable cost + Specific Fixed costs to such decision)} + \frac{\text{Total contribution margin of lost sales}}{\text{Total number of units transferred}}$$

Also Packaging Cost, Bad Debts, Selling & Distribution costs are not included (except specifically mentioned).

Maximum Transfer Price: The buying division clearly would not voluntarily agree to a transfer price (subject to his ability to pay) unless:

$$\text{Transfer price} \leq \text{Cost of buying from outside supplier (i.e. Market Price plus buying cost incurred)}$$

Domestic Transfer Pricing recommendations

- 1) Where a competitive market exists for intermediate products & there is *no* idle capacity, the market price (less adjustments for selling and distribution, packaging cost, bad debts, & collection expense to outside customers) should be used as transfer price.
- 2) Where a competitive market exists for intermediate products & there is idle capacity, variable cost should be transfer price.
- 3) Where no external market exists for the intermediate product, transfers should be made at two-part transfer pricing basis.
- 4) Where an imperfect market for intermediate product and a *small no. of products, transactions are involved*, a negotiated transfer pricing is most suitable method.
- 5) Where a cost-based transfer prices are used standard costs, and not the actual costs, per unit of output should be used. If actual costs are used the selling division will be able to pass on the cost of any inefficiency to the buying division. Using standard costs ensures that costs of inefficiencies are borne by the selling division.

Multinational Transfer Pricing and Maximization of income through transfer pricing mechanism :

Transfer Pricing Policies of domestic companies forecast on "Goal Congruence" and "Motivation". In Multinational companies other factors may dominate, e.g.; Transfer Prices are used to minimize world wide "Income Tax" and "Import Duties".

Many organizations have divisions located in different countries. Deciding on a set of transfer prices to use for exchange between these divisions requires consideration of additional factors. These factors are -

- 1) Income Tax Rates: Items produced by divisions in a low Income tax rate country may be transferred to a division of a high Income tax Rate country at a high transfer price to minimize taxes.
- 2) Import Duties: Sometimes Income tax effect is offset by Import Duty. Products may be transferred into high duty countries at an artificially low transfer price so that, assuming duty is charged *ad valorem*, the duty paid will be low.
- 3) Income repatriation: Some countries restrict the repatriation of incomes or dividends. By increasing the price of goods or services transferred into divisions in these countries, firms can increase the funds repatriated out of these countries without violating income or dividend, restriction.
- 4) Inflation: It is possible to avoid an accumulation of fund in a country from which high inflation rates or where an early devaluation is thought to be a probability.

5) Penetrating a new market: Transfer prices may be set low for an affiliate that is trying to establish a competitive advantage over a local company.

Question 1: In transfer pricing what is common conflict between a division and the company as a whole.

OR

(6 Marks) May/97

“Transfer pricing is a widely debated and contested topic” – Discuss

(5Marks) Nov./99

Ans.: Usually a conflict between a division of the company and the company as a whole is faced by the management of decentralized units when products or services are exchanged among different divisions of the company. Such a conflict becomes more significant in the case of those concerns where profitability is used as criteria for evaluating the performance of each division.

The essence of decentralisation is reflected in the freedom to make decisions. Under such set up it is expected that the top management should not interfere with the decision making process of its subordinates heading different units. In other words, management of decentralized units is given autonomy with regard to decision-making. In this system top management is expected to preserve ‘autonomy in decision making’. The management of such companies also expects that each division should not only achieve its own objective necessary for evaluating the performance but should also achieve the objective of goal congruence.

A divisional head in a company under aforesaid set up is free to use a price as a transfer price for goods and services, which may provide incentive. Such a transfer price may fail to achieve the objective of ‘Goal congruence’ (which means a perfect congruence between division’s goal and the goal of the company). In case of failure of a division to achieve the objective of ‘goal congruence’ the management of the company may ‘dictate their ‘transfer price’. Such an interference of management of the company is usually the main basis of conflict between a division and the company as a whole.

Further this conflict is aggravated if the management advocates the transfer of goods and services at cost. As such the transfer price will not reflect a good picture about the performance of the transferring division. The profitability of the transferring division will not be known by the use of such a transfer price.

Each division appreciates the transfer of its goods/services at usual selling price/market price so as to arrive at the correct return/profitability figure, used for measuring the performance. There is no incentive to the transferring division if goods and services are transferred at variable cost.

Question 2: Enumerate and briefly explain any three methods of determining transfer price.

(6 Marks) May/98

Question 3: What should be the basis of transfer pricing, if unit variable cost and unit selling price are not constant?

(4 Marks) Nov./99

Ans.: If unit variable cost and unit selling price were not constant then the main problem that would arise while fixing the transfer price of a product would be as follows:

There is an optimum level of output for a firm as a whole. This is so because there is a certain level of output beyond which its net revenue will not rise. The ideal transfer price under these circumstances will be that which will motivate these managers to produce at this level of output.

Essentially, it means that some division in a business house might have to produce its output at a level less than its full capacity and in all such cases a transfer price may be imposed centrally.

Question 4: What will be the marketable transfer pricing procedure regarding the goods transferred under the following conditions (each condition is independent of the other)?

(i) When division are not captives of internal divisions and the divisions are free to do business both internally and externally and when there are reasonably competitive external markets for the transferred products.

(ii) If the external market for the transferred good is not reasonably competitive. (3 Marks) Nov./00

b) Discuss the potential for maximization of income by a multinational through the use of transfer pricing mechanism. (3 Marks) Nov./00

Question 5: Indicate the possible disadvantages of treating divisions as profit centres. (4 Marks) Nov./01

Ans.: The Possible disadvantages of treating 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 6: What are some goals of a 'transfer-pricing' system in an organization? (4 Marks) May/06

Question 7: Briefly describe the different methods of Transfer Pricing. (4 Marks) Nov./05

Question 8:

	<i>Division A</i> ₹per unit	<i>Division B</i> ₹per unit
Variable cost	10	15
Transfer price at market value	–	20
Fixed costs	5	10
Profit	5	25
Transfer price/selling price	20	70

Division A can sell externally at ₹20 per unit or transfer internally to Division B at ₹20 per unit.

Division B receives an offer from a customer of ₹30 per unit for its final product.

Requirements

- (a) Would Division B accept the offer of ₹30 per unit given the existing transfer price?
- (b) Is this the correct decision from the company's point of view
 - (i) Division A has surplus capacity?
 - (ii) Division A is operating at full capacity?

Give proper explanations.

[Ans.: (a) No, there is a negative contribution of ₹5 per unit. (b) (i) No, co. could earn a contribution of ₹5 per unit. (b) (ii) Yes, there is a negative contribution of ₹5 per unit, There would be goal congruence and the manager of division B would not make a sub-optimal decision.]

Question 9: 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:

- (i) 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.

(ii) What would be the transfer price, if manager of Division B should be kept motivated?

(iii) 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/05

[Ans.: (i) 800 units should be sold as sale of intermediary and 200 units should be transferred to B (ii) ₹1350; (iii) Full quantity should be sold outside as intermediary]

Question 10: 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 division always works in a team of three professional consultants on each day consulting assignment. The external are to be charged a fee at the rate of ₹4500 for each consulting day. The fee represents the cost plus 150% profit mark up. The break up of the cost involved in the consultancy fee is estimated at 80% as being variable and balance is being fixed.

The textile 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 textile division intends to negotiate the transfer price for the consultancy work, the director of IT division proposed to charge the textile division at ₹4500 per consultancy day.

In respect of the consultancy work of the textiles division, IT division will be able to reduce the variable cost by ₹200 per consultancy day. This is possible in all cases of internal consultations because of the use of specialized equipment.

You are required to explain the implication 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 textile 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 ₹1584000 for engaging the services of two teams of consultants during the aforesaid period of 48 weeks.

[Ans.: (i) ₹4300 for each consulting day; (ii) ₹4300 for each consulting day for 1st team & ₹1240 for each consulting day for 2nd team i.e. ₹2770 (average of 4300 & 1240)(iii) Transfer Price should be ₹3100 (3300-200) per consulting day] (11 Marks) Nov/08-Old Course

[Hint: In part (iii) suggested answers has assumed that both teams were idle]

Question 11: PH Ltd., has two manufacturing departments organized into separate profit centers known as the Basic unit and processing unit. The Basic unit has a production capacity of 4,000 tonnes per month of chem wax but at present its sales are limited to 2,000 tonnes to outside market and 1,200 tonnes to the processing unit.

The transfer price for the year 2003 was agreed at ₹400 per tonne. This price has been fixed in line with the external wholesale trade price on 1st January, 2003. However, due to heavy competition the basic unit has been forced to reduce the wholesale trade price to ₹360 per tonne with effect from 1st June, 2004. This price, however, was not made applicable to the sales made to the processing unit of the company. The processing unit applied for revision of the price as applicable to the outside market buyers as from 1st June, 2004 but the same was turned down by the basic unit.

The processing unit refines chem. wax and packs the output known as colour-X in drums of 50 kg. each. The selling price of colour-X is ₹40 per drum. The processing unit has a potential of selling a further quantity of 16,000 drums of colour-X provided the overall price is reduced to ₹32 per drum. In that event it can buy the additional 800 tonnes of chem wax from the basic unit whose capacity can be fully utilized. The outside market will not however absorb more than the present quantity of 2,000 tonnes.

The cost data relevant to the operation are:

Particulars	Basic unit ₹	Processing unit ₹
Raw Material / tonne	70	Transfer Prices
Variable costs / tonne	140	170
Fixed costs	3,00,000	1,20,000

Required:

- i. Prepare statements showing the estimated profitability for June, 2004 for each unit and the company as a whole on the following basis:
 - (a) At 80% and 100% capacity utilization of the basic unit at a market price and transfer price to the processing unit of ₹400 per tonne.
 - (b) At 80% capacity utilization of the basic unit at the market price of ₹360 per tonne and the transfer price to the processing units of ₹400 per tonne.
 - (c) At 100% capacity utilization of the basic unit at the market price and transfer price to the processing unit of ₹360 per tonne.
- ii. Comment on the effect of the company's transfer pricing policy on the profitability of the processing unit.

[Ans.: (i) (a) At 80% ₹464000 At 100% ₹480000 (b) ₹384000 (c) ₹400000]

Question 12: Tycon Ltd. has two manufacturing departments organised 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 meter) on 1 st June 2004	3.00	Transfer Price
Variable Cost	1.20 (per metre)	80 (per bundle)
Fixed Cost (per month)	412000	100000

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 meter and the transfer price to the Processing house of ₹6 per meter.
 - (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.

[Ans.: (i) (a) At 80% ₹308000, 117500, 425500; At 100% ₹488000, 12500, 505500 (b) ₹208000, 117500, 325500 (c) ₹288000, 112500, 400500 (ii) Processing house will not be interested in buying more than 150000 metres from Textile Unit.] (11 Marks) Nov/04

Question 13: Vivek Ltd., has two manufacturing divisions AD and CD. Each division operates as an independent profit centre.

AD which produces two components BRITE and LITE has a capacity of 1,00,000 hours per annum. The annual fixed overheads of this department amounts to ₹20 lacs. The product wise variable cost data are as under:

Particulars	Brite	Lite
Direct materials	10	5
Direct labour and variable overheads	140	35
Total	150	40

The direct labour and variable overhead rate is ₹35 per hour.

AD has a permanent customer for the purchase of 15,000 units of BRITE per annum at a selling price of ₹300 per unit. The balance capacity is devoted to the production of LITE for which there is an unlimited sales potential at ₹60 per unit.

CD assembles a product known TITE by using an imported component. The annual fixed overheads of this division amount to ₹4 lakhs and the variable cost data per unit are as under:

	TITE ₹/Unit
Imported component	300
Direct materials	40
Direct labour and variable overheads (10 hours @ ₹25)	250
Total	590

The selling price of TITE is ₹700 per unit.

With a view to minimizing the dependence on imported components, the possibility of using the company's own component BRITE, which is similar to the imported component, was explored. The import substitution is possible with slight modification in the manufacture of TITE which in that case will take two extra labour hours per unit. This means an increase of ₹50 in variable costs per unit of TITE. CD envisages a production of 5,000 units per annum of TITE. You are required to present the division wise profitability and the profitability of the company as a whole on the basis of the following conditions:

- i. CD imports its requirement of 5,000 components for the manufacture of TITE.
- ii. CD stops import and substitutes BRITE by drawing 5,000 units of BRITE from AD at the market price of ₹300 per unit.
- iii. Same situation as in (ii) above except that CD gets a relief of ₹50 per unit (net transfer price to CD is ₹250 per unit) of BRITE to compensate the increased labour and variable overhead cost of CD.
- iv. CD revises its production programme to manufacture 12,000 units of TITE by drawing 10,000 units of BRITE from AD at ₹250 per unit and import the balance of 2,000 units of components at ₹300 per unit. Due to installation of additional production capacity, the annual fixed overhead of CD would increase by ₹7,70,000 In order to induce CD to the expansion programme, do you think a negotiated transfer price of ₹240 for BRITE would be agreed by AD? Give reasons and also comment on the best alternative (i) to (iv) for the company as a whole.

[Ans.: Profit of Co. in Alt I: ₹1200000; Alt II: 1300000; Alt III: 1300000; Alt IV: 1400000]

Question 14: A large public sector company has several manufacturing divisions. Two of these are AJ and DJ each of which sells most its output to customers outside the group divisions. AJ division operates at full capacity. It can in other words expand its production capacity only at an extra cost. DJ on the other hand operates at present 50% capacity.

DJ is actively seeking profitable ways to utilize its idle capacity, The management of DJ has been able to secure an order for 2,000 units of its product 'M' to be delivered over a period of a year at a price of ₹105

each. DJ can meet this deliver schedule easily and the estimated breakup of cost of this item per unit is an under.

	(₹)
Components purchased from outside Market	45
Part No.35 purchased from AJ	10
Factory variable overheads costs	28
Selling overheads variable	16
Total Cost per unit	99

Besides this, the interest charges on additional capital required for manufacture of this product will amount to ₹1,000 p.a.

DJ expects that part No.35 will be supplied by AJ. This part which is being manufactured by AJ is being sold to outside customers at ₹15 each and AJ has a market for 20,000 units of this part at this price. Even the production in excess of this quality can be sold by AJ to the outside customers at this price. The variable cost of part 35 to AJ is ₹8.50 each.

DJ on the other hand would be able to procure part 35 from outside suppliers at ₹15 each, being the same price at which AJ sells to outside. Since the payment of market price for part 35 will wipe off the profit, DJ has asked the Chief Executive of AJ to supply the part at a price of ₹10 each.

In case AJ is agreeable to supply the part to DJ, it has two alternatives namely: (a) to supply 2000 parts from its existing productive capacity by diverting supplies from outside customers or (b) to supply 2000 parts by resorting to overtime working, AJ will incur additional production costs of ₹4,000 on the output of 2,000 parts.

Discuss the effect of the following decisions on each of the manufacturing divisions as well as on the overall profitability of the company as a whole with suitable calculations:

- AJ supplies part 35 to DJ at ₹10 each.
- AJ refuses to supply part 35 at ₹10 each but agrees to supply the same at ₹15 each by diverting supplies from outside market.
- DJ produces product 'M' by using part 35 purchases from outside market at ₹15 each.
- AJ manufactures 2,000 units of the part by resorting to overtime and supplies the same to DJ at ₹15 each.

[Ans.: Profit of Co. in Alt I: ₹131000; Alt II: 131000; Alt III: 131000; Alt IV: 140000]

Question 15: S.V.Ltd. manufactures a product which is obtained basically from a series of mixing operations. The finished product is packaged in the company made Glass Bottles and packed in attractive cartons.

The company is organized into two independent divisions viz, one for the manufacture of the End product and the other for the manufacture of Glass Bottles. The product manufacturing division can buy all the bottle requirements from the Bottle manufacturing division.

The General Manager of the Bottle manufacturing division has obtained the following quotations from the outside manufacturers for the supply of empty bottles.

Volume (Empty bottles)	Total purchase value (₹)
8,00,000	14,00,000
12,00,000	20,00,000

A cost analysis of the Bottle manufacturing division for the manufacture of empty bottles reveals the following production costs.

Volume (Empty bottles)	Total cost (₹)
8,00,000	10,40,000
12,00,000	14,40,000

The production cost and sales value of the end product marketed by the product manufacturing division are as under:

Volume Bottles of end product	Total cost of end Product (Excluding cost of empty bottles ₹)	Sales value (Packed in bottles ₹)
8,00,000	64,80,000	91,20,000
12,00,000	96,80,000	127,80,000

There has been considerable discussion at the corporate level as to the use of proper price for transfer of empty bottles from the Bottle manufacturing division to product manufacturing division. This interest is heightened because a significant portion of the Divisional Manager's salary is in incentive bonus based on profit centre results.

As the corporate Management Accountant responsible for defining the proper transfer prices for the supply of empty bottles by the bottle manufacturing division to the product manufacturing division. You are required to show for the two levels of volumes of 8,00,000 and 12,00,000 bottles, the profitability by using (1) Market price and (2) Shared profit relative to the costs involved basis for the determination of transfer prices. The profitability position should be furnished separately for the two divisions and the company as a whole under each method. Discuss also the effect of these methods on the profitability of the two divisions.

[Ans.: Profitability based on cost : On 800000 bottles, Bottle Mfg Division: ₹221276; Product Mfg Division: ₹1378324; On 1200000 bottles, Bottle Mfg Division: ₹214964; Product Mfg Division: ₹1445036; Profitability based on market price : On 800000 bottles, Bottle Mfg Division: ₹360000; Product Mfg Division: ₹1240000; On 1200000 bottles, Bottle Mfg Division: ₹560000; Product Mfg Division: ₹1100000]

Question 16: A company is organized into two large Divisions. Divisions 'A' produces a component which is used by Division 'B' in making a final product. The final product is sold for ₹400 each. Division A has a capacity to produce 2,000 units and the entire quantity can be purchased by Division B.

Division A informed that due to installation of new machines, its depreciation cost had gone up and hence wanted to increase the price of the component to be supplied to Division B to ₹220. Division B, however can buy the component from the outside market at ₹200 each. The variable costs of Division A is ₹190 and fixed costs ₹20 per component. The variable costs of Division B in manufacturing the final product by using the component is ₹150 (excluding the component cost.)

Present statement indicating the position of each of the following situations separately.

- (1) If there are no alternative used for the production facilities of A, will the company benefit if Division B buys from outside suppliers at ₹200 per component?
- (2) If internal facilities of A are not otherwise idle and the alternative use of the facilities will give an annual cash operating saving of ₹30,000 to Division A, should Division B purchase the component from outside suppliers?
- (3) If there are no alternative use for the production facilities of Division A and the selling price for the component in the outside market drops by ₹15, should Division B purchase from outside suppliers?
- (4) What transfer price would you fix for the component in each of the above circumstances?

[Ans.: (i) If Component is purchased from outside, Co.'s Contribution is ₹100000 & If Component is purchased from Division A, Co.'s Contribution is ₹120000 (ii) If Component is purchased from outside, Co.'s Contribution is ₹130000 (iii) If Component is purchased from outside, Co.'s Contribution is ₹130000 (iii) When there are no alternative uses Transfer Price is ₹190, When there are alternative uses Transfer Price is ₹205 & If market price get reduced to ₹185 and there are no alternative uses, Transfer Price is ₹190]

Question 17: A company has two Division viz., LD and KD, LD operates at full capacity and KD operates at 50% Capacity.

LD produces two products, LX and LY using the same labour force for each product. The direct wage rate per production hour is ₹5. During the next year, its budgeted capacity of 42,000 direct labour hours involves a commitment to sell 6,000 kg of LY. The balance capacity will be used for the production of LX. Cost date are:

	LX	LY
Direct Materials	36	28

- (4) If department 'B' is closed down and department 'C' is able to obtain RESP at ₹6.25 per liter in exchange of the entire quantity of BYEA produced by department 'A' at the rate of 120 liters of RESP for every tonne of BYEA supplied to outside firm, will it be more profitable for the company as a whole to produce and sell POTS? Show the calculations.

[Ans.: (i) Dept. A: ₹2700000, (ii) Dept. B: ₹2700000 (iii) Dept. C: 912000 Ltrs., ₹842000 (iv) Profit under existing arrangement ₹6242000 & Profit under new arrangement ₹2455200]

Question 19 [Theoretical Transfer Price]: P Ltd. has two divisions, S and T, S transfer all its output to T, which finishes the work. Costs and revenues at various levels of capacity are as follows:

Output Units	S Costs ₹	T Net revenues (i.e. revenue minus costs incurred in T)	Profit ₹
600	600	2,950	2,350
700	700	3,250	2,550
800	840	3,530	2,690
900	1,000	3,780	2,780
1,000	1,200	4,000	2,800
1,100	1,450	4,200	2,750
1,200	1,800	4,350	2,550

Company profits are maximized at ₹2,800 with output of 1,000 units. If P Ltd. wish to select a transfer price in order to establish S and T as profit centers, what transfer price would motivate the managers of S and T together to produce 1,000 units , no more and no less?

P Ltd. wants that the transfer price should be set at ₹2.10 per unit. Comment on this proposal.

[Ans. Transfer price must be selected in the range ₹2.00 to ₹2.20 per unit(exclusive). At a transfer price of ₹2.10 any increase in output above 1000 units, or any shortfall in output below this would not only reduce the profits of the company as a whole but also the divisional profits of Divisions S and T]

Question 20 [Theoretical Transfer Price]: A Ltd. produces P by its two divisions X and Y. P is first processed in X and then in Y. X and Y are treated as profit centers. The cost value-profit structure is as given below:

Output Units	X Costs ₹	Y Net revenue ₹	Profit ₹
1000	900	4000	3100
1100	1000	4300	3300
1200	1120	4540	3420
1300	1250	4730	3480
1400	1400	4900	3500
1500	1580	5030	3450
1600	1800	5110	3310

Note: Net revenue for Y means the sale proceeds minus costs incurred in y. these costs do not include the price of transferred material chargeable by X.

Required : (a) Discuss the problem. (b) Fix and explain the optimum transfer price for A Ltd.

[Ans.: ₹1.6]

Question 21: BETAGRO Ltd. which has a system of assessment of Divisional performance on the basis of residual income has two divisions Alfa and Beta. Alfa has annual capacity to manufacture 15 lakhs Nos. of a special component which it sells to outside customers: but has idle capacity. The budgeted residual income of Beta is ₹120 lakhs while that of Alfa is ₹100 lakhs .Other relevant details extracted from the Budget of Alfa for the year are:

Sales (to outside customers) 12 lakhs unit @ ₹180per unit
Variable cost per unit ₹160

Divisional fixed cost	₹80 lakhs
Capital employed	₹750 lakhs
Cost of capital	12%

Beta has just received a special order for which it requires components similar to the ones made by Alfa. Fully aware of Alfa's unutilized capacity. Beta has asked Alfa to quote for manufacture and supply of 3,00,000 numbers of the components with a slight modification during final processing. Alfa and Beta agree that this will involve an extra variable cost of ₹5 per unit.

- (1) Calculate the transfer price which Alfa should quote to Beta to achieve its budgeted residual income.
- (2) Indicate the circumstances in which the proposed transfer price may result in a sub-optimal decision for the BETAGRO group as a whole.

[Ans.: Minimum Transfer price to be quoted will be ₹175]

[Hint: Residual Income is the net operating profit after taxes on an investment center in excess of its required profit. Residual Income = NOPAT – Cost of Capital × Investment]

Question 22: AB Ltd. manufactures foam, carpet and upholstery in its three divisions. Its operating statement for 2001-02 showing the performance of these divisions drawn for the use of arrangement is reproduced below: (₹'000)

Particulars	Manufacturing Divisions			Total
	Foam	Carpets	Upholstery	
Sales revenue	1600(A)	1200	1200	4000
Manufacturing costs				
Variable	1200	700	680	2580
Fixed (Traceable)	-	100	20	120
	1200	800	700	2700
Gross profit	400	400	500	1300
Expenses				
Administration	134	116	172	422
Selling	202	210	232	644
	336	326	404	1066(B)
Net Income	64	74	96	234
Division's Ranking	3 rd	2 nd	1 st	

- (A) Sales include foam transferred to the upholstery division at its manufacturing cost ₹2,00,000.
- (B) Common expenses of ₹1,30,000 and ₹1,00,000 on account of administration and selling respectively stand apportioned to these divisions at 10% of gross profit in case of administration and 2.5% of sales in case of selling expenses. Rest of ₹8,36,000 of the expenses are traceable to respective divisions.

The manager of the foam division is not satisfied with the above approach of presenting operating performance. In his opinion his division is best among all the divisions. He requests the management for preparation of revised operating statement using contribution approach and showing internal transfer at market price.

You are required to:

- (a) Draw the revised operating statement using contribution approach and pricing the internal transfer at market price.
- (b) Compute relevant ratios to show comparative profitability of these divisions and rank them in the light of your answer at (a) above. Further, offer your comments on the collection of the manager of foam division.
- (c) State why the contribution approach and pricing of internal transfers at market price are more appropriate in realistic assessment of the performance of various divisions. (19 Marks) May/96

[Ans.: (a) Net Income ₹('000)234; (b) Contribution margin ratio Foam 28.57%, Carpet 41.67% , Upholstery 36.67% Net contribution ratio & ranking Foam 13.33%(I) Carpets 12%(II) and Upholstery 8%(III)]

Question 23: Your company fixes the inter-divisional transfer prices for its products on the basis of cost, plus a return on investment in the division. The Budget for Division A for 1998-99 appears as under:
Investment in Division A

	₹
Fixed Assets	5,00,000
Current Assets	3,00,000
Debtors	2,00,000
Annual fixed cost of the division	8,00,000
Variable cost per unit of product	10

Budgeted volume 4,00,000 units per year
Desired ROI 28%
Determine the transfer price for Division A.

[Ans.: ₹12.70]

Question 24: A Company has two Divisions, Division 'A' and Division 'B'. Division 'A' has a Budget of selling 2,00,000 Nos. of a particular component 'x' to fetch a return of 20% on the average assets employed. The following particulars of Division 'A' are also known:

Fixed Overhead	₹5 lakhs
Variable Cost	₹1 per unit
Average Assets	
Sundry Debtors	₹2 lakhs
Inventories	₹5 lakhs
Plant & equipments	₹5 lakhs

However, there is constraint in Marketing and only 1,50,000 units of the component 'x' can be directly sold to the Market at the proposed price.

It has been gathered that the balance 50,000 units of component 'x' can be taken up by Division 'B'. Division 'A' wants a price of ₹4 per unit of 'x' but Division 'B' is prepared to pay ₹2 per unit of 'x'.

Division 'A' has another option in hand. Which is to produce only 1,50,000 units of component 'x'. This will reduce the holding of assets by ₹2 lakhs and fixed overhead by ₹25,000.

You are required to advise the most profitable course of action for Division 'A'. (15 Marks) Nov./97

[Ans.: Sell 150000 units in market and transfer 50000 units to Division B as Division A's Profit and ROCE is increased by ₹25000 and 0.75% respectively]

Question 25: A company is organized on decentralized lines, with each manufacturing division operating as a separate profit centre. Each division manager has full authority to decide on sale of the division's output to outsiders and to the other divisions.

Division C has always purchase its requirement of a component from Division A. But when informed that division was increasing its selling price to ₹ 150, the manager of Division C decided to look at outside suppliers.

Division C can buy the component from an outside supplier for ₹ 135. But Division A refuses to lower its price in view of its need to maintain its return to the investment.

The top management has the following information:

C's annual purchase of the component	1000 units
A's variable cost per unit	₹ 120
A's fixed cost per unit	₹ 20

Required:

- (i) Will the company as a whole benefit, if Division C bought the component at ₹ 135 from an outside supplier?
- (ii) If A did not produce the material for C, it could use the facilities for other activities resulting in a cash operating savings of ₹ 18000. Should C then purchase from outside source?
- (iii) Suppose there is no alternative use of A's facilities and the market price per unit of the component drops by ₹ 20. Should C now buy from outside? (13 Marks) Nov/98

[Ans.: (i) The co. as a whole will not benefit as it will be required to incur an additional cost of ₹15000; (ii) It is advisable that Division C should purchase the component from outside sources as the decision will benefit the company by ₹3000; (iii) It is advisable that the Division C should buy the component from outside as the decision will benefit the company by ₹5000]

Question 26: City Instrument Company (CIC) consist of the Semi- conductor Division and the Mini-computer Division, each of which operates as an independent profit centre. Semi-conductor Division employs craftsmen, who produce two different electronic components, the new- high performance Super chip and an old product called Okay-chip. These two products have the following cost characteristics:

	Super-chip		Okay-chip	
Material	Parts	₹ 20	Parts	₹ 10
Labour	2 hours x ₹ 140	280	1/2 x ₹ 140	70

Annual Overhead in Semi-conductor Division is ₹ 4000000 all fixed. Owing to high skill level necessary for the craftsmen, the Semi-conductor Division's capacity is set at 50000 hours per year.

To date, only one customer has developed a product utilizing super-chip, and this customer orders a maximum of 15000 super-chips per year at a price of ₹ 600 per chip. If CIC can not meet his entire demand, the customer curtails his own production. The rest of the semi-conductor's capacity is devoted to Okay-chips, for which there is unlimited demand at ₹ 120 per chip.

The Mini-computer Division produces only one product, a process control unit, which requires a complex circuit board imported at a price of ₹ 600. The control unit's cost are:

	Control Unit	
Material	Circuit board	₹ 600
	Other parts	80
Labour	5 hours @ ₹ 100	500

The Mini-computer Division is composed of only a small assembly plant and all overhead is fixed at a total of ₹ 800000 per year. The current market price for the control unit is ₹ 1400 per unit.

A joint research project has just revealed that with minor modifications, a single super-chip could be substituted for the circuit board currently used by the Mini- computer division. The modification would require an extra one hour of labour by Mini-computer's staff, for a total of 6 hour per control unit. Mini-computer has therefore asked Semi-conductor division to declare a transfer price at which Semi-conductor division would sell super-chip internally.

Required:

- (i) Mini-computer expects to sell 5000 control units this year. From the overall view point of CIC, how many super-chips should be transferred to Mini-computer Division to replace circuit boards?
- (ii) If the demand for the control units is sure to be 5000 units, but its price is uncertain, what should be the transfer price of super-chip to ensure proper decisions? (All other data unchanged.)
- (iii) If demand for the control unit rises to 12000 units at a price of ₹ 1400 per unit, how many of 12000 units should be built using super-chip? (All other data unchanged.) (13 Marks) Nov/00

[Ans.: (i) 5000 units (ii) ₹460; (iii) 10000 units]

Question 27: A Company is engaged in the manufacture of edible oil. It has three division as under:

- (i) Harvesting oil seeds and transportation therefore to the oil mill.
- (ii) Oil Mill, which process oil seeds and manufactures edible oil.
- (iii) Marketing Division, which packs the edible oil in 2 kg. containers for sale at ₹ 150 each container.

The Oil Mill has a yield of 1000 kgs. of oil seeds during a period. The Market Division has a yield of 500 cans of edible oil of 2 kg. each from every 1000 kg. of oil. The net weight per can is 2 kg. of oil. The cost data for each division for the period are as under:

Harvesting Division:

Variable cost per kg of oil seed	₹ 2.50
Fixed cost per kg. of oil seed	₹ 5.00

Oil Mill Division:

Variable cost of processed edible oil	₹ 10.00 per kg.
Fixed cost of processed edible oil	₹ 7.50 per kg.

Marketing Division:

Variable cost per can of 2 kg of oil	₹ 3.75
Fixed cost per can of 2 kg of oil	₹ 8.75

The fixed cost are calculated on the basis of estimated quantity of 2000 kg of oil seeds harvested, 1000 kg of processed oil and 500 cans of edible oil packed by the aforesaid divisions respectively during the period under review.

The other oil mills buy the oil seeds of the same quality at ₹ 12.50 per kg. in the market. The market price of edible oil processed by the oil mill, if sold without being packed in the marketing division is ₹ 62.50 per kg of oil.

Required:

- (i) Compute the overall profit of the company of harvesting 2000 kg of oil seeds, processing it into edible oil and selling the same in 2 kg cans as estimated for the period under review.
- (ii) Compute the transfer prices that will be used for internal transfer from
 - (1) Harvesting Division to Oil Mill Division and
 - (2) From Oil Mill Division to Marketing Division
 under the following pricing methods:
 - (1) Shared contribution in relation to variable cost; and
 - (2) Market price.
- (iii) Which transfer pricing method will each divisional manager prefer to use? (12 Marks) May/01

[Ans.: (i) ₹36250; (ii) (1) ₹66667 (2) ₹62500; (iii) Harvesting Division Manager-Market Price method, Oil Mill Division Manager shared contribution method, Marketing Division Manager-Market Price Method]

Question 28: The two manufacturing divisions of a company is organized on profit centre basis. Division X is the only source of a component required by Division Y for their product P. Each unit of P requires one unit of the said component. As the demand of the product is not steady, orders for increased quantities can be obtained by manipulating prices. The manager of Division Y has given the following forecast:

Sales per day (units)	Average price per unit of P (₹)
5,000	393.75
10,000	298.50
15,000	247.50
20,000	208.50
25,000	180.00
30,000	150.75

The manufacturing cost (excluding the cost of the component from Division X) of P in Division Y is ₹ 1406250 on first 5000 units and ₹ 56.25 per unit in excess of 5000 units.

Division X incurs a total cost of ₹ 562500 per day for an output up to 5000 components and the total cost will increase by ₹ 337500 per day for every additional 5000 component manufactured. The manager of Division X has set the transfer price for the component at ₹ 90 per unit to optimize the performance of his Division.

Required:

- (i) Prepare a divisional profitability statement at each level of output, for division X and Y separately;
- (ii) Find out the profitability of the company as a whole at the output level where:
 - (a) Division X's net profit is maximum;
 - (b) Division Y's net profit is maximum.
- (iii) Find out at what level of output, the company will earn maximum profit, if the company is not organized on profit centre basis. (15 Marks) May/02

[Ans.: (i) At 30000 components profitability of X ₹450000, loss of Y ₹990000 (ii) Operating Loss of the company X ₹540000, Profitability of Company Y ₹397500; (iii) Maximum profit will be attained if 15000 components are produced.]

Question 29: Division Z is a profit centre, which produces four products – A B C and D. each product is sold in the external market also. Data for the period as follows:

	A	B	C	D
Market Price Per Unit	₹ 150	₹146	₹ 140	₹ 130
Variable Cost of Production Per Unit	₹ 130	₹ 100	₹ 90	₹ 85
Labour Hours Required Per Unit	3	4	2	3

Production D can be transferred to division Y, but the maximum quantity that might be required for transfer is 2500 units of D.

The maximum sales in the external market are:

A	2800 units
B	2500 units
C	2300 units
D	1600 units

Division Y can purchase the same product as a slightly cheaper price of ₹ 125 per unit instead of receiving transfers of product D from division Z.

What should be the transfer price for each unit for 2500 units of D, if the total labour hours available in division Z are:

- (i) 20000 hours?
- (ii) 30000 hours? (13 Marks) May/00

[Ans.: Transfer Price per unit ₹118.34; (ii) Transfer Price per unit ₹99.13]

Question 30: Division A is a profit centre which produces three products X, Y and Z. Each product has an external market.

Products	X	Y	Z
	₹	₹	₹
External market price per unit	48	46	40
Variable cost of production p.u. in division A	33	24	28
Labour hours required per unit in division A	3	4	2

Product Y can be transferred to Division B, but the maximum quantity that might be required for transfer is 300 units of Y.

The maximum external sales are:

X 800 units Y 500 units Z 300 units

Instead of receiving transfers of product Y from Division A, Division B could buy similar product in the open market at a slightly cheaper price of ₹45 per unit.

What should the transfer price be for each unit for 300 units of Y, if the total labour hours available in Division A are:

- (a) 3,800 hours
- (b) 5,600 hours

[Ans.: (a) ₹44 (b) ₹34]

Question 31: Department x is a profit centre manufacturing products Vx, X and Xt. Each of the products can be sold in the outside market to the extent of the following:

Vx	900 units
X	300 units
Xt	600 units

Market price per unit is ₹ 24, ₹ 23, and ₹ 20 for Vx, X and Xt respectively. Other details are given below:

	Vx	X	Xt
	₹	₹	₹
Variable cost of production p.u.	17	12	14
Labour hours required	3	2	4

Product Vx can be transferred to department y, but the maximum quantity that might be required for transfer is 400 units of Vx. The Manager of department y has powers to buy the product Vx from the external market at a much cheaper price of ₹ 22.

What should be the transfer price for each unit for 400 units of Vx, if the total labour hours available in department X is:

- (a) 4800 hours
- (b) 6200 hours?

(12 Marks) Nov/03

[Ans.: (a) ₹21.50 (b) ₹19.625]

Question 32: 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?

[Ans.: (i) It will be beneficial for the company as whole to buy component from Division X (ii) & (iii) It is beneficial to buy component from outside. (iv) Transfer price (a) ₹256.50 per component, (b) ₹276.75 per component, (c) ₹256.50 per component.] (12 Marks) Nov/05

Question 33: Fasteners Ltd. is having production shops reckoned as cost centres. Each shop charges other shops for material supplied and services rendered.

The shops are motivated through goal congruence, autonomy and management efforts. Fastner Limited is having a welding shop and painting shop. The welding shop welds annually 75,000 purchased items with other 1,50,000 shop made parts into 12,000 assemblies. The assemblies are having variable cost of ₹9.50 each and are sold in market at ₹12 per assembly. Out of the total production, 80% is diverted to painting shop at same price ruling in the market. Welding shop incurs a fixed cost of ₹25,000 per annum. The painting shop is having fixed cost of ₹30,000 and its cost of painting including transfer price from welding shop comes to ₹20 per unit. This shop sells all units transferred to it by welding shop at ₹25 per assembly.

You are required to:

- Find out profit of individual cost centres and overall profitability of the concern.
- Recommend course of action if painting shop wishes to purchase its full requirement (at market price which is ₹10 per assembly) either from open market or from welding shop at market price of ₹10 per assembly.

Give reasons for your recommendations

[Ans.: (a) Overall profit for the company (₹5,000 + ₹18,000) = ₹23,000]

[Hint: Suggested answers has assumed that welding shop can sell only 20% of whole production to outside market]

Question 34: Division A of Better Margins Ltd. has been given a budgeted target of selling 2,00,000 components COM 21, it manufactures at a price which would fetch a return of 25% on the average assets employed by it. The following figures are relevant:

Fixed overhead	₹4,00,000
Variable cost	₹1 per unit
Average assets:	
Sales debtors	2,00,000
Stocks	6,00,000
Plant and other assets	4,00,000

However, the marketing department of the company finds out by a survey that the maximum number of COM 21, the market can take, at the proposed price is only 1,40,000 units.

Fortunately Division B is willing to purchase the balance 60,000 units. The Manager, Division A is willing to sell to Division B at a concessional price of ₹4 per unit. But the Manager, Division B is ready to pay ₹2.25 only per unit, as he feels he can himself make COM 21 in his Division at that price.

Rather than sell to Division B at ₹2.25, the Manager, Division A feels he will restrict the activity of his Division to the manufacture and sale of 1,40,000 components only. By this, he could reduce ₹80,000 in stocks, ₹1,20,000 of plant and other assets and ₹40,000 in selling and administration expenses.

As a Cost Accountant, you are asked to work out the various computations and show that selling 60,000 COM 21 to Division B at ₹2.25 per unit would be in the interest of the organization.

Question 35: A boatyard is divided into three profit centers whose managers are rewarded according to results. Transactions between these profit centres are frequent.

Sales centre (S) buys and sells new boats.

If it needs to take part-exchange from a customer in order to sell a new boat, it transfers the part-exchanged boat to B at an agreed price.

Brokerage (B) buys and sells second-hand boats:

- (i) in part-exchange from S (B names the price at which it can buy a comparable boat that is in a suitable condition for resale to an end-user customer, but deducts the likely cost of repairs) and
- (ii) from other sources, on a normal trading basis.

Repairs (R) does repairs for

- (i) B (to put boats into saleable condition) and
- (ii) other customers.

The following situation arises:

S can sell to a customer for ₹35,000 a new boat which would cost ₹29,000. To do so, it needs to offer ₹16,000 in part-exchange for the customer's old boat. However, the customer's boat is estimated by R to need repairs that will cost:

Materials	₹300
Labour	60 hours at ₹15 per hour

B can buy for ₹15,000 a boat comparable to the one being offered by the customer in part-exchange but which needs no repair. B could then sell that boat for ₹19,000.

Other data:-

R's labour rate per hour is made up as follows: ₹

Variable cost	6.00
Fixed cost	4.50 (based on 20,000 budgeted hours p.a.)
Profit	<u>4.50</u>
	15.00

- 45% of R's time is reserved for work from B
- Annual fixed cost is budgeted at:
 - S ₹70,000
 - B ₹80,000

You are required, in relation to the above situation, to set out the contribution to profit for each profit centre that would result:

- (i) assuming that all estimates and budgets materialized as expected,
- (ii) assuming that all estimates and budgets materialized as in (i), except that the repairs undertaken by R took an extra 10 hours and ₹100 of materials due to a problem not noticed by B or R.

[Ans.: (i) Contribution ₹540 (ii) Increased contribution ₹630]

Question 36: A company is organized on decentralized lines, with each manufacturing division operating as a separate profit centre. Each division manager has full authority to decide on sale of division's output to outsiders or to other divisions. Division AB manufactures a single standardised product. Some output is sold externally and remaining is transferred to division XY where it is a sub-assembly in the manufacture of the division product. The unit cost of division AB product and division XY is as follows:

	Division AB (₹)	Division XY (₹)
Transfer from division AB to XY	-	42.00
Direct material	6.00	35.00
Direct labour	3.00	4.50
Direct expenses	3.00	-
Variable manufacturing overheads	3.00	18.00
Fixed manufacturing overheads	6.00	18.00
Variable selling and packing expenses	<u>3.00</u>	<u>2.50</u>
	<u>24.0</u>	<u>120.00</u>

Division AB sold 40,000 units annually at the standard price of ₹45 in external market. In additions to the external sales, 10,000 units are transferred annually to division XY at internal price of Rupees 42 per unit. Variable selling and packing expenses are not incurred by supplying division for the internal transfer of the product. Division XY incorporates the transferred goods into more advance product. The manager of division XY disagrees with the basis used to set the transfer price. He argues that transfer price should be made at

variable cost since he claims that his division is taking output that division AB should be unable to sell at price ₹45.

He also submitted a report of the relationship between selling price and demand to support of his disagreement. The report of customer demand at various selling prices for division AB and for division XY is as follows:

Division AB			
Selling price per unit (₹)	30	45	60
Demand (Units)	60,000	40,000	20,000
Division XY			
Selling price per unit (₹)	120	135	150
Demand (Units)	15,000	10,000	5,000

The company has sufficient capacity to meet demand at various selling prices. Internal transfer demanded units will be decided by XY division.

Required:

- To calculate divisional profitability and overall profitability of company if division AB transfers demanded units to XY at price of ₹42.
- To calculate divisional profitability and overall profitability of company if division AB transfers demanded units to XY at variable cost.
- In place of internal transfers, AB division can sell 10000 units of their product in new external market without effecting existing market, at price ₹32 per unit and XY division can purchase these units at the rate of ₹31 in open market. Calculate company's profit by following above strategies.

[Ans.: (a) Profitability- Div. AB: ₹900000, Div. XY: ₹60000, Cos.: ₹960000; (b) Profitability: Div. AB: ₹6300000, Div. XY: ₹405000, Cos.: ₹1035000] (12 Marks) June/09[Old Course]

[Note: Suggested answers of ICAI has wrongly taken Total Contribution as Total Profit & has forgotten to subtract fixed costs while making profitability statement. Part (iii) is wrongly solved by suggested answers of ICAI.]

Question 37: Division A of a large divisionalised organization manufactures a single standardized product. Some of the output is sold externally whilst the remainder is transferred to Division B where it is a sub-assembly in the manufacture of that Division's product. The unit cost of Division A's product are as follows:

	(₹)
Direct Material	4
Direct Labour	2
Direct expenses	2
Variable manufacturing overheads	2
Fixed manufacturing overheads	4
Selling and packing expenses- Variable	1
Total	15

Annually 10,000 units of the product are sold externally at the standard price of ₹30. In addition to the external sales, 5,000 units are transferred annually to Division B at an internal transfer charge of ₹29 per unit. This transfer price is obtained by deducting variable selling and packing expenses from the external price since these expenses are not incurred for internal transfers.

Division B incorporates the transferred goods into a more advanced product. The unit costs of the product are as follows:

	(₹)
Transferred in item (from Division A)	29
Direct material and components	23
Direct labour	3
Variable overheads	12
Fixed overheads	12
Selling and packing expenses- Variable	1
Total	80

Division B's manager disagrees with the basis used to set the transfer price. He argues that the transfer should be made at variable cost plus an agreed (minimal) mark-up since he claims that his division is taking output that Division A should be unable to sell at the price of ₹30.

Partly because of this disagreement, a study of the relationship between selling price and demand has recently been made for each division by the company's Sales Director. The resulting report contains the following table:

Customer demand at various selling prices:

Division A			
Selling price (₹)	₹20	₹30	₹40
Demand (units)	15,000	10,000	5,000
Division B			
Selling price (₹)	₹80	₹90	₹100
Demand (units)	7,200	5,000	2,800

The Manager of Division B claims that this study supports his case. He suggests that a transfer price of ₹12 would give Division A a reasonable contribution to its fixed overheads while allowing Division B 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's profits.

You are required to:

1. Calculate the effect of the transfer pricing system on the company's profits, and
2. Establish the likely effect on profits if adopting the suggestion by the Manager of Division B for a transfer price of ₹12.

ICWA-Dec./92

[Ans.: 1. Profit for the company as a whole from the sale of the final product are reduced from ₹223200 (7200 units) to ₹205000 (5000 units) 2. Apart of Contribution of ₹190000 from sale of intermediate product to the external market, contribution of Division A is ₹14400 and of Division B is ₹208800.]

[Hint: Assume that the company has sufficient capacity to meet demand at various selling prices]

Profitability analysis (Strategy-based questions)

Question 38: Optical 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 ₹/ 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 Divisions P and Q.
- ii) Briefly explain the concept of goal congruence.

(12 Marks) Nov./09-N.C.

[Ans.: (i) Division P should sell 3000 units in market and transfer 4000 units to Division Q and Division Q should buy 1000 units from market]

Question 39: 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 ₹Per Unit	Division B ₹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/08

[Ans.:(i) Sell 18000 units in market and 2000 units to B. Total Contribution ₹1034000 (ii) 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 (iii) 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 $32,28,000 - 29,94,000 = ₹ 2,34,000$]

Question 40: AB Ltd. has two divisions, A and B, making products A and B respectively. One unit of A is an input for each unit of B. B has production capacity of 45,000 units and ready market for 45,000 units in both the years 2010 and 2011. Other information available:

Division A	Year	
	2010	2011
Capacity (production units)	50,000	50,000
Maximum demand in usual external market (units)	25,000	30,000
Special order (units) (to be fully accepted or fully rejected)	10,000	15,000
Fixed Cost ₹/ annum upto 30,000 units (Beyond 30,000 units, fixed cost increases by ₹1,00,000 for every additional 10,000 units for each year)	4,30,000	4,30,000
Variable manufacturing cost ₹/unit	35	35

Variable selling cost ₹/unit (only for usual external sales)	10	10
Variable selling cost ₹/unit (only for special order and transfer to B)	5	5
Selling price (usual external market) ₹/ unit	65	65
Selling Price (only special order) ₹/unit	55	55

B buys input A from outside at a slightly incomplete stage at ₹30 per unit and incurs sub-contract charges at ₹20 per unit to complete it to a stage to match the output of Division A. In 2011, subcontract charges will increase to ₹30 per unit. B is willing to pay A, the price if incurs viz. ₹50 and ₹60 per unit in 2010 and 2011 respectively, provided A supplies B's full requirement. For any lesser quantity, (B will accept any quantity), B is willing to pay A only ₹45 and ₹55 per unit in 2010 and 2011 respectively. Assume no changes in inventory levels. In 2011, A may choose to avoid the variable selling overhead of ₹5 per unit on transfers to B or special order by incurring a fixed overhead of ₹50,000 p.a. instead.

- What will be the maximum profits of A under its best strategy in 2011?
- In view of the company's overall interest, calculate the customerwise units to be produced by A in 2010.
- Assuming that A follows its best strategy between what values of transfer price will B be able to negotiate with A, so that A's best strategy is unchanged in 2011. (15 Marks) May/10-O.C.

[Ans.: (i) Transfer 45000 units to B, Usual sales in external market 5000 units & incurring special fixed cost to save variable selling costs; A's Profit ₹545000; (ii) Usual Sales: 25000 units, Special order: 10000 units; Division B: 15000 units. Alternatively, Usual Sales: 25000 units, Special order: 10000 units; Division B: 5000 units. But 1st alternative is recommended; Total Contribution of A & Savings of B = ₹170000; (iii) ₹57.78]

[Note: Suggested answer of ICAI has erroneously solved part (ii) for Year 2011 instead of 2010. Coincidentally units are same.]

Question 41: XYZ Ltd. has two divisions, A and B. Division A makes and sells products 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 variables 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:

- (i) Evaluation of the best strategy for A in the present condition.
 (ii) 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/09-N.C.

[Ans.: (i) Best strategy is to sell maximum units to outside market from which contribution is ₹70,800; (ii) ₹192.20 per unit.]

Question 42: 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 material A for Divisions B and C)	4	15	20	₹/u
Direct labour	2	3	4	₹/u
Variable overhead	1	1	1	₹/u
Selling price to outside customers	15	40	50	₹/u
Existing Capacity	5,000	2,500	2,500	(No. of units)
Maximum External demand	3,750	5,000	4,000	(No. of units)
Additional fixed costs that would be incurred to install additional capacity	24,000	6,000	18,750	₹
Maximum Additional units that can be produced by additional capacity	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 ₹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/09-N.C.

[Ans.: B will not pay A more than ₹13, C should purchase all units from A at ₹13. A should make 10,000 units viz. Outside: 3750 units, To B: 3750 units, To C: 2500 units; Sales by B – 3750 units, Sales by C – 2500 units; Individual strategy is best strategy of the co.]

[Note: Division A is having spare capacity & it has to set TP for its best strategy. Its best strategy will be to charge anything equivalent or above incremental cost p.u. i.e. ₹7 p.u. for 1st 1250 units transferred & ₹11.80 for additional 5000 units transferred. But when considering best strategies of B & C, maximum TP Division B is ready to pay is ₹13 p.u. (15-2) & ₹16 p.u. (15+1). Hence A can fix any transfer price uniformly within range ₹11.80-₹13, but since Division A is setting TP, it is assumed that it will charge maximum TP i.e. ₹13 p.u. Alternate assumptions exists & are equally good]

Question 43: 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./08-N.C.

[Ans.: Y will sell to Z only if X sells to Y at ₹70 per unit and Y will supply to Z maximum 4000 units]

Question 44: M Ltd. makes two products, X and Y, in their respective divisions. Each unit of Y needs one unit of X. Divisions X and Y are profit centres and can function according to their divisional interests.

In the external domestic market, X can sell either 6000 units at ₹1,000 per unit or 5000 units at ₹1,120 per unit.

X has a production capacity of 7000 units, with each unit requiring 2 hours. Y also has a production and demand of 7000 units.

Y can buy product X from outside as follows:

Order Quantity (Units)	Price for the entire order (₹/u)
6001-7000	900
4001-6000	920
2001-4000	1,000
0-2000	1,120

Y resorts to bulk purchase to avail maximum possible discount.

(i) There is an export order (that may either be fully accepted or fully rejected) for X to supply 800 units @ ₹900 per unit.

(ii) There is an offer to hire out X's capacity of 1600 hours at ₹130 per hour. The hiring offer may either be fully accepted or fully rejected.

(iii) Y will not buy from X at any price more than it will incur in the outside market. Y does not place restrictions on quantities to be supplied by X, provided its pricing condition is not violated.

Given that any one or more of the offers may be accepted, what will be X's best strategy?

What will be the corresponding transfer price?

[A detailed cost statement is not essential. Only figures relevant for decision making are required to be considered under each analysis.] (9 Marks) Nov./10-O.C.

[Ans.: Best strategy for X is to sell externally 5000 units @ ₹1120 p.u. & transfer 2000 units to Y at max. T.P. of ₹920 p.u.]



Decision Making

RELEVANT COSTING & DIFFERENTIAL COSTING

A decision model is a format method of making choice, and it often involves both quantitative and qualitative analyses. Management accountants work with managers by analyzing and presenting relevant data to guide decisions.

Incremental Costing: (CIMA's Official terminology) It is a technique used in the preparation of ad hoc information where consideration is given to a range of graduated or stepped changes in the level or nature of activity, and the additional costs and revenues likely to result from each degree of change are presented.

Remember, *Incremental cost* is the additional total cost incurred for an activity & *Differential cost* is the difference in total cost between two alternatives. Sometimes these terms are used interchangeably in practice. Similarly incremental revenues and differential revenues can be defined in terms of revenue.

Opportunity cost is a measure of the benefit of opportunity forgone when various alternatives are considered. It is the benefit foregone or rejected by not using a limited resource in its next-best alternative use. It is the prospective change in cost following the adoption of an alternative machine, process, raw materials, specification or operation. The lost opportunity is a cost that the manager must take into consideration when making a decision. For example, the (relevant) cost of going to school for an CA degree is not only the cost of tuition, books, etc. but also the income forgone (opportunity cost) by studying rather than working.

Quantitative & Qualitative Relevant Information:

Quantitative factors are outcomes that are measured in numerical terms. Some quantitative factors are financial; they can be measured numerically, they can be expressed in monetary terms. Examples include cost of direct materials, direct labour, etc. Other quantitative factors are non-financial; they can be measured numerically, but they are not expressed in monetary terms. E.g. Increase in on time delivery from a production process, reduction in customer waiting time from a decision to invest in additional cash dispensing machine, reduction in the number of units of defective output delivered to customers arising from an investment in quality inspection, reduction in new product-development time for a manufacturing company, % of on-time flight arrivals for an airline company, etc.

Qualitative factors are outcomes that are difficult to measure accurately in numerical terms. E.g. Employee Morale, loss of customer's goodwill, etc.

Relevant Costs and Relevant Revenues

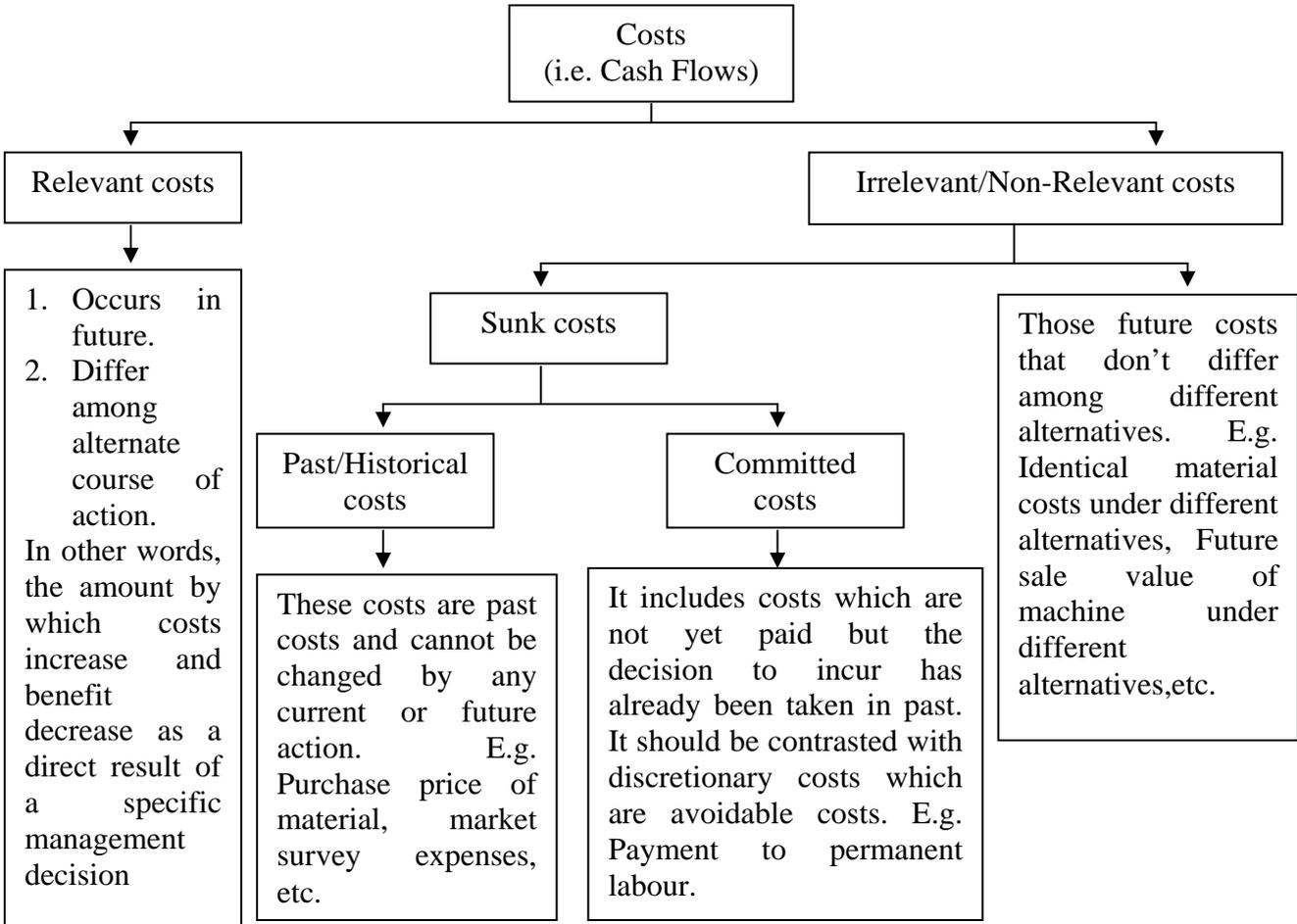
Relevant costs are expected future costs and relevant revenues are expected future revenues that differ among the alternative courses of action being considered. Be sure you understand that to be relevant costs and relevant revenues they must

- Occur in the future**-every decision deals with selecting a course of action based on its expected future results; and
- Differ among the alternative courses of action**-costs and revenues that do not differ will not matter and, hence will have no bearing on the decision being made.

Examples of costs which are not relevant are past expenditures on capital, depreciation of capital assets, accounting gains or losses on the sale of assets, and sunk costs of any type. **Sunk costs** are costs made as a result of a prior decision and are not relevant to the current decision as they cannot be altered by it.

Unfortunately, accounting profits or losses on asset disposal result from the comparison of the sunk cost involved in its purchase (less any depreciation) as compared to the revenue generated by disposal. The prospect of accounting losses on disposal of an asset are often enough to discourage a manager from making a beneficial decision to replace the asset. Idle or unused capacity also has no value in a relevant cost decision since capacity already exists due to prior decisions and will continue to exist even it remains unused. Shared facilities or production processes are not relevant where the process would occur regardless of the number of intermediate products produced (greater than one).

Remember, Expenses incurred on conducting a market survey to assess the potential market or associated with research and development activities well before the product is considered for introduction are sunk costs for a product. Further, labour payment on piece rate system is always relevant, since there is no question of payment on idle time in such cases.



Remember, Relevant costs are cash flows. This means that costs or charges which do not reflect cash spending (additional), should be ignored. Hence following shall be ignored:

- Depreciation
- Notional Rent
- All absorbed overheads – Fixed overheads absorption is always irrelevant although variable overhead costs are usually relevant (because they should be incurred at the same rate at which they are absorbed).

Question 1: "Sunk cost is irrelevant in decision-making, but irrelevant costs are not sunk costs". Explain with example. (4 Marks) May/06 & (4 Marks) Nov./09-O.C.

Ans.: 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. For example, the written down value of assets

previously purchased are sunk costs. Sunk costs are not relevant for decision making because they are past costs.

But not all irrelevant costs are sunk costs. For example, a comparison of two alternative production methods may result in identical direct 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.

Question 2: Explain with one example each that sunk cost is irrelevant in making decisions, but irrelevant costs are not sunk costs. (2 Marks) May/01

Sunk cost is a historical cost incurred in the past. In other words it is a cost resource already acquired. Further decision in respect of this resources will not be affected by it For example, book value of machinery. Hence sunk costs are irrelevant in decision making.

Irrelevant cost are not necessarily sunk costs. For example, when a comparison of two alternative production methods using the same materials quantity is made, then direct materials cost is not affected by the decision but this materials cost is not sunk cost.

Question 3: Briefly explain the concept of 'Opportunity Costs'. (4 Marks) Nov/96

Question 4: What are incremental costs and sunk costs? Discuss. (3 Marks) Nov/98

Question 5: What is meant by Incremental Revenue? (4 Marks) Nov/97

Question 6: What are relevant costs? Identify two common pitfalls in relevant cost analysis.(4 Marks) Nov /98

Ans.: Relevant costs are those expected future costs which are essential to a decision. The two key aspect of these costs are as follows :

1. They must be expected future costs.
2. They must be different among the alternative courses of action.

For example, in a decision relating to the replacement of an old machine, the written down value of the existing machine is not relevant but its sale price is relevant.

Relevant cost analysis helps in drawing the attention of managers to those elements of costs which are relevant for the decision. Two common pitfalls in relevant cost analysis are as under :-

First pitfall in relevant cost analysis is to assume that all variable costs are relevant : All variable costs are not relevant. Even among future costs, those variable costs which will not differ under various alternatives are irrelevant. For example, a company proposes to rearrange plant facilities and estimates its future costs under two alternatives, as under :

Particulars	Do not re-arrange	Re-arrange
	₹	₹
Direct material cost/unit	10	10
Direct labour cost/unit	5	4

In the above example, the direct material cost (variable cost) remains constant under both alternatives, hence it is irrelevant to the decision as to whether plant facilities are to be re-arranged or not.

Second pitfall is to assume that all fixed costs are irrelevant: All fixed costs are not irrelevant. If fixed expenses remain unchanged under different alternatives such expenses are only irrelevant to the decision at hand but if they are expected to be altered they should be considered as relevant.

For example, if the plant capacity is 50,000 units and additional 10,000 units can only be manufactured by expanding capacity which entails additional fixed expenses of ₹50,000. This increase in fixed expenses is relevant to the decision whether the firm should accept order for additional 10,000 units or not.

Question 7: Distinguish between "Marginal cost" and 'Differential Cost". (5 Marks) May/99

Ans.: Marginal cost represents the increase or decrease in total cost which occurs with a small change in output say, a unit of output. In Cost Accounting variable costs represent marginal cost.

Differential cost is the change (increase or decrease) in the total cost (variable as well as fixed) due to change in the level of activity, technology or production process or method of production.

In other words, it can be defined as the cost of one unit of product or service which would be avoided if that unit was not produced or provided.

The main point which distinguishes marginal cost and differential as that change in fixed cost when volume of production increases or decreases by a unit of production. In the case of differential cost variable as well as fixed cost. i.e. both costs change due to change in the level of activity, whereas under marginal costing only variable cost changes due to change in the level of activity.

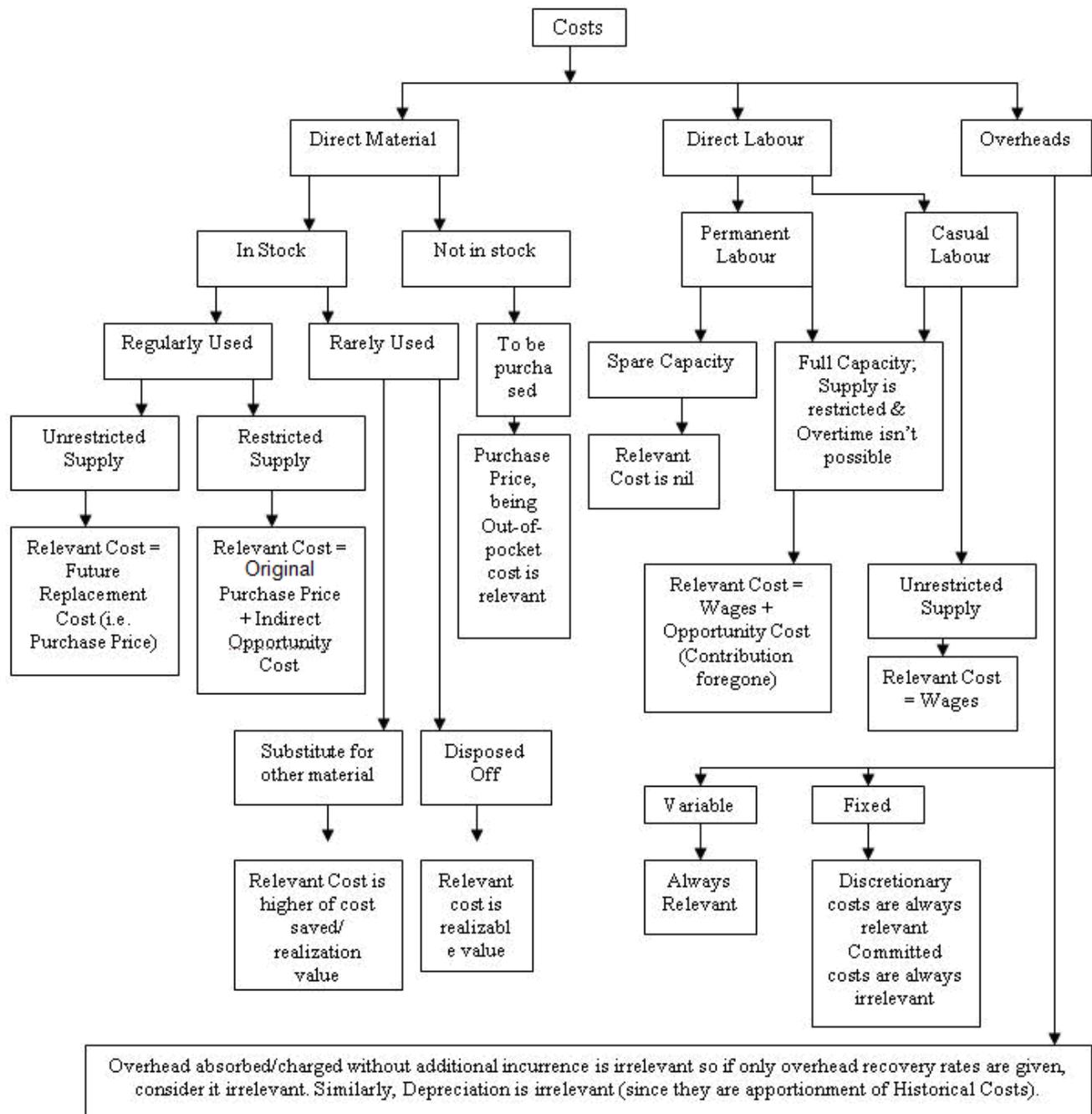
Question 8: Explain the concept of relevancy of cost by citing three examples each of relevant costs and non-relevant costs. (4 Marks) Nov./08-O.C.

Question 9: Explain the concepts of Opportunity costs and Relevant costs. (4 Marks) June/09-N.C.

Question 10: What are the applications of incremental/ differential costs? (5 Marks) May/10-N.C.

Ans.: The areas in which Application of Incremental/ differential cost techniques of cost analysis can be used for making managerial decisions are:

- Make or buy decisions.
- Dropping or adding a product line
- Whether to process a product further or not.
- Acceptance of an additional order from a special customer at lower than existing price.
- Equipment replacement decision. original
- Optimizing investment plan.



Case 1. Opportunity cost of material already purchased & having no other use in current production process and having no realizable value:- Suppose a concern was using till last year a particular type of material P under its production process. It has already purchased 5,000 kg. of material P during last year @ ₹2 per kg. and placed in its godown, This material is now not used by the concern under its current production and there is no demand of this material in the market so it is decided by the management that the concern will **either** give this material to someone free of cost **or** throw it away without incurring further cost and get its storage space free for other use. By chance the concern receives one offer to produce a product which will require exactly 5,000 kg. of this material P. What will be the opportunity cost of material required to be used for proposal under consideration?

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Case 2. Opportunity cost of material already purchased and having no other use in current production process but having realizable value:- Suppose in the above example if 5,000kg. of material P can be sold in the market @ ₹1.25.per kg. then the opportunity cost (best alternative use) of the material for the offer under consideration will be

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Case 3. Opportunity cost of material required under proposed production, only some portion thereof is held in stock out of past purchase and having no other use in current production process but having realizable value:- Suppose there is an offer to manufacture a particular product which will require 12,000 kg. of material P. It is currently available in the market @ ₹3 per kg. If the concern has already purchased 5,000 kg. of material P during last year @ ₹2 per kg. and placed in its godown . This material is now not used by the concern under its current production process, and this 5,000 kg. of material P can be sold in the market @ ₹1.25 per kg. What will be the opportunity cost of material required to be used for proposal under consideration?

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Case 4. Opportunity cost of material already purchased & having no other use in current production process and having no realizable value but can be disposed by incurring some additional cost:- Suppose a concern was using till last year a particular type of material P under its production process which is of highly toxic nature. It has already purchased 5,000 kg. of material P during last year @ ₹2 per kg. and placed in its godown. This material is now not used by the concern under its current production and it can be disposed of by incurring an additional cost of ₹500. By chance the concern receives one offer to produce a product which will require exactly 5,000 kg. of this material P. What will be the opportunity cost of material required to be used for proposal under consideration?

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Case 5. Opportunity cost of material already purchased & held in godown and having regular use in current production process:- Suppose a concern uses material X in its routine production. During the last year it purchased material in bulk quantity @ ₹7 per kg. Out of the aforesaid purchases 40000 kg. of material X is still in godown . The same material is now available in the market @ ₹9 per kg. (replacement cost). There

is a proposal to produce one special equipment, which requires 8,000 kg. of the aforesaid material. What will be the opportunity cost of material required to be used for proposal under consideration?

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Case 6. Opportunity cost of material already purchased and can be used in regular production as a substitute material:- Suppose there is a proposal under consideration which require 5,000 kg. of material A. During the last year the concern purchased material A in bulk quantity @ ₹7 per kg. Out of the aforesaid purchase 5,000 kg. of material A is still in godown. If this material is not used for the proposal under consideration it can be used in place of 5,000 kg. of a substitute material Z which is in regular use. The current replacement cost of material Z is ₹8 per kg. What will be the opportunity cost of material required to be used for proposal under consideration?

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Case 7. Opportunity cost of material already purchased , then can be used after suitable alteration in place of other material or can be disposed off:- Suppose there is a proposal under consideration which require 5,000 kg. of material A. During the last year the concern purchased material A in bulk quantity @ ₹10 per kg. Out of the aforesaid purchases 5,000 kg. of material A is still in godown. If this material is not used for the proposal under consideration it can be used after suitable alteration in place of 5,000 kg. of material B which is in regular use. The current replacement cost of material B is ₹8 per kg. The alteration cost of material A to be used in place of material B is ₹2 per kg. and current resale value of material A is ₹4 per kg. What will be the opportunity cost of material A required to be used for proposal under consideration?

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Value under alternative 1.

Value under alternative 2

Question 11: X Ltd. has been approached by a customer who would like a special job to be done for him and is willing to pay ₹22,000 for it. The job would require the following materials

Material	Total units required	Units already in stock	Book value of units in stock ₹/unit	Realizable value ₹/unit	Replacement cost ₹/unit
A	1,000	0	-	-	6
B	1,000	600	2	2.5	5
C	1,000	700	3	2.5	4
D	200	200	4	6	9

- a) Material B is used regularly by X Ltd. and if stocks were required for this job they would need to be replaced to meet other production demand.

- b) Materials C and D are in stock as the result of previous excess purchase and they have a restricted use. No other use could be found for material C but material D could be used in another job as substitute for 300 units of Material E, which currently cost ₹5 per unit (of which the company has no units in stock at the moment).

What are the relevant costs of material, in deciding whether or not to accept the contract?

Assume all other expenses on this contract to be specially incurred beside the relevant cost of material are ₹550.

[Ans.: Total Relevant Cost is ₹16000; Contract should be accepted since offer is for ₹22000 in relation to relevant cost of ₹16000]

Question 12: A company owns a machine which was purchased three years ago for ₹18,000. Depreciation based on useful life of six years with no salvage value has been recorded each year. The present written down value of equipment is ₹9,000. Management is considering replacing this machine with a new machine which will reduce the variable operating costs. The new machine will cost ₹7,000 and will have expected life of three years with no scrap value. The variable operating costs are Re. 0.30 per unit of output for the old machine and Re. 0.20 per unit for the new machine. It is expected that both the machines will be operated at their maximum capacity of 20,000 units per annum. The current disposal or sale value of the old machinery is ₹4,000.

Should the company retain or replace? Assume (exclusively for complicity) that Re. 1 of each inflow or outflow in year 1 is equal to Re. 1 of each outflow in, say, year 3.

[Ans.: It is beneficial to replace the equip. (₹3000)]

Question 13: 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:

Book value of material M	₹60
Realisable value of material M	₹80
Replacement cost of material M	₹100

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 ₹20 per hour. Other costs are as follows:

Out-of-pocket expenses	₹30 per unit
Allocated overheads	₹10 per unit

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/07

[Ans.: ₹110 per unit]

Question 14: Mr. X has taken a shop on lease and made a down payment of ₹2,50,000. Additionally, the rent under lease amount is ₹96,000 per annum. If lease agreement is cancelled by Mr. X, then the initial payment is forfeited. Mr. X plans to use the shop for the general stores business, and has estimated operations for the next year as follows:

Sales	₹25,00,000	
Less : Value added tax (VAT)	₹2,80,000	
Sales after VAT		22,20,000
Cost of goods sold	12,50,000	
Wages and wages related cost	2,76,000	
Rent including down payment	3,46,000	
Rates, lighting and insurance	2,80,000	
Audit, legal and general expenses	50,000	22,02,000

Net profit before tax	18,000
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In the business, Mr. X will be devoting half of his time, however no provision has been made for his remuneration/salary. Mr. X also has an option to sublet the shop to his friend for a monthly rent of ₹18,000, if he does not use the shop himself.

You are required to:

1. Identify the sunk and opportunity cost in the above problem.
2. State most profitable decision, which should be taken by Mr. X, supporting with appropriate calculation. (11 Marks) CIMA Foundation-Adapted, (ICWA-June/01)-Adapted & (5 Marks) Nov/09-O.C.

[Ans.: Net Relevant Income from own business: ₹268000; Net Relevant Rental Income: ₹120000, hence X should start his own business]

Question 15: A company has prepared the following budget for the forthcoming year:

	₹lakhs
Sales	20.00
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	0.40
Total costs	18.00
Profit	2.00

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./08-N.C.

[Ans.: Net Benefit in accepting the order is of ₹28,000]

Question 16: A company had nearly completed a job relating to construction of a specialized equipment, when it discovered that the customer had gone out of business. At this stage, the position of the job was as under:

	(₹)
Original cost estimate	1,75,200
Cost incurred so far	1,48,500
Costs to be incurred	29,700
Progress payments received from original customer	1,00,000

After searches, a new customer for the equipment has been found. He is interested to take the equipment, if certain modifications are carried out. The new customer wanted the equipment in its original condition, but

without its control device and with certain other modification. The costs of these additions and modifications are estimated as under:

Direct material (at cost)	₹1,050
Direct wages Dept. : A	15 man days
Dept. : B	25 man days
Variable overheads	25% of direct wages in each department
Delivery costs	₹1,350

Fixed overheads will be absorbed at 50% of direct wages in each department.

The following additional information is available:

- The direct materials required for the modification are in stock and if not used for modification of this order, they will be used in another job in place of materials that will now cost ₹2,250.
- Department A is working normally and hence any engagement of labour will have to be paid at the direct wages rate of ₹120 per man day.
- Department B is extremely busy. Its direct wages rate is ₹100 per man day and it is currently yielding a contribution of ₹3.20 per rupee of direct wages.
- Supervisory overtime payable for the modification is ₹1,050.
- The cost of the control device that the new customer does not require is ₹13,500. If it is taken out, it can be used in another job in place of a different mechanism. The latter mechanism has otherwise to be bought for ₹10,500. The dismantling and removal of the control mechanism will take one man day in department A.
- If the convention is not carried out, some of the materials in the original equipment can be used in another contract in place of materials that would have cost ₹12,000. It would have taken 2 man days of work in department A to make them suitable for this purpose. The remaining materials will realize ₹11,400 as scrap. The drawings, which are included as part of the job can be sold for ₹1,500

You are required to calculate the minimum price which the company can afford to quote for the new customer as stated above. (12 Marks) May/01

[Ans.: Minimum price which the company can quote is ₹61975]

Question 17: A company has in stock, materials K which was purchased four years ago at ₹40,000. These materials have become obsolete and can be sold as scrap for ₹10,000. There are two alternatives:

Alternative I

The material can be converted into a specialized product as per details given below:

Add materials AX	: 600 kg.
Direct labour	: 2000 skilled hours at ₹6 per hour 4000 unskilled hours at ₹4 per hour
Advertisement	: ₹10,000

The resultant output of 500 units can be sold at ₹150 per unit.

Material AX is in regular use of the company. The company has 1000 kg. of AX in stock, purchased at ₹50 per kg. Its replacement cost is ₹70 per kg. and the re-sale value is ₹40 per kg. Variable overheads for conversion of the entire output is ₹2,000.

Alternative II

Material K can be used as a substitute in a regular job where it will replace the material which would otherwise have to be purchased for ₹8,000. This job will earn a profit of ₹6,000.

The skilled labour is in short supply and they have to be diverted from other jobs where they earn a contribution of ₹2 per hour. Unskilled labour is surplus to the extent of 10000 hours and they are being paid under a contract which cannot be terminated.

You are required to present a statement advising as to how deal with the stock of material K.

[Ans.: It is suggested to scrap the material for ₹10000]

Question 18: A Ltd. has been offered a contract that, if accepted, would significantly increase next year's activity level. The contract requires the production of 20,000 kgs. of product X and specifies a contract price of ₹1,000 per kg. The resources required in the production of each kg. of X include the following:

Resources per kg. of X

Labour:		
Grade 1		2 hours
Grade 2		6 hours
Material		
A		2 units
B		1 liter

Grade 1 labour is highly skilled and although currently under-utilized in the firm, it is A's policy to continue to pay Grade 1 labour in full. Acceptance of the contract would reduce the idle time of Grade 1 labour. Idle time payments are treated as non-production overheads.

Grade 2 is unskilled with a high turnover, and may be considered a variable cost. The cost to A for each type of labour are: Grade 1 ₹40 per hour; Grade 2 ₹20 per hour.

The materials required to fulfill the contract would be drawn from the materials already in stock. Material A is widely used within the firm and any usage for the contract will necessitate replacement. Material B was purchased to fulfill an expected order that was not received. If, material B is not used for the contract, it will be sold.

For accounting purposes FIFO is used. The various values and costs for A and B are as follows: (₹p. u.)

Particulars	A	B
Book value	80	300
Replacement cost	100	320
Net realizable value	90	250

A single recovery rate for fixed factory overheads is used throughout the firm, even though some of these costs could be attributed to a particular product or department. The overhead is recovered by applying a pre-determined rate per productive labour hour. Initial estimates of next year's activity, which exclude the current contract, show fixed production overhead of ₹60,00,000 and production labour hours of 3,00,000. Acceptance of the contract would increase fixed production overheads by ₹22,80,000.

Variable production overheads are accurately estimated at ₹30 per productive labour hour.

Acceptance of the contract would encroach on the resources used to produce and sale another product Y, which is also made by A Ltd. It is estimated that the sale of Y would then decrease by 5,000 units in the next year. However, this reduction in sale of Y would enable attributable fixed factory overhead of ₹5,80,000 to be avoided. Information on Y is as follows:

	(Per unit)
Selling price	₹700
Labour Grade 2	4 hours
Materials relevant variable costs	₹120

Required:

Advise A Ltd. on the desirability of the acceptance of the contract purely on economic considerations. Show your calculations: (15 Marks) May/02

[Ans.: Accept the contract as the pre-tax operating income is ₹200000]

Question 19: Asha Road Carriers is a transporting company that transports goods from one place to another. It measures quality of service in terms of :

- (i) Time required to transport goods
- (ii) On-time delivery
- (iii) Number of lost or damaged cartons.

To improve its business prospects and performance the company is seriously considering to install a scheduling and tracking system, which involves an annual outlay of ₹1,50,000, besides equipments costing ₹2,00,000 needed for installation of the system. The company proposes to utilise the proceeds of the fixed deposit maturing next month to purchase the equipment. The rate of interest at present on deposit is 10%. The company furnishes the following information about its present and anticipated future performance:

	Current	Expected
On-time delivery	85%	95%
Variable costs per carton lost or damaged	₹50	₹50
Fixed costs per carton lost	₹30	₹30
Number of cartons lost or damaged	3000	1000

The company expects that each per cent point increase in on-time performance will result in revenue increase of ₹18,000 per annum. Contribution margin of 45% is required. Should Asha Road Carries acquire and install the new system?
(11 Marks) Nov./03

[Ans.: Increase in net saving ₹11000, so new systems should be installed]

Question 20: B Ltd. is having a big plant where tailor-made jobs are carried out. Recently a customer has approached them for a job as per specification supplied. B Ltd. does not want to lose the customer and is ready to quote a lower price. The planning engineer was asked to prepare a material requirement as per the specifications. The cost estimates worked out as under:

(1) Steel sheets 5000 kg at ₹15 per kg.	₹75000
(2) Steel rods 1000 kg at ₹10 per kg	10000
(3) Bearing hardware items, etc,	15000
(4) Employee Costs:	
Monthly rated – grade A 400 hours at ₹10	4000
Monthly rated – grade B 600 hours at ₹8	4800
(5) Overheads:	
Fabrication shop – 500 hours at ₹20	10000
Welding shop – 300 hours at ₹40	12000
Planning Engineers – 200 hours at ₹15	3000
Design Engineers – 100 hours at ₹15	1500
Total Estimated Cost	<u>135000</u>

Following additional information is available:

- (1) The stocks of steel sheets are more than sufficient and were purchased a year ago. Present market price of this item is ₹12 per kg.
- (2) The steel rods were purchased five years back at ₹10 per kg. Present purchase price is ₹18 per kg. This material is already declared as non-moving and can be sold in market as such at ₹15 per kg. or can be substituted for alloy steel rods which are presently costing ₹17 per kg.
- (3) The labour force is always moved from job to job depending upon urgency. It is likely that the above job, if accepted, will have to be done by grade A workers alone.
- (4) The fabrication shop is treated as profit centre. A transfer price of ₹20 per hour is used for charging to other shops in the workshop. The fabrication shop also done jobs for outsiders whom ₹25 per hour is charged. The transfer price are calculated as under:

	Fabrication	Welding
Variable Cost per machine hour	₹7	₹16
Departmental Fixed Costs	6	20
Profit	7	4
Transfer Price	20	40

- (5) The hourly rates of planning/design engineers are ₹10 per hour. However, for outside consultancy work, it is practice to charge ₹15 per hour.

The management wants to have the bare minimum cost for the job so that the opportunity of getting the order is not lost.

Revise the cost estimate using the additional information. Give reasons for each of the revised figure used in your calculations.

[Ans.: Total estimated relevant costs is ₹109300]

Question 21: You are the management accountant of publishing and printing company which has been asked to quote for the production of programme of the local village fair. The work would be carried out in addition to the normal work of the company. Because of existing commitments, some weekend working would be required to complete the printing of the programme. A trainee accountant has produced the following cost estimate based upon the resource required as specified by the production manager:

Direct Material	- paper (book value)	₹5000
	- inks (purchase price)	2400
Direct Labour	- skilled 250 hours @ ₹4.00	1000
	- unskilled 100 hours @ ₹3.50	350
Variable Overhead	350 hours @ ₹4.00	1400
Printing press depreciation	200 hours @ ₹2.50	500
Fixed production costs	350 hours @ ₹6.00	2100
Estimated department cost		<u>400</u>
		<u>13150</u>

You are aware that considerable publicity could be obtained for the company if you are able to win this order and the price quoted must be very competitive.

The following notes are relevant to the cost estimate above:

- (1) The paper to be used is currently in stock at a value of ₹5000. It is of an unusual colour which has not been used for some time. The replacement price of paper is ₹8000, whilst the scrap value of that in stock is ₹2500. The production manager does not foresee any alternative use for the paper if it is not used for the village fair programmes.
- (2) The inks required are not held in stock. They would have to be purchased in bulk at a cost of ₹3000. 80% of the ink purchases would be used in printing the programmes. No other use is foreseen for the remainder.
- (3) Skilled direct labour is in short supply, and to accommodate the printing of the programmes, 50% of the time required would be worked at weekends for which a premium of 25% above the normal hourly rate is paid. The normal hourly rate is ₹4.00 per hour.
- (4) Unskilled labour is presently under-utilised, and at present 200 hours per week are recorded as idle time. If the printing work is carried out at weekend, 25 unskilled hours would have to occur at this time, but the employees concerned would be given two hours time off (for which they would be paid) in lieu of each hour worked.
- (5) Variable overhead represents the cost of operating the printing press and binding machines.
- (6) When not being used by the company, the printing press is hired to outside companies for ₹6.00 per hour. This earns a contribution of ₹3.00 per hour. There is unlimited demand for this facility.
- (7) Fixed production costs are those incurred by and absorbed into production, using an hourly rate based on budgeted activity.
- (8) The cost of estimating department represents time spent in discussions with the village fair committee concerning the printing of its programme.

Required:

- (a) Prepare a revised cost estimate using the opportunity cost approach, showing clearly minimum price that the company should accept for the order. Give reasons for each resources valuation in your cost estimate.
- (b) Explain why contribution theory is used as a basis for providing information relevant to decision making.
- (c) Explain the relevance of opportunity costs in decision making.

[Ans.: Revised Cost Estimate: ₹8625]

[Hint: Total unskilled hours are 100 hours, out of which 75 hours will be utilized on weekdays & 25 hours will be utilized on weekends. Since on weekend, employees concerned would be given two hours time off (for which they would be paid) in lieu of each hour worked, hence hours paid for carrying 25 hours work will be 75 (25+50). Therefore, total hours required to carry 100 hours work = 150 (75 weekdays + 75 weekends) & idle time available = 200 hours. Hence relevant cost of unskilled labour will be NIL]

Question 22: A research project, to date, has cost a company ₹ 250000 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 ₹ 400000. The following additional information is available:

- (i) Materials have just been received for ₹ 60000. These are extremely toxic, and if not used in the project, have to be disposed of by special means at ₹ 15000.
- (ii) Labour: ₹ 75000. 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 ₹150000. The accountant estimated that the prime cost of those sales would be ₹100000 and the overhead absorbed (all fixed) would amount to ₹ 25000.
- (iii) Research staff: ₹ 160000. 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 ₹ 25000.
- (iv) Share of General Building expense: ₹35000.

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. (10 Marks) May/07

[Ans.: Project should be allowed to proceed as it will provide incremental cash inflows of ₹130000]

Question 23: A company manufacturing several products for regular sales has conducted a market survey at a cost of ₹ 1,00,000 to introduce a new product NP. The market survey suggests that there is a demand for the sale of 1,00,000 units of NP at ₹18 each for one year.

The following information has been furnished by the company:

- (i) Raw Materials: Each article of NP requires one unit of each of the three types of the raw materials namely A, B, and C. Material A is in regular use of the company and the stock is replaced as and when exhausted. Material B is not in regular use of the company but as a result of overbuying in an earlier contract, the company at present holds a stock of 60,000 units. Material C is used only in NP and hence the company has to purchase the same as per the requirement of production of the new product. The data relating to three the items of raw materials are as under:

Raw Material	Current Stock (units)	Cost per unit of raw material		
		Original cost (₹)	Current replacement (₹)	Current resale cost (₹)
A	1,00,000	2.00	2.50	1.75
B	60,000	3.50	3.00	1.00
C	-	-	6.00	5.00

- (ii) Direct labour: NP requires for each article:
Skilled labour 0.25 hours at ₹3 per hour and unskilled labour 2 hours at ₹2 per hour. Due to shortage to skilled labour, the company has, in the event of deciding to take up the production of NP, to divert the skilled labour from some other product which earns a contribution of ₹2 per hour of skilled labour. The company has a surplus of 3,00,000 hours of unskilled labour for which payment is being made one time basis as per contract and it is not possible to terminate these surplus workers.
- (iii) Additional Staff required for the manufacture of NP:
One foreman at ₹ 36,000 p.a.
One supervisor at ₹24,000 p.a.

- (iv) Machines: Two machines namely Machine Type P and Machine Type Q are required to produce NP. Machine Type P is in regular use on the other products also and Machine Type Q is now idle. If NP is not produced machine Type Q can be sold immediately. The relevant data relating to each type of machine are as under:

Particulars	(₹)	
	At the start of the year	At the close of the year
Type P – Replacement cost	1,60,000	1,30,000
Resale value	1,20,000	94,000
Type Q – Replacement cost	26,000	18,000
Resale value	22,000	17,000

The company charges depreciation on Straight Line Basis.

- (v) Overheads:

Fixed overheads of the company ₹ 18,00,000 per annum.
Variable overheads ₹1.50 per unit of the new product NP.

Using the concept of relevancy of costs, prepare a Cost Sheet to show the cost per unit of the new product NP. Substantiate the figures with necessary explanation.

[Ans.: Total Cost is ₹1400000 & cost per unit is ₹14]

Question 24: A company has been making a machine to order for a customer, but the customer has since gone into liquidation, and there is no prospect that any money will be obtained from the winding up of the company.

Costs incurred to date in manufacturing the machine are ₹50,000 and progress payment of ₹15,000 have been received from customer prior to the liquidation.

The sales department has found another company willing to buy the machine for ₹34,000 once it has been completed. To complete the work, the following cost would be incurred:-

- (a) Materials these have been bought at a cost of ₹6,000. They have no other use, and if the machine is not finished, they would be sold for scrap for ₹2,000.
- (b) Further labour costs would be ₹8,000. Labour is in short supply, and if the machine is not finished, the work force would be switched to another job, which would earn ₹30,000 in revenue, and incur direct cost (not including direct labour), of ₹12,000 and absorbed (fixed) overhead of ₹8,000.
- (c) Consultancy fees ₹4,000. If the work is not completed, the consultant's contract would be cancelled at a cost of ₹1,500.
- (d) General overheads of ₹8,000 would be added to the cost of the additional work.

Should the new customer's offer be accepted? Prepare a statement showing the economics of the proposition.

May/91

[Ans.: In view of incremental profit of ₹11500, the offer of new customer can be accepted]

Question 25: SV Ltd manufacturing a product called FLOTAP. The company is organized into two divisions, viz, Division A and Division B.

Division A manufactures FLOTAP and Division B, which manufactures the containers, packs FLOTAP in the containers and stores them by using a special protective material called 'germicide'. The details of the expenses incurred by Division B during 2002 under:

(₹)

Direct material including germicide	420,000
Direct labour	3,00,000
Supervision	48,000
Maintenance of machine	21,600
Rent of a party of warehouse used	27,000
Depreciation of machinery	90,000
Miscellaneous overheads	94,500
Administration overheads apportioned to the Division	1,44,000
Total	11,45,100

PH Ltd., a company, engaged in warehousing of a variety of products approached SV Ltd. to undertake to manufacture the containers required on contract basis for a period of four years for 7,50,000 per annum and/or store the packed product for a further sum of ₹1,50,000 per annum.

Division B uses a machine for manufacture of containers. This machine was installed four years ago at a capital cost of ₹7,20,000 and it has a useful life of four more years. It can be currently sold at ₹1,50,000.

Division B purchased germicide worth ₹6,00,000 during the last year. Out of this, one-fifth was used during the last year and the cost thereof is included in the material cost of 2002. The original purchase price of germicide was ₹3,000 per tonne but, if sold now, the stock of germicide would fetch only ₹2,400 per tonne. Its current replacement cost is ₹3,600 per tonne.

Division B hired a warehouse for storage of the product for ₹54,000 per annum. It uses only half of the space and has taken only half the amount of rent into account. The remaining space of warehouse is idle.

If the contract for manufacture of the containers and the storage of the product, FLOTAP is given to PH Ltd. Division B will be closed down. In that event the supervisory staff will be transferred to another department. The terminal benefits to be met as regards workers will amount to ₹45,000.

If SV Ltd. continues to store the FLOTAP and leaves the manufacture of the containers to PH Ltd. the machine in Division B will not be required and the storage space requirements cannot be dispensed with. The supervisory staff will be required to be retained in Division B and only 10% of all materials will be used. The saving on account of labour retrenchment will come to ₹15,000 per annum. The miscellaneous overheads will be reduced by 80%.

If SV Ltd. continues to manufacture the containers and leaves the storage of FLOTAP to PH Ltd, Division B will retain the machine and the warehouse space for use. The supervisory staff will also be retained and 90% of all materials will be required. The labour force will continue and the miscellaneous overheads will be reduced by 20%

You are required to evaluate the above three proposals on four year term basis and state your recommendations.

[Ans.: Net cash outflow in Alt. I is ₹1022100, Alt. II is ₹2012400 & Alt. III is ₹3512700. All alternatives result in net cash outflow, Therefore it is in interest of SV Ltd. to continue and to manufacture containers and store them in Division B.]

Question 26: Soft Drinks Ltd. bottles and distributes 'Amrit' brand cold drinks. It operates its distribution division as a cost centre. Budgeted cost for the year ending 31st March, 1996 is as follows:

	(₹)
Cash Operating Costs	21,00,000
Depreciation on Fleet of Vehicles (8X ₹52,500)	4,20,000
Apportioned Corporate Costs	3,00,000
	28,20,000

Distribution division has started operation on 1st April 1994. Each vehicle of the fleet was acquired at a cost of ₹2,40,000 and had an estimated economic life of four years. Salvage value of each vehicle at the end of four years (March 31, 1998) was estimated at ₹30,000.

Countrywide Distributors Ltd. which has countrywide network for the distribution of food and beverages has offered Soft Drinks Ltd. a three years distribution contract for ₹19,50,000 each year. The contract will start on 1st April 1995.

If Soft Drinks Ltd accepts the offer, it will close down its own distribution division, and will sell the delivery vehicles. Current (April 1, 1995) disposal price of each vehicle is estimated at ₹75,000. Soft Drinks Ltd. will avoid cash operating cost of ₹21,00,000.

Security analysts have recommended the purchase of share of Soft Drinks Ltd., security analysts are forecasting a net profit of ₹6,60,000 for 1995-96 as against an estimated profit of ₹6,30,000 for 1994-95, the forecast assumes that the company will continue operation of its distribution division.

Required:

- (a) Tabulate a comparison of all relevant cost for next three years (1995-96 to 1997-98) for the two alternatives-use of own distribution division or use of countrywide distributors. Recommend whether Soft Drinks Ltd. should accept the offer of Countrywide distributors. (11 Marks) May/95
- (b) Why might Soft Drinks Ltd. be reluctant to accept the offer of Countrywide distributors? (8 Marks) (Ignore Income-tax and time value of money. Wherever appropriate, suitable assumptions to be made by you)

[Ans.: Relevant Cost:	95-96	96-97	97-98
Own Dis.	2100	2100	1860
Countrywide Dis.	1350	1950	1950]

Question 27: A Ltd. produces and markets a range of consumer durable appliances. It ensures after-sales service through X Ltd. The big appliances are serviced at customer's residence while small appliances are serviced at workshop of X Ltd.

The material supplied to X Ltd. is charged above cost at 10%. X Ltd. charges customers at 25% over the above price. For labour, the company receives 10% of the rate fixed for work done under the after-sales service agreement and 15% of the rate fixed in case of jobs not covered under the agreement from X Ltd. 60% by value of the total work undertaken by X Ltd. was for big appliances and rest accounted for small appliances during the previous year.

The company decides to carry out all or some of the work itself and has chosen one area in the first instance. During the previous year the company earned a profit of ₹2,16,000 as detailed below from X Ltd. for the area chosen:

Particulars	(₹)	
	Material	Labour
Under after-sales service agreement	60,000	1,00,000
For jobs not covered under the agreement	20,000	36,000

The company forecasts same volume of work in that area for the ensuring period. The following three options are under consideration of the management:

- (i) To set up a local service centre to provide service for small appliances only. The existing system is to continue for big appliances.
- (ii) To set up a local service centre to provide service for big appliances only. The existing system is to continue for small appliances.
- (iii) To set up a local service centre to provide service to all appliances. The existing system then stands withdrawn.

The relevant costs for carrying out jobs under the above options are under: (₹'000)

Particulars	Option-1	Option-2	Option-3
Heat, rent light etc.	125	50	150
Management costs	108	83	150
Service staff cost	230	440	750
Transport cost	25	220	230

You are required to find out the most profitable option. (15 Marks) Nov./96

[Ans.: Net Benefit in Option -1 ₹('000) 184, in Option -2 ₹('000) 445, in Option -3 ₹('000) 884, hence it is advisable to choose any of the options.]

Question 28: Mahila Griha Udyog Industries is considering to supply its products-a special range of namkeens to a departmental store. The contract will last for 50 weeks, and the details are given below:

(₹)	
Material:	
X (in stock-at original cost)	1,50,000
Y (on order-on contract)	1,80,000
Z (to be ordered)	3,00,000
Labour:	
Skilled	5,40,000
Non-Skilled	3,00,000
Supervisory	1,00,000
General Overheads	10,80,000
Total cost	26,50,000
Price offered by departmental store	18,00,000
Net Loss	8,50,000

Should the contract be accepted if the following additional information is considered?

- (i) Material X is an obsolete material. It can only be used on another product, the material for which is available at ₹1,35,000 (Material X requires some adaptation to be used and cost ₹27,000).
- (ii) Material Y is ordered for some other product which is no longer required. It now has a residual value of ₹2,10,000.
- (iii) Skilled labour can work on other contracts which are presently operated by semi-skilled labour at a cost of ₹5,70,000.
- (iv) Non-skilled labours are specifically employed for this contract.
- (v) Supervisory staff will remain whether or not the contract is accepted. Only two of them can replace other positions where the salary is ₹35,000.
- (vi) Overheads are charged at 200% of skilled labour. Only ₹1,25,000 would be avoidable, if the contract is not accepted.

(12 Marks) May/99

[Ans.: Since there is a net incremental cash flow of ₹152000 therefore, contract should be accepted]

Question 29: Ranka Builders has been offered a contract by Excel Ltd. to build for its five special Guest Houses for use by top management. Each Guest House will be an independent one. The contract will be for a period of one year and the offer price is ₹one crore. In addition, Excel Ltd. will also provide 2 grounds of land free of cost for the purpose of construction. The Chief Accountant of Ranka Builders has prepared an estimate on the basis of which he has advised that the contract should not be accepted at the price offered. His estimate was as follows:

		(₹Lakhs)
Land (3 Grounds at ₹20 lacks each)		60
Drawing and Design		7
Registration		10
Materials:		
Cement and Sand		6
Bricks and Tiles		4
Steel		10
Other (including interior decoration)		10
Labour -Skilled		12
-Unskilled		8
-Supervisor's Salary		5
Overheads- General		12
Depreciation		6
Total		150

The Accountant also provides the following information:

Land: The total requirement of land is 3 grounds costing ₹20 lakhs per ground. Excel Ltd. will provide 2 grounds free of cost.

Drawing and Design: These have already been prepared and 50% of the cost has already been incurred^{See Note 1}.

Materials:

- (i) Cement and sand are already in stock and in regular use. If used for this contract, they have to be replaced at a cost of ₹8 lakhs.
- (ii) Bricks and tiles represent purchases made several months before for a different contract. They could be sold readily for a net ₹5 lakhs after meeting all further expenses.
- (iii) Others: Materials worth ₹2 lakhs relating to interior decoration are in stock for which no alternative use is expected in the near future. However, they can be sold for ₹1 lakh.

Labour:

- (i) Skilled workers will be transferred to this project from another project. The Project Manager claimed that if the men were returned to him, he could have earned the company an additional ₹2 lakhs in term of profits^{See Note 2}.
- (ii) The supervisor undertakes various tasks in the sites and his pay and continuity of employment will not be affected by the new contract. If the contract is taken, he will devote half of his time.

Overheads:

- (i) The equipment that would be used on the contract was bought one year before for ₹30 lakhs and is expected to last for five years. It can also be used on other contracts and the current replacement price will be ₹32 lakhs and in a year's time it will be ₹25 lakhs.
- (ii) The general overheads includes both specific and absorbed overheads. If the contract is not undertaken, ₹4 lakhs of the same can be avoided.

Ranka Builders has also on hand another project, which would not be executed if the contract from Excel Ltd. were to be accepted. The estimated profit on that project is ₹10 lakhs.

In the light of information given above, you are required to indicate with reasons whether the contract from Excel Ltd. should be accepted or not. (10 Marks) Nov./99

[Ans.: Total relevant cost is ₹10850000; Contract price is ₹1 crore. So, the offer should not be accepted.]

[Note: 1. Suggested answers of ICAI has assumed that Designs & Drawings are 50% paid although 100% incurred-This assumption seems grossly wrong.

2. Suggested answers of ICAI has assumed that amount of ₹2 lakhs is without deducting labour costs-This assumption seems grossly wrong]

Question 30: B Ltd. is a company that has, in stock materials of type XY that cost ₹75,000, but that are now obsolete and have a scrap value of only ₹21,000. Other than selling the material for scrap, there are only two alternative uses for them.

Alternative I: Converting the obsolete materials into a specialized product, which would require the following additional work and materials:

Material A	600 units
Material B	1,000 units
Direct Labour	
5,000 hours unskilled	
5,000 hours semi-skilled	
5,000 hours highly skilled	
Extra selling and delivery expenses	₹27,000
Extra advertising	₹18,000

The conversion would produce 900 units of saleable product and these could be sold for ₹300 per unit. Material A is already in stock and is widely used within the firm. Although present stocks, together with orders already planned, will be sufficient to facilitate normal activity and extra material used by adopting this alterative will necessitate such materials being replaced immediately. Material B is also in stock, but it is unlikely that any additional supplies can be obtained for some considerable time, because of an industrial dispute. At the present time Material B is normally used in the production of Product Z, which sells at ₹390 per unit and incurs total variable cost (excluding Material B) of ₹210 per unit. Each unit of Product Z uses 4 units of Material B. The details of Material A and B are as follows:

(₹)

	Material A	Material B
Acquisition cost at the time of purchase	100 per unit	₹10 per unit
Net realizable value	85 per unit	₹18 per unit
Replacement cost	90 per unit	-

Alternative II: Adopting the obsolete materials for use as a substitute for a sub-assembly that is regularly used within the firm. Details of the extra work and materials required are as follows:

Material C	1,000 units
Direct Labour:	
	4,000 hours unskilled
	1,000 hours semi-skilled
	4,000 hours highly skilled

1,200 units of the sub-assembly are regular used per quarter at a cost of ₹900 per unit. The adaptation of material XY would reduce the quantity of the sub-assembly purchased from outside the firm to 900 units for the next quarter only. However, since the volume purchased would be reduced, some discount would be lost and the price of those purchased from outside would increase to ₹1,050 per unit for that quarter.

Material C is not available externally though 1,000 units required would be available from stocks; it would be produced as extra production. The standard cost per unit of Material C would be as follows: (₹)

Direct labour :	6 hours unskilled labour	18
Raw materials		13
Variable overhead :	6 hours at ₹1	6
Fixed overheads :	6 hours at ₹3	18
		55

The wages rate and overheads recovery rates for B Ltd. are:

Variable overhead	₹1 per direct labour hour
Fixed overheads	₹3 per direct labour hour
Unskilled labour	₹3 per direct labour hour
Semi-skilled labour	₹4 per direct labour hour
Highly skilled labour	₹5 per direct labour hour

The unskilled labour is employed on a casual basis and sufficient labour can be acquired to exactly meet the production requirements. Semi-skilled labour is part of the permanent labour force, but the company has temporary excess supply of this type of labour at the present time. Highly skilled labour is in short supply and cannot be increased significantly in the short-term, this labour is presently engaged in meeting the demand for product L, which requires 4 hours of highly skilled labour. The contribution from the sale of one unit of product L is ₹24.

Given the above information, you are required to present cost information advising whether the stock of Material XY should be sold, converted into a specialized product (Alternative I) or adopt for use as a substitute for a sub-assembly (Alternative II). (16 Marks) Nov./00

[Ans.: Net relevant revenue of Alternative I is ₹20000 and Alternative II is ₹12000]

Question 31: Engineers Ltd. is just ready to deliver a machine specially designed for Durables & Co. when it is learnt that the latter has gone bankrupt.

An enquiry comes from another firm, Steady Enterprises, which can accept the machine meant for Durable & Co. if certain alterations are done to suit Steady Enterprises needs and the price is attractive.

The following factors prevail:

(a) Costs incurred on the machine for Durables & Co.	
Direct Material	₹560000
Direct Labour	400000
Variable Overhead	140000
Fixed Overhead	300000
Fixed Selling & Dist. Overhead	1500000

Notes: If the negotiation with Steady Enterprises fails, part of the material used may be dealt with as under:

(a) (I) Brass materials – could be sold as scrap for ₹100000.

- (II) Steel materials – could be sold as scrap for ₹26000, but to sell it as scrap some 100 hours labour will be hired at ₹10 per hour to bring it to saleable condition.
- (III) Balance Materials will have to be removed at a cost of ₹5000, but will have a 'nil' sale value.
- (b) Price quoted to Durables & Co. was 1800000.
- (c) To cater to Steady Enterprises needs, alteration cost will be:

	Department M	Department A
Direct Materials	₹10000	₹5000
Direct Labour	10 men for 2 months @ ₹3000 per man-month	6 women for 2 months @ ₹2000 per woman-month
Variable Overhead	20% of Direct labour cost	25% of Direct labour cost
Fixed Overhead	60% of Direct labour cost	50% of Direct labour cost

Notes: (c) (I) Materials required are already in stock and valued at cost. If the work for Steady Enterprises is not undertaken, the company has the following choice:

- Material for Department M will be used for another job.
- Material for Department A, lying as it is for some years, will remain useless unless put on quick sales for ₹3000.

The present market prices for the materials for M and A are ₹12000 and ₹6000 respectively.

- (III) Department M is current working at full capacity, earning a contribution of ₹3 towards fixed overhead and profit per Re. 1 of labour.
- (IV) Department A is presently working at 40% of its capacity, but as per agreement with the Union its present work force of 24 women cannot be reduced. A worker in this department gets ₹2000 a month as wages. In order to utilize its labour, Department A undertakes some off-loading work for ₹32500 per month from a sister concern when the workload in Department A falls below 50% capacity. Variable cost associated with off-loading work is ₹4000 per month. The conversion work for Steady Enterprises will mean 25% additional workload for Department A for 2 months.
- (d) The pattern and specifications of the original machine could be sold to a customer for ₹60000.
- (e) For supervision of the job for Steady Enterprises, a temporary Supervisor would be needed for 2 months at an agreed salary of ₹10000. He will be a person deputed by Steady Enterprises. The company charges all indirect and supervisory salaries to fixed overhead.
- (f) Durable & Co. has already made an earnest money deposit of ₹180000 for the machine. As per terms of the contract, this deposit stands forfeited and Engineers Ltd. is now free to treat the sum as miscellaneous income.
- (g) Taxation may be ignored.

Engineers Ltd. seeks your advice for the minimum price, based on relevant costs only, for the quotation it will make to Steady Enterprises.

[Ans.: Minimum Price is ₹520000]

Question 32: A construction company has accepted contract AX and work thereon is about to begin. However, the company has received an offer for another contract BX. The company cannot, due to certain constraints, take up both the contracts simultaneously. In case the company is desirous of taking up contract BX, it can get the first contract AX rescinded upon payment of a penalty of ₹70,000.

The following are the estimates relating to the two contracts:

Particulars	(₹)	
	Contract AX	Contract BX
Material X-in stock at original cost	54,000	-
Material Y-in stock at original cost	-	62,000
Material X-firm orders placed at original cost	76,000	-
Material X-Not yet ordered (at current cost)	1,50,000	-
Material-Z Not yet ordered (at current cost)	-	1,78,000
Labour-to be engaged and paid for	2,15,000	2,75,000
Site Management Costs	85,000	85,000
Travel and other expenses	17,000	14,000
Depreciation of Plant	24,000	32,000
Interest on Capital at 12%	12,800	16,000
Head Office expenses allocated to contracts	31,690	33,100

Total	6,65,490	6,95,100
Contract Price	7,20,000	8,80,000
Estimated Profit	54,510	1,84,900

The following additional information is available:

- Material X is not in regular use, it can be used as substitute for other materials, which are currently quoted at 10% less than the original cost of X.
- Material Y is in regular use and its price has doubled since it was purchased. Its net realizable value if sold will be its new price less 15%. It can, however, be kept in store for use in other contracts to be taken up in the next year.
- If contract AX is undertaken, a part of the plant having spare capacity can be hired out for a rental of ₹15,000 for the period.
- It is the policy of the company to charge notional interest on the estimated working capital at 12% per annum.
- Either of two contracts can be completed by 31st March, 2003, which is the close of the company's financial year.
- Site management cost is fixed.

Required:

- (i) Using the relevancy of cost concept prepare a comparative statement to show the net benefit resulting from each contract.
- (ii) Advise the management of the company as to which of two contracts should be undertaken.

[Ans.: (i) Expected net benefit of Contract AX ₹236000 and Contract BX ₹219000 (ii) Continue with Contract AX.] (16 Marks) Nov./02

Question 33: Star Bicycle Company, produced and sold 1,10,000 bicycles annually, under the brand name 'Smart' with a price tag ₹899. Like all other players in the industry, Star too was running under capacity. The manufacturing cost of these cycles was material ₹300, labour ₹200 and Manufacturing ₹300, 40% of the manufacturing cost was variable. General and administration expenses were 50% of labour cost.

Star has now received a proposal to sell 25,000 bicycles per year under the brand name 'Jeet' to a chain store at a price of ₹800. The brand will be exclusive for the chain stores as they will market it as their own product. Expenditure for producing 'Jeet' will be the same as that of 'Smart' as design of 'Jeet' will exactly be same as that of 'Smart' with only some cosmetic changes. To produce 'Jeet' however, ₹6,00,000 additional fund will be required on an average. Further it estimated that sale of 'Jeet' through the chain store will reduce the sale of 'Smart' by 10,000 units.

You are required to calculate the relevant cost of 'Jeet', given that the weighted average cost of capital Star Co. is 15%. [ICWA-Dec/02]

[Ans.: Relevant Cost of 'Jeet' bicycle is ₹623.60]

Question 34: ACE Ltd. has an inventory of 5,000 units of a product left over from last year's production. This model is no longer in demand. It is possible to sell these at reduced prices through the normal distribution channels. The other alternative is to ask someone to take them on "as is where is" basis. The latter alternative will cost the company ₹5,000.

The company produced 2,40,000 units of the product last year, when the unit costs were as under:

	(₹)	
Manufacturing Cost:		
Variable	6.00	
Fixed	1.00	7.00
Selling and Distribution Cost:		
Variable	3.00	
Fixed	1.50	4.50
Total Cost		11.50
Selling Price per Unit		14.00

Required:

Should the company scrap the items or sell them at a reduced price? If you suggest the latter, what minimum price would be recommend?
(8 Marks) May/98

[Ans.: If the company can get anything more than ₹2 per unit, then it is worthwhile to sell the stock of 5000 units and earn an additional contribution.]

Question 35: A firm furnishes the following information:

Capacity in Units	Unit Cost ₹	Unit Price ₹
2000	40	100
3000	35	95
4000	34	94
5000	32	-
6000	31	-

At present the firm is operating at 4000 units capacity and has received an order for 2000 units from an export market at ₹ 28 per unit. Should the order be accepted?
(4 Marks) May/00

[Ans.: The firm should accept the order]

Question 36: ABC Ltd. an LPG cylinder manufacturing unit, gets an order from Oil Corporation for supply of 40,000 cylinders at the standard price of ₹700 per cylinder. Getting orders is a major problem. If an order is not executed in full for any reason not only will ABC Ltd. lose the benefit; but it stand the risk of the order quantity being reduced for the next quarter also. The cylinders are made in two halves and then welded together. The cost structure is:

Materials	12.5 kg. per half
Labour	₹50 per half

Welding charges and fitting charges would be ₹30 per cylinder.

Unfortunately special steel plates are in short supply and ABC Ltd. has only stock of 500MT. Another friendly unit which has in anticipation, made bottom halves, has offered to supply 40,000 numbers. What is the maximum price ABC Ltd can pay to the unit for the bottom halves? Transportation and unloading etc. will cost ₹5 per each half.

[Ans.: The price = ₹330 per bottom half. (₹13200000÷40000)]

Question 37: Mr. Phillips owns a gift shop, a restaurant and a lodge in Shimla. Typically he operates these only during the season period of four months in a year. For the past season the occupancy rate in the lodge was 90% and level of activity in case of gift shop and restaurant at 80%.

The relevant data for the past seasons were as under:

Particulars	Gift shop		Restaurant		Lodge	
	Amount ₹	%	Amount ₹	%	Amount ₹	%
Receipts/Sales	48,000	100	64,000	100	1,80,000	100
Expenditure:						
Cost of Sales	26,400	55	35,200	55	-	-
Supplies	2,400	5	6,400	10	14,400	8
Insurance and Taxes	1,920	4	6,400	10	36,000	20
Depreciation	2,880	6	8,000	12.5	39,600	22
Salaries	4,800	10	4,800	7.5	25,200	14
Electricity Charges	960	2	3,200	5	13,500	7.5
Total	39,360	82	64,000	100	1,28,700	71.5
Profit	8,640	18	-	-	51,300	28.5

Additional information:

- (i) Cost of sales and supplies vary directly with the occupancy rate in case of lodge and level of activity in case of gift shop and restaurant.
- (ii) Insurance & Taxes and depreciation are for the entire period of twelve months.
- (iii) Salaries paid are for the season period except a chowkidar for the lodge who is paid for the full year at ₹400 per month.
- (iv) Electricity charges include fixed charges of ₹640, ₹1,920 and ₹9,900 for gift shop, restaurant and lodge respectively. The balance amount varies directly with occupancy rate in case of lodge and level of activity in case of gift shop & restaurant. Fixed electric charges are for the season except in case of lodge where ₹6900 is for the season and ₹3,000 for the entire period of twelve months.

Mr. Phillips is interested in increasing his net income. The following two options are under his consideration:-

- (1) To continue the operations during the season period only by inserting advertisement in newspaper thereby occupancy rate will reach 100% in case of lodge and 90% level of activity in respect of gift-shop and restaurant. The costs of advertisement are estimated at ₹12,000.
- (2) To continue operations throughout the entire period of twelve months comprising season period of four months and off-season period of eight months. The occupancy rate is expected at 90% and 40% during season period and off-season period respectively in case of the lodge. The room rents are bound to be reduced to 50% of the original rates during off-season period. The level of activity of gift-shop and restaurant is expected at 80% and 30% during season and off-season period respectively but 5% discount on the original rates will have to be offered during off-season period.

Which option is profitable? As a Cost Accountant would you like to suggest him any other alternative based upon the above figures which can be adopted to earn more net profit. (Use incremental revenue and differential cost approach).

Nov./93

[Ans.: By adopting the Option 1, the net increase in incremental revenue by ₹120 (i.e. ₹11000-10880) over the Option 2. Therefore, Option 1 is suggested to adopt.]

Question 38: S Ltd. is a civil engineering company based at Calcutta. Contracts are carried out under the supervision of project managers who are send out from Head Office and remain on site for the duration of the contract. The project managers recruits local labour, and arranges for plant and materials to be provided by head office.

Sometimes ago, the company successfully tendered for two contracts which have now become mutually exclusive. It is currently considering which of these to accept. Both jobs would last for 12 months.

The following information about each contract is available.

(₹'000)

Particulars	Nagpur	Delhi
Contract price	170	180
Penalty Payment (this is condition of the tender, if offered the job and it is not accepted)	16	8
Materials required:		
In stores (at cost)	20	24
Contacted for	-	36
To be ordered (at current cost)	40	34
Labour required:		
Project manager's salary	10	10
Travel, lodgings etc.	4	4
Local recruitment	70	56
Head Office:		
Plant depreciation	6	6
Interest on plant	2	2
General administration	8	8

Notes:

- (1) The materials which would be used on the Nagpur job have increased in money value by 60% over their purchase cost. S Ltd. has no other use for these materials on any other contract apart from

the Nagpur one, but they could be re-sold to other companies in the industry at 90% of their value. Transportation and other selling cost would further decrease the cash inflow from the sale by 16.67% of the sales price.

- (2) The materials for the Delhi job have no other obvious use, but could be sold for scrap if the contract were cancelled. The scrap value would be 10% of cost and cost of transport etc. would be paid by the scrap merchant. It is likely, however, that the material could be used next year on another contract in substitution for a different material normally costing 20% less than the cost of the materials to be used on the Delhi contract.
- (3) Local labour can be hired as and when required.
- (4) Plant is depreciated on a straight line basis, and the interest on plant charge is a nominal cost added for accounting purpose.
- (5) The two contracts would require similar plant, although more plant would be required for the Delhi than for the Nagpur job. The plant not required on the Nagpur job would be sub-contracted out by Head Office for ₹2,000 per annum.
- (6) Head Office administration costs are fixed at ₹25,000 for the coming year. This excludes project manager's salaries.

Required:

- (i) Present the data of management in a form which will assist in making the decisions to which job to undertake. Provide notes to explain the principles which have been used in selecting the data and to support any calculations made.
- (ii) Comment on the appropriateness of the approach used in your analysis.
- (iii) List briefly any other factors which would ought to be considered before finally making the decision in this case

Question 39: A company manufactures two products 'AB' and 'CD' by utilizing 25% and 40% of its total capacity respectively. The cost data per unit for 1994-95 are as under:

Particulars		'AB'	'CD'
Production & sales	(units)	5,000	10,000
Selling price	(₹)	80	100
Direct material	(₹)	10	30
Direct labour (₹5 per hour)	(₹)	25	20

Variable overheads are 100% on wages. Fixed overheads for 1994-95 amounted to ₹2,25,000.

During 1995-96, the company expects that the direct material costs will rise by 5%, the labour hourly rate will rise by 25 paise and variable overheads will continue to maintain same relationship with wages as was in 1994-95.

For the same volume of output as was in 1994-95, the selling price is to be enhanced by 5% in case of 'AB' and 4% in case of 'CD'.

The company has the following proposals for consideration of the management for 1995-96 to improve profitability:

- (a) Utilize the balance capacity to produce 'AB' and to sell this increased production at the existing selling price of ₹80
- (b) Utilize the balance capacity to produce 'CD'. While doing so the efficiency will however go down by 16% on account of newly recruited labour in respect of this increased production. Fixed selling price and distribution expenses of ₹50,000 will have to be spent to sell this additional output.
- (c) Introduce new product 'EF' to utilize the balance capacity. One unit of 'EF' can be manufactured in 7 labour hours. Direct material will cost ₹40 per unit. Its selling price per unit will be ₹145. Variable overheads will maintain same ratio to wages as for other two products. To boost the sales of 'EF' special advertisement expenses of ₹30,000 will be spent.

The present allocation of 25% and 40% capacities for 'AB' and 'CD' cannot be changed and only the spare capacity is required to be used for production under aforesaid proposals.

Required:

- (i) Present a statement of profit for 1994-95.
- (ii) Using incremental revenue and differential cost approach, find out which proposal is more profitable for 1995-96.
- (iii) Present a statement of profit for 1995-96 based on above recommendation.

[Ans.: (i) Profit ₹175000 (ii) Net incremental value of proposal A, B & C ₹119000, 115375, ₹127500 respectively; (iii) Total Profit ₹312500] May/10 (RTP-N.C.)-Adapted & (19 Marks) Nov./95

[Note: While calculating Net incremental value of proposals, Suggested answers of ICAI has taken increase in profit due to inflation as well, which seems grossly wrong assumption.]

Question 40: ZED Ltd. operates two shops. Product A is manufactured in Shop-1 and customer's jobs against specific orders are being carried out in Shop-2. Its annual statement of income is:

Particulars	(₹)		
	Shop-1 (Product-A)	Shop-2 (Job Works)	Total
Sales/Income	1,25,000	2,50,000	3,75,000
Material	40,000	50,000	90,000
Wages	45,000	1,00,000	1,45,000
Depreciation	18,000	31,500	49,500
Power	2,000	3,500	5,500
Rent	5,000	30,000	35,000
Heat and Light	500	3,000	3,500
Other Expenses	4,500	2,000	6,500
Total Costs	1,15,000	2,20,000	3,35,000
Net Income	10,000	30,000	40,000

The depreciation charges are for machines used in the shops. The rent and heat and light are apportioned between the shops on the basis of floor area occupied. All other costs are current expenses identified with the output in a particular shop.

A valued customer has given a job to manufacture 5,000 units of X for shop 2. As the company is already working at its full capacity, it will have to reduce the output of product A by 50%, to accept the said job. The customer is willing to pay ₹25 per unit of X. The material and labour will cost ₹10 and ₹18 respectively per unit. Power will be consumed on the job just equal to the power saved on account of reduction of output of A. In addition the company will have to incur additional overheads of ₹10,000.

You are required to compute the following in respect of this job:

- (a) Differential cost; (b) Full cost; and (c) Opportunity cost; and (d) Sunk cost.

Advise whether the company should accept the job.

(19 Marks) May/96

[Ans.: (a) ₹105250; (b) ₹162750; (c) ₹16750; (d) 12750. The company should not accept the job because there will be a cash disadvantage ₹42750]

MAKE OR BUY

Question 41: ABC Ltd. produces a variety of products each having a number of components parts. Product B takes 5 hours to produce on a particular machine which is working at full capacity. B has a selling price of ₹100 and variable cost of ₹60 per unit. A component part X-100 could be made on the same machine in two hours at a variable cost of ₹10 per unit. The suppliers' price for the components is ₹25 per unit.

Required: Advise whether the company should buy the component X-100

(If necessary make suitable assumptions)

(5 Marks) May/95

[Ans.: Relevant cost (p.u.) ₹26 & Supplier's price (p.u.) ₹25. Since the supplier's price is less than relevant cost of production, therefore, it is advisable to buy X-100 from outside suppliers.]

Question 42: Product 'A' takes five hours to produce on a particular machine and it has a selling price of ₹ 50 and a marginal cost of ₹35

On the same machine, another product 'B' can be made at two hours at a marginal cost of ₹ 5 per unit.

Supplier's price of product 'B' is ₹ 10 per unit.

Assuming that machine hour is the key factor, advice whether product 'B' could be bought out or manufactured. (6 Marks) Nov./99

[Ans.: Product B should be bought]

Question 43: A company manufactures three components. These components pass through two of the company's departments P and Q. The machine hour capacity of each department is limited to 6000 hours in a month. The monthly demand for components and cost data are as under:

Components	A	B	C
Demand (units)	900	900	1350
	₹	₹	₹
Direct Material/units	45	56	14
Direct labour/units	36	38	24
Variable Overheads/unit	18	20	12
Fixed overheads P @ ₹8 per hour	16	16	12
Q @ ₹10 per hour	30	30	10
Total	145	160	72

Components A and C can be purchased from market at ₹129 each and ₹70 each respectively.

You are required to prepare a statement to show which of the components in what quantities should be purchase to minimize the cost. (7 Marks) Nov./02

[Ans.: 250 units of component A should be purchased from outside]

Question 44: Household Equipments Ltd. is producing a kitchen equipment from five components, three of which are made using general purpose machines and two by manual labour. The data for the manufacture of the equipment is as follows:

Components	A	B	C	D	E	Total
Machine Hours reqd. per unit	10	14	12	-	-	36
Labour Hours reqd. Per unit	-	-	-	2	1	3
Variable cost per unit (in ₹)	32	52	58	12	6	160
Fixed cost per unit (apportioned)	48	102	116	28	34	316
Total component cost	80	154	174	40	40	476
Assembly cost /unit (all variable)						₹40
Selling price /unit						₹600

The marketing department for the company anticipates 50% increase in demand during the next period. General purpose machinery used to manufacture A, B and C is already working to the maximum capacity of 4,752 hours and there is no possibility of increasing this capacity during the next period. But, labour is available for making components D and E also for assembly according to demand. The management is considering the purchase of one of the components A, B or C from the market to meet the increase in demand. These components are available in the market at the following prices;

Component A	:	₹ 80
Component B	:	₹160
Component C	:	₹125

Required

- Profit made by the company from current operations.
- If the company buys any one of the components A, B or C, what is the extent of additional capacity that can be created?
- Assuming 50% increase in demand during the next period, which component should buy from the market?
- The increase in profit, if any, if the component suggested in (c) is purchased from the market.

[Ans.: (a) ₹11088; (b) A: 38.5% B: 63.6% C: 50% (c) Product C (d) Increase in profit ₹13134]

ICWA-Dec./95

Question 45: GG Ltd manufactures and sells equipment called water purifier. The cost data for each batch of ten number of water purifier is as follows:

Components	A	B	C	D	E
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Machine Hours	20	28	24	-	-
Labour Hours	-	-	-	4	2
	₹	₹	₹	₹	₹
Variable Costs	64	108	116	24	8
Fixed Cost as Apportioned	36	52	64	26	22
Assembly cost (all variable) ₹ 50 per batch.					
Selling price ₹ 800 per batch					

Maximum available machine capacity for making components A, B and C is 10800 hours and it can not be increased further. Labour is available for making components D and E and for assembling the product. Estimated increase in demand next year is 50% and fixed cost in general may increase by ₹ 10000.

In order to release production capacity to meet increased market demand, the company decides to purchase one of the machine made components.

Quote Ltd is the only supplier of component A, B, and C. because of incomplete records; it is unable to quote single figure prices. Its quotation is as follows:

Component	Pessim- Probabilistic view	Probabilistic view	most likely view	Probabilistic view	Optimist- Probabilistic view	Probabilistic view
	₹	₹	₹	₹	₹	₹
A	120	0.25	110	0.5	80	0.25
B	200	0.25	130	0.5	140	0.25
C	160	0.25	140	0.5	120	0.25

It is agreed between the companies that the price of each of the components will be determined on an overall basis based on information found in the quotation.

You are required to:

- Indicate, in the context of the key factor, the maximum number of batches that could be produced, if each of the three alternatives namely buying A B or C is considered (8 Marks)
- Analyse the financial implication of purchase and advise which component is to be bought keeping in view the fact that production capacity will be limited to a 50% increase. (4 Marks)
- Prepare a profit statement for the period assuming that the component chosen by you is bought out and extra production is made and sold. (4 Marks) May/00

[Ans.: Purchased from outside
A B C

- No. of batches produced internally (in batches) 207.69 245.45 225
- Component C should be purchased from outside as it gives maximum contribution of ₹91,350
- Profit on manufacturing of 225 batches ₹51,350]

Question 46: Stirling Industries Ltd., manufactures a product 'Z' by making and assembling three components A, B and C. The components are made in a machine shop using three identical machines each of which can make any of the three components. However, the total capacity of the three machines is only 12,000 machine-hours per month and is just sufficient to meet the current demand. Labour for assembling is available according to requirements. Further details are given below:

Components	Machine-house required per unit	Variable cost per unit	Market price at which the component can be purchased if required
A	4	₹48	₹64
B	5	60	75
C	6	80	110
Assembling	-	30 (per unit of Z)	-

Fixed costs per month amount to ₹50,000. Product 'Z' is sold at ₹300 per unit.

From next month onwards. The company expects the demand for 'Z' to rise by 25%. As the machine capacity is limited, the company wants to meet the increase in demand by buying such numbers of A, B or C which is most profitable.

You are asked to find out the following:

- (a) Current demand and profit made by the company.
- (b) Which component and how many units of the same should be bought from the market to meet the increase in demand?
- (c) Profit made by the company if suggestion in (b) is accepted.

ICWA-Dec./98

[Ans.: Profit-₹15600 (b) Balance 600 units of B should be purchased from market (c) ₹23000]

Question 47: P Ltd manufacture plastic can of a standard size. The variable cost per can is ₹ 4 and the selling price is ₹ 10 each. The factory of the company has eight machines of identical size. Any individual machine can produce 30 cans per hour. The factory works on a 300 days per annum basis and actual available hour per machine per day is 7.5. The company has an order of 420000 cans from an oil company, to supply. The yearly fixed cost of the company is ₹ 20 lacs. P Ltd has received an order from another firm for supplying 60000 nos. of plastic moulded toys. The price of the toys is ₹ 60 each and the variable cost is ₹ 50 each. While this order would be acceptable for supplying for total quantities only, on acceptance, a special mould costing ₹ 225000 would be required to be acquired to manufacture the toys. The time study exercise has revealed that 15 nos. of toys can be produced per hour by any of the machines;

Advise the company, with reasons in the following situations:

- (i) Whether to accept the order of manufacturing moulded toys, in addition to supplying 420000 nos. of cans or not;
- (ii) Whether to accept the order manufacturing moulded toys, if the order of cans increased to 540000 nos. or not;
- (iii) While a sub- contractor is willing to supply the toys, either whole or part of the required quantities at an all inclusive rate of ₹ 57.5 each, what would be the minimum excess capacity needed to justify the manufacturing of any portion of the toys order, instead of sub-contracting
- (iv) The company had an understanding that the order of the cans will be increased during the year on negotiation, and planned and manufactured 450000 cans during the year. For utilizing the excess capacity, they also accepted the toys order and sub-contracting only 15000 nos. of toys.
- (v) At the year's end, however, it was revealed that the order of the cans could be for 480000 nos, if it was properly negotiated. How much loss has been suffered by the company due to improper prediction of demand and negotiation?

(17 Marks) Nov./01

[Ans.: (i) Accept the order, increase in profit by ₹375000; (ii) No; (iii) 2000 excess machine hours are required; (v) ₹67500]

Question 48: XYZ Ltd. is currently manufacturing 5,000 units of the product 'XY 100' annually, making full use of its machine capacity. The selling price & total cost p. u. associated with 'XY 100' are as follows:

	₹p.u.	₹p.u.
Selling price		900
Cost per unit:		
Direct materials	200	
Variable machine costs @₹100 per hr.	150	
Manufacturing overhead costs	180	
Marketing and administrative costs	<u>200</u>	<u>730</u>
Operating income per unit of 'XY 100'		<u>170</u>

XYZ Limited can sell additional 3,000 units of 'XY 100', if it can outsource those additional units. ABC Limited, a supplier of quality products, has agreed to supply upto 6,000 units of 'XY 100' per year at a price of ₹ 650 per unit delivered at XYZ's factory.

(including Relevant Costing, Make or Buy, Subcontracting, Shut Down Point, etc.)

XYZ Limited can use its facility to produce an alternative product 'XY 200'. It can sell up to 12,000 units of 'XY 200' annually. Estimated selling price and total costs per unit to manufacture and sell 12,000 units of 'XY 200' are as follows:

	₹	₹
Selling price per unit		600
Costs per unit :		
Direct materials	200	
Variable machine costs @ ₹100 per hr.	50	
Manufacturing overhead costs	60	
Marketing and administrative costs	<u>110</u>	<u>420</u>
Operating income per unit of 'XY 200'		<u>180</u>

Other information pertaining to the operating of XYZ Limited is as follows:

(a) XYZ Limited use machine hours as the basis for assigning fixed manufacturing overhead. The fixed manufacturing overhead for the current year is ₹3,00,000. These costs will not be affected by the product-mix decision.

(b) Variable marketing and administrative costs per unit for various products are as follows:

Manufactured	'XY 100'	₹80
Purchased	'XY 100'	₹40
Manufactured	'XY 200'	₹60

Fixed marketing and administrative costs for the current year is ₹6,00,000. These costs will not be affected by the product-mix decision.

Calculate the quantity of each product that XYZ Limited should manufacture and/or purchase to maximize operating income. Show your calculations. (16 Marks) May/02

[Ans.: Manufacture "XY 200" 12000 units; "XY 100" 1000 units; Purchase "XY 100" 6000 units]

Question 49: 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 utilization. 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% variable)	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 utilize 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 manufacture 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	33,000
Total	1,41,000

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 alternative for the use of the capacity so released, which are as under :

- (a) Rent out the released capacity at Re. 1 per hour.
- (b) 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:

- i) Prepare a statement showing profitability of the company envisaged in the budget.
- ii) Evaluate the export order and state whether it is acceptable or not.
- iii) Make an appraisal of proposal to manufacture component 'EH' and state whether the component 'EH' should be manufactured in the factory or purchased form the market. Assume that no alternative use of spare capacity is available.
- iv) Evaluate the alternative use of the spare capacity and state whether to manufacture or buy the component 'EH' and if your decision is to buy the component 'EH', which of the two alternatives for the use of spare capacity will you prefer? (16 Marks) Nov./04

[Ans.: (i) Profit ₹3168000 (ii) Acceptable (iii) 'EH' should be manufactured in the factory (iv) 'EH' should be purchased and 'GYP' should be manufactured.]

Question 50: New Vistas Ltd. is in the midst or make or buy decision. One of the components P44E produced by the company and incorporated into another product before being sold, takes 4 hours of manufacture and its budget manufacturing cost is as under:

Direct Material	₹14
Direct Labour	₹12
Variable Overheads	₹ 8
Fixed Overheads	<u>₹20</u>
	<u>54 per unit</u>

- i. One of its reliable suppliers has offered to supply P44E at a guaranteed price of ₹50 per unit. Should the company accept the offer?
- ii. Meanwhile a new situation has arisen. As per a recent Government Regulation, if P44E is continued to be manufactured, the company will incur additional inspection and testing charges of ₹56,000 per annum and this has not been included in the existed budgeted manufacturing cost of the component. In this situation, what should the company do?
- iii. As there is an embargo in the company on additional recruitment of labour, if P44E is not manufactured, the direct labour released will be employed in increasing the production of an existing product which takes 8 hours to make and is sold for ₹90. Its budgeted manufacturing cost is as under:

Direct Material	₹10
Direct Labour	₹24
Variable Overheads	₹16
Fixed Overheads	<u>₹40</u>
	<u>90 per unit</u>

- iv. The financial accountant is a bit perturbed. He points out the only last year, a special machine, exclusive for manufacture of P44E, was bought at the cost of ₹1 lakh. It cannot be resold or used elsewhere. If the production of this compeonent is stopped, a sum of ₹90,000 has to be written off from the profits of the year, being the book value of the discarded machine.

What are your comments?

[Ans.: (i) Manufacture (ii) If it is proposed to manufacture more than 3500 components, then own manufacturing will be profitable. If it is less than 3500 components, then it is advised to purchase. (iii) As the limiting factor is labour hours, it is better to manufacture the another existing product and purchase the component at the guaranteed price of ₹50, (iv) Book cost is irrelevant cost.]

Question 51: X is a multiple product manufacturer. One product line consists of motors and the company produces three different models. X is currently considering a proposal from a supplier who wants to sell the company blades for the motors line.

The company currently produces all the blades it requires. In order to meet customer's needs, X currently produces three different blades for each motor model (nine different blades). The supplier would charge ₹25 per blade, regardless of blade type. For the next year X has projected the costs of its own blade production as follows (based on projected volume of 10,000 units):

Direct materials	₹75,000
Direct labour	65,000
Variable overhead	55,000
Fixed overhead:	-
Factory supervision	35,000
Other fixed cost	<u>65,000</u>
Total production costs	<u>2,95,000</u>

Assume (1) the equipment utilized to produce the blades bus no alternative use and no market value, (2) the space occupied by blade production will remain idle if the company purchases rather than makes the blades, and (3) factory supervision costs reflect the salary of a production supervisor who would be dismissed from the firm if blade production ceased.

(i) Determine the net profit or loss of purchasing (rather than manufacturing) the blades required for motor production in the next year.

(ii) Determine the level of motor production where X would be indifferent between buying and producing the blades. If the future volume level were predicted to decrease, would that influence the decision?

(iii) For this part only, assume that the space presently occupied by blade production could be leased to another firm for ₹45,000 per year. How would this affect the make or buy decision?

[Ans.: (a) Loss: ₹20000 (b) Indifference Point is 6364 units (c) Loss: ₹25000] (9 Marks) June/09-O.C.

Question 52: B Ltd. produces and sells Bicycles. It also manufactures the chains for its Bicycles. It expects to produce and sell 24000 Bicycles during 1996-97. It is considering an offer from an outside vendor to supply any number of chains at ₹12 per chain.

The accountant of B Ltd. reports the following costs for producing 24000 chains:

Cost	Cost per unit (₹)	Total Cost (₹)
Direct Material	5.00	120000
Direct Labour	4.00	96000
Variable manufacturing overhead	2.00	48000
Inspection, set-up, etc.	1.00	24000
Machine rent	1.00	24000
Allocated fixed overhead	1.25	30000
	<u>14.25</u>	<u>342000</u>

The following additional information is available:

(i) Inspection, set-up, etc. vary with the number of batches in which the chains are produced. Currently chains are being produced in the batch size of 2000 units.

(ii) Direct labour cost represents wages to four workers who are exclusively engaged in the manufacturing of chains. These workers are in permanent capacity and cannot be retrenched.

- (iii) If B Ltd. procures all its chains from outside vendor, it will not require machine which it has hired for manufacturing chains.

Required:

- (i) Assume that if B Ltd., purchases chains from outside vendor, the facility (including workers) where the chains are currently manufactured will remain idle. Should B Ltd. accept the offer from outside vendor at the anticipated production and sale volume of 24000 units?
- (ii) Whether your decision in (i) will change if facilities can be used to upgrade the bicycles which will result in incremental revenue of ₹22 per bicycle. The variable cost of upgrading would be ₹18 and tooling cost would be ₹16000.
- (iii) Assuming that facilities will be used as stated in (ii) above. Further, assume that with better planning, B Ltd. will be able to manufacture chains in batch size of 4000 units (instead of 2000 units) if it decides to produce chains inside. (13 Marks) Nov./95

[Ans.: (i) Should not accept order from outside vendor, because this decision will lead to reduction in profit by ₹72000 (ii) Should accept the offer of alternative use of facilities for upgrading the bicycle. It will lead to increase of ₹80000 in contribution. This is more than the excess of bought out price over variable and avoidable cost. (iii) If inspection cost decreases, then excess of bought-out price over variable and avoidable costs would be ₹84000. In comparison to this, net contribution from using the internal facilities for upgrading quality of chains will ₹80000. Therefore, if batch size increases and inspection cost reduces, then use of internal facilities of updation of quality of chain is advocated. If decision to update is taken in (ii), it will increase profit by ₹4000]

Question 53: A company is engaged in manufacture of an electronic gadget. It produces 24,000 such gadgets per annum. The company also manufactures 24,000 units of a component. The department expenses per annum is as under:

Direct Materials	₹38,40,000
Direct Labour	15,36,000
Indirect Labour	7,20,000
Inspection and testing	4,80,000
Lighting	40,000
Power	4,80,000
Insurance	30,000
Depreciation (fixed)	96,000
Miscellaneous fixed expenses	54,000

If the company stops manufacturing the components and buys the same from market, the saving in the department budget would be as under:

Direct Materials	20%
Direct Labour	25%
Indirect labour	20%
Inspection & testing	25%
Power	25%

The purchase price of the component is ₹70 each.

Required:

- i. State whether the company should make or buy the components.
- ii. The company has received an offer of 12,000 units of the electronic gadget at the price of ₹245 each. If the offer is accepted by the company, the capacity will be fully utilized and the components have to be purchased. Should the company then make or buy the component? (Nov./84)

[Ans.: (i) Co. should make the component {Net Benefit ₹6 per unit} (ii) Accept Export order and buy the component (Net cash inflow ₹36000)]

SUBCONTRACTING

Question 54: Lee Electronics manufacture four types of electronic products, A, B, C, 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 overheads at different levels of operation are:

Level of operation (In production hours)	Total Fixed Cost (₹)
Upto 1,50,000	10,00,000
1,50,001-3,00,000	10,50,000
3,00,001-4,50,000	11,00,000
4,50,001-6,00,000	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 is 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.

Nov./90 [Adapted] & (18 Marks) Nov. 09-N.C.

[Ans.: Make : A – 35000 units; D – 30000 units; Subcontract: A – 17000; B – 48500 units; C – 26500 units; Total Profit ₹2324000; Alternatively, Make : A – 10000 units; D – 30000 units; Subcontract: A – 42000; B – 48500 units; C – 26500 units; Total Profit ₹2324000, but 1st alternative is preferable]

Question 55 [Bottleneck resource]: A company manufactures two products EXE and WYE, which pass through two of its departments exclusively used for them. A market research study conducted by the company reveals that the company can sale either 38,500 units of EXE or 31,500 units of WYE in a year. The manufacturing cost and selling price details are as under:

	EXE		WYE	
Selling price per unit	375		540	
Costs:				
Department 1: Direct materials	58		100	
Direct labour	5 hours	50	7.5 hours	75
Department 2: Direct materials	21		26	
Direct labour	7.5 hours	90	10 hours	120
Overheads:	Department 1		Department 2	
Variable overhead rate per DLH	₹2.40		₹3.60	
Fixed overheads	₹5, 00,000		₹10, 00,000	
Budgeted direct labour hours	1,75,000		2,80,000	

Since the quantity which can be sold exceeded the production capacity, the company has been considering the use of sub-contracting production facilities. Accordingly, when tenders were floated, two contractors

responded as under:

Contractor DS offers to produce up to a maximum of 17,500 units of EXE or 14,000 units of WYE in a year for the type of work done by department 1 of the company. The price charged by DS is ₹138 per unit of EXE and ₹212 per unit of WYE. These prices included the cost of direct materials used in department 1 of the company.

Contractor DW can produce up to a maximum of 11,200 units of EXE and 7,000 units of WYE in a year for the type of work done by department 2 of the company. The price charged by DW is ₹150 per unit of EXE and ₹192 per unit of WYE. These prices included the cost of direct materials used in department 2 of the company.

Required:

(1) If the company does not wish to use the sub-contracting facility, which of the two product and in what quantity should be produced and sold by the company by using its own manufacturing capacity to earn maximum profit? Calculate the resultant maximum profit.

(2) If the company wishes to produce either 38,500 units of EXE or 31,500 units of WYE by using sub-contracting facility, state which of the two products should be produced to maximise the profits. Calculate the resultant maximum profit. (16 Marks) May/03

[Ans.: (i) EXE should be produced internally as the resultant profit earned (₹25,95,000) is maximum; (ii) WYE should be produced as it yield ₹35,07,328 as profit]

Question 56[Overtime and Subcontract + Bottleneck resource + 2 Key Factors for 2 products]: A company manufactures two products P and Q. Both the products pass through the company's two departments, A and B. The market demand for a month is 2500 units of P and 2000 units of Q. The company has normal capacity of 600 hours in department A and 520 hours in department B per month. Overtime is acceptable upto 50% of normal hours in each department.

The details relating to the product are as under:

	Product	
	P	Q
Direct material cost per unit	₹ 10 5	
Fixed overheads per month	₹18000	6400

		Department	
		A	B
Direct labour time per unit (minutes)			
Product:	P	6	12
	Q	18	12
Direct wage rate per hour			
Normal time	₹	10	12
Overtime	₹	15	18

In the event of the company not being able to fulfill the demand for want of capacity, the balance quantity of the product can be sold by buying from a sub-contractor, who was agreed to supply product P at ₹ 18 and product Q at ₹ 12 per unit.

Required:

- (i) Calculate the quantity of each product to be manufactured and/ or to be sub- contracted in a most economical way to fulfilling the market demand.
- (ii) Present a statement showing the total cost involved in your solution in (i) above. (16 Marks) May/01

[Ans.: Total Cost is ₹81314]

Question 57: X Ltd. has incurred losses during the past five years. Its projection for the year 2002 is also not very encouraging. The management is seriously considering the closure of the only manufacturing unit.

However, it is quite open to getting the products on a sub-contracting basis and to continue its administrative and marketing functions. Currently, four products are being manufactured and sold by catering to different markets. The management is also willing to sacrifice any of these products to ensure survival.

The projections for the four products for 2002 are:

(₹ in crores)				
	A (₹)	B (₹)	C (₹)	D (₹)
Sales	72.0	54.0	84.0	60.0
Costs:				
Material	48.0	30.0	54.0	36.0
Labour	18.0	12.0	30.0	30.0
Allocated Overheads:				
Manufacturing	6.0	4.8	7.2	4.8
Admin. & Selling	2.4	1.2	3.6	2.4
Total Cost	74.4	48.0	94.8	73.2
Profit / Loss	(2.4)	6.0	(10.8)	(13.2)
The projected volume and sub-contracting charges are:				
	A	B	C	D
Volume ('000 nos.)	2,000	1,500	3,000	2,000
Sub-contracting charges / unit (₹)	80	70	90	130

Manufacturing, administrative and selling overheads consists of staff salaries, rent, essential maintenance and tax payable to the local authorities.

In case the management decides to discontinue the manufacturing operations a minimum notice period of 3 months will be required to be given to the staff as well as to the landlords of the manufacturing unit and offices. You may assume that both the manufacturing as well as the administrative and selling overheads are fixed in nature, and that in the notice period mentioned above, these expenses would continue to be incurred.

- Assume that labour costs are related to the volume of operations and do not involve any notice period for discontinuance;
- Assume that the costs are incurred and revenues earned evenly in each of the calendar months.

Based on the above, you are required to advise the management on the best option out of the options under its consideration, viz.:

- (i) Issue notices to the staff, the landlords of manufacturing unit and offices on the first day of the year and discontinue all the operations on that very day.
 - (ii) Issue notices as above on the first day of the year and continue the operations till the end of the notice period (only profitable products need to be continued).
 - (iii) Issue notices to the staff and the landlord, only in the manufacturing unit, resort to sub-contracting and to continue the administrative and marketing functions. (Sub-contracting is needed to be done on profitable products only).
- (17 Marks) Nov./01

[Ans.: The third option is most viable]

EXPORT PRICING

Question 58: C Ltd. an Indian company, has entered into an agreement of strategic alliance with Z Inc. of United States of America for the manufacture of personal computers in India. Broadly, the terms of agreement are:

- (i) Z will provide C with kits in a dismantled condition. These will be used in the manufacture of the personal computer in India. On a value basis, the supply, in terms of the FOB price will be 50% thereof.

- (ii) C will procure the balance of materials in India.
- (iii) Z will provide to C with designs and drawings in regard to the materials and supplies to be procured in India. For this, C will pay Z a technology fee of ₹3 crores.
- (iv) Z will also be entitled total royalty at 10% of the selling price of the computers fixed for sales in India as reduced by the cost of *standard* items procured in India and also the cost of imported kits from Z.
- (v) C will furnish to Z detailed quarterly returns.

Other information available:

- (i) FOB price agreed \$510.
Exchange rate to be adopted \$1 = ₹47.059
[Note: In making calculations, the final sum may be rounded to the next rupees]
- (ii) Insurance and freight – ₹500 per imported kit;
- (iii) Customs duty leviable is 150% of the CIF prices; but as a concession, the actual rate leviable has been fixed at 30% of CIF.
- (iv) The technology agreement expires with the production of 2,00,000 computers;
- (v) The quoted price on kits includes a 20% margin of profits on cost to Z.
- (vi) The estimated cost of materials and supplies to be obtained in India will be 140% of the cost of supplies made by Z.
- (vii) 48% of the value in rupees of the locally procured goods represent cost of the standard items.
- (viii) Cost of assembly and other overheads in India will be ₹2,000 per personal computer.

Required: Calculate the selling price, of a personal computer in India bearing in mind that C has targeted a profit of 20% to itself on the selling price (12 Marks) Nov/01

[Ans.: Selling Price per computer ₹43000]

Question 59: X Ltd having an installed capacity of one lakh units of a product is currently operating at 70% utilization. At current level of input price, the F.O.B. cost per unit, taking credit of applicable export incentive workout as follows:

Capacity Utilization	70%	80%	90%	100%
FOB cost per unit (₹)	97	92	87	82

The company has received three foreign offers as under:

- Sources A: 5000 units @ ₹ 55 per unit FOB
- Sources B: 10000 units @ ₹ 52 per unit FOB
- Sources C: 10000 units @ ₹ 51 per unit FOB

Required:

Advise the company whether it should accept any or all the export orders. (10 Marks) Nov./07

[Ans.: All the 3 proposals should be accepted as they will result in a profit of ₹80000 and idle capacity of 5000 units.]

SHUT DOWN POINT

Shut Down is a case where the business would be closed temporarily. In this case the some fixed costs will continue to incur.

$$\text{Shut Down Point (units)} = \frac{\text{Avoidable Fixed Cost} - \text{Shut Down Cost (i.e. saving in fixed cost)}}{\text{Contribution per unit}}$$

$$\text{Shut Down Point (in ₹)} = \frac{\text{Avoidable Fixed Cost} - \text{Shut Down Cost (i.e. saving in fixed cost)}}{\text{P/V Ratio}}$$

If demand is more than calculated units we must continue the business, otherwise it is preferable to shut it down (subject to non financial considerations).

Here, Shut down cost can be sub-divided into 3 parts:

- Costs incurred on suspension of operations.
- Costs incurred during continued shut down.
- Costs incurred in resuming operation after re-opening.

Question 60 [Shut down/Continue point]: A firm incurs a fixed cost of ₹1,20,000 at 60% capacity. At 0% capacity, fixed cost is only ₹40,000. If its VC Ratio is 80%, find out the Shutdown point.

[Ans.: ₹4,00,000/-]

Question 61: The selling price per unit of a product is ₹14. For the forthcoming period, the demand will be only 5,000 units. The fixed expenses at 50% activity (5,000 units) will be ₹30,000. The company is thinking of shutting down operations, in which case an additional amount of ₹2,000 will have to be incurred for shutting down and only ₹20,000 of the above fixed costs can be avoided.

What should be the variable cost per unit to recommend a shut down?

[Ans.: If variable cost per unit is above 10.40, it is recommended to shut-down] (6 Marks) Nov./10-O.C.

Question 62: G Ltd. produces and sells 95000 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?

[Ans.: Yes it is recommended to shut down the plant; Shut down point = 102500 units; Capacity utilization at shut down = 86.32%] (5 Marks) Nov./10-N.C.

Question 63 [Shut down/Continue point]: A paint manufacturing company manufacture 2,00,000 per annum medium-sized tins of "Spray Lac Paints" when working at normal capacity. It incurs the following costs of manufacturing per unit:

	(₹)
Direct Material	7.80
Direct Labour	2.10
Variable overheads	2.50
Fixed overheads	4.00
Product Cost per unit	16.40

The selling price is ₹21 per tin and variable selling and administrative expenses is 60 paise per tin.

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 shutdown for the quarter are estimated at ₹14,000.

- Express your opinion, as to whether the plant should be shut down during the quarter, and
- Calculate the shut down point for the quarter in terms of number of tins.

[Ans.: 14000 tin] (6 Marks) Nov/08-NC[Adapted]

Question 64 [Shut down/Continue point]: The annual budget of a company at 60% and 80% levels of performance is as under:

Level of Performance	60%	80%
	₹('000)	₹('000)
Direct Material	360	480
Direct Labour	480	640
Production Overhead	252	276
Administration Overhead	124	132
Selling & Distribution Overhead	136	148
	1352	1676

The company is in great difficulties at the present moment in selling its products and is now operating at 50% level.

The sales revenue for the year is estimated at ₹9,90,000. The Directors are seriously considering suspending operations till the market picks up.

Market Research undertaken by the Company reveals that there is every indication that in about twelve months' time, the sales will pick up and the company can comfortably operate at 75% level of performance and earn a sales revenue of ₹18 lakhs in that year.

The Sales personnel of the company do not want to suspend operations for fear of adverse reactions in the market; but the Directors want to decide the issue purely on financial consideration.

If the manufacturing and other operations of the company are suspended for a year, it is estimated that:

- The present fixed costs could be reduced to ₹2,20,000 per annum.
- The settlement cost of personnel not required would amount to ₹1,50,000.
- The maintenance of plant has to go on and that would cost ₹20,000 per annum.
- On resuming operations, the costs connected with opening after a shut-down would amount to ₹80,000.

Submit a report to the Directors and indicate therein, based on purely financial consideration, whether it would be advisable or not to suspend the company's operation in the current year.

[Ans.: Co. will incur a loss of ₹200000 if it continue producing @ 50% & will incur a loss of ₹470000 if it shut its operations temporarily]

Question 65: Supreme Ltd, which manufactures the component EXCEL, has achieved a turnover of ₹ 600000 for the calendar year 2002. The manager of the company has informed that the company has worked at the profit volume ratio of 25% and the margin of safety of 20%. But he feels due to severe competition, the selling price is to be reduced to maintain the same volume of sales for the year 2003. He does not expect any change in variable costs. He expects that due to cost reduction programme, the profit volume ratio and margin of safety will be 20% and 30% respectively and considerable saving in Fixed cost for 2003.

Even if the company prefers to shut down its operations for 2003, it expects to incur a minimum fixed cost of ₹ 60000. You are expected to:

- Present the comparative statement for the year 2002 and 2003 showing under marginal costing.
- What will be minimum sales required, if it decides to shut down its unit in 2003. (11 Marks) Nov./03

[Ans.: (i) Contribution for 2002 ₹150000 and 2003 ₹112500; (ii) ₹93750]

Question 66: TQM Limited makes engines for motor cars for its parent company and for two other motor car manufacturers.

On 31st December, the company has sufficient work order for January and one further order for 21,000 engines. Due to recession in the economy, no further order are expected until May when it is hoped economic prospect for the motor car industry will have improved. Recently factory has been working at only 75% of full capacity and the order for 21000 engines represents about one month production at this level of activity.

The board of directors are currently considering following two options :

(i) Complete the order in February and close the factory in March and April.

OR

(ii) Operate at 25 per cent of full capacity for each of three months of February, March and April.

The costs per month at different levels of activities are as follows:

	At 75% (₹)	At 25% (₹)	Idle(₹)
Direct material	5,25,000	1,75,000	-
Direct labour	5,23,600	1,73,250	-
Factory overhead:			
Indirect material	8,400	4,900	4,900
Indirect labour	1,01,500	59,500	-
Indirect expenses:			
Repair & maintenance	28,000	28,000	-
Other expenses	52,500	34,400	26,600
Office overhead:			
Staff salaries	1,48,400	98,000	67,550
Other overheads	28,000	19,950	11,200

Other information is as follows:

- Material cost and labour cost will not be incurred where there is no production.
- On the reopening of the factory, one time cost of training and engagement of new personnel would be ₹65,800 and overhauling cost of plant would be ₹14,000.
- Parent company can purchase engines from open market at reasonable price.

Required:

To express your opinion, along with calculations, as to whether the plant should be shut down during the month of March and April or operate 25% of full capacity for three months. (11 Marks) June/09-O.C.

[Ans.: TQM Ltd. is recommended to operate at 75% capacity in Feb. and shut down in March & April]

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 a 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 constrain, it may selling off it's unprofitable or less profitable division and utilised the recourse so released. Cost Benefit Analysis & Capital Budgeting Method are the useful tool for analysing 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 organisation, it is better to cut down of that operation of the product or business segment or subsidiary.
4. If managing of the organization is very constrained, it is good to dispose off the unwanted and undesirable activity of the organization, which involve large management skill so that it can concentrated on the core activities of the organization.
5. In the situation where the firm suffering from loss, selling off or divestment policy is one suitable option to exit in the current position and to go for turn around strategy.

Question 67: What is divestment strategy? Highlight the main reasons for divestment?(4 Marks)June/09-N.C.

Question 68: 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 p.u. (₹)	40	75	85
Direct Materials p.u. (₹)	10	14	18
Direct wages pu. @ ₹2 p.hr.	8	12	10
Variable overhead pu. (₹)	8	9	10
Fixed overhead (₹) p.u.	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:

- (i) Prepare a statement of profitability of products A, B and C in existing situation.
- (ii) Evaluate the above proposals independently and calculate the overall profitability of the company under each proposal.
- (iii) What proposal should be accepted, if the company wants to maximise its Profit?

May/10 (RTP-N.C.)-Adapted & (10 Marks) May/10-N.C.

[Ans.: ₹1070000; (ii)(a) ₹1424800, (b) ₹1378250, (c) ₹1337500; (iii) Proposal (c)]

INVENTORY DECISIONS

Formulae

1. Minimum level of inventory = Re-order level - (Average rate of consumption × lead time)
2. Maximum level of inventory = Re-order level + Re-order quantity –
(Minimum consumption × Minimum re-order period)
3. Re-order level = Maximum re-order period × Maximum Usage

Or

Minimum level or safety stock level + (Average or normal rate of consumption × Average time to obtain fresh supplies).

$$4. \quad \text{Average inventory level} = \text{Minimum} + \frac{1}{2} \text{ Re- order quantity} \quad (\text{or}) \\ (\text{Maximum level} + \text{Minimum level}) \div 2$$

$$5. \quad \text{EOQ} = \sqrt{\frac{2 \times \text{Annual consumption (A)} \times \text{ordering cost per order (C}_o)}{\text{Carrying cost per unit per annum (C}_h)}}$$

$$6. \quad \text{Total ordering cost} = \text{No. of order} \times C_o$$

$$\text{Annual carrying or storing or holding cost} = \text{Quantity per order} \div 2 \times C_h$$

Total ordering & carrying cost (Known as Relevant Storing cost)

$$= \sqrt{2 \times \text{Annual consumption} \times C_o \times C_h}$$

$$7. \quad \text{Buffer stock} = \text{ROL} - \text{Consumption during the lead time.}$$

If the result is negative then it is known as Stock Out Quantity

$$\therefore \text{Stock out quantity} = \text{Consumption during the lead time} - \text{ROL}$$

$$\therefore \text{Expected Stock out quantity} = \sum (\text{Present Stock out quantity} - \text{increase in ROL}) \times \text{Probability}$$

$$\text{Stock out cost} = \text{Expected Stock out quantity} \times C_S \quad (\text{Stock-out cost p.u.})$$

$$\text{Storing cost} = \text{Increase in stock} \times C_h$$

8. The best stock policy : Select the min of annual carrying/storing/holding + total ordering cost + stock out cost. (objective minimization of total cost)

Question 69: Kartik Co. is organized into two processes. Raw material is introduced into Process A and its output becomes the raw material for Process B. The finished goods of Process B is sold in the market. Process A has a capacity to process an input of 200000 kg of raw material per annum. The normal scrap is 10% and 5% of input in Process A and Process B respectively. The realizable value of scrap is Re.1 and ₹2 per kg respectively for processes A and B. The operating data for a year are as under:

	Process A	Process B
Direct Wages	₹2200000	2100000
Overheads	₹956000	1345800

There are three suppliers of raw material whose price quotations and terms are as under:

Supplier	Price ₹/kg	Terms
P	10.00	Maximum quantity offered is 120000 kg.
Q	11.20	Maximum quantity offered is ₹160000 kg.
R	11.00	₹11 only when the entire quantity of 200000 kg is ordered. For any quantity less than 200000 kg the price charged is ₹11.60 per kg

In each case, the raw material is to be collected from the supplier's factory. The variable transport cost for bringing the raw material is ₹1.20 per kg, ₹1 per kg and Re. 1 per kg for P, Q and R respectively. The annual fixed transport cost will be ₹200000 irrespective of the supplier from whom the material is purchased.

The output emerging from Process B can be sold to three customers at the prices and terms given below:

Customer	Price ₹/kg	Discount	Condition
K	65	2%	Maximum quantity acceptable to K is 80000 kg
L	64	2%	Maximum quantity acceptable to L is 160000 kg
M	61.80	-	Provided the entire production of the company is sold to M

In the case of customers K and L, fixed delivery costs of ₹5000 in total per month will be incurred. The variable delivery costs in respect of customers K and L respectively are ₹2.60 and ₹1.44 per kg. However, customer M will collect the output from the company's factory at his own cost.

Required:

1. Indicate with supporting calculations the choice of (a) Suppliers and (b) customers
2. Based on your recommendation above, prepare a statement showing the process-wise costs and profit of the company for the year.

[Ans.: Profit is ₹1484000]

Question 70: The Stock Control Policy of Sakti Co. is that each stock is ordered twice a year, the quantum of each order being one-half of the year's forecast demand. The Materials manager, however, wishes to introduce a policy in which for each item of stock, Re-order Levels and EOQ is calculated.

For one of the items X, the following information is available:

Forecast Annual Demand	3600 units
Cost per unit	₹100
Cost of Placing an order	₹40
Stockholding Cost	20% of the average stock value
Lead Time	1 month
Buffer stock to cover fluctuation in demand	100 units

If the new policy is adopted, calculate for stock Item X, - (a) Re-order Level that would be set by the Materials manager (b) Anticipated Reduction in value of the average stock investment (c) Anticipated reduction in total inventory costs in the first and subsequent years. (10 Marks) Nov./01

[Ans.: (a) 400 units (b) ₹74000 (c) ₹3680]

Question 71: X Ltd. presently has its inventory turnover (based on Cost of Goods Sold ÷ Average Inventory) at 10 times p.a. as compared with the industry average of 4. Average Sales are ₹450000 p.a. Variable Cost of Sales are 70% of Sales and Fixed Costs are ₹10000 per annum. Carrying Costs of Inventory (excluding financing costs) are 5% per annum. Sales force complained that low inventory levels are resulting in lost sales due to Stock-outs. The Sales manager has made an estimate based on stock-out reports as under:

Inventory Policy	Inventory Turnover	Sales
Current	10	₹450000
A	8	₹500000
B	6	₹540000
C	4	₹565000

On the basis of the above estimates and assuming a 40% tax rate and an after-tax required return of 20% on investment in inventory, which policy would you recommend.

[Ans.: Policy as its net benefit is ₹₹75034]

MISCELLANEOUS

Question 72: A company can produce and sell at its maximum capacity 20,000 units of a product. The sale price is ₹ 100. The present sale is 15,000 units. To produce over 20,000 units and upto another 10,000 units some balancing equipments are to be installed at a cost of ₹ 10 lakhs and the same will have a life span of 10 years.

The current cost structure is as under:

Direct material	30% of sale value
Direct labour	20% of sale value

Variable overheads	₹ 20 per unit
Profit	₹ 15 per unit

The present cost is estimated to go up due to price escalation as under:
10% in direct material from present level of 30%
25% in Direct labour from present level of 20%
₹ 50000 in fixed overheads per year.

There is a concrete proposal from a party to take 10000 units additionally over the present level of output on a long term basis at a unit price of ₹ 90. Apart from the investment of ₹ 10 lakhs, as above, the fixed overheads will increase by ₹ 50000 due to additional administrative expenses.

The company is in a dilemma as to whether to accept the order for 10000 units or to use the present unused capacity of 5000 units for which there will be additional selling expenditure of ₹ 50000. Ignore financial charges and give your recommendation. (14 Marks) Nov./98

[Ans.: Attaining the maximum capacity by incurring additional selling expenditure is the best proposal]

Question 73: Unique Product manufactures and sells in a year 20000 units of a particular product to definite customer at a price of ₹ 100 per unit. The concern has a capacity to produce 25000 units of the product per annum. To produce beyond 25000 units per annum, the concern will have to install a new equipment at a cost of ₹ 15 lakhs. The equipment will have a life span of 10 years and will have no residual value. There is an offer from a client to purchase 10000 units of the product regularly at a price of ₹ 90 per unit. The order, if accepted, will have to be over and above the existing level of production of 20000 units. The cost structure is as under:

	Per Unit ₹
Direct material	30
Direct labour	20
Variable overhead	10
Profit	20

During the coming year, it has been estimated that the cost of direct material, as compared to the current year will be increased by 10%. Because of certain wage agreement direct labour cost will increase by 25%. Fixed overhead will increase by 10%. If the new order of 10000 units is accepted, fixed overhead will increase further by ₹ 60000 due to increased administrative charges.

You are required to analyze whether the concern should accept the order or instead of that try to secure order for the balance unused capacity, as available now, through some sales promotion expenses which will be ₹ 50000 per annum. Ignore financial charges for the new investment. (8 Marks) May/00

[Ans.: It is advisable to produce and sell 25000 units @ ₹100 per unit and utilize full production capacity, as only then the profit would be maximum i.e. ₹310000]

Question 74: A company manufacturing chemicals furnishes the following data of their activities for the year 1993-94. The company manufactures three products namely Ethylene, EDC, and VCL. Ethylene is consumed for making EDC and EDC is consumed for making VCL. One metric ton of Ethylene is required to make one metric ton of EDC and one metric ton of EDC is required for making one metric ton of VCL. The other particulars:

	Ethylene	EDC	VCL
Production capacity per annum (metric tons)	25000	30000	30000
Cost per Metric ton:			
Variable Costs	₹20	₹30	₹40
Product Fixed Costs	20	30	40
Common Fixed Costs	10	15	20
Total	50	75	100
Selling Price per Metric Ton (₹)		150	300
Sales per annum (Metric tons)		10000	15000

The company restricts the manufacture of all its products only to the extent of the sales demand. The management is concerned with the low capacity utilization. In order to achieve fuller utilization of plant capacity, the company entered into negotiations with various parties. As a result of the negotiations, X who buys one-third of the current sales volume of VCL, offers to buy 20000 metric tons of VCL per annum of ₹250 per metric ton provided the entire quantity of 20000 metric tons is sold to him. This purchase is for the captive consumption of X and therefore will not affect the market price of VCL. X also offers to supply EDC for manufacture of VCL to the extent of 5000 metric tons at a price of ₹125 per metric ton. The company can also buy EDC from open market at ₹140 per metric ton if the order is for 10000 metric tons or more.

The bases of various costs given above are as follows:

- (i) Variable costs exclude the cost of internally consumed Ethylene in the manufacture of EDC and costs of EDC consumed in the manufacture of VCL.
- (ii) Fixed Costs are based on normal capacity production.
- (iii) The product fixed costs can be avoided only if there is nil production of the product concerned.
- (iv) Common fixed costs are to be incurred irrespective of production and sales.
- (v) No closing stocks are maintained.

You are required to: (a) Draw up a statement of profitability in respect of the year 1993-94 as originally envisaged by the company.

(b) If the company decides to accept the offer of X to buy 20000 metric tons of VCL at ₹250 per metric ton and if the balance quantity of production of VCL can be sold in the market show the revised statement of profitability of the company. (14 Marks) Nov/94

[Ans.: (a) Profit ₹250000 (b) Profit ₹1050000]

[Note.: Suggested answers by ICAI has taken an assumptions that Normal Capacity is Annual Production Capacity & co. will stop selling 10000 metric tons of EDC to outside customers]

Question 75 [Second Shift]: Agrocaps Ltd. engaged in manufacturing agricultural machinery, is preparing its annual budget for the coming year. The company has a metal pressing capacity of 20000 hours, which will be insufficient for manufacture of all requirements of components A, B, C and D.

The company has the following choices:

- (i) Buy the components entirely from outside suppliers.
- (ii) Buy from outside suppliers and/or use a partial second shift.

The data for the current year are given below:

Component	Standard production cost per unit			
	A	B	C	D
Requirements in units	2000	3500	1500	2800
Variable Costs:	₹	₹	₹	₹
Direct materials	37	27	25	44
Direct wages	10	8	22	40
Direct expenses	10	20	10	60
Fixed overhead	5	4	11	20
Total production cost	62	59	68	164

Direct expenses relate to the use of the metal presses which cost ₹10 per hour to operate. Fixed overheads are absorbed as a percentage of direct wages.

Supply of all or any part of the total requirements can be obtained at the following prices, each delivered to the factory:

Component	₹	Component	₹
A	60	C	52
B	59	D	168

Second shift operations would increase direct wages by 25 per cent over the normal shift and fixed overhead by ₹500 for each 1000 (or part thereof) second shift hours worked.

You are required to present, with calculations:

- (b) Which component, and in what quantities should be manufactured in the 20000 hours of press time

available?

- (c) Whether it would be profitable to make any of the balance of components required on a second shift basis instead of buying them from outside suppliers.

Nov./92

[Ans.: All requirements of D & A can be manufactured and only 600 units of product B can be manufactured. The balance requirement of product B i.e. 2900 units will have to be bought-out or manufactured in the second shift.]

Question 76[Second Shift]: A company has a capacity of 40,000 hours per annum for manufacture of four components required for assembly of a product. The data are as under:

Components	P ₹	Q ₹	R ₹	S ₹
Materials	64.75	47.25	43.75	77.00
Labour (₹8.75 per hour)	17.50	35.00	17.50	105.00
Direct Expense	17.50	14.00	38.50	70.00
Fixed Overheads	8.75	7.00	19.25	35.00

The data relating to the number of components required per annum and the prices of the components, if purchased from the market, are as under:

	P	Q	R	S
No. of components required	2,400	4,800	1,200	2,400
Purchase price per component (₹)	105	103	91	294

If the company resorts to working a second shift to manufacture its requirement of components, it will increase the labour costs by 25% over normal shift. In addition the fixed costs will increase by ₹875 per 1,000 hours or parts thereof of second shift working.

You are required to prepare statements to show:

- Which of the components and in what quantities should be manufactured in 40,000 hours.
- Whether it will be profitable to manufacture any balance quantity of components by second shift operation.

[Ans.: (i) S-2400, P-2400, Q-1600 (ii) Second shift is not recommended]

Question 77: R Ltd will produce 300000 kgs of S and 600000 kgs of Y from an input of 900000 kgs of raw material Z.

The selling price of S is ₹ 8 per kg and that of Y is ₹ 6 per kg. Processing cost amount to ₹ 54 lacs per month as under:

Raw material Z 900000 kgs	
At ₹ 3 per kg	₹ 2700000
Variable processing cost	₹ 1800000
Fixed processing cost	₹ 900000
Total	5400000

There is an offer to purchase 60000 kgs of Y additional at a price of ₹ 4 per kgs. The existing market for Y not be affected by accepting the offer. But the price of S is likely to be decreased uniformly at all sales.

Find the minimum reduced average price for S to sustain the increased sales.

(7 Marks) Nov./99

[Ans.: ₹7.91]

Question 78: AB Ltd. manufactures product 'X'. the company operates single shift of 8 hours for 300 days in a year. The capital employed in the business is ₹18 crores.

The manufacturing operations of the company comprise of four production departments. The company at present produces 9,000 units of product 'X' at mimum capacity. However, the capacity utilization of all the four departments are not equal and the present individual capacity utilizations are as under:

Department	Capacity Utilisation %
A	75
B	100
C	70
D	50

The present return on capital of the company has gone down to 10% from the earlier cut-off rate of 15% due to increased cost of production.

As the company cannot operate more than one shift, the management is considering two alternative proposals to increase the return on capital employed.

Alternative I

To hire out the surplus capacity of departments A, C and D. The cost and revenue projections are as under:

Department	Hire Charges per Hour	Incremental Cost per Hour
A	2,500	2,000
C	1,800	1,500
D	1,600	1,200

Alternative II

To increase the installed capacity of the factory to 12,000 units by adding plant and machinery in department B at a capita cost of ₹4 crore. Any Balance surplus capacity in other departments after meeting the increased volume to be hired out as per alternative I. The additional units would fetch incremental revenue of ₹1,600 per unit.

You are required to evaluate the two proposals and suggest to the management, which of the two proposals is to be accepted. (10 Marks) May/00

[Ans.: ROI for Alternative I is 10.533% and Alternative II is 10.53%]

Question 79 [Joint Cost]: P. W. Perfume Company manufactures various qualities of perfumes and colognes. One popular line of colognes includes three products that result from a joint production process. Below are data from the most recent month of production:

Product	Sales Price	Quantity	Joint cost	Cost after split off	Total cost
Evergreen	₹40	10,000	₹28	₹20	₹48
Morning Flower	₹100	6,000	₹28	₹40	₹68
Evening Flower	₹150	4,000	₹28	₹50	₹78

As the Controller, you are called into the Presidents Office with the Director of Marketing. The President says, "I don't understand your product cost report. Either, we are selling our largest-volume product at a loss or the product cost data are all wrong. Now what is it?"

Required:

- (i) Respond to the Presidents question.
- (ii) Another company has just introduced a product that competes directly with Morning Flower to compete successfully with the other company's product, the price of Morning Flower cologne must be reduced to ₹60. Should the company do so and sell below cost?
- (iii) If P. W. Perfume Company has a policy of maintaining a gross margin of 20 per cent on sales, what would your answer be in response to the price reduction in part (ii)?
- (iv) What is the minimum price for which Morning Flower can sell and still meet the 20 per cent product gross margin for the group of products? (13 Marks) Nov./00

[Ans.: (i) Profit earned from Evergreen ₹833333, Morning Flower ₹150000 & Evening Flower ₹166667; (ii) The co. should sell Morning Flower below cost; (iii) A reduction in sale price would result in a loss of revenue of ₹140000; (iv) Minimum price per unit is ₹83.33]

Question 80 [Joint Cost]: Inorganic Chemicals purchase salt and processes it into more refined product such as caustic soda, chlorine and polyvinyl chloride (PVC). For the month of October, 1998, the firm

purchased salt for ₹ 80000, conversion cost incurred were ₹ 120000 upto the split-off point, at which time two salable products were produced: Caustic soda and chlorine. Chlorine could be further processed into PVC. Production and other relevant information for the month of October, 1998 are as follows:

	Production	Sales	Sale price per ton
Caustic soda	2400 tons	2400 tons	₹ 100
Chlorine	1600 tons	-	-
PVC	1000 tons	1000 tons	₹ 400

The full production of chlorine was further processed at an incremental cost of ₹ 40000 to yield 1000 tons of PVC. There were no by-products or scrap from this further processing of chlorine. The organization did not have any opening or closing stocks of any of the above commodities for October, 1998. There is a very active market for chlorine. The firm could have sold its entire production for October, 1998 at ₹ 150 per ton.

You are required to calculate:

- How the joint cost of ₹ 200000 would be allocated between caustic soda and chlorine under each of the methods, viz., (a) sales value at split-off: (b) physical measure (tons): and (c) estimate net realizable value?
- The gross margin percentage of (a) caustic soda and (b) PVC under the three methods given in (i) above.
- Daily Swimming pool Ltd. offers to purchase 1600 tons of chlorine in November, 1998 at 150 per ton. This would mean that no PVC would be produced that month. Will the acceptance of the offer affect the operating income for November, 1998?

[Ans.: Caustic Soda Chlorine

(i)	(a) Sale value at split off	240000	240000	
	(b) Sales in tons	2400	1600	
(ii)	Sale Value at split off	Physical Measure(tons)	Estimated net realizable value(₹)	
	(a)Caustic Soda	58.33%	50%	66.67%
	(b) PVC	65%	70%	60%
(iii)	Incremental operating income (₹120000)]			

Question 81: A company manufactures two products. Each product passes through two departments A and B before it becomes a finished product. The data for a year are as under:

	Product	Aristocrat	Deluxe
(i)	Maximum sales potential in units	7400	10000
(ii)	Product unit data:		
	Selling price per unit	₹90	₹80
	Machine hour per unit:		
	Dept. A Hours	0.50	0.30
	Dept. B Hours	0.40	0.45
(iii)	Maximum capacity of Department A is 3400 hours and of department B is 3840 hours.		
(iv)	Maximum quantity of direct material available is 17000 Kg. Each product requires 2 Kg of direct materials. The purchase price of direct material is ₹ 5 per Kg.		
(v)	Variable costs are budgeted at ₹50 per hour for department A and ₹ 60 per hour for department B.		

In view of aforesaid production capacity constraints, the company has decided to produce only one of the two products during the year under review.

Required:

- Which of the two products should be produce and sold in the year under review to maximize the profit. State the number of units of that product and the resultant contribution.
- The surplus capacity available in Department A or Department B after manufacture of either Aristocrat or Deluxe is proposed to be hired out to earn a contribution of ₹40 per hour in the case of Department A and

₹ 60 per hour in the case of department B. Prepare a statement to show whether Aristocrat or Deluxe should now be produced to maximize the total contribution. Calculate such total contribution.

- (iii) The company has been advised to produced 4250 units of each product and also to hire out to hire out the surplus capacity of Department A and/or Department B. You are required to examine the feasibility of this proposal and to prepare a budget analysis showing to total contribution for the year.

[Ans.: (i) 8500 units of Deluxe model should be produced; (ii) Total contribution: Aristocrat ₹278000, Deluxe ₹272900; (iii) Total Contribution ₹264400] (16 Marks) May/04

Question 82: Zilmil Ltd makes two product 'Brightly' and 'Lightly'. Both the products use the same labour force, the size of which is restricted to 78000 hours per month. Brightly needs 2 hours per unit to make whereas lightly needs one hour. The estimated production and sale, manufacturing and selling expenses per month are as follows:

Production and sale (in nos.) Cost per month (₹)	Brightly		Lightly	
	12000	16000	40000	48000
	3400000	3800000	6200000	6680000

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	12000	14000	16000	18000	20000	22000
Lightly:						
Selling price per unit (₹)	163	162	161	160	154	152
Sales demand per month	40000	42000	44000	46000	48000	50000

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

ICWA June/94-Adapted & (11 Marks) May/06

[Ans.: Brightly-16000 units, ₹268 per unit; Lightly – 46000 units, ₹160 per unit]

Question 83: A manufacturing company has an installed capacity of 150000 units per annum. Its cost structure is given below:

	(Per unit)
	₹
Variable cost	10
Labour (Minimum ₹ 100000 per month)	10
Overheads	4

Fixed overheads: ₹ 192300 per annum

Semi-variable overheads ₹ 60000 per annum at 75% capacity, which increased by 4000 per annum for every 5% increase in capacity utilization for the year as a whole.

The capacity utilization for the next year is estimated at 75% for three month, 80% for six month and 90% for the remaining part of the year. If the company is planning to have a profit of 20% on the selling price, calculate the selling price per unit (12 Marks) May/10 – O.C.[Adapted] & (12 Marks) Nov./03

[Ans.: Selling price per unit ₹32.90]

Question 84 [Bottleneck resource]: 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:

Per unit	Part A	Part B
Alloy usage	1.6 kgs	1.6 kgs
Machine time : Machine A	0.6 hrs	0.25 hrs
Machine time : Machine B	0.5 hrs	0.55 hrs
Target Price (₹)	145	115

(including Relevant Costing, Make or Buy, Subcontracting, Shut Down Point, etc.)

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 optimise contribution at the offered price. If Y Ltd. reduces target price by 10% and offers ₹60 per hour of unutilised machine hour, what will be the total contribution from the spare part identified above? (8 Marks) May/10-N.C.

[Ans.: (i) Total Contribution-Part A: ₹179982, Part B: ₹162500; Hence Part A (ii) ₹153369]

Question 85 [Bottleneck resource]: TP Ltd. produces a product which passes through two processes - cutting and finishing.

The following information is provided :

	Cutting	Finishing
Hours available per annum	50,000	60,000
Hours needed per unit of product	5	12
Fixed operating costs per annum excluding direct material	10,00,000	10,00,000

The selling price of the product is ₹1,000 per unit and the only variable cost per unit is direct material, which costs ₹400 per unit. There is demand for all units produced.

Evaluate each of the following proposals independent of each other:

- An outside agency is willing to do the finished operation of any number of units between 5,000 and 7,000 at ₹400 per unit.
- An outside agency is willing to do the cutting operation of 2,000 units at ₹200 per unit
- Additional equipment for cutting can be bought for ₹10,00,000 to increase the cutting facility by 50,000 hours, with annual fixed cost increased by ₹2 lacs. (4 Marks) Nov./10-O.C.

[Ans.: Current Profit ₹10 lacs; (i) Increase in profit ₹10 lacs; (ii) Increase in costs ₹4 lacs; (iii) Initial cost ₹2 lacs & Increase in annual costs ₹2 lacs]

Question 86: A Company manufactures two products 'X' and 'Y'. Company's fixed cost per annum is ₹5 lacs. These products are sold for ₹288 per unit of 'X' and ₹432 per unit of 'Y'. Standard cost data are:

	Product 'X'	Product 'Y'
	₹	₹
Direct Raw Material	40	80
Direct wages ₹8 per hour in Departments:		
1	48	72
2	24	48
3	72	—
4	—	96
Variable overhead	32	28

The Company operates 8 hours shift for 300 days in a year. Number of workers engaged by each department is given below:

Department	1	2	3	4
No. of Workers	45	24	27	36

Required:

- (a) How many units of each product should be manufactured and what is the resultant maximum profit, if numbers of employees cannot be increased or transferred?
- (b) If only one product is to be manufactured by the Company, which of the products would give the maximum profit and what is the amount of such profit? (11 Marks) May/06

[Ans.: (a) Product X-7200 units, Product Y-6000 units, Maximum Profit ₹666400; (b) Product Y-7200 units, Product X – 4800 units, Maximum Profit ₹623200]

Question 87: Carcare Corporation has just today paid for and installed a special machine for polishing cars at one of its prestigious outlets. It is the first day of the company’s fiscal year. The machine costs ₹20,000. Its annual operating costs total ₹15,000 exclusive of depreciation. The machine will have a four-year useful life and a zero terminal disposal value.

After the machine has been used for one day, a machine salesman walks in. He offers a different machine that promises to do the same job at a yearly operating cost of ₹9,000, exclusive of depreciation. The new machine will cost ₹24,000 in cash, duly installed. The “old” machine is unique and can be sold outright for only ₹10,000 minus ₹2,000 removal cost. The new machine, like the old one, will have a four-year useful life and zero terminal disposal value.

For simplicity, ignore income taxes, interest and present value considerations.

Sales, all in cash, will be ₹1,50,000 annually and other cash costs will be ₹1,10,000 annually, regardless of this decision.

Required:

- (a) Prepare a statement of cash receipts and disbursements for each of the four years under both alternatives. What is the cumulative difference in cash flows for the four years taken together?
- (b) Prepare Income Statements for each of the four years under both alternatives. Assume straight-line depreciation. What is the cumulative difference in operating income for the four years taken together?
- (c) What are the irrelevant items in your presentations in requirements (a) and (b)? Why are they irrelevant?
- (d) Suppose the cost of the “old” machine was ₹10,00,000 rather than ₹20,000. Nevertheless, the old machine can be sold outright for only ₹10,000 minus ₹2,000 removal cost. Would the net differences in requirements (a) and (b) change? Explain.
- (e) “To avoid a loss, we should keep the old machine.” What is the role of book value in decisions about replacement of machines? (19 Marks) Nov./98

[Ans.:

	Keep Old Machine			Buy New machine		
	Year 1	2 nd , 3 rd & 4 th year each	All 4 years	Year 1	2 nd , 3 rd & 4 th year each	All 4 years
(a) Net Cash inflow	5	25	80	(5)	31	88
(b) Operating Income	20	80	13	25	88	8

- (c) Purchase cost of old machine (₹20000), Sale Revenue (₹150000) and other cash costs (₹110000).
- (d) The net difference will not change.]

Question 88: A firm needs a component in an assembly operation. If it wants to do the manufacture itself, it would need to buy a machine for ₹ 4 lakhs which will last for 4 years with no salvage value. Manufacturing cost in each of the 4 year would be ₹6 lakhs, ₹7 lakhs, ₹8 lakhs & ₹10 lakhs respectively. If the firm had to buy the components from a supplier, the cost would be ₹ 9 lakhs, ₹10 lakhs, 11 lakhs and ₹ 14 lakhs respectively in each of the four year. However, the machine would occupy floor space which would have been used for another machine. This latter machine would be hired at no cost to manufacture an item, the sale of which would produce net cash flows in each of the four year of ₹ 2 lakhs. It is impossible to find room for both the machine and there are no other external effects. The cost of capital is 10 % and the present value factor for each of the four year is 0.909, 0.826, 0.751 and 0.683 respectively.

Should the firm make the component or buy from outside.

(10 Marks) May/99

[Ans.: There is a saving of ₹14800 in buying the component from outside]

Question 89: A company produces main product "Super" and a co-product "Mild". The main product is sold entirely to its collaborator, but the product "Mild" is sold at the local market. The company increased its capacity as a result of which the output of "Mild" increased to 15000 m/t per annum at a price of ₹ 1000 pt.

However in the face of increased competition to sell the entire output of 15000 m/t of "Mild" the company will have to reduce the sale price by ₹ 50 pt. every year for next five year and thereafter the price will at ₹ 750 pt. As an alternative the company can convert "Mild" into "Medium" at a variable cost of ₹ 200 per (metric) tone. However to enter the market the sale price will have to be ₹ 1200 pt in the first year and ₹ 1300 pt, in the second year.

The sale of Medium will be 1000m/t in the first and there upon going up by 1000m/t each year. The company will have to invest ₹ 30 lakhs in capital outlay to produce "Medium"

You are required to present the projected sales volume (quantity and value) of products "Mild" and "Medium" and also appraise the investment of ₹ 30 lakhs at 12% per annum for the period of next 5 years.

Year	Present value of Rupee one at 12% p.a.
1	0.89
2	0.79
3	0.71
4	0.64
5	0.57

(11 Marks) May/00

[Ans.: The company should opt for second option as the NPV (₹477.31 lacs) is better than the first option (₹464.925 lacs)]

Question 90: A consumer goods manufacturer uses large volume of tin containers, which are sold on a returnable basis to their local distributors, who are required to deposit ₹25% per tin, refundable on return of the tins. The company incurs a cost of ₹32 per tin, which, depending upon its condition on return, can be used six to eight times. Unusable tins are sold as scrap at ₹8 per tin, normally, 15,000 tins are scrapped each month.

The company has received a suggestion from an employee to convert such scrapped tins into usable lids for the container, as a cost reduction proposal. Following data is available concerning this proposal:

- Each rejected tin can be converted into 5 lids of acceptable quality, after rejections.
- Cost of conversion into lids is ₹50 per 100 pcs.
- Each tin weighs 1 kg and each lid weighs 120 gms.
- Scrapped lids and other off-cuts of the tin can be sold @ ₹5/kg.
- Company's requirement of lids is one lakh per month, which it currently buys at ₹2 per pc.

Required:

- An evaluation of the proposal, with supporting working and your recommendation whether or not to accept the proposal.
- A statement of estimated savings that will accrue to the company, if the proposal is accepted.

[Ans.: (a) Proposal should be accepted (b) Savings of ₹270000]

Question 91: 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:

- (i) State what is Ret's best strategy along with supporting calculations.
- (ii) Compute the break-even point in units, considering only the above costs. (13 Marks) June 09-N.C.

[Ans.: Buy 150 units from Company Ltd & sell 110 at store & 40 outside; (ii) 175 units.]



Miscellaneous Theory Chapters

TOTAL QUALITY MANAGEMENT (TQM)

TQM is composed of three paradigms:

Total = Quality involves everyone and all activities in the company.

Quality = Conformance to Requirements (Meeting Customer Requirements).

Management = Quality can and must be managed.

Definition:

TQM is defined as 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.

- The TQM approach highlights the need for a customer-oriented approach to management reporting, eliminating some or more of traditional reporting practices.
- TQM seeks to increase customer satisfaction by finding the factors that limit current performance.
- The emphasis of TQM is to design and build quality in the product, rather than allow defectives and then inspect and rectify them. The focus is on the causes rather than the symptoms of poor quality.

Though the goal is zero defects, the methodology is one of continuous improvement.

Three core concepts of TQM:

1. **Quality Control (QC):** It is concerned with the past, and deals with data obtained from previous production, which allow action to be taken to stop the production of defective units.
2. **Quality Assurance (QA):** It deals with the present, and concerns the putting in place of system to prevent defects from occurring.
3. **Quality Management (QM):** It is concerned with the future, and manages people in the process of continuous improvement to the products and services offered by the organization.

Various stages / steps to be taken in the implementation of TQM:

Stage 1: Identification of customers/customer groups: through a team approach (a technique called Multi-voting), the firm should identify major customer groups. This helps to prioritize the list of customers and provides a focus of services.

Stage 2: Identifying customer expectations: Once the major customer groups are identified, their expectations are listed. The question to be answered is – what does the customer expect from the firm?

Stage 3: Identifying customer decision-making requirements and product utilities: Where the focus is on quality improvement, the overriding need is to stay close to the customers and follow their suggestions. In this way, a decision-support system can be developed, incorporating both financial and non-financial information, which seeks to satisfy user requirements. Hence, the firm finds out the answer to – what are customer's decision – making requirements and product utilities? The answer is sought by listing out managerial perceptions and not by actual interaction with the customers.

Stage 4: Identifying perceived problems in decision-making process and product utilities: Using participative processes such as brainstorming and multi-voting, the firm seeks to list out its perception of problem areas and shortcomings in meeting customer requirements.

This will list out areas of weakness where the greatest impact could be achieved through the implementation of improvements. The firm identifies the answer to the question – what problem areas do we perceive in the decision-making process?

Stage 5: Comparison with other organizations and bench marking: Detailed and systematic internal deliberations allow the firm to develop a clear idea of their own strengths and weaknesses and of the areas of most significant deficiency. The benchmarking exercise allows the firm to see how other companies are coping with similar problems and opportunities.

Stage 6: Customer feedback: Stages 1 to 5 provide information base, developed without reference to the customer. This is rectified at stage 6 with a survey of representative customers, which embraces their views on perceived problem areas. Interaction with the customers and obtaining their views, helps the firm in correcting its own perceptions and refining its processes.

Stage 7 & 8: The identification of improvement opportunities and Quality Improvement Process: The outcomes of the customer survey, benchmarking and internal analysis provides the inputs for stages 7 and 8, i.e. the identification of improvement opportunities and the implementation of a formal improvement process. This is done through a six-step process called PRAISE, for short.

“PRAISE Analysis”

The identification of improvement opportunities and implementation of quality improvement process (Stages 7 and 8) of the TQM Process is through a six-step activity sequence, identified by the acronym ‘PRAISE’.

Step	Activity	Elements
1	Problem Identification	<ul style="list-style-type: none"> • Areas of Customer Dissatisfaction • Absence of Competitive Disadvantage • Complacency Regarding Present Arrangements
2	Ranking	Prioritize problems and Opportunities by <ul style="list-style-type: none"> • Perceived Importance, and • Ease of Measurement and solution
3	Analysis	<ul style="list-style-type: none"> • Ask “why?” to identify possible causes. Keep asking “why?” to move beyond the symptoms and to avoid jumping to premature calculations. • Ask “what?” to consider potential considerations. • Ask “how much?” to quantify cause and effect.
4	Innovation	<ul style="list-style-type: none"> • Use Creative thinking to generate potential solution. • Operationalise these solutions by identifying Barriers to implementation, Available enablers, and People whose co-operation must be sought
5	Solution	<ul style="list-style-type: none"> • Implement the preferred solution • Take appropriate action to bring about the required changes • Reinforce with training and documentation back-up
6	Evaluation	<ul style="list-style-type: none"> • Monitor the effectiveness of actions • Establish and interpret performance indicators to track progress towards objectives • Identify the potential for further improvements & return to step 1

Difficulties experienced at each step in the PRAISE process:

Step	Activity	Difficulties	Remedies
1	Problem Identification	<ul style="list-style-type: none"> • Effects of a problem are apparent but problem themselves are difficult to identify. • Problem may be identifiable, but it is difficult to identify a measurable improvement opportunity 	<ul style="list-style-type: none"> • Participative approaches like brainstorming, multi-voting, panel discussion • Quantification and precise definition of problem
2	Ranking	<ul style="list-style-type: none"> • Difference in perception of individuals in ranking. • Difference in preferences based on functions e.g. production, finance, marketing etc. • Lack of consensus between individuals 	<ul style="list-style-type: none"> • Participative approach • Subordination of individual to group interest
3	Analysis	Adoption of adhoc approaches and quick-fix solutions	Lateral Thinking Brainstorming
4	Innovation	<ul style="list-style-type: none"> • Lack of creativity or expertise • Inability to operationalise ideas, i.e. convert thoughts into action points 	Systematic evaluation of all aspects of each strategy
5	Solution	Resistance from middle mangers	<ul style="list-style-type: none"> • Effective internal communication • Training of personnel and managers • Participative approach

6	Evaluation	<ul style="list-style-type: none"> • Problems in implementation • Lack of measurable data for comparison of expectations with actual 	Effective control system to track actuals Feedback system
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Central to the PRAISE system are (a) quality control – the search for continuous improvements in quality – and (b) total employee involvement – the co-operation and commitment of employees. This dual approach provides a single focus – the customer – whose increased satisfaction remains the primary goal of the procedure.

Fundamental principles associated with four P's of quality improvement

The problems listed for the PRAISE process, may lead to P of TQM process. It is possible that the organization is led to Total Quality Paralysis instead of improvement. To avoid such disruption and paralysis the following principles (called the four P's) of TQM should be followed:

1. **People:** Some individuals are not ideally suited to the participatory process of TQM. This will be inferred from lack of enthusiasm, non-attendance at TQM meetings, failure to complete delegated work, remaining a "Mute Spectator" at TQM meetings etc. To avoid misdirection, TQM teams should consist of team spirited individuals who have a flair for accepting and meeting challenges.
2. **Process:** It is essential to approach problem-solving practically and to regard the formal process as a system designed to prevent participants from jumping to conclusions. As such it will provide a means to facilitate the generation of alternatives while ensuring that important discussion stages are not omitted.
3. **Problem:** Problems need to be approached in a bite-sized chunks, with teams tackling solvable problems with a direct economic impact, allowing for immediate feedback together with recognition of contribution made by individual participants.
4. **Preparation:** Additional courses on creative thinking and statistical processes are needed in order to give participants a greater appreciation of the diversity of the process.

This training must quickly be extended beyond the immediate accounting circle to include employees at supervisory levels and also who are involved at the data input stage.

A three-point action plan for implementation of the process is:

1. **Bite-sized chunks:** Big improvement opportunities are generally complex and require extensive inter departmental co-operation. The choice of a relatively small problem in the first instance provides a greater chance of success. Therefore, the TQM team has to proceed from small to big issues gradually.
2. **Solvable problem:** The problem selected should not be trivial, but it should be one with a potential impact and a clear improvement opportunity. Measurable progress towards implementation should be accomplished within a reasonable time in order to maintain the motivations of participants and advertise the success of the improvement itself.
3. **Recognition of participants:** The successful projects and team members should receive appropriate recognition throughout the enterprise. Prominent individuals should be rewarded for their efforts as a measure of personal recognition and as encouragement to others. The reward may be recognition itself, and sometimes monetary/non-monetary prizes may also be given.

Six Cs of TQM

1. **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.
2. **Culture** - Training lies at the centre of effecting a change -in culture and attitudes. Negative perceptions must be changed to encourage individual contributions.
3. **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.
4. **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.
5. **Customer focus:** Perfect service with zero defects in all that is acceptable at either internal or external levels.

6. **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.

Control in the TQM

The fundamental principles of TQM focus on continuous improvement, which enhance the satisfaction of customer requirements. A properly defined control function is essential for achievement of TQM objectives.

This control is prevalent in the TQM process in the following areas:

1. **Process definition:** The definition of the process, inputs and outputs gives a framework for the writing of procedures and standard methods and also provides a focus for improvement opportunities. The clear definition and documentation of procedures facilitates job flexibility, makes control easier and increases the level of productivity.
2. **Database:** Documentation of key data on processes is an important step in TQM. By charting processes for each activity, establishing time barriers, constraints, priorities degrees of difficulty and expected improvement times, a critical database is established.
3. **Quality Manual:** It defines the basic philosophy of the organization, the structure and responsibilities of managers and departments and the relationship between them. It also contains the methods to be used to ensure quality, including the composition of teams and the audit procedure to be adopted.
4. **Improved decision-making:** By providing a sound control environment, which supports business decisions with appropriate measurement and analysis, the controllership function pursues complete customer satisfaction. The aim is to achieve acknowledged industry leadership for excellence of process, personnel and service.
5. **Control and continuous improvement:** TQM facilitates not only control, but also continuous improvement. The monitoring of the data around a process will allow modifications which makes it in-control and capable. As changes or improvements are made they are documented and the system updated so that everyone uses the current best method.
6. **Use of Control reports:** Diagrams, Statistical quality control charts and cost of quality reports are prepared for periodic review of the TQM system in operation. The deviation from expected costs are analyzed for suitable corrective action. The various types of costs to be reported are (i) Prevention Costs; (ii) Appraisal Costs; (iii) Internal failure costs; and (iv) External Failure Costs.

There are a measure of all costs directly associated with the achievement of complete conformance to product quality requirements. These are not just the cost of quality management or inspection function. Specifically quality costs are the sum total of

- | | | |
|---------------------|---|---|
| a. Prevention Costs | - | (Quality Engineering, Quality planning). |
| b. Appraisal Costs | - | Cost of appraising product for conformance tor equirements. |
| c. Failure Costs | - | Costs incurred by failure to conform to requirements |
| I. Internal | | |
| II. External | | |

Each of them, broadly, consists of:

- | | |
|---------------------|--|
| a. Preventive Costs | * Design Quality Assurance |
| | * Test Equipment Design |
| | * Supplier Quality assurance |
| | * Vendor rating |
| | * Central Quality Organization (with a strong Quality Engineering function). |
| | * Training |
| | * Quality Planning |

- * Development Testing
- * Process capability studies
- * Product Reliability tests
- b. Appraisal Costs -
 - * Inspection
 - * Testing
 - * Supplier Quality Assurance
 - * Test and inspection equipment maintenance, calibration and repair.
 - * Environmental and Reliability Testing.
 - * Production time spent in checking and sorting product
 - * Depreciation of inspection and Test Equipment.
- c. Failure Costs -
 - i. Internal (In Plant)
 - * Scrap
 - * Rework
 - * Excess material provisioning/ procurement.
 - * Concession and Salvage
 - * Sub-standard performance
 - * Additional inspection, testing and assembly.
 - * Trouble shooting
 - * Reinspection and / or Retest
 - * Defect investigation
 - * Modifications necessitated by defects/failures
 - * Waiting time due to rectification, modification
 - ii) External (in user's place)
 - * Warranty
 - * LOSS OF CUSTOMER CONFIDENCE (LOSS OF BUSINESS- applicable to export orders, local customers.
 - * Sending repair crew to repair at Customer's premises
 - * Bringing back faulty goods, their repair and re transmittal
 - * Cost of replacement

The above approach has been called the " PAF Model".

User Quality Costs:

In this approach an attempt is made to determine the costs incurred by the user when the purchased materials or equipment has problems. Such non – quality costs can be broadly grouped under seven categories as given below:

Category of user Quality Cost	Example	Categories of User Quality Costs
Cost of repairs	1A	Parts and material for failed items and any associated items which also must be replaced.
	1 B	Labour for replacing the failed items and Sociated items.
Cost of effectiveness loss	2 A	idle direct labour before and during a shutdown and during startup of a process
	2 B	Extra defective product made before, during the immediately after process shutdown
Cost of maintaining extra capacity because of expected failure	3 A	Equipment parts and materials
	3 B	Direct and indirect labour
Cost of damages caused by a failed item	4 A	injuries to personnel
	4 B	Training new personnel when a replacement is required
Lost income	5 A	Profit on production lost during downtime of failed item
	5 B	Monetary penalties incurred because downtime due to a failed item causes the user to miss schedules or impose other inconveniences on his customer
Extra investment cost	6 A	Special installation and /or Compared to competing products "running in" requirements. Special checkout and maintenance equipment
	6 B	
Extra operating & maintenance cost compared to competing products	7 A	Lower functional output per cycle of operation
	7 B	Special power and fuels

Remedies to correct misdirection in TQM

TQM may become misdirected on the following grounds:

1. Focus on documentation process and ill-measurable outcomes
2. Emphasis on quality assurance rather than improvement; and
3. Internal-focus, which is at odds with the alleged customer orientation.

This can be correction by reviving the customer focus with total employee involvement (TEI), oriented towards organizational goals. This will involve the following areas of thrust:

1. Loyalty to the vision of the company through the pursuit of tough, visible goals.
2. Recognition of satisfied customers and motivated employees as the true assets of a company.
3. Delegation of decision-making to the point of responsibility by eliminating hierarchical ties of authority to allow direct and speedy response to customer needs.

4. Decentralization of management to make best use of the creative energy of the workforce.

Question 1: Define Total Quality Management? What are the six Cs for successful implementation of TQM? (4 Marks) May/04, (4 Marks) May/05 & (6 marks) May/07

Question 2: Discuss the benefits accruing from the implementation of a Total Quality Management programme in an organization. (4 Marks) Nov./08

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

1. There will be increased awareness of quality culture in the organization.
2. It will lead to commitment to continuous improvement.
3. It will focus on customer satisfaction.
4. A greater emphasis on team work will be achieved

Question 3: How does Total Quality Management (TQM) facilitates value addition in an organization? (4 Marks) Nov./02

Question 4: Explain four P's of quality improvement principle. (4 Marks) Nov./09-O.C.

Question 5: List out the remedies available for difficulties experienced during implementation of PRAISE. (4 Marks) Nov./10-N.C.

Question 5: What are the critical success factors for the implementation of a 'Total Quality Management' programme? (5 Marks) Nov./09-N.C.

Question 6: 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 from X ltd is ₹ 180 per hundred units of the component and it is found that on an average 3% of the total receipt from this supplier is defective. The corresponding quotation from Y ltd is ₹ 174 per hundred units, but the defective would go up to 5%. If the defectives are not detected, they are utilized in production causing a damage of ₹ 180 per hundred units of the component.

The company intends to introduce a system of inspection for the components on receipt. The inspection cost is estimated ₹ 24 per hundred units of the component. Such an inspection will be able to detect only 90% 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 10000 units of the component)

(10 Marks) Nov./07

[Ans.: If not inspected: Cost per 100 good component is X Ltd. ₹191.13, Y Ltd. ₹192.63; If inspected: Cost per 100 good component is X Ltd ₹205.86, Y Ltd. ₹201.13 Hence inspection is not justified. (ii) X Ltd]

Question 7: Eastern Switching Co. (ESC) produces telecommunications equipment Charles, ESC's president, believes that product quality is the key to gaining competitive advantage. Laurent implemented a total quality management (TQM) program with an emphasis on customer satisfaction. The following information is available for the first Year (2004) of the TQM program compared with the previous year.

	2003	2004
Total number of units produced and sold	10,000	11,000
Units delivered before scheduled delivery data	8,500	9,900
Number of defective units shipped	400	330
Number of customer complaints other than for defective units	500	517
Average time form when customer places for defective unit to When unit is delivered to the customer	30 days	25 days
Number of units reworked during production	600	627
Manufacturing lead time	20 days	16 days
Direct and indirect manufacturing labor - hours	90,000	1,10,000

Required:

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1. For each of the years 2003 and 2004, calculate
 - a. Percentage of defective units shipped.
 - b. On-time delivery rate
 - c. Customer complaints as a percentage of units shipped
 - d. Percentage of units reworked during production
2. On the basis of your calculations in requirement 1, has ESC's performance on quality and timeliness improved?
3. Philip Larkin, a member of ESC's board of directors, comments that regardless of the effect that the program has had on quality, the output per labor-hour has declined between 2003 and 2004. Larkin believes that lower output per labor-hour will lead to an increase in cost and lower operating income.
 - a. How did Larkin conclude that output per labor-hour declined in 2004 relative to 2003?
 - b. Why might output labor-hour decline in 2004?
 - c. Do you think that a lower output per labor-hour will decrease operating income in 2004? Explain briefly.

[Ans.:

1.	2003		2004	
a. Percentage of defective units shipped	$\frac{400}{10,000} = 4\%$		$\frac{330}{11000} = 3\%$	
b. Customer complaints as a percentage of units shipped	$\frac{500}{10000} = 5\%$		$\frac{517}{11000} = 4.7\%$	
c. On-time delivery	$\frac{8500}{10000} = 85\%$		$\frac{9900}{11000} = 90\%$	
d. Percentage of units reworked during production	$\frac{600}{10000} = 6\%$		$\frac{627}{11000} = 5.7\%$	

Question 8: TQ Ltd. implemented a quality improvement programme and had the following results:

	2007	2008
	(Figures in ₹'000)	
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.

[Ans.: (i) Classification of Quality Costs

Figures ₹'000

	2007	% of sales	2008	% of sales
Sales	6,000		6,000	
Prevention				
Quality training	75	1.25	150	2.5
Appraisal				
Product Inspection	200		240	
Materials Inspection	80		60	
	280	4.67	300	5
Internal Failure				
Scrap	600		300	

Rework	500		400	
	1100	18.33	700	11.67
External Failure				
Product warranty	300	5	150	2.5
	1755	29.25	1300	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. (6 Marks) Nov/08-NC& ICWA-June/03 [Adapted]

Question 9: Your company plans to operate department d at normal capacity next year producing one lakh units of product P. Assuming no defective works, these units can be manufactured in 2.5 lakhs labour hours at a cost of Re.0.50 per hour, factory overhead would amount to ₹1,50,000 of which ₹50,000 would be fixed five units of materials can be purchased in two qualities; a high quality at ₹1.05 per unit or a lower quality at ₹0.80 per unit.

Under expected conditions, using high quality materials 10% of the work will be defective requiring complete replacement of the material, additional labour costs and variable overhead, scrap materials recovered from defectives production could be sold at Re.0.30 per unit of high quality material used.

As an alternative to this arrangement, the use of the lower quality material is being considered by this would require an extra operation to be performed on it. An additional machine and tooling would be needed at a cost of ₹3, 000 per annum. The additional operation would take half an hour for each unit of product P produced, not talking defective work into a account.

It is estimated that 20% of the work would be defective all of which would require complete replacement. Scrap material from the lower quality material could be sold for ₹5, 000. Present information to management indicating the more profitable course of action.

[Ans.: Had there been no defectives for production of 1,00,000 pieces of P 1,00,000X5=5,00,000 units of raw material would be required. In case of high quality material , defective being 10% total raw material required is 5,00,000 units/0.90 =5,55,556 units. In case of lower quality material, defective being 20%, total raw material requirement is 5,00,000 units/0.08 =6,25,000 units. Similarly labour and variable overhead requirement are to be adjusted accordingly.

I. Using high quality materials (scrap 10%) (₹)
Cost of 1,00,000 pieces of P 8,66,666

II. Using lower quality materials (scrap 10%) (₹)
Cost of 1,00,000 pieces of P 8,74,250

Analysis: Hence the high quality material should be used.

Question 10: A company manufactures a component on batches of 2000 each. Each component is tested before being sent to the agents for sales .Each components can be tested at the factory at a cost of ₹25. If any component is found to be defective, it can be rectified by spending ₹200. In view of the large demand for the components and the sophisticated system of manufactures, a proposal came up that the practice of pre – testing of the components be dispensed with to save costs. In that event, any defective component is received back from the customer under warranty, the cost of rectification and redespach will be ₹400 per component. State at what percentage of manufacture of components will the company find it cheaper to pre-test each component. (ICWA-Dec/00)

[Ans.:-Let the defectives be'd'

(I) Total Cost ₹(2000x25)+200d
(II) Percentage of defectives to total components 250/2000*100 =12.5%

Analysis: If defectives exceed 12.5% of the total number of components per-testing is recommended.

Question 11: A company manufactures a single product, the estimated costs of which are as follow:

Direct Materials ₹10 each, Direct wages 8 hours at Re.0.50 per hour
Overhead absorption rate ₹1.75 per hour.(50% fixed overhead include)
During this period 1,000 units will be produced and sold as follow:-

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900 units of first at	₹30 each
50 units of second at	₹20 each
50 units of third at	₹10 each

Present information to management showing the loss due to the production of inferior units.

By reprocessing the inferior units taking the full reprocessing time of a further 8 hours and adding further material Costing ₹4 per unit these, "seconds" and "thirds" can be converted into firsts. Present information to the management.

[Note: No change in the profit position hence this need not be considered.]

Question 12: Carlton Ltd. makes and sells a single product; the unit specifications are as follows:

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

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 (QMP). The following additional information regarding costs and revenues are given as of now and after implementation of Quality Management Programme.

Before the implementation of QMP		After the implementation	
1.	5% of incoming material from suppliers scrapped due to poor receipt and storage organisation.	1.	Reduced to 3%.
2.	4% of material X input to the machine process is wasted due to processing problems.	2.	Reduced to 2.5%
3.	Inspection and storage of Material X costs Re. 1 per square metre purchased.	3.	No change in the unit rate
4.	Inspection during the production cycle, calibration checks on inspection, equipment vendor rating and other checks cost ₹2,50,000 per period	4.	Reduction of 40% of the existing cost.
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.	5.	Reduction to 7.5%
6.	Production Quantity is increased to allow for return from customers (these are replaced free of charge) due to specification failure and account for 5% of units <u>actually delivered</u> to customer.	6.	Reduction to 2.5%
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.
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.
- (b) 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/05

[Ans.: (a)

	Existing	After TQM Programme
Total units before inspection	6,000	5,541
Total purchases	52,632	46,871
Gross time	4,500	3,167
(b) Net profit	3,67,088	

Question 13: Burdoy Plc has a dedicated set of production facilities for component X. A just in time system is in place such that no stock of materials: work-in-progress or finished goods are held.

At the beginning of the period 1, the planned information relating to the production of component X through the dedicated facilities as follows:

- Each unit of component X has input materials: 3 units of material A at ₹18 per unit and 2 units of material B at ₹9 per unit.
- Variable cost per unit of component X (excluding materials) is ₹15 per unit worked on.
- Fixed cost of the dedicated facilities for the period ₹162,000.
- It is anticipated that 10% of the units of X worked on in the process will be defective and will be scrapped.

It is estimated that customer will require replacement (free of charge) of faulty units of components X at the rate of 2% of the quantity invoiced to them in fulfillment of orders.

Burdoy Plc is pursuing a total quality management philosophy. Consequently all losses will be treated as abnormal in recognition of a zero defect policy and will be valued at variable cost of production. Actual statistics for each period 1 to 3 for component X are shown in appendix 3.1. No change have occurred from the planned price level for materials, variable overhead or fixed overhead costs.

Required:-

- Prepare an analysis of the relevant figure provided in appendix 3.1 to show that the period 1 actual results were achieved at the planned level in respect of (i) Quantities and losses and (ii) Unit cost levels for materials and variable costs.
- Use your analysis from (a) in order to calculate the value of the planned level of each of internal and external failure cost for period 1.
- Actual free replacements of component X to customers were 170 units and 40 units in period 2 and 3 respectively. Other data relating to period 2 and 3 is shown in appendix 3.1.

Burdoy Plc authorized additional expenditure during period 2 and 3 as follows:

Period 2: Equipment accuracy checks of ₹10,000 and staff training of ₹5,000

Period 3: Equipment accuracy checks of ₹10,000 plus ₹5,000 of inspection costs; also staff training cost of ₹5,000 plus ₹3,000 on extra planned maintenance of equipment.

Required:-

- (i) Prepare an analysis for each of period 2 and 3 which reconciles the number of components invoiced to customer with those worked on in the production process. The analysis should show the changes from the planned quantity of process losses and change from the planned quantity of replacement of faulty components in customer hands.
- (ii) Prepare a cost analysis for each of period 2 and 3 which shows actual internal failure costs, external failure costs, appraisal costs and prevention costs.
- (iii) Prepare a report which explains the meaning and internal relationship of the figure in Appendix 3.1 and the analysis in (a), (b), and (c) (i) (ii). The report should also give examples of each cost type and components on their use in the monitoring and progressing of the TQM policy being pursued by Burdoy Plc.

Appendix 3.1 Actual Statistics for component X

	Period 1	Period 2	Period 3
Invoices to customers (units)	5,400	5,500	5,450
Worked on in the process	6,120	6,200	5,780
Total Costs:			
Material A and B (₹)	440,640	446,400	416,160
Variable cost of production (₹) (excluding material cost)	91,800	93,000	86,700
Fixed cost	162,000	177,000	185,000

[Ans:

	Units
(a) (i) Components worked on in the process	6120
Less: planned defective units	612
replacements to customer (2% X 5400)	108
Components invoiced to customers	5400

Therefore actual result agree with planned results

(ii) Planned components cost = (3 X ₹18 for material A) + (2 X ₹9 for material B) + ₹15 variable cost = ₹87
 Comparing with the data in appendix:
 Materials = ₹440 640/6120 = ₹72
 Variable overhead = ₹91 800/6120 = ₹15
 This indicates that prices were at the planned levels.

(b) Internal failure costs = ₹53 244(612 units X ₹87)
 External failure costs = ₹9396 (108 units X ₹87)

(c) (i)	Period 2 (units)	Period 3 (units)
Components invoiced to customers	5500	5450
Planned replacement (2%)	110	109
Unplanned replacement	60 (170-110)	-69 (40-109)
Components delivered to customers	5670	5490
Planned process defects (10% of worked on in the process)	620	578
Unplanned defects (difference to agree with with final row)	-90	-288
Components worked on in the process	6200	5780

(ii)	Period 2(₹)	Period 3(₹)
Internal failure costs	46,110 (620-90) X ₹87	25,230 (578-288) X ₹87
External failure costs	14,790 (110+60) X ₹87	3,480 (109-69) X ₹87
Appraisal costs	10,000	15,000
Prevention costs	5,000	8,000]

PRICING DECISIONS & PARETO ANALYSIS

PRICING OF FINISHED PRODUCT:

I. Cost Plus pricing:

It is the most widely used method of pricing a product as it ensures that the selling price is greater than the total cost of a product. This method helps business firms to generate profits and survive in the future.

Under cost plus pricing the selling prices of a product are determined based on its estimated cost plus a fixed profit margin. Here 'cost' means full cost at current output and wage levels since these are regarded as most relevant in price determination.

The unit cost of the product can be determined by using different methods viz. total cost, manufacturing cost or variable / incremental cost. The percentage of mark up to be added to estimated cost also vary and depends upon the cost figures used.

Cost Determination: For cost determination purposes, the following principles are adopted:

1. **Cost Classification:** Costs may be classified into: Manufacturing, Administration and Selling & Distribution Costs; (Under Absorption costing) or Variable and Fixed Costs (Under Marginal costing)
2. **Size of the unit and scale of operations:**
 Small manufacturers: An individual manufacturer may take his cost of production into account and arrive at a price at which the products are to be sold in the concerned region.
 Medium and large manufacturers: A manufacturer having several factories all over the country may determine the weighted average cost of the factories so as to arrive at a uniform ex-factory price for the country as a whole. If commodities are in short supply, high cost of individual units may have to be allowed in the price. However, in the case of high cost producers, the profit element may have to be reduced to encourage them to reduce their costs.
3. **Uniform costing for whole industry:**
 The price may be fixed after taking into account the cost of representative unit from the industry, which may fall within the range of lowest cost unit and highest cost unit.
 The factories in the industry may be classified into (i) Small size (ii) Medium Size; and (iii) Large size. Representative samples are drawn and costs are determined by reference to the distribution of the factories. For example, the costs of medium size factories can be taken into account if this group forms the greater part of the industry.
4. **Determination of Fixed costs:**
 Variable costs can be easily determined on a per unit basis. However, fixed costs per unit will have to be ascertained with informed judgment.
 Fixed cost per unit should normally be based on the level of production and capacity utilization likely to be achieved, i.e. Normal Capacity or Capacity based on Sales expectancy.
 Any assumption of low utilization may result in over estimating the cost. Conversely, a high utilization assumption may result in under estimating the cost.

It is therefore, desirable that the level of production and capacity utilization, which are likely to apply in the near future, should be arrived at with utmost care on realistic basis keeping in view both the past performance and the future demand.

5. Depreciation:

If a firm wants to survive and stay in business, it has to maintain its fixed capital intact so that its fixed assets may be replaced at the end of their useful working life out of the funds generated from profits retained in the business.

In a period of relatively stable price levels, depreciation based on historical cost of fixed assets would be adequate for achieving this object.

In periods when the price level is continuously changing, the firm may not be left with adequate funds generated out of accumulated depreciation at the end of the life of the plant to replace it at a higher price.

Hence depreciation should be properly included as part of cost so as to leave sufficient profits for asset replacement.

Advantages of Cost plus pricing

1. **Guaranteed Contribution:** When full costs plus basis is used for pricing, the firm earns a guaranteed contribution equivalent to fixed costs plus profit margin. Even, profit margin is taken as nil, fixed costs included in prices will guarantee minimum contribution.
2. **Assured Profit:** Cost plus is a fair method of price fixation. The business executives are convinced that the price fixed will cover the cost.
3. **Reduced risks and uncertainties:** If price is greater than cost, the risk is covered. This is true when normal expected capacity basis of cost estimation is used. The decision- maker may accept a pricing formula that seems reasonable for reducing uncertainty.
4. **Most suitable in long run:** Cost plus pricing is ideal in the long run since there are no permanent opportunity costs. The effect of seasonal fluctuations is ironed out and prices are established based on normal long run costs.
5. **Considers market factors:** Cost plus pricing does not mean that market forces are ignored. The mark up added to the cost to make a price reflect the well-established customs of trade, which guide the price fixer towards a competitive price.
6. **Full Recovery of all costs of the product:** For long-run pricing decisions, full costs of the product informs managers of the minimum costs to be recovered so as to continue in business rather than shut down.
7. **Price Stability:** Price fixation based on full costs of the product promotes price stability, because it limits the ability of sales person to cut prices. Price stability facilitates planning.
8. **Simplicity:** A full cost formula for pricing does not require a detailed analysis of cost- behaviour patterns to separate costs into fixed and variable components for each product. It is simple to operate.

Disadvantages of Cost plus pricing

1. **Ignores demand:** Cost plus pricing ignores demand and fails to take into account the buyers' needs and willingness to pay, which govern the sales volume obtainable at each series of prices.
2. **Ignores competition:** It fails to reflect competition adequately.
3. **Arbitrary Cost allocation:** It assumes that the costs have been estimated with exact accuracy. This assumption is not true particularly in multi-product firms where the common costs are allocated arbitrarily.
4. **Ignores opportunity costs:** For many decisions incremental cost plays a vital role in pricing, rather than full costs. This aspect is ignored. Also opportunity costs, most relevant for decision-making are summarily ignored.
5. **Price-Volume relationships:** Since the fixed overheads are apportioned on the basis of volume of production, the cost will be more if sales volume is less and vice-versa. The increase or decrease in sales volume is dependent on price. Thus it is a vicious circle- cost plus mark up is based on sales volume & sales volume is based on price.

II. Rate of Return Pricing

Rate of return pricing is used when each division is treated as an Investment Centre. Determination of return on capital employed is one of the most crucial aspects in price fixation and performance evaluation of Investment Centres. The firm should determine an average mark-up on cost, which is necessary to produce a desired rate of return on its investment.

The issues to be considered are:

- ✓ Basis on which the capital employed is computed Components to be covered in the return on capital Fairness of the rate or return.
- ✓ The fairness of the rate of return varies from industry to industry and from time to time and is primarily dependent on the risks involved. In following fair rate of return, the desirability of earning adequate profits to plough back into business should be kept in mind.
- ✓ It would be correct to assume that allowing the industry to earn adequate return on the capital employed would attract additional capital and increase the number of factories and production of all commodities which must ultimately lead to competition and reduction in costs and prices.

III. Variable Costs Pricing:

Selling prices are fixed above variable costs in order to generate contribution. However, in the short run, selling prices may be equal to variable cost or sometimes even below variable cost. Some illustrative situations are:

- Products / Materials are perishable in nature. Launch of new product at competitive prices.
- Sales of old and defective stocks, seconds sales, etc.
- Disposal of accumulated stocks, where market prices have fallen (to save carrying costs)
- Sale of one product with reduced margin, to boost sales of other products having higher profit margin.

IV. Pricing above marginal cost, but below total cost.

In periods of recession, a firm may sell its articles at a price less than the total cost but above the marginal cost for a limited period. The advantages of this policy arise due to avoidance of shut-down. Thus the benefits are:

1. The firm can continue to produce and use the services of skilled employees who are well trained and will be difficult to re-employ later if discharged.
2. Plant and machinery can be prevented from deterioration through idleness.
3. The firm would be ready to take advantage of improved business conditions later. The firm can continue in the market and reduce loss of market share to Competitors.

Such pricing policy is necessarily **restricted to the short run**. When business conditions improve in the long run, such pricing below total cost but above marginal costs is not advisable.

V. Differential selling prices:

Use of differential selling price, which is above marginal cost but below total cost is primarily intended to absorb surplus capacity. It can be achieved in any of the following ways:

- **Different Markets – Export Pricing:** The firm producing a branded article may use the surplus capacity to produce the same article to be sold above variable cost in a different market, e.g. export sales. The articles sold in the home market will recover all fixed expenses. Since price reduction in the home market is injurious to the normal sales, it is not resorted to. Any reduction in the selling prices in the export market will not affect the price prevailing in the home market.
- **Different products:** The firm may produce and sell one product, which covers the entire fixed overheads and use the surplus capacity to produce another product, which may be sold at a price above its marginal cost. The overall profitability will thus increase. The manufacture of the second product should be confined to surplus capacity and it should not have the possibility of becoming a major product at the low price at which it is sold. If it becomes so, there will be a reduction in profit.

VI. Competitive Pricing:

When a company fixes its price mainly on the consideration of what its competitors are charging, its pricing policy is called Competitive Pricing or competition-oriented pricing.

The company need not charge the same price as charged by its competitors. But under such a pricing method the Company keeps its prices lower or higher than its competitors by a certain percentage.

Competitive price so determined does not maintain a rigid relation between its price, cost or demand.

The Company's own costs or demand may change, but it will maintain its price because its competitors maintain their prices. Conversely, the Company will change its price when its competitors change their price, even if its own costs or demand have not altered.

The different types of competitive pricing are

- Going rate pricing
- Sealed bid pricing

VII. Incremental pricing:

Incremental pricing involves comparison of the impact of decisions on revenues and cost. If a pricing decision results in a greater increase in revenue than costs, it is favourable. It also means that consideration is being given to other objectives of the business. Thus profitability can be set as the matter of primary consideration and then the decision can be adjusted to bring it in consonance with the other decision of the business.

Incremental pricing analyses all aspects of decision-making as listed below:

Relevant Cost Analysis: This technique considers changes in costs rather than in average cost. Overhead allocations are irrelevant. Incremental revenue inflows and cost outflows are included for decision-making.

Product-Line Relationship Analysis: This technique necessitates consideration being given to possible complementary relations in demand. Sale of one product may lead to the sale of a complementary product. This overall effect on profitability has to be evaluated.

Opportunity Cost Analysis: the incremental revenue should cover the opportunity cost and also generate surplus. A price which results in an incremental revenue which in turn merely covers the incremental costs is not sufficient. If the opportunity foregone is greater than incremental revenue, the decision is not sound.

Time Factor Analysis: The decision should take into account the short run and long run effects. A high price may increase its immediate profits but may lead to loss of revenue in the long run owing to competitors snatching the business.

CVP Analysis: In fixing prices, consideration should be given to price volume relationship.

The responsiveness of the market to the price should be such that the volume is increased to achieve full utilization of plant capacity.

Risk Analysis: Consideration should also be given to the evaluation of uncertainty and risk factor. The decision taken should be able to maximize the expected value based on probability theory.

VIII. New Product Pricing:

New Product Pricing is generally a difficult decision because of the uncertainty involved in the estimation of their demand. For determining optimal prices, the following procedure may be adopted by a firm.

Market Survey: Experimental sales are conducted in different markets using different prices to see which price is suitable. For example, choose three different markets and by using the same amount of sales promotional activities, ascertain what is the right price.

Price Volume Relationship: The relationship between price and volume should be ascertained, using the concept of elasticity of demand. The extent of volume increase due to price reduction and vice-versa, can be reasonably quantified through such analysis.

Incremental Contribution Approach: For decision making, the firm should adopt the incremental contribution approach i.e. additional total contribution from additional sales quantity. The firm can increase its prices as long as there is further incremental contribution. Such analysis may prove that the highest prices yielding the largest unit contributory margin need not necessarily maximize the profits. A lower price may well go to maximize the profits.

PRICING STRATEGIES

Pricing strategy is defined as a broad plan of action by which an organization intends to reach its goal. Some illustrative strategies are:

- Expanding product lines that enjoy substantial brand equity.
- Offer Quantity discounts to achieve increase in sales volume.

Some types of pricing strategies, which a firm can adopt are:

- **Market entry Strategies** – New Product Pricing – Skimming or penetration Pricing
- **Discount Strategies** – Differentials and discounts to Dealers, Distributors and Customers etc.
- **Price Discrimination Strategies** – based on customers, time, product version etc. Geographic Pricing Strategies

A. Skimming Pricing Strategy:

It is a policy of high prices during the early period of a product's existence and in the later years the prices are gradually reduced. It is an attempt to exploit those segments of the market that are relatively insensitive to price changes. For example, high initial price may be charged to take advantage of the novelty appeal of a new product when the demand is initially inelastic. It offers a safeguard against unexpected future increase in costs, or a large fall in demand after the novelty appeal has declined. This policy should not be adopted when the substitutes are already available in the market.

The reasons for following such a policy are:

1. **Inelastic Demand:** The demand is likely to be inelastic in the earlier stages till the product is established in the market. The firm can take advantage of high prices.
2. **Sales Boost:** The change of high price in the initial periods serves to skim the cream of the market that is relatively insensitive to price. The gradual reduction in price in the later years will tend to increase the sales.
3. **Assured Profit:** 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. Contribution is guaranteed.
4. **Cost Revenue Matching:** High initial capital outlays, needed for manufactures, results in high cost of production. Also, the manufacturer has to incur huge promotional activities resulting in increased costs. High initial prices will be able to finance the cost of production. Gradually, the economies of scale and savings in costs are passed on to customers.

B. Penetration Pricing Strategy

It is a policy of using a low price as the principal instrument for penetrating mass markets early. This method is used for pricing a new product and to popularize it initially. 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. 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 is necessary before determining the price.

The circumstances in which penetrating Pricing can be adopted are:

1. **Elastic demand:** The demand of the product is high, when price is low. Hence lower prices mean large volumes and hence more profits.
2. **Mass Production:** When there are substantial savings in large-scale production, increase in demand is sustained by the adoption of low pricing policy.
3. **Frighten off competition:** The prices fixed at a low level act 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"

PARETO ANALYSIS

PARETO ANALYSIS is a rule that recommends focus on the most important aspects of the decision making, in order to simplify the process of decision –making.

It is based on the 80:20 phenomenon, first observed by Vilfredo Pareto, an Italian economist. He noticed that 80% of the wealth of Milan was owned by 20% of its citizen. This pattern of 80:20 or approximations like 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 aspect. It helps to clearly establish top priorities and to identify both profitable and unprofitable targets.

Usefulness of Pareto Analysis: Pareto analysis is useful to

1. Prioritize problems, goals and objectives. Identify root causes
2. Select and define key quality improvement programs. Select key customer relations and service programs. Select key employee relations improvement programs.
3. Select and define key performance improvement programs. Maximize research and product development time.
4. Verify operating procedures and manufacturing processes
5. Sales/distribution of Products or services.
6. Allocate physical, financial and human resources.

Situations where Pareto Analysis can be applied:

Pareto analysis is applicable in the presentation of Performance Indicators data through selection of representative process characteristics that truly determine or directly or indirectly influence or conform the desired quality or performance result or outcome. It is generally applicable to the following business situations:

1. **Product Pricing**
 - Where a company sells a number of products, it may not be possible to analyse cost-volume-price-profit relationships for all products.
 - Pareto Analysis is used for analyzing the firm's estimated sales revenues from various products and it might indicate that approximately 80% of its total sales revenue is earned from about 20% of its products.
 - This helps top management to delegate the pricing decision for approximately 80% of its products to the lower managerial levels. Top management can concentrate on pricing decisions for the important 20% products, which are essential for the company's survival.
 - Sophisticated pricing methods can be adopted for the important products while for other products cost based pricing methods may be used.
2. **Customer profitability Analysis:**
 - The modern business thinking is to recognize the customer and satisfy his requirements. Hence instead of analyzing products, customers can be analysed for their relative profitability to the organization.
 - It is often found that approximately 20% of customers generate 80% of the profits.

- Such analysis is useful for evaluation of the portfolio of customer profile, and decision making such as whether to continue serving a customer group, what is the extent of promotion expenses to be incurred etc.
3. **ABC Analysis – Stock Control:**
Raw material stock control, it is found that only a few of the goods in stock make up most of the value. About 70% of the materials value is due to high priced materials which constitute only 20% of the quantity.
These materials are classified into A, B and C categories based on their importance. Control is directed primarily over 'A' category items by setting EOQ, Stock levels, Surprise Stock Verification procedures etc.
The outcome of such analysis is that by concentrating on small proportion of stock items that jointly accounts for 80% of the total value, a firm will be able to control most of the monetary investment in stocks.
4. **Activity Based Costing**
Activity Based Costing involves the identification of cost drivers for various items of Overhead expenses. Generally, 20% of the firm's cost drivers are responsible for 80% of the total cost. By analyzing, monitoring and controlling those cost drivers that attribute to high costs, a better control and understanding of overhead will be obtained.
5. **Quality Control**
- Pareto analysis can be extended to discover from an analysis of defect report or customer complaints which 'vital few' causes are responsible for most of the reported problems.
 - Generally 80% of reported problems are traceable to 20% of the underlying causes. By concentrating one's efforts on rectifying the vital 20%, one can have the greatest immediate impact on product quality.
 - Pareto Analysis indicates how frequently each type of failure (defect) occurs. The purpose of the analysis is to direct management attention to the areas where the best return can be achieved by solving most of quality problems, perhaps just with a single action.

Question 14: Enumerate the circumstances which are favourable for the adoption of a penetrating pricing policy. (4 Marks) May/99, (4 Marks) May/01 & (3 Marks) May/04

Question 15: Outline the features of penetration pricing strategy. (7 Marks) May/10-O.C.[Adapted] & (6 Marks) Nov./06

- Ans.: (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 16: Explain the concept of cost plus pricing. What are its advantages and disadvantages? (8 Marks) May/00

Question 17: State the merits of cost-plus contracts. (3 Marks) May/04

Question 18: Describe two pricing practices in which non-cost reasons are important, when setting prices. (3 Marks) Nov/00

- Ans.:** Two pricing practices in which non-cost reasons are important when setting price are:
 (i) Price discrimination and (ii) Peak load pricing.

- (i) **Price discrimination:** This is the practice of charging to some customers a higher price than that charged to other customers e.g. Airlines tickets for business travellers and LTC travellers are priced differently.
- (ii) **Peak load pricing:** This pricing system is based on capacity constraints. Under this pricing system a higher price for the same service or product is demanded when it approaches physical capacity limits e.g. telephones, tele-communication, hotel, car rental and electric utility industries are charged higher price at their peak load.

Question 19: What is Price Discrimination? Under what circumstances it is possible?

(4 Marks) May/10-N.C.

Ans.: Price discrimination is charging different prices with respect to customers, products, places and time. Price discrimination is possible if the following conditions are satisfied:

- (a) the maker must be capable of being segmented for price discrimination;
 (b) the customers should not be able to resell the product of the segment paying higher price; and
 (c) the chance of competitors' underselling in the segment of higher prices should not be possible.

Question 20: What is 'Price Skimming Policy' and at what situation it should be exercised.

(3 Marks) May/02 & (4 Marks) Nov./04 & (2 Marks) Nov./09-N.C.

Question 21: State the pricing strategy that you would advise in the following situations which are independent of each other :

- (i) A new product is to be launched. It has had high promotional expenditure and its demand in the market is not known.
 (ii) A new product is to be launched. It is to be mass manufactured.
 (iii) A product which has an external market demand is to be transferred to another division of the same company. For the external market, variable selling costs of ₹10 per unit and fixed selling costs amounting to ₹10 lacs p.a. are incurred. These costs are not applicable to divisional transfers. The divisional transfer can take up only 20% of the output produced.
 (iv) A special one-time order for the use of idle capacity is offered. This order will not impact the existing sales of the company. The product has competition in the market.
 (v) There is stock of a discontinued product. It has severe competition and the product is perishable.

[Ans.: (i) Skimming Pricing (because of inelastic demand); (ii) Penetration Pricing; (iii) Incremental Pricing i.e. Incremental Costs + Opportunity Costs (Selling costs will not be charged); (iv) Incremental Pricing; (v) Variable cost pricing (Selling Price is variable cost or sometimes even below variable costs)]

(7 Marks) Nov./10-O.C.

Question 22: How Pareto analysis is helpful in pricing of product in the case of firm dealing with multi-products?

(3 Marks) Nov./05

Question 23: What is Pareto Analysis? Name some applications.

(5 Marks) May/08

Question 24: Explain the usefulness of Pareto analysis and its application to business situations.

(4 Marks) Nov./03

Question 25: Explain different types of Competitive pricing?

(4 Marks) May/05

Question 26: (a) State the general guidelines to be used in adopting a pricing policy in a manufacturing organization.

(3 Marks) Nov./08-O.C.

(b) Enumerate the uses of Pareto Analysis.

(3 Marks) Nov./08-O.C.

Question 27: 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 80000 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.

[Ans.: ₹23.61]

(6 Marks) May/05 & (4 Marks) Nov./10-N.C.

Question 28 [Pricing Decisions]: LMV Limited manufactures product Z in departments. A and B which also manufacture other products using same plant and machinery. The information of product Z is as follows

Items	Department A (₹)	Department B (₹)
Direct material per unit	30	25

Direct labour per (₹10 per hour)	30	40
Overhead rates		
Fixed	8 per hour	4 per hour
Variable	6 per hour	3 per hour
Value of Plant and Machinery	25 lakhs	15 lakhs

Overheads are recovered on the basis of direct labour hours. Variable selling and distribution overheads relating to product Z are amounting to ₹30,000 per month. The product requires a working capital of ₹4,00,000 at the target volume of 1,500 units per month occupying 30 per cent of practical capacity.

You are required

- i) To calculate the price of product Z to yield a contribution to cover 21 percent rate of return on investment.
- ii) Set the minimum selling price of the product if (1) the product is well established in the market; (2) the product is first time launched in the market. (7 Marks) Nov./09-O.C.

[Ans.: Required Selling price p.u. ₹193.67]

Question 29 [Pricing Decisions]: 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:

Material	:	Iron 10 kgs @ ₹5 per kg. Copper: 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?

[Ans.: (i) ₹264 p.u.; Penetration Pricing; (ii) ₹313]

(6 Marks) Nov./09-N.C.

Question 30: [Pareto Analysis]: In the table below the level of retail sales (₹'000) and closing stock (₹ '000) for the last trading year are given for two pharmacies (A and Z) operated by XYZ Ltd.

Category	Sales		Stock	
	A	Z	A	Z
OTC medicine and healthcare	175	120	35	40
Toiletries	150	100	60	65
Photographic	125	60	20	12.5
Food / Drink	100	75	20	20
Baby- Care	50	25	10	5
Sanitary products	50	25	10	5
Foot Care	30	20	2	5
Cosmetics etc	25	30	40	45
Hair care	25	10	10	5
Perfumery	20	10	10	7.5
Other	50	25	13	5
Total	800	500	230	215

Required: Prepare a Pareto analysis for the following.

- (1) The retail shop sales data.

(2) The stock data for A and Z.

[Ans.:**XYZ Ltd.****Sales in A** (rearranged for the purpose of ranking)

Rank	Category	Sales (₹'000)	Cum. Sales(₹'000)	%
1	OTC	175	175	21.9
2	Toiletries	150	325	40.6
3	Photo	125	450	56.3
4	Food/ Drink	100	550	68.8
5	Baby	50	600	75.0
5	San. Prod.	50	650	81.3
5	Other	50	700	81.3
8	Foot Care	30	730	91.3
9	Cosmetics	25	755	94.4
10	Hair-care	25	780	97.5
11	Perfume	20	800	100.0

Stock in A (rearranged for the purpose of ranking)

Rank	Category	Stock(₹'000)	Cum. Stock(₹'000)	%
1	Toiletries	60	60	26.1
2	Cosmetics	40	100	43.5
3	OTC	35	135	58.7
4	Photo	20	155	67.4
4	Food/ Drink	20	175	76.1
6	Other	13	188	81.7
7	Baby	10	198	86.1
7	San. Prod.	10	208	90.4
7	Hair	10	218	94.8
7	Perfume	10	228	99.1
11	foot care	2	230	100.0

Sales in Z (Rearranged for ranking)

Rank	Category	Sales(₹'000)	Cum. Sales(₹'000)	%
1	OTC	120	120	24
2	Toiletries	100	220	44
3	Food/ Drink	75	295	59
4	Photo	60	355	71
5	Cosmetics	30	385	77
6	Baby	25	410	82
6	San. Prod.	25	435	87
6	Other	25	460	92
9	Foot care	20	480	96
10	Hair	10	490	98
11	Perfume	10	500	100

Stock in Z (Rearranged for ranking)

Rank	Category	Stock (₹'000)	Cum. Stock(₹'000)	%
1	Toiletries	65	65	30.2
2	Cosmetics	45	110	51.2
3	OTC	40	150	69.8
4	Food/ Drink	20	170	79.1
5	Photo	12.5	182.5	84.9
6	Perfume	7.5	190	88.4
7	Baby	5	200	93.0
7	San. Prod.	5	200	93.0
7	foot care	5	205	95.3
7	Hair	5	210	97.7
7	Other	5	215	100.0

BENCHMARKING

Benchmarking is the process of identifying and learning from the best practices anywhere in the world.

- It is powerful tool for continuous improvement in performance.
- It involves comparing firm’s products, services or activities against other best performing organization, either internal or external to the firm. The objective is to find out how the product, service or activity can be improved and ensure that the improvements are implemented.
- It attempts to identify an activity that needs to be improved and finding a non-rival organization that is considered to represent world-class best practice and studying how it performs the activity.

Different types of Bench marking:

1. **Competitive Bench marking:** It involves the comparison of one’s own products, processes and business results with that of competitors. Bench marking partners are drawn from the same industry. To protect confidentiality it is common for the companies to undertake this type of benchmarking through associations of third parties.
2. **Strategic Benchmarking:** It involves a systematic process by which a company seeks to improve its overall performance by examining the long-term strategies. It involves comparing high-level aspects such as developing new products and services, core competencies etc. It is similar to process benchmarking in nature but differs in its scope and depth.
3. **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. Globalisation and advances in information technology leads to use of this type of benchmarking.
4. **Process benchmarking:** It involves the comparison of an organisation’s critical business processes and operations against best practice organization that performs similar work or deliver similar services.
5. **Functional benchmarking:** This is used when organizations look to benchmark with partners drawn from different business sectors or areas of activity to find ways of improving similar functions or work processes. This sort of benchmarking can lead to innovation and dramatic improvements.
6. **Internal Benchmarking:** It involves seeking partners from with the same organization, for example from business units located in different areas. The main advantages are (a) Easy access to sensitive data and information (b) Availability of standardized data; and (c) Lesser requirement of time and resources. However, real innovation may be lacking.
7. **External Benchmarking:** It involves seeking help of outside organization that are known to be best in class. It provides opportunities of learning from those who are at leading edge. However, this type of benchmarking may take up more time and resource to ensure the comparability of data and information. The credibility of the findings and the development of sound recommendation.
 - a) **Intra-Group Benchmarking:** Here the groups of companies in the same industry agree that similar units within the cooperating companies will pool data on their process. The processes are benchmarked against each other at or near operation level. ‘Improvement Task forces’ are established to identify and transfer best practice to all members of the group.
 - b) **Inter-industry benchmarking:** In Inter-industry benchmarking a non-competing business with similar process is identified and asked to participate in a benchmarking exercise. For example, a publisher of schoolbook may approach a publisher of university level books to establish benchmarking relationship.

Stages in the process of Benchmarking

Stage 1: Planning

- a) **Determination of benchmarking goal statement:** This requires identification of areas to be benchmarked, which uses the following criteria:

Benchmark for Customer Satisfaction	Benchmark for improving Bottom line
<ul style="list-style-type: none"> • Consistency of product or service • Process Cycle time. • Delivery Performance • Responsiveness to Customers 	<ul style="list-style-type: none"> • Waste and Reject levels • Inventory levels • Work in progress • Cost of Sales

Requirement. <ul style="list-style-type: none"> • Adaptability to Special Needs. 	<ul style="list-style-type: none"> • Sales per employee
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- b) **Identification of best performance:** The next step is seeking the best. To arrive at the best is both expensive and time consuming, so it is better to identify a company, which has recorded performance success in a similar area.
- c) **Establishment of the benchmarking or process improvement team:** This should include persons who are most knowledgeable about the internal operations and will be directly affected by changes due to benchmarking.
- d) **Defining the relevant benchmarking measures:** Relevant measures will not include the measures used by the organization today but they will be refined into measures that comprehend the true performance differences. Developing good measurement is key to successful benchmarking.

Stage 2: Collection of data and information: This involves the following steps

- Compile information and data on performance. They may include mapping processes.
- Select and contact partners
- Develop a mutual understanding about the procedures to be followed and, if necessary, Benchmarking Protocol with partners.
- Prepare questions
- Distribute schedule of questions to each partner
- Undertake information avid data collection by chose method for example, interview, site- visits, telephone, fax and e-mail.
- Collect the findings to enable analysis.

Stage 3: Analysis of findings:

- Review the findings and produce tables, Charts and graphs to support the analysis
- Identify gaps in performance between our organization and better performers.
- Seek explanations for the gaps in performance. The performance gaps can be positive negative or zero.
- Ensure that comparisons are meaningful and credible. Communicate the findings to those who are affected.
- Identify realistic opportunities for improvements. The negative performance gap indicates an undesirable competitive position and provides a basis for performance improvement. If there is no gap it may indicate a natural position relative to the performance being benchmarked. The zero position should be analysed for identifying means to transform its performance to a level of superiority or positive gap.

Stage 4: Recommendations:

1. **Making recommendations:**

- Deciding the feasibility of making the improvements in the light of the conditions that apply within own organization.
- Agreement on the improvements that are likely to be feasible
- Producing a report on the Benchmarking in which the recommendations are included.
- Obtaining the support of key stakeholder groups for making the changes needed. Developing action plans for implementation.

2. **Implementing recommendations:**

- Implement the action plans
- Monitor performance
- Reward and communicate successes
- Keep key stakeholders informed of progress.

Stage 5: Monitoring and reviewing: This involves:

- Evaluating the benchmarking process undertaken and the results of the improvement against objectives and success criteria plus overall efficiency and effectiveness.
- Documenting the lessons learnt and make them available to others
- Periodically re-considering the benchmarks for continuous improvement.

Pre-requisites for successful benchmarking

1. **Commitment:** Senior managers should support benchmarking and must be committed to continuous improvements.

2. **Clarity of Objectives:** The objectives should be clearly defined at the preliminary stage. Benchmarking teams have a clear picture of their organization's performance before approaching others for comparisons.
3. **Appropriate Scope:** The scope of the work should be appropriate in the light of the objectives resources, time available and the experience level of those involved.
4. **Resources:** Sufficient resources must be available to complete projects within the required time scale.
5. **Skills:** Benchmarking teams should have the right skills and competencies.
6. **Communication:** Stakeholder, particularly staff and their representatives are to be kept informed of the reasons for benchmarking.

Difficulties in implementation of Benchmarking

1. **Time consuming:** Benchmarking is time consuming and at times difficult. It has significant requirement of staff time and company resources. Companies often waste time in benchmarking non-critical functions.
2. **Lack of Management Support:** Benchmarking implementation require the direct involvement of the senior manager etc. The drive to be best in the industry or world cannot be delegated.
3. **Resistance from employees:** It is likely that there may be resistance from employees.
4. **Paper Goals:** Companies can become preoccupied with the measure. The goal becomes not to improve process but to match the best practices at any cost.
5. **Copy-paste attitude:** The key element in benchmarking is the adaptation of a best practice to tailor it to a company's needs and culture. Without that step, a company merely adopts another company's process. This approach condemns benchmarking to fail.

Benchmarking Code of Conduct:

To contribute to efficient, effective, and ethical benchmarking, individuals agree for themselves and their organization to abide by the following principles for benchmarking with other organizations.

1. **Principle of Legality:** Avoid discussion or actions that might lead to or imply an interest in restraint of trade; market or customer allocation schemes, price fixing dealing arrangements bid rigging, bribery or misappropriation. Do not discuss costs with competitors if costs are an element of pricing.
2. **Principles of Exchange:** Be willing to provide the same level of information that you request in any benchmarking exchange.
3. **Principle of Confidentiality:** Treat benchmarking interchange as something confidential to the individuals and organizations involved. Information obtained must not be communicated outside the partnering organization without prior consent of participating benchmarking partners. An organization's participation in a study should not be communicated externally without their permission.
4. **Principle of Use:** Use information obtained through benchmarking partnering only for the purpose of improvement of operations with the partnering companies themselves. External use or communications of a benchmarking partner's name with their data of observed practices requires permission of that partner. Do not, as a consultant of client, extend one company's benchmarking study findings to another without the first company's permission.
5. **Principle of first part Contact:** Initiate contacts, whenever possible, through a benchmarking contact designated by the partner company. Obtain mutual agreement with the contact on any hand off of communication or responsibility to other parties.
6. **Principle of Third Party Contact:** Obtain an individual's permission before providing their name in response to a contact request.
7. **Principle of Preparation:** Demonstrate commitment to the efficiency and effectiveness benchmarking process with adequate preparation at each process particularly, at initial partnering contact.

Question 31: What are benchmarking code of conduct? (4 Marks) May/10-O.C. & (3 Marks) Nov./04

Question 32: Describe the four types of bench marking of critical success factors. (4 Marks) Nov./08-O.C.

Question 33: Explain briefly stages involved in the process of Bench marking (5 Marks) Nov./09-O.C.

JUST IN TIME & BACK FLUSHING

Question 34: What is JIT? Explain how it eliminates wastage of resources.

(4 Marks) Nov./03

Or

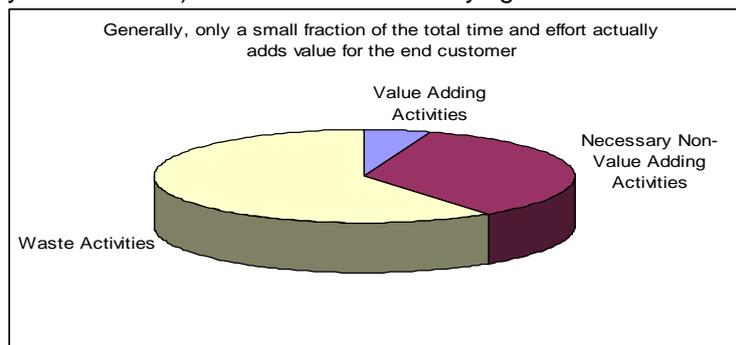
Describe Just-in-time system.

(6 Marks) Nov./08-N.C.

Ans.: *Just-in-time* (also popularly known as *lean production* or *stockless production*) is can be described as an approach with the objective of producing the right part in the right place at the right time (in other words, "just in time").

JIT is, in its most basic form, the systematic elimination of waste – overproduction, waiting, transportation, inventory, motion, over-processing, defective units – and the implementation of the concepts of continuous flow and customer pull.

The philosophy of JIT is simple - inventory is defined to be waste. It is best described as a philosophy of management, dedicated to the elimination of waste. JIT applies primarily to *repetitive manufacturing* processes in which the same products and components are produced over and over again. An activity that consumes resources but creates no value for the customer. Muda (vulgar Japanese word for "waste") is divided into Muda 1 and Muda 2. Muda 1 is waste that creates no value but is unavoidable with current technologies and policies. An example would be the payroll process. Muda 2 creates no value and can be eliminated. An example would be shop-floor labor reporting. Waste results from any activity that adds cost without adding value, such as the unnecessary moving of materials, the accumulation of excess inventory, or the use of faulty production methods that create products requiring subsequent rework. JIT is an inventory strategy implemented to improve the return on investment of a business by reducing in-process inventory (increasing the inventory turnover rate) and its associated carrying costs.



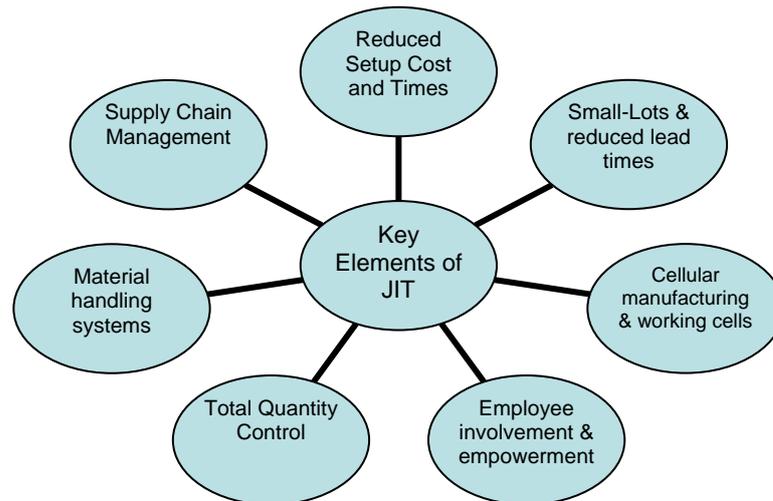
The basic elements of JIT were developed by Toyota in the 1950's, and became known as the Toyota Production System (TPS). JIT was well-established in many Japanese factories by the early 1970's. JIT began to be adopted in the U.S. in the 1980's (General Electric was an early adopter), and the JIT/lean concepts are now widely accepted and used. Some companies in India which are following the JIT system are HONDA MOTORS, AT & T & SIEMENS.

Question 35: What are key elements of JIT? Explain in details.

Ans.: 1. Reduced Setup Cost and Times : from months to hours thus making small-lot production economically viable; achieved by organizing procedures, using carts, and training workers to do their own setups. Aim for single digit setup times (less than 10 minutes) or "one-touch" setup -- this can be done through better planning, process redesign, and product redesign. A good example of the potential for improved setup times can be found in auto racing, where a NASCAR pit crew can change all four tires and put gas in the tank in under 20 seconds. The pit crew's efficiency is the result of a team effort using specialized equipment and a coordinated, well-rehearsed process. Similarly in industries for semi-versatile machinery such as big stamping presses

2. Small-Lot production & reduced lead times^A : reducing setup times allows economical production of smaller lots; close cooperation with suppliers is necessary to achieve reductions in order lot sizes for purchased items, since this will require more frequent deliveries; lead times can be reduced through close cooperation with suppliers, possibly by inducing suppliers to locate closer to the factory. Control systems such as a **kanban** (card) system (or other signaling system) should be used to convey parts between work stations in small quantities (ideally, one unit at a time).

[⁴Lead Time is the amount of time between placing of an order & the receipt of the goods ordered.]



3. Cellular manufacturing & working cells³ : production lead times can be reduced by moving work stations closer, together applying group technology and cellular manufacturing² concepts, reducing queue length (reducing the number of jobs waiting to be processed at a given machine), and improving the coordination and cooperation between successive processes. The general idea is that the machines needed to carry out the manufacture of a particular product family¹ are arranged in the form of discrete 'mini' assembly line. The machines are grouped together in a sequential order required by processing so that there is an even, constant and balanced flow of materials throughout the entire production process without queuing by machines or returning to stores.

E.g., Traditional manufacturing operations are organized by functional specialty into plant departments that all presses are in one department, all milling machines in another, welding machines in another and so forth. Workers are spread out along linear shaped production lines and inevitably produce goods in large batches or lots. Batch oriented linear production means that an operation completes all of the shop order and then moves it to the next operation for further processing. In a JIT cellular organization, just the opposite is the norm. Production is organized by **product rather than by function** with equipment dedicated or partially dedicated to a family of products. Production in such "cells" is conducted sequentially in the order in which operations must be performed to produce the end item. Workers in this type of environment are in close proximity to one another and are performing operations on lots of one.

[1. Product family: Products with similar production requirements.

2. Cellular manufacturing: The layout of machines of different types performing different operations in a tight sequence, typically in a U-shape, to permit single-piece flow and flexible deployment of human effort by means of multi-machine working.

3. Working cell: A small cluster of machines, which can be run by a single machine operator.]

4. Employee involvement and empowerment: workers should be trained to operate several machines, to do several specialized tasks, to perform minor maintenance tasks, for house keeping and to perform quality inspections. Use machine and worker idle time to maintain equipment and prevent breakdowns. In general, JIT requires teams of competent, empowered employees who have more responsibility for their own work.

5. Implement a zero defects quality program : A *quality at the source* program must be implemented to give workers the personal responsibility for the quality of the work they do, the authority to stop production when something goes wrong & if possible to immediately fix it & If the defect cannot be readily fixed to halt the entire line by pulling a cord (called *jidoka*).

6. Stabilize and level the Master Production Schedule (MPS)⁴ with uniform plant loading: create a uniform load on all work centers through constant daily production (establish **freeze windows** to prevent changes in the production plan/schedule for some period of time) and mixed model assembly (produce roughly the same mix of products each day, using a repeating sequence if several products are produced on the same line). Meet demand fluctuations through end-item inventory rather than through fluctuations in production level. Use of a stable production schedule also permits the use of **backflushing** to manage inventory: an end item's bill of materials is periodically exploded to calculate the usage quantities of the various components that were used to make the item, eliminating the need to collect detailed usage information on the shop floor.

[4. Master Production Schedule: It specifies the quantity of each finished unit of products to be produced, and the time at which each unit will be required.]

7. Supplier involvement, supplier quality assurance and: the manufacturer should treat its supplier as a long-term partners; they often must be trained in ways to reduce setup times, inventories, defects, machine breakdowns, etc. in order to enable them to take responsibility for delivering the best possible parts/services to the manufacturer in a timely manner. Errors leading to defective items must be eliminated, since there are no buffers of excess parts.

Question 36: What do you mean by Kanban Production Control System & how does it differ from traditional systems? Give appropriate examples.

Ans.: A kanban or "pull" production control system uses simple, visual signals to control the movement of materials between work centers as well as the production of new materials to replenish those sent downstream to the next work center. As implemented in the Toyota Production System, a **kanban** is a card that is attached to a storage and transport container. It identifies the part number and container capacity, along with other information, and is used to provide an easily understood, visual signal that a specific activity is required.

Egs. of Pull system:

1. Imagine a supermarket, where there are cards attached to all items on shelves. At the checkout, the cashier takes the cards off the items and sends them to the warehouse, who send replacement items. The warehouse also uses the same system, and when a carton is picked off the shelves, the card attached to it is sent further back upstream.

2. Kanban system implementation might be a "three-bin system" for the supplied parts (where there is no in-house manufacturing) — one bin on the factory floor, one bin in the factory store and one bin at the suppliers' store. The bins usually have a removable card that contains the product details and other relevant information — the kanban card. When the bin on the shop floor is empty, the bin and kanban card are returned to the store. The store then replaces the bin on the factory floor with a full bin, which also contains a kanban card. The store then contacts the supplier and returns the now empty bin with its kanban card. The suppliers inbound product bin with its kanban card is then delivered into the factory store completing the final step to the system. Thus the process will never run out of product and could be described as a loop, providing the exact amount required, with only one spare so there will never be an issue of over-supply. This 'spare' bin allows for the use, transport and uncertainty in supply that are inherent in the system.

Eg. Of Push System:

Consider the alternative. Every Friday, the warehouse sends three cartons of frozen peas to each supermarket. The number of cartons delivered is based on a calculation, done at some time in the past, on average usage. This means that some supermarkets will run out, whilst others will have peas coming out of their ears! This is a push system.

Many manufacturers have implemented electronic kanban systems. Electronic kanban systems, or E-Kanban systems, help to eliminate common problems such as manual entry errors and lost cards. E-Kanban systems can be integrated into enterprise resource planning (ERP) systems.

In some pull systems, other signaling approaches are used in place of kanban cards. For example, an empty container alone (with appropriate identification on the container) could serve as a signal for replenishment. Similarly, a labeled, pallet-sized square painted on the shop floor, if uncovered and visible, could indicate the need to go get another pallet of materials from its point of production and move it on top of the empty square at its point of use.

A kanban system is referred to as a **pull-system**, because the kanban is used to pull parts to the next production stage only when they are needed. In contrast, an MRP⁵ system (or any schedule-based system) is a **push system**, in which a detailed production schedule for each part is used to push parts to the next production stage when scheduled. Thus, in a pull system, material movement occurs only when the work station needing more material asks for it to be sent, while in a push system the station producing the material initiates its movement to the receiving station, assuming that it is needed because it was scheduled for production. The weakness of a push system (MRP) is that customer demand must be forecast and production lead times must be estimated. Bad guesses (forecasts or estimates) result in excess inventory and the longer the lead time, the more room for error. The weakness of a pull system (kanban) is that following the JIT production philosophy is essential, especially concerning the elements of short setup times and small lot sizes, because each station in the process must be able to respond quickly to requests for more materials.

[5. Material Requirements Planning (MRP) is software based production planning and inventory control system used to manage manufacturing processes.]

Question 37: How does the JIT approach help in improving an organization's profitability? (4 Marks) May/07
OR

Explain, how the implementation of JIT approach to manufacturing can be a major source of competitive advantage. (4 Marks) Nov./08-O.C.

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

- (i) Least scrapping - Immediate detection of defective goods being manufactured so that early correction is ensured with least scrapping.
- (ii) Reduced WIP costs - Eliminates/reduces WIP between machines within working cell.
- (iii) Reduced Overhead Costs - Overhead costs from non-value added activities in the form of rentals for inventory, insurance, maintenance costs etc. are reduced.
- (iv) Higher Selling Price - Higher product quality ensured by the JIT approach leads to higher premium in the selling price.
- (v) Early Detection - Detection of problem areas due to better production/scrap reporting/labour tracing and inventory accuracy lead to reduction in costs by improvement.

Question 38: Explain in brief the JIT approach for reducing WIP inventory.

OR

Difference in operating speeds of machines may lead to higher WIP inventory. How does JIT system resolve this issue?

Ans.: JIT approach for reducing WIP inventory:

At times, there may be huge differences between the operating speeds of different machines, e.g. Process 1 of machinery may produce 180 components per hour whereas Process II machine may finish only 135 units per hour. This affects cost in following manner:

- Piling up of WIP inventory: Work-in-process inventory builds up in front of the slowest machines.
- Delayed tracing of Defectives: Defective parts produced by an upstream machine may not be discovered until the next downstream machine operator finds them later. By that time, the upstream machine may have created more defective parts, all of which must now be destroyed or reworked.

In JIT philosophy, there are two ways to resolve the above problems.

1. **Kanban Card:** Explained in detail in Question 3
2. **Working Cells:** Explained in detail in Question 2 Point 3

Question 39: What are the advantages of working cells in JIT environment?

Ans.: The establishment of working cells has the following advantages:

- The individual machine operator takes each output part from machine to machine within the cell; and thus there is no way for WIP to build up between machines.
- The operator can immediately identify defective output which otherwise is difficult for each machine of the cell. The smaller machines used in a machine cell are generally much simpler than the large automated machinery they replace. Hence maintenance costs are reduced.
- It is much easier to reconfigure the production facility when it is necessary to produce different products, avoiding the large expense of carefully repositioning and aligning equipment.

Question 40: How does JIT help in shortening set-up and operation times?

OR

Outline the JIT approach for shortening set-up and operation times.

Ans.: Long set-ups and operation time involve indirect costs like product obsolescence, inventory carrying costs, and many defective products (because problems may not be discovered until a large number of items have already been completed). This problem will be resolved under JIT by adopting the following steps.

1. **Test data:** A videotape of a typical set is prepared for analysis purposes.
2. **Evaluation:** A team of industrial engineers and machine users examine this tape, spotting and gradually eliminating steps that contribute to a lengthy set-up.
3. **Motion and time study:** By eliminating unnecessary production steps and improving others after a number of iterations, it is possible to achieve substantially lower set-up times than before.
4. **Effects:** Reduction in set-up time has the following effects: Reduction in the amount of work-in-process, Reduction in the number of products that can be produced before, defects are identified and fixed, thereby reducing scrap costs.

Question 41: List a few benefits associated with JIT system.

Ans.: Benefits associated with JIT system are:

1. **Reduction in Inventory levels:** Unnecessary piling up of Raw Materials, WIP and finished goods are avoided. The focus is on production and purchase as per the firm's requirements.
2. **Reduction in Wastage of Time:** Wastage of time in various ways like inspection time, machinery set-up time, storage time, queue time, defectives rework time etc., are reduced.
3. **Reduction in Scrap Rates:** There will be sharp reductions in the rates of defectives or scrapped units. The workers themselves identify defects and take prompt action to avoid their recurrence.
4. **Reduction in Overhead Costs:** By reducing unnecessary (non value-added) activities and the associated time and cost-drivers, overheads can be greatly reduced e.g. material handling costs, rework costs, facility costs etc.

Question 42: Explain the Impact of JIT on Product Prices.

Ans.: When a company achieves a higher level of product quality, along with ability to deliver products on the dates required, customers may be willing to pay a premium. If customers are highly sensitive to quality or delivery reliability (which are the benefits of JIT), it may be possible to increase price substantially.

If customers place a higher degree of importance on other factors, then there will be no opportunity for a price increase. In case all firm in an industry adopt JIT, they offer the same level of quality and service. JIT philosophy, in such cases, just keeps a company from losing sales to its competitors.

The impact of a JIT system on product pricing is primarily driven by customer's perceived need for higher product quality and reliable delivery times, as well as the presence of competitors with JIT system, the same installation, and operational base.

Question 43: Identification of Machine Cells under JIT for systematic Overhead Cost Allocation.

Ans.: a. A working Cell or a machine Cell is a small cluster of machines, which can be run by a single machine operator.

b. It designed to produce either a single product or a single component that goes into a similar product line. Therefore all costs generated by the machine cell can be charged directly to the only product it produces.

c. When a company completely changes over to the use of machine cells in all locations, the cost related to all the cells can now be charged directly to products. The balance costs left may be assigned to the Overhead Cost Pool and identified with the products through Activity Based Costing. This results in more accurate product costs.

Some **examples** of shift from Overheads to Direct Machine Cell Costs are:

a. **Depreciation:** Depreciation of each machine in a machine cell can be charged directly to a product. It may be possible to depreciate a machine based on its actual use, rather than charging off a specific amount per month.

b. **Electricity:** Power used by the machine in a cell can be separately metered and charged directly to the products that pass through the cell. Excess electricity cost charged to the facility as whole has to be charged to an overhead cost pool for allocation.

c. **Material handling:** In a JIT system, most material handling cost are limited since machine operators move parts around within their machine cells. Only costs for materials handling between cells and charged to an overhead cost pool for allocation.

d. **Operating Suppliers:** Supplies are used mostly with the machine cells to the majority of item sin this expense category can be separately tracked by individual cell and charged to products directly.

e. **Repairs and maintenance:** All maintenance costs incurred for machinery can be grouped into machine cells. By having the maintenance staff, charge their time and materials to these cells, these costs can be charged straight to products. Maintenance work on the facility will be charged to an Overhead cost pool.

f. **Supervision:** If supervision is by machine cell, the cost of the supervisor can be split among the cells supervised. However the cost of general facility management as well as of any support staff, must still be charged to an overhead cost pool.

With such a higher proportion of direct costs associated with each product managers have much more relevant information about the true cost of each product manufactured.

Question 44: 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) May/10-N.C. & (4 Marks) Nov./04 & (5 Marks) June/09-OC

Ans.: Backflush accounting is a product costing approach, used in a Just-In-Time (JIT) operating environment, in which costing is delayed until goods are finished. Standard costs are then flushed backward through the system to assign costs to products. The result is that detailed tracking of costs is eliminated. Journal entries to inventory accounts may be delayed until the time of product completion or even the time of sale, and standard costs are used to assign costs to units when journal entries are made, that is, to flush

costs backward to the points at which inventories remain. On completion of finished goods, its quantity is multiplied by components required per item produced (as per bills of material). Resultant value is subtracted from beginning inventory; balance inventory is closing stock/inventory. The principle of backflushing is that whenever one part is made, the stock of the components on the part's bill of material (BOM)⁸ can be reduced by the quantity on the bill of material. If, for instance, the stock of car batteries is held beside the car assembly line, the stock of car batteries can be reduced by one every time a car is made (typically the component stock is reduced when the work order is booked into stock). It can be argued that backflush accounting simplifies costing since it ignores both labour variances and work-in-progress.

The problems of back flushing that must be corrected before it will work properly are:

1. Accurate BOM - Bill of material accuracy must be maintained at 100% including scrap factors.
2. Proper changes in BOM - Any changes to bills of material must be timed to match the backflush of the changed process.
3. Inventory accuracy - Stock checking is more difficult as computer record must be checked with stock on the shelf plus all materials and ingredients that have been issued but not yet backflushed.
4. Scrap reporting - All scrap and re-work must be reported as soon as it happens.
5. Production reporting - Every single jobs requiring any stocked materials must have a work order opened and backflushed.
6. Lot Tracing – 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 to be recalled. Only a picking system (issue material from stores on a pick list based on a works order system) can adequately record this information. Some computer systems allow picking and backflushing system to coexist.

[8. BOM File specifies sub-assemblies components and materials required for each finished good.]

Question 45: Discuss the treatment of material, labour, overheads, & WIP in back flush accounting.

Ans.: Traditional & Standard costing systems use **sequential tracking costing system** for accounting costs. It has trigger points⁷, corresponding to journal entries as transaction occur i.e. purchase, issue of material, production, overhead absorption, completion of finished goods, etc.

An alternative approach to sequential tracking is backflush costing. Backflush accounting system simplifies the accounting records by avoiding the need to follow the movement of materials and work-in-progress through the manufacturing process within the organization.

There are several variants of backflush accounting, one of them is that inspite of separate raw materials and WIP A/c there is single **Raw and in-Process A/c (RIP)**. The use of standard costs and variances is likely to be incorporated into the accounting entries. Transfers from raw and in-progress account to finished goods (or cost of sales) will probably be made at standard cost. The difference between the actual inputs and the standard charges from the raw and in-progress account will be recorded as a residual variance which will be recorded in the profit and loss account. Thus, it is essential that standard costs are a good surrogate for actual costs if large variances are to be avoided.

Conversion costs are recorded as incurred in backflush accounting system. All indirect expenses (**Direct Labour is treated as indirect cost**) are treated as period costs in it. Direct Labour and overhead are combined into temporary A/c i.e. Conversion cost control A/c. This A/c accumulates the actual conversion cost on debit side and applied conversion cost on the credit side.

Naturally, management will still be eager to ascertain the cause of any variances which arise from the inefficient usage of materials, labour, and overheads. However, investigations are far more likely to be undertaken using non-financial performance indicators as opposed to detailed cost variances.

Backflush accounting is ideally suited to a just-in-time philosophy and is employed where the overall cycle time is relatively short and inventory levels are low.

[7. Trigger point = point at which entries are made in A/cing system. It may be receipt of materials or completion/sale of goods. If system is full JIT, completion is trigger point.]

Question 46 [JIT]: The Evans Corporation manufactures wireless telephone. Evans is deciding whether to implement a JIT production system. Which would require annual tooling costs of ₹150000. Evans estimated that the following annual benefits would arise from JIT production.

- a. Average inventory would decline by ₹700000. from ₹900000 to ₹200000.

- b. Insurance space materials – handling , and setup costs, which currently total ₹200000,would decline by 30%.
- c. The emphasis on quality inherent in JIT system would reduce rework costs by 20%. Evans currently incurs ₹3,50,000 on rework.
- d. Better quality would enable Evans to raise the selling prices of its products by ₹3 per unit Evans sells 30,000 units each year.

Evans's required rate to return on inventory investment is 12% pr year.

Required;

Calculate the net benefit or cost to the Evans Corporation from implementing a JIT production system. Suppose Evans implements JIT productions. (a) Give examples of performance measures Evans could use to evaluate and control JIT production. (b) What is the benefits to Evans of implementing an enterprise resource planning (ERP) system?

[Ans.: Annual Relevant Costs of Current Production System and JIT Production System for Evans Corporation.

<u>Relevant Items</u>	<u>Relevant Costs under Current Production System</u>	<u>Relevant Costs under JIT Production System</u>
Total net incremental costs	₹6,58,000	₹5,04,000
Annual difference in favor of JIT production	↑	↑
	↑ ₹1,54,000 ↑	

Question 47 [JIT]: 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/05

[Ans.: (i)

Particulars	Current Policy	JIT
	₹	₹
Total relevant cost	18,32,076	18,21,925.15

Comments: Hence, a JIT purchasing policy should be adopted by the company.

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.]	

MANUFACTURING RESOURCE PLANNING & ENTERPRISE RESOURCE PLANNING

MANUFACTURING RESOURCES PLANNING(MRP I&II)

It is a part of production operation system. Management has to develop a lot of strategies for production plan. In early 1960's a material acquisition plan was first introduced known as Material Requirement Plan (MRP-I). MRP-2 is latest all-round development of that plan.

A brief history of MRP –1

Material requirement planning is a computerized production scheduling system which takes the forward schedule of final product requirements (the master production schedule) and translates it progressively into the numbers of sub-assemblies, components and raw materials required at each stage of the manufacturing cycle.

It is a management information system providing a basis for production decisions when what is manufactured has a composite structure and when lead items are important features. Obviously, the ability of the system to deliver what is required in the correct place at the correct time will be dependent on the quality of information which is put into the computer model.

AIMS OF MATERIAL REQUIREMENT PLANNING:

1. Determine for final products namely, what should be produced and at what time.
2. Ascertaining the required units of production of sub-assemblies.
3. Determining the requirement for materials based on an up-to-date bill of materials file (BOM).
4. Computing inventories, WIP, batch sizes and manufacturing and packaging lead times.
5. Controlling inventory by ordering bought-in components and raw materials in relation to the orders received or forecast rather than the more usual practice of ordering from stock-level indicators.

Benefits: Detailed forecast of the inventory position is highlighted period by period.

DATA REQUIREMENTS TO OPERATE MATERIAL REQUIREMENT PLANNING SYSTEM:

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.

The Bill of material file: The bill of material file specifies the sub-assemblies, components and materials required for each finished good.

The inventory file: This file maintains details of items in hand for each sub-assemblies, components and materials required for each finished goods.

The routing file: This file specifies the sequence of operations required to manufacture components, sub-assemblies and finished goods.

The master parts file: This file contains information on the production time of sub- assemblies and components produced internally and lead times for externally acquired items.

Method of operation of material requirement planning system:

A material requirements planning (MRP) system is a computer based inventory information system which is used to plan and control raw material and component parts inventories.

Like all computer-based information system, MRP systems can be divided into following:

- Pre-requisite information
- System input
- System processing
- System output

Pre-requisite information and system input:

1. The master production schedule (MPS) file states the production goal, generally for a week time, in terms of desired units of production. MRP system first focuses on the forecasted units of production and timing of

finished goods demand and the determines the demand for materials, components and sub-assemblies at each stages of production. This makes MRP a push system in which once the scheduled production starts, the output of each department is pushed through the system to the next department for processing or into inventory to be retrieved later.

2. The bill of materials (BOM) file contains information about how the production of the finished goods is undertaken. A bill of material structure is used:

- a) To assess all of the raw materials and component parts required to complete a product, and,
- b) To describe the multiple levels of assembly or manufacturing necessary to complete a unit of finished product.

3. The inventory records files of the MRP system defines current levels of finished goods, raw materials, and component parts inventory at the beginning of some planning period. During the planning period, the organization may receive units of raw materials, components parts, sub-assemblies, and even finished goods inventory from suppliers, vendors, and subcontractors. These planned inventory receipts and delivery lead times are included in the inventory records file so that their addition can be appropriately considered in the time bucket of their arrival.

Pre-requisites for successful operation of MRP:

1. **Strict adherence to the schedule:** The successful operation of MRP system requires a strict adherence to the latest production and purchasing schedules. Workers must be educated to understand the importance of schedule adherence, and controls should be in place to ensure this adherence.

2. **Accurate data base:** Data accuracy is vital to the system. If a plan is based on inaccurate data it may be impossible to adhere to the schedule. For example, if the bill of materials file is not updated to reflect any changes in product composition it will be impossible to adhere to the schedule.

MRP- II

When the scope of MRP-1 is developed further, which includes

1. Planning of raw material
2. Planning of component & sub- assemblies
3. Compute the other resources e.g. machine or labour capacity
4. To create a full integrated plan for management

then it is known as Manufacturing resources planning (MRP – 2)

MRPII (also written MRP-2) adds the MRP schedule into a capacity planning system and then builds the information into a production schedule. It is also seen as a link between strategic planning and manufacturing control. The sequence of events is as follows:

From that document, a manufacturing, plan is developed based upon inputs from purchasing & production. Adjustments may be necessary to allow for production rates. Possible inventory levels in seasonal trades & the size of the workforce. The manufacturing plan leads into a detailed master production schedule which is akin to the original philosophy of MRP already outlined.

If correctly applied, MRPII provides a common data base for the different function units such as manufacturing, purchasing and finance within a firm.

ENTERPRISE RESOURCE PLANNING (ERP)

ERP refers to software, which integrates all departments and functions across a company into a single computer system that can serve all those needs of different departments.

It combines all computerized departments together with the help of a single integrated software program that uses a single database so that various departments can more easily share information and communicate with each other.

Need for ERP:

1. **Complete Automation and Faster Service:** ERP automates the tasks involved in performing a business process such as order fulfillment, which involves taking an order from a customer, shipping it and billing for it. The order process moves like a bolt of lightning through the organization, and customers get their orders faster and with fewer errors than before. Similarly, the major business processes like employee benefits or financial reporting can be speeded up.
2. **Standardized Processes:** Manufacturing companies find that multiple business units (departments) across the company adopt different methods and computer systems for the same product.

Standardizing these using a single integrated computer system can save time and increase productivity.

3. **Integrated Financial Data:** ERP creates a single version of the financial position and performance that cannot be questioned because everyone is using the same system. It is very useful in analyzing the performance and deviations of different business units (responsibility centres) rather than obtaining individual reports from each such business unit.
4. **Standardised HR Information:** HR may not have a unified, simple method for tracking employee time and communicating with them about benefits and services. ERP can help companies with multiple business units in this regard.
5. **Tailor-made:** ERP systems are designed as per the requirements of individual companies based on the nature, scale and methods of operations. It is superior to other standardized application packages (software), which may not be fully useful to a multifaceted company.
6. **Information Management:** A good MIS should avoid information overload, ERP helps proper information management since all data are made available at one place, accessible to different users based on their individual requirements.

Components of ERP:

The following may be identified as the primary components (sub-systems) of ERP system:

Sales and marketing	Shop floor control
Master scheduling	Accounts payable/receivable
Material requirement Planning	Logistics
Capacity requirement planning	Asset Management
Bill of materials Purchasing	Financial Accounting

Features of ERP:

1. **Integrated:** ERP facilitates company-wide information integration covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory, accounts, human resources, etc. ERP provides complete integration of systems not only across departments but also across companies under the same management.
2. **Information Sharing:** ERP bridges the information gap across organizations.
3. **Project Management:** ERP is the solution for better project management
4. **E-Com Facilities:** ERP allows automatic introduction of technologies like Electronic Fund Transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video Conferencing, E-Commerce etc.
5. **Business Decision Making Solution:** ERP provides business intelligence tools like Decision Support systems (DSS), Executive Information System (EIS), Reporting, Data Mining and Early warning systems (Robots) for enabling people to make better decisions. It eliminates most business problems like material shortage, productivity enhancements, customer service, cash management, inventory problems, quality problems, prompt delivery etc.
6. **Futuristic:** ERP not only addresses the current requirements of the company but also provides the opportunity of continually improving and refining business processes.

Benefits of ERP:

1. **Product Costing:** ERP system supports advanced costing methods like Standard Costing, Actual Costing, Activity based costing, thereby helping in determination of cost products accurately.
2. **Cost Monitoring and Control:** ERP can integrate all costing methods and information with finance. This provides the company with essential financial information or monitoring and controlling costs.
3. **Planning and Managing:** The ERP system simplifies complicated logistics and helps in planning for and managing different divisions in different locations as a single unit.
4. **Information Flow:** The advanced utility of the ERP system helps in processing the flow of product and financial information in several different ways.
5. **Efficient Database Management:** The ERP system aids in the efficient managing of data on warehouse, suppliers customers etc. required to run an organization effectively and profitably.
6. **Inventory Management:** Inventory reporting supports all reporting of specific and general types of stock transactions like stock transfers, reclassifications, ID changes and physical inventory results. Also ERP can manage stock and purchase requisitions selections of appropriate locations for receipts, inventory valuation, warehouse management and cost accounting.
7. **Customer Satisfaction:** ERP system defines the logistics processes flexibly and efficiently to deliver the right product from the right warehouse to the right customer at the right time – every

time, thereby satisfying the customers. It also supports planning transportation, confirmation, dispatch and proof of delivery processing. Additionally, it ensures better after sales service.

8. **Competitive Edge:** ERP system helps a company to gain the Competitive Edge by (a) enabling the company to respond quickly and accurately to change in market conditions; (b) improving business process (c) ensuring quality control; (d) improved and objective production planning; intranet and Extranet Solutions.

Question 48: Write short notes on Material Requirement Planning (5 Marks) May/02

Question 49: Mention the data required to operate the material requirement planning system. (4 Marks) Nov./10-N.C.

Question 50: State the major features of Enterprise Resource Planning (ERP) (4 Marks) Nov./07, (3 Marks) May/03 & (4 Marks) Nov./02

Question 51: State the benefits accruing from Enterprise Resource Planning (ERP) (4 Marks) May/04 & (4 Marks) Nov./10-O.C.

Question 52: (i) What do you mean by ERP? (2 Marks) Nov./06
(ii) Name six benefits of ERP in an enterprise. (3 Marks) Nov./06

COMPUTER-AIDED MANUFACTURING

The manufacturing process is carried out by a range of machinery that, together with its concomitant software, comes under the collective heading of computer-aided manufacturing (CAM).

Maximum elements of CAM are computer numerical control (CNC) and robotics.

CNC machines are programmable machine tools. These are capable of performing a number of machining tasks, e.g. cutting, grinding, moulding, bending etc.

A program stores all the existing manufacturing activities and set-up instructions for a particular machine or bank of machines, providing facility of changing its configuration in a matter of seconds via the keyboard; changes to existing configurations and new configurations are easily accommodated. CNC therefore offers great flexibility, and reduces set-up times.

Human operators will tire and are error prone. CNC machines are able to repeat the same operation continuously in identical manner, with high accuracy level.

For Example the car producer, found that the time taken to completely retool car body panel jigs in their intelligent body assembly system (IBAS) fell from 12 months to less than

3 months by reprogramming the process machinery by computer and using computerised jig robots.

BUSINESS PROCESS RE-ENGINEERING

Business process re-engineering involves examining business processes and making substantial changes in the day to day operation of the organisation. It involves the redesign of work by changing the activities.

A business process consists of a collection of activities that are linked together in a co-ordinated & Sequential manner to achieve goal & objective.

For example, material handling might be classed as

- ❖ Scheduling production,
- ❖ Storing materials,
- ❖ Processing purchase orders,
- ❖ Inspecting materials, and,
- ❖ Paying suppliers.

The aim of business process re-engineering is to improve the key business process in an organisation by focusing on

- ❖ Simplification,
- ❖ Cost reduction,
- ❖ Improved quality, and,
- ❖ Enhanced customer satisfaction

UNIFORM COSTING

When several undertakings start using the same costing principles and/or practices they are said to be following uniform costing. The basic idea behind uniform costing is that the 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. The principles and methods of compilation, analysis, apportionment and absorption of overheads differ from one concern to the other in the same industry; but if a common or uniform pattern is adopted by all, it helps mutually in cost control and cost reduction. Therefore, it is necessary that a uniform method of costing should be adopted by the member unit of an industry.

Objectives of Uniform Costing: The main objectives of Uniform Costing are as follows :—

1. To facilitate the comparison of costs and performances of different units in the same industry; it provides objective basis.
2. To eliminate unhealthy competition among the different units of an industry.
3. To improve production capacity level and labour efficiency by comparing the production costs of different units with each other.
4. To provide relevant cost information/data to the Government for fixing and regulating prices of the products.
5. To bring standardization and uniformity in the operation of participating units.
6. To reduce production, administration, selling and distribution costs, and to exercise control on fixed costs.

Essential requisites for the installation of Uniform Costing System: A successful system of uniform costing has the following requirements :—

- (1) Co-operation among member units. There should be co-operation and a policy of give and take amongst the different units in the industry which are to use uniform costing system. Without any reservations, every participating member should be willing to supply the required information to a central body appointed by themselves.
- (2) Spirit of sharing experience. The bigger units should be prepared to share their experiences with the smaller concerns so that the latter may be able to improve their performances.
- (3) No rivalry. There should be no rivalry or jealousy amongst the participating members.
- (4) Free exchange of ideas. Ideas should be freely exchanged amongst the participating members in order to enable them to judge their efficiency with reference to other units.
- (5) Leveling the key factors. Certain key factors such as methods and principles of cost accounting peculiar to individual units should be carefully noted. These key factors will give different costs of different undertakings in the same industry which will make cost comparison difficult. Thus efforts should be made to locate the key factors which create differences. These varying factors should be leveled out by giving a weight age on an equitable basis.
- (6) Cost manual. A cost manual which lays down the recommended cost accounting plan should be circulated amongst the participating members by the central body.
- (7) Adequate information for categorization. Some sort of categorization should be made both in respect of long-term and short-term differences in order to make comparison useful. To distinguish such differences, adequate qualitative and quantitative information should be available.
- (8) Central organisation. There should be central organization for the collection, co-ordination and presentation of information. The method of collection and presentation of information should be properly laid down and clearly indicated.
- (9) Proper explanation of the scheme. The scheme must be properly explained to all concerned. This is necessary to convince about its utility and make all concerned to work for its success.

Advantages of Uniform Costing: The advantages accruing from the use of uniform costing system are as follows:

- i. The management of each firm will be saved from the exercise of developing and introducing a costing system of its own.
- ii. A costing system devised by mutual consultation and after considering the difficulties and circumstances prevailing in different firms is readily adopted and successfully implemented.
- iii. It facilitates comparison of cost figures of various firms to enable the firms to identify their weak and strong points besides controlling costs.
- iv. Optimum achievement of efficiency is attempted by all the firms by utilizing the experience of other concerns in the industry.

- v. Standing in the industry of each firm will be known by making a comparison of its cost data with others.
- vi. Services of cost consultants or experts may be available jointly to each firm in the industry by sharing their experiences and expenses.
- vii. Research and development benefits of bigger firms may be made available to smaller firms.
- viii. It helps in the reduction of labour turnover, as a uniform wage system is the pre-condition of a uniform costing system.
- ix. It helps Trade Associations in negotiating with the Government for any assistance or concession in the matters of taxation, exports, subsidies, duties and prices determination etc.
- x. Unhealthy competition is avoided among the firms in the same industry in framing pricing policies and submitting tenders.
- xi. Prices fixed on the basis of uniform costing are representative of the whole industry and thus are reliable.
- xii. Uniform costing provide a basis for the comparative assessment of the performance of two firms in the same industry but in different sectors.
- xiii. It helps the Government in regulating the prices of essential commodities such as bread, sugar, cement, steel etc.

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.

Question 53: What are the requisites for the installation of a uniform costing system?

(4 Marks) Nov./08-N.C. & (4 Marks) May/10-N.C.

Question 54: What is uniform costing? Why it is recommended?

(4 Marks) June/09- N.C.

INTER-FIRM COMPARISON

It is technique of evaluating the performance, efficiency, costs and profits of firms in an industry. It consists of voluntary exchange of information/data concerning costs, prices, profits, productivity and overall efficiency among firms engaged in similar type of operations for the purpose of bringing improvement in efficiency and indicating the weaknesses. Such a comparison will be possible where uniform costing is in operation.

An inter-firm comparison indicates the efficiency of production and selling, adequacy of profits, weak spots in the organisation, etc. and thus demands from the firm's management an immediate suitable action. Inter-firm comparison may enable the management to challenge the standards which it has set for itself and to improve upon them in the light of the current information gathered from more efficient units. Such a comparison may be carried out in electrical industry, printing firms, cotton spinning firms, pharmaceuticals, cycle manufacturing, etc.

Requisites of inter-firm comparison system: The following requisites should be considered while installing a system of inter-firm comparison:

1. Centre for Inter-Comparison — For collection and analyzing data received from member units, for doing a comparative study and for dissemination of the results of study a Central body is necessary. The functions of such a body may be:
 - i. Collection of data and information from its members;
 - ii. Dissemination of results to its members;
 - iii. Undertaking research and development for common and individual benefit of its members;
 - iv. Organising training programmes and publishing magazines.
2. Membership - Another requirement for the success of inter-firm comparison is that the firms of different sizes should become members of the Centre entrusted with the task of carrying out inter-firm comparison.

3. Nature of information to be collected - Although there is no limit to information, yet the following information useful to the management is in general collected by the Centre for inter-firm comparison.
 - i. Information regarding costs and cost structures.
 - ii. Raw material consumption.
 - iii. Stock of raw material, wastage of materials, etc.
 - iv. Labour efficiency and labour utilisation.
 - v. Machine utilisation and machine efficiency.
 - vi. Capital employed and Return on capital.
 - vii. Liquidity of the organisation.
 - viii. Reserve and appropriation of profit.
 - ix. Creditors and debtors.
 - x. Methods of production and technical aspects.
4. Method of Collection and presentation of information - The Centre collects information at fixed intervals in a prescribed form from its members. Sometimes a questionnaire is sent to each member; the replies of the questionnaire received by the Centre constitute the information/data. The information is generally collected at the end of the year as it is mostly related with final accounts and Balance Sheet. The information supplied by firms is generally in the form of ratios and not in absolute figures. The information collected as above is stored and presented to its members in the form of a report. Such reports are not made available to non-members.

Advantages of Inter-firm comparison::

- a) 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.
- b) It helps a concern in knowing its strengths or weaknesses in relation to others so that remedial measures may be taken.
- c) It ensures an unbiased specialized reporting on particular problems of the concern.
- d) It develops cost consciousness among members of the industry.
- e) It helps Government in effecting price regulation.
- f) 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.

Limitations of inter-firm comparison

- a) Top management feels that secrecy will be lost.
- b) Middle management is usually not convinced with the utility of such a comparison.
- c) In the absence of a suitable Cost Accounting System, the figures supplied may not be reliable for the purpose of comparison.
- d) Suitable basis for comparison may not be available.

Types of Comparisons

The following are the three types of comparisons made for this purpose:

- (i) Comparison of Management Ratios. The management ratios are those which are linked to sales, profits and assets of a business. These ratios are meant to provide the management in a nutshell, a comparative picture of its operating performance, financial result, growth, liquidity etc. compared with those of other firms in the industry or trade. These ratios are worked out on the basis of figures supplied by each member. In the pyramid of ratios (given on previous page) the apex ratio is profit related to the capital employed, which takes into account the various factors affecting the business. The ratios worked out are useful to the management to the extent that the comparison reflects the earning capacity, return on capital employed, earnings on fixed assets, liquidity, growth etc, of the business vis-à-vis others and on the basis of this information it can act for future improvement.
- (ii) Comparison of cost ratios. Management may not be satisfied with the ratios calculated in (i) They would like to go a step further to make inter-firm comparison more meaningful and to find out how they are doing in relation to others as regards the cost of production. In a competitive world cost ratios will assume greater importance for the simple reason that cost reduction becomes a compelling necessity when there is acute competition. The members of the Association will, under this type of inter-firm comparison, have to disclose much more information than they will be required to do in case of (i). the advantages of cost ratio comparison will be more marked in the areas where cost reduction is visualized.
- (iii) Comparison of Technical Data. This of comparison will be of special interest to industries working in highly competitive economies. Such comparison will gradually lead to rationalization of industry. It is

visualized that technical comparison will be in the realm of quantity of materials used, their utilization, process involved, machinery used, and certain other technical aspects of production. The following are the main ratios which are calculated for this purpose:

- | | |
|--|---|
| 1. $\frac{\text{Quantity of Raw Material Consumed}}{\text{Man Hours / Machine House}}$ | 2. $\frac{\text{Cost of Raw Materials Consumed}}{\text{Man Hours / Machine Hours}}$ |
| 3. $\frac{\text{Cost of Raw Materials Consumed}}{\text{Quantity Produced}}$ | 4. $\frac{\text{Cost of Scrap}}{\text{Cost of Raw Materials Consumed}}$ |
| 5. $\frac{\text{Quantity of Scrap}}{\text{Quantity of Raw Materials Consumed}}$ | 6. $\frac{\text{Quantity Produced}}{\text{Rated Capacity}}$ |
| 7. $\frac{\text{Quantity Produced}}{\text{Main Hours/Machine Hours}}$ | 8. $\frac{\text{Cost of Rejected Material}}{\text{Cost of Production}}$ |
| 9. $\frac{\text{Cost of Reworking}}{\text{Cost of Production}}$ | 10. $\frac{\text{Loss on Process}}{\text{Cost of Material}}$ |
| 11. $\frac{\text{Idle Time Hours}}{\text{Total Available Time}}$ | 12. $\frac{\text{Overtime Hours}}{\text{Main Hours}}$ |
| 13. $\frac{\text{Cost of Idle Time}}{\text{Direct Labour Cost}}$ | 14. $\frac{\text{Cost of Overtime}}{\text{Direct Labour Cost}}$ |
| 15. $\frac{\text{Power Units Consumed}}{\text{Machine Hours}}$ | 16. $\frac{\text{Cost of Machine Maintenance}}{\text{Cost of Production}}$ |
| 17. $\frac{\text{Cost of Maintenance of Other Factory Assets}}{\text{Cost of Production}}$ | |

Note: Where different processes are involved in the manufacturing of a product, ratios could be worked out for each process.

Question 55: Make an assessment of the comparative position of firms A,B and C after calculating relevant ratios on the basis of the following information:

	Firm A ₹	Firm B ₹	Firm C ₹
Inventory (31-12-2006)	10,00,000	15,00,000	20,00,000
Sales (for 2006)	66,00,000	83,25,000	89,60,000
Cost of Goods Sold (for 2006)	60,00,000	75,00,000	80,00,000
Expenses of Management	5,00,000	7,50,000	10,00,000
Receivables (31-12-2006)	13,20,000	24,97,500	35,84,000

SOLUTION

Inventory Turnover Ratio	=	$\frac{\text{Cost of goods sold}}{\text{Inventory}}$
Firm A:		$\frac{₹60,00,000}{₹10,00,000} = 6 \text{ times}$
Firm B:		$\frac{₹75,00,000}{₹15,00,000} = 5 \text{ times}$
Firm C:		$\frac{₹80,00,000}{₹20,00,000} = 4 \text{ times}$

₹20,00,000

Form the above we see that inventory turnover ratio of firm A is better than that of B and C. Firm C has the lowest ratio, i.e., it has the slowest moving stock.

Average Collection Period	=	$\frac{\text{Receivables}}{\text{Sales}} \times 360$
Firm A:		$\frac{₹13,20,000}{₹66,00,000} \times 360 = 72 \text{ days}$
Firm B:		$\frac{₹24,97,500}{₹83,25,000} \times 360 = 108 \text{ days}$
Firm C:		$\frac{₹35,84,000}{₹89,60,000} \times 360 = 144 \text{ days}$

The average number of days credit allowed to customers is 72 days in firm A and 144 days in firm C, which is just the double of A. It indicates that firm A is following a sound credit policy whereas firms B and C are following a liberal credit policy. It is possible that firms B and C may have given credit to weak customers and they are not making the payment in time.

Inventory turnover ratio and average collection period indicates that firm A is making an efficient use of its working capital as compared to firms B and C. C's position in this regard is the weakest.

Calculation of the Amount of Net Profit

	Firm A ₹	Firm B ₹	Firm C ₹
Sales	66,00,000	83,25,000	89,60,000
Less: Cost of Goods sold	<u>60,00,000</u>	<u>75,00,000</u>	<u>80,00,000</u>
Gross Profit	6,00,000	8,25,000	9,60,000
Less: Expenses of Management	<u>5,00,000</u>	<u>7.50,000</u>	<u>10,00,000</u>
Net Profit	1,00,000	75,000	40,000
			(Loss)
Percentage of Gross Profit to Sales	<u>9.1%</u>	<u>9.9%</u>	<u>10.7%</u>

Firm A is earning a net profit of ₹1,00,000 in spite of the low percentage of gross profit. This is because of less expenses of management. On the hand, C is suffering a loss of ₹40,000 in spite of the highest percentage of gross profit. This is because of the highest figure of management expenses. Firms B and C should try to curtail the expenses of management and increase the inventory turnover ratio to make an improvement in their performance.

To conclude, performance of firm A is better than the performance of firms B & C.

Question 56: Two companies in the same industry show the following data as adopted from the annual financial statements:

	X ₹(Lakhs)	Y ₹(Lakhs)
Total Sales Income	24.00	25.92
Variable Cost	15.60	17.80
Fixed Costs	4.80	5.00
Capital Employed	12.00	13.00

- Compare : (i) Capital turnover , (ii) Profit before tax as % of sales value, (iii) Profit before tax as % on capital employed, (iv) Gross marginal income as percentage of sales, (v) Break-even sales, and (vi) margin of safety as % on sales.
- Suppose you are the Accountant of Company X, comment on working. Besides information given in X, do you feel any other interesting information which can be derived from the above?

SOLUTION (a)

	X ₹(Lakhs)	Y ₹(Lakhs)
Sales	24.00	25.92
Less: Variable Cost	<u>15.60</u>	<u>17.80</u>
Gross Marginal Income	8.40	8.12
Less: Fixed Cost	<u>4.80</u>	<u>5.00</u>
Profit	<u>3.60</u>	<u>3.12</u>

(i) Capital Turnover

$$= \frac{\text{Sales}}{\text{Capital employed}} \quad \frac{24}{12} = 2 \text{ times} \quad \frac{25.92}{13.00} = 1.99 \text{ times}$$

(ii) % of Profit on Sales

$$= \frac{\text{Profit before tax}}{\text{Sales}} \times 100 \quad \frac{3.60}{24.00} \times 100 = 15\% \quad \frac{3.12}{25.92} \times 100 = 12\%$$

(iii) % of profit on Capital Employed

$$= \frac{\text{Profit before tax}}{\text{Capital employed}} \times 100 \quad \frac{3.60}{12} \times 100 = 30\% \quad \frac{3.12}{13} \times 100 = 24\%$$

(iv) % of Gross Marginal Income to Sales

$$= \frac{\text{Gross Marginal Income}}{\text{Capital employed}} \times 100 \quad \frac{8.40}{24.00} \times 100 = 35\% \quad \frac{8.12}{25.92} \times 100 = 31.327\%$$

(v) Break- even Sales

$$= \frac{\text{Fixed Cost}}{\text{P/V Ratio or Gross Marginal Income \%}} \quad \frac{4.80}{35\%} = ₹13.71 \text{ Lakhs} \quad \frac{5.00}{31.327\%} = ₹15.96 \text{ lakhs}$$

(vi) Margin of Safety as % on Sales

$$= \frac{\text{Margin of Safety}}{\text{Sales}} \times 100 \quad \frac{10.29}{24.00} \times 100 = 42.88\% \quad \frac{9.96}{25.92} \times 100 = 38.43\%$$

(b) The company X is better placed as revealed by all six ratios calculated above. Although the quantum of sales is more in Y, the profit realized is less. Further return on capital employed can be calculated:

$$= \frac{\text{Return}}{\text{Capital employed}} \times 100 \quad \frac{3.60}{12.00} \times 100 = 30\% \quad \frac{3.12}{13.00} \times 100 = 24\%$$

Question 57: The standard ratios for the industry and the ratios of company X are given. Indicate the company's strengths and weaknesses as shown by your analysis.

Industry

Company X

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Costing & O.R.

World's largest CA Final student's consultancy group: <http://groups.yahoo.com/group/costingbyparaggupta>

Current Assets/Current Liabilities	2.4	2.67
Sales/Debtors	8.0	10.00
Sales/Stock	9.8	3.33
Sales/Total Assets	2.0	1.43
Net Profit/Sales	3.3%	2.1%
Net Profit/Total Assets	6.6%	3.0%
Net Profit/Net Worth	10.7%	4.8%
Total Debt/Total Assets	63.5%	37.7%

SOLUTION

- (i) Current ratio indicates better position as current assets are comparatively higher than current liabilities of a similar industry. However, the current assets may be proportionately higher due to excessive stock as had been reflected in ratio (iii).
- (ii) Debtors turnover ratio indicates that the industry in general allows 1.5 (12 * 8) months credit to customers but Company X allows 1.2 (12 * 10) month credit to customers. This indicated marginally controlled credit facilities. This shows effective credit policy and collection policy though there is a scope for development of potential customers with further review of credit policy.
- (iii) Stock turnover ratio indicates that stock is alarmingly high as the industry's norm J.22 months (12*9.8) sales as against 3.6 months (12 * 3.33) sales of Company. This has not been properly reflected in current ratio as the current liabilities might have not been also equally high. But positively the stock is abnormally high.
- (iv) Asset turnover ratio indicates that assets are comparatively higher to its turnover indicating overstocking or under-utilisation of fixed assets. This ratio further indicates over-stocking.
- (v) Net profit ratio is lower as compared to standard ratio. This indicates higher cost of production and less earnings before interest and tax. This requires either increase in sales realization or reduction in the cost of manufacture to ensure a reasonable return on investment.
- (vi) Net profit / worth ratio indicates that the capital structure of the X Company is having very low debt/ equity ratio. The earning capacity and earning per share is also very low.
- (vii) Total Debt/ Total Asset Turnover ratio is lower for X Company which indicates low capita gearing. The total assets are substantially high leading to this ratio lower than the standard even though the current ratio is high.

On the above basis it can be said that stock is very high though there is good control over debtors and credit control policy. There is need for increasing the operational efficiency of production. Debts can be increased. The company is over capitalized due to high stock and fixed assets. The company should make attempt to reduce operating expenses to increase the net profit ratio. The company's performance is not satisfactory as compared to standard of the industry and there exists scope for improvements.

Direct product profitability (DPP)

As traditional absorption costing, which normally uses labour hours as a basis for absorption, is rarely suitable for service and retail organisations other methods had to be devised. One relatively new way of spreading overheads in retail organisations, which is used in the grocery trade in particular, is direct product profitability (DPP). DPP started in the USA in the 1960s at General Electric, and was then taken up and used by Proctor and Gamble in the 1980s. In 1985 the Food Marketing Institute in the USA laid down a standard approach to the system and two years later DPP was taken up by the Institute of Grocery Distribution in the U.K. The system described below was introduced in the late 1980s and has since undergone transformation as activity based costing.

In recent years DPP has developed considerably in parallel with activity-based costing. DPP has become much more sophisticated and is now very similar to activity-based costing. One of the reasons for its development during the 1990s has been the development of EPOS and EFTPOS (electronic point of sale and electronic funds transfer) systems that have enabled access to the detailed data needed for direct product cost and profitability calculations.

Benefits of DPP

- ☒ Better cost analysis
- ☒ Better pricing decisions

- ⊗ Better management of stores and warehouse space
- ⊗ The rationalisation of product ranges.

Direct product profitability statement : Retail organisations traditionally deducted the bought- in cost of goods from the selling price to give a gross margin. The gross margin is useless measure for controlling the costs of the organisation itself or making decisions about the profitability of the different products. This is because none of the costs generated by the retail organisation itself are included in its calculation. For example, it does not include the storage costs of the different goods and these costs vary considerably from one good to another. A method was needed which related the indirect costs to the goods according to the way the goods used or created these costs.

Indirect costs, for DPP may be analysed into basic cost categories as follows:

- (i) Overhead cost : This is incurred through an activity that is not directly linked to a particular product.
- (ii) Volume related cost : The cost is incurred in relation to the space occupied by products.

This includes storage and transport costs.

- (iii) Product batch cost : This cost is often a time based cost. If product items (that is a number of identical products which are handled together as a batch) are stocked on shelves a labour time cost is incurred.
- (iv) Inventory financing costs : This is the cost of tying up money in stock and is the cost of the product multiplied by interest rate per day or per week.

Customer profitability analysis : In many organisations it is just as important to cost customers as it is to cost products. Different customers or groups of customers differ in their profitability. This is a relatively new technique that ABC makes possible because it creates cost pools for activities. Customers use some activities but not all, and different groups of customers have different 'activity profiles'.

Service organisations, such as a bank or a hotel, in particular need to cost customers. A bank's activities for a customer will include the following types of activities:

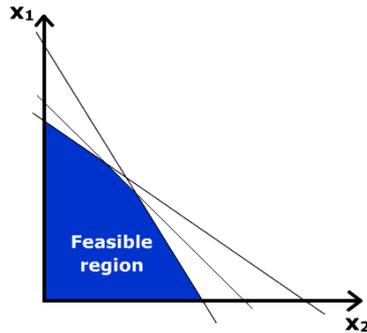
- ⊗ Withdrawal of cash
- ⊗ Unauthorised overdraft
- ⊗ Request for a statement
- ⊗ Stopping a cheque
- ⊗ Returning a cheque because of insufficient funds.

Different customers or categories of customers will each use different amounts of these activities and so customer profitability profiles can be built up, and customers can be charged according to the cost to serve them. A hotel may have activities that are provided for specific types of customers, such as well laid-out gardens, a swimming pool and a bar. Older guests may appreciate and use the garden, families use the swimming pool and business guests use the bar. If the activities are charged to the relevant guests a correct cost per bed occupied can be calculated for this type of category. This will show the relative profitability and lead to strategies for encouraging the more profitable guests.

Even a manufacturing organisation can benefit from costing its customers. Not all customers cost the same to serve even if they require the same products. Some customers may be located a long way from the factory and transport may cost more. Other customers may be disruptive and place rush orders that interrupt production scheduling and require immediate, special trans- port. Some customers need after sales service and help with technical matters, etc.

Benefits of customer profitability analysis.

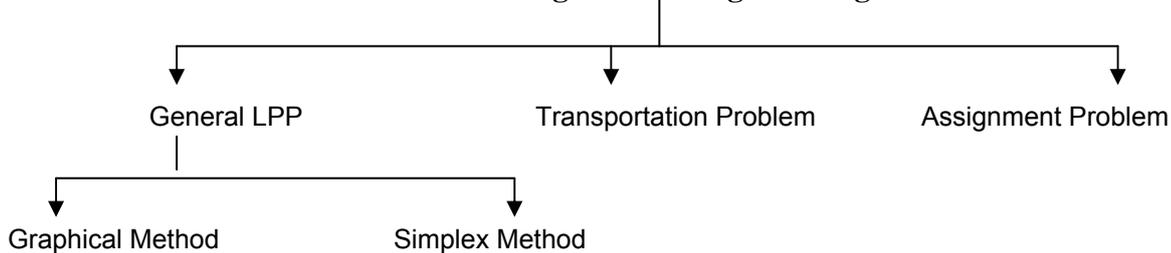
1. It helps the supplier to identify which customers are eroding overall profitability and which customers are contributing to it.
2. It can help to provide a basis for constructive dialogue between buyer and seller to improve margins.



Linear Programming Problems

Linear Programming is a mathematical technique for determining the optimal allocation of resources achieving the specified objective when there are alternative uses of the resources like money, manpower, materials, machines and other facilities. The objective in resource allocation may be either cost minimization or profit maximization.

Methods of solving Linear Programming Problems



Steps in formulation of LPP:

- 1) The information stated in the problem is summarized in a table.
- 2) Identify the variables required & denote them by the symbols.
- 3) Formulate the objective function to be optimized (maximized or minimized) as a linear function of the variables.
- 4) Express the linear constraints mathematically in terms of variables.
- 5) Add the non-negative constraints from the consideration that -ve values of the variables do not have any valid significance.

1. A common mistake in LP is to use the gross profit per unit instead of the contribution margin per unit in a maximizing function for a manufacturing firm. Similarly, it is a mistake to use the full (absorption) cost of good sold per unit instead of the variable cost per unit in a cost minimizing function. These mistakes are usually caused by relying on a traditional income statement, which deducts cost of good sold from sales in determining gross profit.
2. Fixed costs or revenues that do not vary as units are produced or sold are not relevant in an LP problem.
3. If question has asked just to formulate the problem then Objective function is meant for maximizing profit (not just contribution) or minimize total cost (not just variable cost), although if question has asked to find the optimum solution then we will maximize contribution or minimize variable costs & will adjust fixed costs after solving the whole question

Rules for Graphical Method:

- 1) Istly, formulate the LPP (steps are defined *supra*).
- 2) Graph each of the linear constraints by treating each linear inequation as an equation.
- 3) Identify the feasible region of the solution i.e. the area which satisfies all of the linear constraints simultaneously. Ensure that region is bounded. If the region is not bounded, either there are additional hidden conditions which can be used to bound the region or there is no solution to the problem.

Note: ICAI's study material has suggested that the region drawn shall be bounded for both, problems of

maximization as well as minimization, but as per an email clarification from BOS of ICAI (posted on group on 14th July'09), we don't need to find hidden conditions.

- 4) Find the coordinates of the corner points of the feasible region as the optimum solution lies at one of the corners of the feasible region [Extreme Point Theorem].
- 5) Compute the value of the objective function at each point obtained in Step 4).
- 6) The set of values corresponding to the maximum (or minimum) value of the objective function is the solution of the linear programming problem when it is a maximization (or minimization) problem.

Assign some arbitrary value to objective function (this value can be obtained by taking the LCM of the coefficients of x & y in the objective function) & draw the line for the equation representing the objective function. Common points obtained from drawing a line parallel to this line (touching feasible region along any edge) which is farthest from origin represents the optimal solution in problems of maximization.

Question 1: Maximize, $Z = 3x + 5y$
 Subject to constraints,
 $x + 2y \leq 20$
 $x + y \leq 15$
 $y \leq 8$
 $x, y \geq 0$

Solve the LPP under graphical method.

[Ans.: $Z^{\max} = 55$ when x is 10 and y is 5]

Question 2: Minimize, $Z = 2x + 3y$
 Subject to constraints,
 $-x + 2y \geq 4$
 $x + y \geq 6$
 $x + 3y \geq 9$
 $x, y \geq 0$.

Solve the LPP under graphical method.

[Ans.: $Z^{\min} = 15.33$ when x is $\frac{8}{3}$ and y is $\frac{10}{3}$]

Question 3: XYZ chemical company is producing two products A and B. The processing times are 3 hours and 4 hours per unit for A on operations one and two respectively and 4 hours and 2 hours per unit for B on operations on one and two respectively. The available time is 36 hours and 28 hours for operation one and two respectively. The product A can be sold at ₹3/- profit per unit and B at ₹8/- profit per unit. Solve for maximum profit programme by graphical & simplex method.

[Ans.: Profit is ₹72, no. of units produced for A is nil & no. of units produced for B is 9]

Question 4: A manufacturer can produce two different products, A and B during a given time period. Each of these products requires four different manufacturing operations: Grinding, Turning, Assembling & Testing. The manufacturing requirements in hours per unit of product are given below for A & B

	A	B
Grinding	1	2
Turning	3	1
Assembling	6	3
Testing	5	4

The available capacities of these operations in hours for the given time period are: Grinding, 30; Turning, 60; Assembly, 200; Testing 200. The contribution to profit is ₹2 for each unit of A and ₹3 for each unit of B. The firm can sell all that it produces at the prevailing market price. Formulate the problem as a linear programming model to maximize profit by graphical method.

[Ans.: Profit is ₹54 when no. of units produced for A is 18 & B is 6]

Question 5: 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./10-N.C.

[Ans.: Profit is ₹366.67 when no. of tonnes produced for X is 20/3 & Y is 28/3]

Question 6 (Diet Problem): A diet for a sick person must contain at least 4000 units of vitamins, 50 units of minerals and 1400 units of calories. Two foods A and B are available at a cost of ₹4/- and ₹3/- per unit respectively. If one unit of A contains 200 units of vitamins, 1 unit of mineral and 40 calories and one unit of food B contains 100 units of vitamins, 2 units of minerals and 40 calories. What combination of food be used to have least cost?

[Ans.: Least cost is ₹110 when units purchased for A is 5 & B is 30]

Question 7: A company that produces soft drinks has a contract that requires that a minimum of 80 units of the chemical A and 60 units of the chemical B into each bottle of the drink. The chemicals are available in a prepared mix from two different suppliers. Supplier X_1 has a mix of 4 units of A & 2 units of B that costs ₹10, and supplier X_2 has a mix of 1 unit of A and 1 unit of B that costs ₹4. How many mixes from company X_1 and company X_2 should the company purchase to honour contract requirement & yet minimize cost? Solve by both graphical as well as Simplex Method.

[Ans.: Cost will be ₹260 when co. purchases 10 mixes from X_1 & 40 mixes from X_2]

[Note: In minimization problems, ICAI's Study material has suggested finding hidden conditions to bound the region, but as per an email clarification from ICAI (posted on group on 14th July'09), we don't need to find hidden conditions]

Question 8: A company manufactures two products A & B, involving three departments-Machining, Fabrication, & 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 LPP to maximize profit. What will be the product mix at maximum profit level? (9 Marks) May/05

[Ans.: $x = 120$ units & $y = 300$ units and the maximum profit is ₹39600]

Question 9: The budgeted data relating to two products manufactured by a Co. for a month are as under:

	Product A	Product B
Selling price	300	200
Variable manufacturing cost	160	60
Sales commission	60	40

Each unit of product incurs costs in the company's two departments P and Q. The total capacity available for the month under review is budgeted to be 1,400 hours in department P and 2,000 hours in department Q. The capacity costs amount to ₹14,000 and ₹20,000 respectively per month for P and Q irrespective of the level of usage made of it. The number of hours required in each of these departments to complete one unit of output is as under:

	A	B
Department P	2	4
Department Q	5	4

The maximum output which the company can sell in the month is restricted to 400 units of either of the products. You are required to formulate the Linear Programming (LP) model and solve it graphically to determine the optimal product mix and profit. (8 Marks) May/04

[Ans.: Optimal Profit ₹7000]

Question 10: A company produces two types of belts; X and Y. Profits on these types are ₹2 & ₹1.5 each belt respectively. **A belt of type X requires twice as much time as a belt of type Y. The company can produce at the most 1000 belts of type Y per day.** Material for 800 belts only per day is available. At the most 400 buckles for belts of type X & 700 for those of type Y are available per day. How many belts of each type should the company produce so as to maximize the profit? (7 Marks) ICWA June/07-[Adapted]

[Hint: Let time taken to make one belt of type Y is t, therefore total time available in one day is 1000t. Now we know, type x requires twice as much time as a belt of type y therefore total time for producing both these belts is 2tx + yt. Therefore, **2x+y ≤ 1000**]

[Ans.: 200 belts of type X and 600 belts of type Y]

Question 11: A manufacturer of patent medicines is preparing a production plan on medicines, A & B. There are sufficient raw materials available to make 20000 bottles of A and 40000 bottles of B, but there are only 45000 bottles into which medicines can be put. **Further, it takes 3 hours to prepare enough material to fill 1000 bottles of A, it takes 1 hour to prepare enough material to fill 1000 bottles of B & there are 66 hours available for this operation.** The profit is ₹8 per bottle for A & ₹7 per bottle for B. How should the manufacturer schedule his production in order to maximize his profit?

[Hint: Equation for bold line will be $3x/1000 + y/1000 \leq 66$]

[Ans.: 10500 bottles of A and 34500 bottles of B, max. profit ₹325500]

Question 12: In a chemical industry two products A and B are made involving two operations. The production of B also results in a by-product C. The product A can be sold at a profit of ₹3 per unit and B at a profit of ₹8 per unit. The by-product C has a profit of ₹2 per unit. Forecasts show that up to 5 units of C can be sold. **The company gets 3 units of C for each unit of B produced.** The manufacturing times are 3 h per unit for A on each of the operation one & two and 4h and 5h per unit for B on operation one and two respectively. Because the product C results from producing B, no time is used in producing C. The available times are 18h and 21h of operation one and two respectively. The company desires to know that how much A and B should be produced keeping C in mind to make the higher profit. Formulate LP model for this problem.

[Ans.: Maximize $Z = 3x_1 + 8x_2 + 2x_3$

Subject to constraints

$$3x_1 + 4x_2 \leq 18$$

$$3x_1 + 5x_2 \leq 21$$

$$x_3 \leq 5, x_3 = 3x_2$$

$$x_1, x_2, x_3 \geq 0$$

(10 Marks) May/01

[Hint: Since the ratios of the number of units produced between B and C is 1:3, therefore $x_2 = \frac{1}{3}x_3$]

Question 13: Distinguish between a slack variable & an artificial slack variable in linear programming.

(3 Marks) May/03

Slack variable: In order to convert every constraint of the type 'less than equal to' in a LP problem into an equality constraint, so that solution of the problem can be arrived, we add a variable to each such constraint. The variable so added in each constraint is known as slack variable. *Slack Variables represent idle or unused resources.* The contribution per unit of a slack variable is always taken as zero in objective function. A slack variable is always non negative.

Constraint $3x + 2y \leq 90$ can be written as $3x + 2y + s_1 = 90$; here s_1 is a slack variable and is +ve.

Artificial variable: In order to convert constraints of the type 'greater than equal to' equality for finding the solution of the L. P. problem, we first subtract a surplus variable and then add a variable. This variable is also

added in the constraints of the type 'equal to' to start with the initial feasible solution. The variable added in the constraints as explained above is known as artificial variable. Artificial variable is a *fictitious variable* and cannot have any physical or economic meaning. It is intentionally introduced to form an initial solution for further iterations. It has an infinitely large cost coefficient. Artificial variables are always positive.

Constraints $3x + 4y \geq 50$ & $2x + 6y = 40$ can be written as $3x + 4y - s_1 + A_1 = 50$ & $2x + 6y + A_2 = 40$; Here s_1 is a surplus variable and A_1 & A_2 are artificial variables. s_1, A_1 & A_2 are +ve.

Rules for Simplex Method:

- 1) Istly, formulate the LPP (steps are defined *supra*).
- 2) Add Slack Variable. (The \leq type inequality can be transformed into equalities by addition of slack variables.)
- 3) Deduct Surplus Variable & Add Artificial Slack Variable. (This is done to convert \geq type inequalities into equalities.)
 [Similar to Slack Variable, Surplus Variable is subtracted to convert inequality into equality but as it has -1 as its coefficient it cannot be directly used as basic variable. To specify a basic variable an artificial variable is generally added with an infinitely large cost coefficient (M)]

For Initial Simplex tableau:

3.1 Setup the Simplex tableau.

Fixed Ratio	Profit/Cost Per unit (C_B)	C_j Basic Variables	x_1	x_2	Coefficient values from constraint equations			Quantity (b_i)	Replacement Ratio
					s_1	s_2	A_1		
	0	s_1			1		0		
	M	A_1			0		1		
Z_j					0		M		
Net Evaluation Row ($C_j - Z_j$)					0		0		

Unit Matrix

Where, s_1 is slack variable, s_2 is surplus variable & A_1 is Artificial Slack Variable.

- 3.2 In the first row i.e. C_j , we are supposed to write coefficients of variables in the objective function.
- 3.3 Basic Variables (a.k.a. Program Variables): It contains artificial slack variables (A_1, A_2, A_3 , etc.) & slack variables (s_1, s_2, s_3 , etc.). It never contains surplus variables (i.e. negative slack variables).
- 3.4 Profit/Cost per unit (C_B): Coefficients of basic variables in objective function.
- 3.5 Write unit matrix as coefficients of basic variables.
- 3.6 In Z_j row, below basic variables, copy Profit/Cost per unit & write zeroes in Net Evaluation Row (NER).

Step 3.6 is basically part of optimality test but has been deliberately written earlier just to do questions easily.

- 3.7 Fill the table below non-basic variables by coefficients values from constraint equations.
- 3.8 Quantity column (b_i) (a.k.a. solution values): These represent constraint values written in constraint equations.
- 3.9 Optimality Test:
 - a) NER: Add the products of Profit/Cost per unit (C_B) with respective column coefficients & write it in Z_j row i.e., $Z_j = \sum C_B \cdot a_{ij}$, where a_{ij} are the matrix element in the i th row and j th column. Now subtract it from objective function's coefficient of respective column (C_j) i.e. $C_j - Z_j$
 - b) For maximization problems: Check that whether there is any +ve NER, it indicates the magnitude of opportunity cost of not including 1 unit of respective column variables (in other words, it represents the net profit which would result from introducing one unit of variable to the product).
For minimization problems: Check that whether there is any -ve NER.
[Note: If all values of NER are other than positive (or other than negative) in case of maximization (or minimization) problem the calculated simplex table is optimal one & no further iterations are required, otherwise step 3.10 will be performed.]

Deriving a Revised Tableau for Improved/Optimal Solution:

- 3.10 Selection of entering variable: For maximization problem - The column with **highest +ve NER** is key column (In case of tie choose arbitrarily). For minimization problem - The column with **highest -ve NER** is key column (In case of tie choose arbitrarily). The variable heading this column is entering variable.
- 3.11 Selection of leaving variable: Divide Quantity (b_i) by corresponding elements of key column & write it in Replacement Ratio column. The row having **least non-negative** replacement ratio is key row, & the current variable for this row is leaving variable. The element at the intersection of key row & the key column is known as pivot/key element & is encircled.
- 3.12 Fixed ratio: This is calculated for all rows (variables) other than Key row.
Fixed ratio = row element in key column \div key no.
- 3.13 Setup a new updated simplex table.
 - a. Basic Variables:
For key row – Leaving variable will be replaced by entering variable.
For Non key rows - Variable will remain same as that of preceding simplex table.
 - b. Profit/Cost per unit (C_B): Coefficients of basic variables in objective function.
 - c. Write unit matrix as coefficients of basic variables.
 - d. In Z_j row, below basic variables, copy Profit/Cost per unit & write zeroes in Net Evaluation Row (NER).
 - e. Key Row [for non-basic variable column & quantity column (b_i):] Divide all the nos. in the key row by the key no.
 - f. Non Key Rows [for non-basic variable column & quantity column (b_i):]
Old row no. – (Corresponding no. in key row \times Corresponding fixed ratio)
 - g. Perform Optimality test (Same as Step 3.9)

- Marginal Value of Resource (a.k.a. shadow price or opportunity cost) is the value of NER under slack variables (s_1, s_2, s_3 , etc.). From the optimal (or other) solution profit gets reduced (or cost gets increased) by the amount this value is multiplied units of no. of units of such slack variables introduced.
- Fractions of simplex table must be retained & should not be decimalized.

Question 14: The final simplex table for the problem is given below:

Maximize, $Z = 3x_1 + 4x_2 + x_3$
 Subject to, $x_1 + 2x_2 + 3x_3 \leq 90$ (constraint for operation 1)
 $2x_1 + x_2 + x_3 \leq 60$ (constraint for operation 2)
 $3x_1 + x_2 + 2x_3 \leq 80$ (constraint for operation 3)
 $x_1, x_2, x_3 \geq 0$

Programme	Profit	Quantity	3	4	1	0	0	0
			x_1	x_2	x_3	s_1	s_2	s_3
x_2	4	40	0	1	10/6	4/6	-1/3	0
x_1	3	10	1	0	-1/3	-1/3	2/3	0
s_3	0	10	0	0	8/6	8/6	-10/6	1
		($C_j - Z_j$)	0	0	-28/6	-10/6	-2/3	0

Find the solution, maximum profit, idle capacity and the loss of total contribution of every one unit reduced from the right hand side of the constraints. Nov./88

[Ans.: $x_1 = 10; x_2 = 40; x_3 = 0$; Maximum $Z = 190$; Idle Capacity = 10 hours in Operation 3; Loss of Total Contribution = ₹5/3 per hour and ₹2/3 per hour in Operation 1 & 2 respectively.]

Question 15: 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 0.03%. 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 grades 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./05

[Ans.: The optimal solution is $X_1 = 40, X_2 = 40$ & $X_3 = 20$ with maximum $Z = 1360$]

Question 16: A gear manufacturing company makes two types of gears – A and B. Both gears are processed on 3 machines, Hobbing M/c, Shaping M/c and Grinding M/c. The time required by each gear and total time available per week on each M/c is as follows:

Machine	Gear (A) (Hours)	Gear (B) (Hours)	Available Hours
Hobbing M/c	3	3	36
Shaping M/c	5	2	60
Grinding M/c	2	6	60

Other data:

Selling price (₹)	820	960
Variable cost (₹)	780	900

Determine the optimum production plan and the maximum contribution for the next week by simplex method. The initial table is given below:

Cj	Variable	Qty\Cj	40	60	0	0	0
			x_1	x_2	x_3	x_4	x_5
0	x_3	36	3	3	1	0	0
0	x_4	60	5	2	0	1	0
0	x_5	60	2	6	0	0	1

[Ans.: Optimum $Z = 660$ with $X_1 = 3$ and $X_2 = 9$]
May/07

(7 Marks)

Question 17: Solve by Simplex Method:

Minimize, $Z = 20x_1 + 10x_2$
 Subject to, $x_1 + x_2 \geq 10$
 $3x_1 + 2x_2 \geq 24$
 $x_1, x_2 \geq 0$

Nov./87

[Ans.: $Z^{\min} = 120$ when x_1 is 0 and x_2 is 12]

Question 18: 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

$100x_1 + 80x_2$ Note

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./09-N.C.

[Ans.:

Cj	Variable	Qty\Cj	100	80	0	0	0	0	-M
			x_1	x_2	s_1	s_2	s_3	s_4	A_1
0	s_1	150	3	5	1	0	0	0	0
0	s_2	20	0	1	0	1	0	0	0
0	s_3	300	8	5	0	0	1	0	0
-M	A_1	25	1	1	0	0	0	-1	1

[Note: In the above question “ $100x_1 + 80x_2$ ” was misprinted as “ $100x_1 = 80x_2$ ” in question paper. This mistake was corrected by ICAI in their suggested answers, so I am using correct word itself]

Question 19: You are given the following linear program. Introduce appropriate variables and restate the problem to set up the simplex tableau. (Do not attempt further solution.)

Maximise:

$$8x_1 + 4x_2 - 3x_3 + 10x_4$$

s.t.

$$2x_1 - x_2 + x_3 + 2x_4 \geq 40$$

$$3x_1 - x_2 + x_4 \leq 90$$

$$2x_1 + x_2 + x_4 = 60$$

$$x_1, x_2, x_3, x_4 \geq 0$$

(5 Marks) Nov./10-O.C.

[Ans.:

		Qty\Cj	8	4	-3	10	0	-M	0	-M
Cj	Variable		x_1	x_2	x_3	x_4	s_1	A_1	s_2	A_2
-M	A_1	40	2	-1	1	2	-1	1	0	0
0	s_2	90	3	-1	0	1	0	0	1	0
-M	A_2	60	2	1	0	1	0	0	0	1]

Question 20: A company produces two products, x_1 and x_2 with respective unit contributions of ₹8 and ₹6. Each product passes through machining operations in two machining centres, MI and MII, whose capacities are limited to 60 and 48 hours respectively with corresponding slack variables s_1 and s_2 . The following table gives the values for an method for an interaction under the simplex maximizing the contribution:

	x_1	x_2	s_1	s_2	
Basic Variables					
x_1	1	0	1/3	-1/6	(MI constraint)
x_2	0	1	-1/6	1/3	(MI constraint)

You are required to:

- (i) Evaluate if this iteration represents the optimal solution.
- (ii) Find out what will be the optimal contribution.

(7 Marks) May/10-O.C.

[Ans.: (i) Yes (ii) Optimal contribution will be ₹132 ($60 \times 5/3 + 48 \times 2/3$)]

Additional Question (iii): Find out quantity of output of 2 products at optimal contribution.

[Ans.: Quantities of x_1 and x_2 will be 12 units & 6 units respectively]

[Hint: While formulating the problem, assume coefficients as a & b for variables x_1 & x_2 in 1st constraint and coefficients as c & d for variables x_1 & x_2 in 2nd constraint. Now solve the simplex table & compare 3rd table of your simplex table from the abovementioned simplex table to arrive at values of a, b, c & d. Use this value of a, b, c & d and place them in 3rd table (quantity column) to arrive at values of quantities.]

Miscellaneous Questions

Question 21 (Transportation Problem): The following matrix gives the unit cost of transporting the product from production plant P_1, P_2 & P_3 to destinations D_1, D_2 & D_3 . Plants P_1, P_2 & P_3 have a **maximum** production of 65, 24 and 111 respectively and destinations D_1, D_2 & D_3 must receive **at least** 60, 65 & 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).

(9 Marks) Nov./08-N.C.

[Ans.: Minimize, $Z = 400x_{11} + 600x_{12} + 800x_{13} + 1000x_{21} + 1200x_{22} + 1400x_{23} + 500x_{31} + 900x_{32} + 700x_{33}$

Subject to,
 $x_{11} + x_{12} + x_{13} \leq 65$
 $x_{21} + x_{22} + x_{23} \leq 24$
 $x_{31} + x_{32} + x_{33} \leq 111$
 $x_{11} + x_{21} + x_{31} \geq 60$
 $x_{12} + x_{22} + x_{32} \geq 65$
 $x_{13} + x_{23} + x_{33} \geq 75$

where, $x_{ij} \geq 0$ ($i, j = 1$ to 3)

[Note: If bolded words are absent in question, we will use = in Demand & supply constraints in spite of \geq & \leq]

Question 22 (Transportation Problem): Transport Ltd. provides tourist vehicles of 3 types- 20-seater vans, 8-seater big cars & 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 eight-seater big car types 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 & back) and 40 officials need to be transported in Route II (from Residence to Branch office & back). The cost per round trip for each type of vehicle along each route is given below.

	Figs-₹/round trip		
	20-seater vans	8-seater big cars	5-seater small cars
Route I- Residence-Head Office & Back	600	400	300
Route II- Residence-Branch Office & Back	500	300	200

You are required to formulate the information as LPP with objective of minimizing the total cost of hiring vehicles for the client company, subject to the constraints mentioned above. (10 Marks) May/08

[Hint: Minimize, $Z=600x_1 + 400x_2 + 300x_3 + 500y_1 + 300y_2 + 200y_3$

Subject to,
 $x_1 + y_1 \leq 4$
 $x_2 + y_2 \leq 10$
 $x_3 + y_3 \leq 20$
 $20x_1 + 8x_2 + 5x_3 = 180$
 $20y_1 + 8y_2 + 5y_3 = 40$
 $x_1, x_2, x_3, y_1, y_2, y_3 \geq 0$

Question 23 (Trim Problem): The Fine Paper Company produces rolls of paper used in cash registers. Each roll of paper is 500 ft. in length and can be produced in widths of 1,2,3 and 5 inch. The company's production process results in 500 feet rolls that are 12 inches in width. Thus company must cut its 12 inch roll to the desired width. It has six basic cutting alternatives as follows:

Cutting Alternative	No. of Rolls				Waste (inches)
	1"	2"	3"	5"	
1	6	3	0	0	0
2	0	3	2	0	0
3	1	1	1	1	1
4	0	0	2	1	1
5	0	4	1	0	1
6	4	2	1	0	1

The maximum demand requirements for the four rolls are as follows:

Roll Width (inches)	Demand Requirements (Rolls)
1	3000
2	2000
3	1500
5	1000

The company wishes to minimize the waste generated by its production meeting its demand requirements. Formulate LP model.

[Ans.: Minimize, $x_3 + x_4 + x_5 + x_6$
 Subject to, $6x_1 + x_3 + 4x_6 \leq 3000$
 $3x_1 + 3x_2 + x_3 + 4x_5 + 2x_6 \leq 2000$
 $2x_2 + x_3 + 2x_4 + x_5 + x_6 \leq 1500$
 $x_3 + x_4 \leq 1000$
 $x_j \geq 0$; where $j = 1$ to 6]

Question 24: The Delhi Florist Company is planning to make up floral arrangements for the upcoming festival. The company has available the following supply of flowers at the costs shown:

Type	Number Available	Cost per flower
Red Roses	800	₹0.20
Gardenias	456	₹0.25
Carnations	4000	₹0.15
White Roses	920	₹0.20
Yellow Roses	422	₹0.22

These flowers can be used in any of the four popular arrangements whose makeup and selling prices are as follows:

Arrangement	Requirement	Selling Price
Economy	4 red roses 2 gardenias 8 carnations	₹6
May time	8 white roses 5 gardenias 10 carnations	₹8
Spring colour	4 yellow roses 9 red roses 10 carnations 9 white roses	₹10
Deluxe rose	6 yellow roses 12 red roses 12 white roses 12 yellow roses	₹12

Formulate a LPP which allows the florist company to determine how many units of each arrangement should be made up in order to maximize profits assuming all arrangements are sold. Nov./90

[Ans.: Maximize, $3.5x_1 + 2.77x_2 + 3.58x_3 + 4.56x_4$
 Subject to, $4x_1 + 9x_3 + 12x_4 \leq 800$
 $2x_1 + 5x_2 \leq 456$
 $8x_1 + 10x_2 + 10x_3 \leq 4000$
 $8x_2 + 9x_3 + 12x_4 \leq 920$
 $4x_2 + 6x_3 + 12x_4 \leq 422$
 $x_j \geq 0$; where $j = 1$ to 4]

Question 25 (Blending Problems): A refinery makes 3 grades of petrol (A, B, C) from 3 crude oils (d, e, f) Crude f can be used in any grade but the others satisfy the following specifications.

Grade	Specifications	Selling Price per liter
A	Not less than 50% crude d Not more than 25% crude e	8.0
B	Not less than 25% crude d Not more than 50% crude e	6.5
C	No specifications	5.5

There are capacity limitations on the amount of the three crude elements that can be used;

Crude	Capacity	Price per litre
D	500	9.5
E	500	5.5
F	300	6.5

It is required to produce the maximum profit.

[Hint:

	D	E	F	Sell Price per liter
A	X_{A1}	X_{A2}	X_{A3}	8
B	X_{B1}	X_{B2}	X_{B3}	6.5
C	X_{C1}	X_{C2}	X_{C3}	5.5
Cost price per liter	9.5	5.5	6.5	
Capacity	500	500	300	

$$Z = 8(X_{A1}+X_{A2}+X_{A3}) - (9.5X_{A1}+5.5X_{A2}+6.5X_{A3}) + 6.5(X_{B1}+X_{B2}+X_{B3}) - (9.5X_{B1}+5.5X_{B2}+6.5X_{B3}) + 5.5(X_{C1}+X_{C2}+X_{C3}) - (9.5X_{C1}+5.5X_{C2}+6.5X_{C3})$$

$$\text{i.e. } Z = -1.5 X_{A1} + 2.5 X_{A2} + 1.5 X_{A3} - 3.0 X_{B1} + 1.0 X_{B2} - 4.0 X_{C1} - 1.0 X_{C3}$$

Subject to constraints,

$$\begin{aligned} X_{A1} &\geq 0.50 (X_{A1}+X_{A2}+X_{A3}) \\ X_{A2} &\leq 0.25 (X_{A1}+X_{A2}+X_{A3}) \\ X_{B1} &\geq 0.25 (X_{B1}+X_{B2}+X_{B3}) \\ X_{B2} &\leq 0.50 (X_{B1}+X_{B2}+X_{B3}) \\ X_{A1}+X_{B1}+X_{C1} &\leq 500 \\ X_{A2}+X_{B2}+X_{C2} &\leq 500 \\ X_{A3}+X_{B3}+X_{C3} &\leq 300 \\ X_{ij} &\geq 0 \text{ where } i = A, B \text{ \& } C \text{ \& } j = 1, 2 \text{ \& } 3 \end{aligned}$$

Question 26: A manufacturer produces three products Y_1, Y_2, Y_3 from three raw materials X_1, X_2 and X_3 . The cost of raw materials X_1, X_2 and X_3 is ₹30, ₹50 and ₹120 per kg respectively and they are available in a limited quantity viz. 20 kgs of $X_1, 15$ kgs of X_2 and 10 kgs of X_3 . The selling price of Y_1, Y_2 and Y_3 is ₹90, ₹100 and ₹120 per kg respectively. In order to produce 1 kg of Y_1 $\frac{1}{2}$ kg of $X_1, \frac{1}{4}$ kg of X_2 and $\frac{1}{4}$ kg of X_3 are required. Similarly to produce 1 kg of $Y_2, \frac{3}{7}$ kg $X_1, \frac{2}{7}$ kg of X_2 and $\frac{2}{7}$ kg of X_3 and to produce 1 kg of $Y_3, \frac{2}{3}$ kg of X_2 and $\frac{1}{3}$ kg of X_3 will be required.

Formulate the linear programming problem to maximize the profit.

(10 Marks) Nov./00

[Ans.: Maximize, $Z = 32.50y_1 + 38.57y_2 + 46.67y_3$

Subject to $7y_1 + 6y_2 \leq 280$

$$21y_1 + 24y_2 + 56y_3 \leq 1260$$

$$21y_1 + 24y_2 + 28y_3 \leq 840$$

$$y_1, y_2, y_3 \geq 0$$

Question 27 (Planning-production & financing) Consider a company that must produce two products over a production period of three months of duration. The company can pay for materials and labour from two sources:

The firm faces three decisions:

- (1) How many units should it produce of Product 1?
- (2) How many units should it produce of Product 2?
- (3) How much money should it borrow to support the production of the two products?

In making these decisions, the firm wishes to maximize the profit contribution subject to the conditions stated

below:

- (i) Since the company's products are enjoying a seller's market, it can sell as many units as it can produce. The company would therefore like to produce as many units as possible subject to production capacity and financial constraints. The capacity constraints, together with cost and price data, are given in Table -1.

Product	Selling Price (Per unit)	Cost of Production (Per unit)	Capacity, Price and Cost data		
			Requirement Hours per unit in Department		
			A	B	C
1	14	10	0.5	0.3	0.2
2	11	8	0.3	0.4	0.1
Available hours per production period of three months			500	400	200

- (ii) The available company funds during the production period will be ₹3 lakhs.
- (iii) A bank will give loans up to ₹2 lakhs per production period at an interest rate of 20 percent per annum provided the company's acid (quick) test ratio is at least 1 to 1 while the loan is outstanding. Take simplified acid-test ratio given by

$$\frac{\text{Surplus cash on hand after production} + \text{Accounts receivable}}{\text{Bank Borrowing} + \text{Interest accrued thereon}}$$

- (iv) Also make sure that the needed funds are made available for meeting the production costs.

Formulate the above as a Linear Programming Problem.

(20 Marks) Nov./92

[Ans.: Maximize, $Z = 4x_1 + 3x_2 - 0.05x_3$

Subject to, $0.5x_1 + 0.3x_2 \leq 500$
 $0.3x_1 + 0.4x_2 \leq 400$
 $0.2x_1 + 0.1x_2 \leq 200$
 $10x_1 + 8x_2 - x_3 \leq 300000$
 $-4x_1 - 3x_2 + 0.05x_3 \leq 300000$
 $x_3 \leq 200000$
 $x_1, x_2, x_3 \geq 0$

[Hint: Quick ratio clearly specifies that sales & interest are on accrual basis & not on cash basis.]

Question 28 (Agriculture Application): An agriculturist has a farm with 125 acre. He produces Radish, Muttar and Potato. Whatever he raises is fully sold in the market. He gets ₹5 for Radish per kg., ₹4 for muttar per kg., & ₹5 for potato per kg. The average yield is 1,500 kg. of Radish per acre; 1,800 kg. of muttar per acre and 1,200kg. of Potato per acre. To produce each 100 kg. of Radish and muttar and to produce each 80kg. of potato, a sum of ₹12.50 has to be used for manure. Labour required for each acre to raise the crop is 6 man days for Radish and Potato each and 5 man days for Muttar. A total of 500 man days of labour at the rate of ₹40 per man day are available.

Formulate this as a LPP model to maximize the Agriculturist's total profit.

(10 Marks) May/97

[Ans: $Z = 7072.5x_1 + 6775x_2 + 5572.5x_3$

Z constraint in detail, $7500x_1 + 7200x_2 + 6000x_3 - 187.5x_1 - 225x_2 - 187.5x_3 - 240x_1 - 200x_2 - 240x_3$

Subject to constraints,

$$x_1 + x_2 + x_3 \leq 125$$

$$6x_1 + 5x_2 + 6x_3 \leq 500$$

$$x_1, x_2, x_3 \geq 0$$

Question 29 (Production Runs): An oil refinery can blend three grades of crude oil to produce quality A and quality B petrol. Two possible blending processes are available. For each production run, the older process uses 5 units of crude Q, 7 units of crude P and 2 units of crude R and produces 9 units of A and 7 units of B. The newer process uses 3 units of crude Q, 9 units of crude P and 4 units of crude R to produce 5 units of A and 9 units of B.

Because of prior contract commitments, the refinery must produce at least 500 units of A and at least 300 units of B for the next month. It has 1,500 units of crude Q, 1,900 units of crude P and 1,000 units of crude R. For each unit of A, refinery receives ₹60 while for each unit of B, it receives ₹90.

Formulate the problem as linear programming model so as to maximize the revenue. (4 Marks) Nov./09-O.C.

[Ans.: Maximize, $Z = 60(9x_1 + 5x_2) + 90(7x_1 + 9x_2)$

Subject to, $7x_1 + 9x_2 \leq 1900$

$5x_1 + 3x_2 \leq 1500$

$2x_1 + 4x_2 \leq 1000$

$9x_1 + 5x_2 \geq 500$

$7x_1 + 9x_2 \geq 300$

$x_1, x_2 \geq 0$

Question 30: A Computer Company produces three types of models, which are first required to be machined and then assembled. The time (in hours) required for these operations for each model is given below:

Model	Machine Time	Assembly Time
P III	20	5
P II	15	4
Celeron	12	3

The total available machine time and assembly time are 1,000 hours and 1,500 hours respectively. The selling price and other variable costs for three models are:

	P III	P II	Celeron
Selling Price (₹)	3,000	5,000	15,000
Labour, Material and other Variable Costs (₹)	2,000	4,000	8,000

The company has taken a loan of ₹50,000 from a Nationalised Bank, which is required to be repaid on 1.4.2001. In addition, the company has borrowed ₹1,00,000 from XYZ Cooperative Bank. However, this bank has given its consent to renew the loan.

The balance sheet of the company as on 31.3.2001 is as follows:

Liabilities	₹	Assets	₹
Equity Share Capital	1,00,000	Land	80,000
Capital reserve	20,000	Buildings	50,000
Profit & Loss Account	30,000	Plant & Machinery	1,00,000
Long-term Loan	2,00,000	Furniture etc.	20,000
Loan from XYZ Cooperative Bank	1,00,000	Cash	2,10,000
Loan from Nationalized Bank	50,000		
Total	5,00,000	Total	5,00,000

The company is required to pay a sum of ₹15,000 towards the salary. Interest on long-term loan is to be paid every month @ 18% per annum. Interest on loan from XYZ Cooperative and Nationalised Banks may be taken as ₹1,500 per month. The company has already promised to deliver three P III, Two P II and five Celeron type of computers to M/s. ABC Ltd. next month. The level of operation I the company is subject to the availability of cash next month.

The Company Manager is willing to know that how many units of each model must be manufactured next month, so as to maximize the profit.

Formulate a linear programming problem for the above. (20 Marks) May/93 [Adapted] & (10 Marks) May/01

[Hint: Maximize $Z = 1000x_1 + 1000x_2 + 7000x_3 - (\text{₹}15,000 + \text{₹}3,000 + \text{₹}1,500)$

s.t.c, $20x_1 + 15x_2 + 12x_3 \leq 1000$

$5x_1 + 4x_2 + 3x_3 \leq 1500$

$2000x_1 + 4000x_2 + 8000x_3 \leq \text{₹}140500$

Where $x_1 \geq 3, x_2 \geq 2, x_3 \geq 5$]

[Assumption: Since, loan from cooperative bank will be repaid on 1st April,'01 Interest on loan represents interest on loan from nationalized bank only.]

Question 31: A firm produces three products A,B & C. Its uses two types of raw materials I & II of which 5000

and 7500 units respectively are available. The raw material requirements per unit of product are given below:

Raw Material	Requirement per unit of product		
	A	B	C
I	3	4	5
II	5	3	5

The labour time for each unit of product A is twice that of product B and three times that of product C. The entire labour force of the firm can produce the equivalent of 3000 units of A. The minimum demand of the three products is 600, 650 and 500 units respectively. **Also, the ratios of the number of units must be equal to 2:3:4.** Assuming the profits per unit of A,B & C as ₹50, 50 and 80 respectively. Formulate the problem as linear programming model in order to determine the number of units of each product which will maximize the profit. (10 Marks) Nov./97

[Hint: 1. Let time taken to produce one unit of Product A is t, therefore total time available is 3000t. Now we know, the labour time for each unit of product A is twice that of product B and three times that of product C, therefore total time for producing all three products is $tx_1 + tx_2/2 + tx_3/3$. Therefore, $x_1 + x_2/2 + x_3/3 \leq 3000$
 2. Since the ratios of the number of units produced must be equal to 2:3:4, therefore $1/2 x_1 = 1/3 x_2$ and $1/3 x_2 = 1/4 x_3$ or $3x_1 = 2x_2$ and $4x_2 = 3x_3$]

Question 32: Renco Foundries is in the process of drawing up a Capital Budget for the next three years. It has funds to the tune of ₹100000 which can be allocated across the projects A, B, C, D and E. The net cash flows associated with an investment of ₹1 in each project are provided in the following table:

	Cash Flow at Time			
	0	1	2	3
From inv. A	-₹ 1	+₹ 0.5	+₹ 1	₹ 0
From inv. B	₹ 0	-₹ 1	+₹ 0.5	+₹ 1
From inv. C	-₹ 1	+₹1.2	₹ 0	₹ 0
From inv. D	-₹1	₹ 0	₹ 0	+₹1.9
From inv. E	₹ 0	₹ 0	-₹ 1	+₹1.5

Note: Time 0 = present, Time 1 = 1 year from now, Time 2 = 2 years from now, Time 3 = 3 years from now. For example, ₹ 1 invested in investment B requires a ₹ 1 cash outflow at time 1 and returns ₹ 0.50 at time 2 and ₹ 1 at time 3.

To ensure that the firm remains reasonably diversified, the firm will not commit an investment exceeding ₹75000 in any project. The firm cannot borrow funds; therefore the cash available for investment at any time is limited to cash on hand. The firm will earn interest at 8% per annum by parking the uninvested funds in money market instruments. Assume that the returns from investments can be immediately reinvested. For example, the positive cash flow received from project C at time 1 can immediately be reinvested in project B.

Required: Formulate an LP that will "Maximize cash on hand at time 3". (20 Marks) Nov./95

[Ans.: Maximize $Z = b + 1.9d + 1.5e + 1.08S_2$

Subject to Constraints,

$$a + c + d + S_0 = 100000$$

$$0.5a + 1.2c + 1.08 S_0 = b + S_1$$

$$a + 0.5b + 1.08S_1 = e + S_2$$

$$a, b, c, d, e \leq 75000$$

Where a, b, c, d, e, and S_i ($i = 0, 1, 2$) ≥ 0

Question 33: Let us assume that you have inherited ₹1,00,000 from your father-in-law that can be invested in a combination of only two stock portfolio, with the maximum investment allowed in either portfolio set at ₹75,000. The first portfolio has an average rate of return of 10%, whereas the second has 20% In terms of risk factors associated with these portfolios. The first has a risk rating of 4 (on a scale from 0 to 10), and the second has 9. Since you wish to maximize your return, you will not accept an average rate of return below 12% or a risk factor above 6. Hence, you then face the important question. How much should you invest in each portfolio?

Formulate this as a linear programming problem and solve it by Graphic Method.

[Hint: For finding bounded region apply 'true false' technique] (10 Marks) May/99 & Nov./08-RTP-O.C.

[Ans.: Co. should invest ₹60000 in first portfolio and ₹40000 in second portfolio to achieve the maximum average rate of return of ₹14000]

Question 34: A manufacturer of three products tries to follow a policy of producing those which contribute most to fixed cost and profit. However, there is a policy of recognizing certain minimum sales requirements. Currently these are:

Product	Unit per week
X	20
Y	30
Z	60

There are three producing departments. The product time in hour per unit in each department and the total times available for each week in each department are:

Department/Product	Time required per product(in hrs.)			Total hours
	X	Y	Z	
1	0.25	0.20	0.15	420
2	0.30	0.40	0.50	1048
3	0.25	0.30	0.25	529

The contribution per unit of product X,Y,Z is ₹10.50, ₹9.00 and ₹8.00 respectively. The company has scheduled 20 units of X, 30 units of Y and 60 units of Z for production in the following week.

You are required to state:

- Whether the present schedule is an optimum one from a profit point of view and if it is not what it should be;
- The recommendations that should be made to the firm about their production facilities (following the answer to (a) above)

[Hint.: Solve it: Maximize, $Z = 10.5x_1 + 9x_2 + 8x_3 + 960$

Subject to, $0.25x_1 + 0.20x_2 + 0.15x_3 \leq 400$

$0.30x_1 + 0.40x_2 + 0.40x_3 \leq 1000$

$0.25x_1 + 0.30x_2 + 0.25x_3 \leq 500$

$x_1, x_2, x_3 \geq 0$; where $X = x_1 + 20$, $Y = x_2 + 30$, $Z = x_3 + 60$]

[Note: In situations where inequalities are like $0 \leq x \leq 20$, lower bounds shall be introduced i.e. we shall introduced a new variable like $x_1 = x - 20$ so computations can be made easy.]

Question 35: The costs and selling prices per unit of two products manufacturing by a company are as under:

Product	A (₹)	B (₹)
Selling Price	500	450
Variable costs		
Direct Materials @ 25 per kg	100	100
Direct Labour @ 20 per kg ^[Note1]	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 input is limited to the following:

Direct Materials	480 kgs
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 as ₹40 per hour as a separate service, show what the modification will be required in the formulation of the linear programming problem. You are required to re-formulate the problem but not to solve. (11 Marks) Nov./08-O.C.

[Ans.:(i) Maximize, Z (Contribution) = $100x + 75y$

subject to, $4x + 4y \leq 480$
 $4x + 2y \leq 400$
 $x + 2y \leq 200$

where, $x, y \geq 0$

& Maximum profit is ₹4000 [₹11000(contribution) – ₹7000(fixed cost^[Note 2])] when production of A is 80 units & production of B is 40 units.

(iii) Maximize, Z (Contribution) = $90x + 55y$ {Painting hours @ 40 per hour is taken in computation}

subject to, $4x + 4y \leq 480$
 $4x + 2y \leq 400$
 $x + 2y \leq 200$

where, $x, y \geq 0$

[Note: 1. In the above question Direct Material was written twice in question paper [i.e. Direct Labour was also written as Direct Material]. This mistake was corrected by ICAI in their suggested answers, so I am using correct word itself i.e. Direct Labour.]

2. Here company's fixed costs are on allocation basis, so fixed costs (absorbed) on individual products are not required to be calculated for individual products. We will directly calculate fixed cost as ₹7000 (i.e. 400 D.L. Hours @ ₹17.50 per hour).

3. It is advisable to go through part (iii) after going through concepts of Relevant costing]

Question 36: Explain the limitations of linear programming.

(4 Marks) May/04 & (5 Marks) Nov./00

Answer: Important limitations of linear programming problems are as follows:

1. **Linear Constraints:** In some situations it is not possible to express both the objective function and constraints in linear form. E.g. Setup time is often non-linear constraint and is independent of the quantity produced.
2. **Lack of Synergy emphasis:** Joint interactions between some activities leads in comparatively less resource usage than sum of these quantities resulting from each activity being performed individually. From Linear programming it is not possible to handle such situations.
3. **Fractions:** Linear Programming may yield fractional valued answers for the decision variables, whereas it may happen that only integer values of the variables are logical. Rounding-off the values obtained may not result into an optimal solution. E.g. No. of units produced.
4. **Uncertain Conditions:** It is applicable only in static situations & objective function and the constraints equations should change during the period of study. Furthermore, these coefficients may actually be random variables, each with an underlying probability distribution for the values. Such problems can't be solved using LPP.
5. **Heavy calculations:** For large problems having many constraints, the computational difficulties are enormous, even when assistance of large digital computers is available.
6. **Single Objective:** LPP deals with problems that have a single objective. Real life problems may involve multiple and even conflicting objectives.

Question 37: Enumerate the industrial applications of linear programming.

(4 Marks) May/03

Answer: The industrial applications of linear programming are:

- Product mix problems
- Production scheduling
- Blending problems
- Transportation & distribution problems.

Question 38: What are practical applications of linear programming.

(7 Marks) May/07

Answer: Linear programming can be used to find optional solutions under constraints.

In production:

- product mix under capacity constraints to minimize costs/maximize profits along with marginal costing.
- Inventory management to minimize 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 production management and product 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.

Least Important Topics

Situation	Treatment
Multiple Optimal Situation	<u>Graphical:</u> If for a given question two or more extreme points yields same value of objective function it is multiple optimal solution. <u>Simplex:</u> For any optimal solution if NER of a non-basic variable is ZERO, it indicates that this variable can become incoming variable & there are more than 1 optimal solution.
Infeasibility	<u>Graphical:</u> If a solution satisfies all constraints and the non-negativity conditions it is called feasible solution, otherwise it is infeasible solution <u>Simplex:</u> If artificial variable persists in the optimal solution table as basic variable with non-zero quantity it is a infeasible solution.
Unboundedness	<u>Graphical:</u> For maximization type of LPP, unboundedness occurs when there is no constraint on the solution so that one or more of the decision variables can be increased indefinitely without violating any of the constraints. <u>Simplex:</u> If all Replacement Ratios are –ve i.e. Outgoing variable cannot be identified, it is an unbounded solution.
Degeneracy	<u>Only Simplex:</u> It occurs if there is a tie in the replacement ratios for determining outgoing variable; the next tableau would give a degenerate solution. In case of degeneracy, the outgoing variable should be selected on an arbitrary basis. The variable not selected as outgoing variable will bear “0” in the quantity column in the subsequent table.

Dual

Any LPP can be re-formulated into what is known as its dual. We can convert the Minimization Problem into Maximization Problem & vice versa. This is known as duality.

Method of Deriving Dual:

- 1) Convert equations in inequalities (e.g. $x+y=10$ can be written as $x+y \geq 10$ & $x+y \leq 10$)
- 2) Convert LPP in Standard form i.e.
 - i) All variable should be non-negative.
 - ii) For Maximization Type Problems → All constraints should be of “ \leq ” type.
For Minimization Type Problems → All constraints should be of “ \geq ” type.
 - iii) If we have m constraints & n variables in primal (initial primal), we must have n constraints & m variables in Dual. Exception: It will not be so if we have equation in our initial LPP [i.e. we have processed Step i) & have converted equation in inequation s]. In such case we will introduce new variable for similar variables [introduced by virtue of step i)].

Question 39: Write short notes on the characteristics of the dual problem.

(Nov./96)

Ans.:

If Primal	Then Dual
(i) Objective is to maximize	(i) Objective is to minimize
(ii) Objective is to minimize	(ii) Objective is to maximize
(iii) No. of constraints	(iii) No. of variables
(iv) No. of variables	(iv) No. of constraints
(v) Primal constraints “ \leq ” type	(v) Dual constraints “ \geq ” type
(vi) Primal constraints “ \geq ” type	(vi) Dual constraints “ \leq ” type
(vii) Primal variable x_j unrestricted in sign	(vii) Dual constraint j is = type
(viii) Primal constraint i is = type	(viii) Dual variable y_i is unrestricted in sign
(ix) R.H.S. of constraints	(ix) Coefficients of Objective function

(x) Coefficients of Objective function	(x) R.H.S. of constraints
(xi) Primal is infeasible	(xii) Dual is unbounded
(xii) Dual is unbounded	(xii) Primal is infeasible
(xiii) NER of Optimal table of primal	(xiii) Quantity column of Optimal table of Dual
(xiv) Quantity column of Optimal table of Primal	(xiv) NER of Optimal table of Dual

Question 40: Formulate the dual for the following linear program:

$$\begin{aligned} \text{Maximize: } & 100x_1 + 90x_2 + 40x_3 + 60x_4 \\ \text{Subject to, } & 6x_1 + 4x_2 + 8x_3 + 4x_4 \leq 140 \\ & 10x_1 + 10x_2 + 2x_3 + 6x_4 \leq 120 \\ & 10x_1 + 12x_2 + 6x_3 + 2x_4 \leq 50 \\ & x_1, x_2, x_3, x_4 \geq 0; \end{aligned}$$

(Only formulation is required. Please do not solve.)

(6 Marks) June/09-N.C.

[Ans.: Dual will be: Minimize, $G = 140a + 120b + 50c$
 Subject to,
 $6a + 10b + 10c \geq 100$
 $4a + 10b + 12c \geq 90$
 $8a + 2b + 6c \geq 40$
 $4a + 6b + 2c \geq 60$
 & $a, b, c \geq 0$

Question 41: XYZ company has three departments - Assembly, painting and packing with the capability of making three types of almirahs. An almirah of Type 1 requires one hour of assembly, 40 minutes of painting and 20 minutes of packing time respectively. Similarly, almirah of type II needs 80 minutes of assembly, 20 minutes of painting and one hour of packing time respectively. The last type requires 40 minutes each of assembly, painting and packing time. The total times available at assembly, painting, and packing departments are 600 hours, 400 hours, and 800 hours respectively. Determine the number of each type of almirahs that should be produced in order to maximize the profit. The unit profits for types I, II and III are ₹40, 80 and 60 respectively.

Suppose the manager is thinking of renting the productive capacities of the three departments to another almirah manufacturer – Steel Racks Company. Steel Racks is interested in minimizing the rental charges. On the other hand the XYZ company would like to know the worth of a productive hour to them, in each of the departments to determine the rental rates. Formulate the problem as a LPP. Explain clearly. May/90

[Ans.: Type I almirah = 0 units; Type II almirah = 200 units; Type III almirah = 500 units; Maximum profit = ₹46000; Rental rates per hour for assembly, painting & packing departments are ₹50, ₹40 & ₹Nil respectively. Minimal total rental charges = ₹46000]