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Total classes @ 3 Hrs.

64

Management Accounting- Preface

Management accounting is the process of identifying, measuring, analysing, interpreting, and communicating information following the goals of the organisation. It also includes the strategic planning of the business.

The role of management accounting is very different in today's world. Management accountants serve as internal business consultants, with the cross-functional relationship of the managers from all areas of the organization.

A management accountant plays a vital role to create value for the organisation by managing resources, activities, and people to achieve the goals.

The top management (i.e. owners, directors) set the goals of them organisation with the help of managers. To fulfill that, an organisation acquires resources, hires people, and then engages it in a pre-determined set of activities. It is up to the management team to make the best use of the organisation's resources, activities, and people in achieving the organisation's goals. The day-to-day work of the management team comprises four activities:

- Decision making
- Planning
- Directing operational activities
- Controlling.

The process of management accounting adds & increase value of an organisation by following five major objectives:

1. Provides information for decision making and planning
2. Assist managers in directing and controlling operational activities.
3. Motivate mangers to achieve organisation's goals.
4. Performance measurement with budgetary control and/or standard costing .
5. Evaluate the competitive position in the industry in pursuance to strategic planning.

Now days management accounting analysis is considered so crucial in managing an enterprise that in most cases managerial accountants are integral members of the management team. In the present days competitive business environment only the management accountant can contribute to its value addition process by applying the concept of balance scorecard.

Syllabus of Paper 5 – Cost Management / Management Accountancy

(One Paper – Three Hours -- 100 Marks)

Level of Knowledge: Expert Knowledge.

Objectives:

To gain expert knowledge of:

- (a) Use of costing data decision-making and control, and
- (b) Emerging modern cost management concepts.

Contents:

1. Cost concepts in decisions-making; Relevant cost, Differential cost, Incremental Cost and Opportunity cost; Objectives of a Costing System; Inventory Valuation; Creation of Database for operational control; Provision of data of Decision-Making.
2. Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-Even Analysis; Cost –Volume –Profit Analysis; Various decision-making problems.
3. Standard Costing and Variance Analysis.
4. Pricing decision including pricing strategies; Pareto Analysis.
5. Target Costing, Life Cycle Costing
6. Costing of Service Sector
7. Measurement of Divisional profitability – pricing decisions including transfer pricing.
8. Activity Based Cost Management.
9. Just-in-time Approach, Material Requirement Planning, Enterprise Resource Planning.
10. Total Quality Management.
11. Value Chain Analysis
12. Budgetary Control & Performance measurement: Flexible Budgets; Performance Budgets; Zero based Budgets; Balanced Score Card; Bench Marking; Theory of Constraint.
13. Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Some important instruction

How to prepare Class note?

Maintain separate copies (Rule sheet) for class note & home work. All pages should be numbered. Mention the corresponding copy and page no. at the side of each problem. This is very important for cross reference and it helps to reduce your revision time, mainly before the examination. Maintain content in each copy.

How to prepare for the exam to ensure quality answer?

Maintain separate copies (Rule sheet) for class note & home work.

All pages should be numbered.

Mention the corresponding copy and page no. at the side of each problem. This is very important for cross reference and it helps to reduce your revision time, mainly before the examination. Maintain content in each copy.

Our main objective in the examination is to score 65%+, because the end of the day every one will ask how much u score not how much u answer. So, our simple strategy is to answer 80+ with good quality, so that the score is automatically 65+. Many of my students score 72, 73 out of 80 or 85.

As we write only 80 or 85 marks in 3 hours, automatically

- a. the available time to answer per question will increase
- b. reduces no. of mistakes, which a student normally does with the attempt of 100 marks within the same time.
- c. Help “quality answer” by which we can score full marks per question.
- d. Help to avoid the hardest question in the paper

So, getting 70 marks by answering 80 is not an impossible task but need a good strategy.

The other pre-conditions of quality answers are:

- 1) Proper heading for each statement.
- 2) Write units and notation with every calculation, particularly Rs. and Rs. per unit.
- 3) Supporting notes with each answer.
- 4) Simple quality English.
- 5) Always starts the answer with the definition of the subject. Don't starts the answer like “ It is a very important concept of cost Accounting.” It is important that is why it given in examination. Such answer creates impression that the student is answering volume not by quality.
- 6) Always starts the answer in a fresh page, preferable at the left hand side of page while answering the problem.
- 7) Do not use any pencil or any color in our answer. Do not underline the key or catch word of each sentence, as the evaluator is fill some time insulted. Mention proper question no. in each answer. All part answer should be in a sequence. Do not write any “faltu” sentence whose meaning not even clear to you.
- 8) A good hand writing is must for a “quality answer”.

Tips for the final revision phase:

As the exam looms closer, consider the following list of techniques and make use of those that work for you:

- Summaries your notes into more concise form, perhaps on index cards that you can carry with you for revision on the way into work.
- Go through your notes with a highlighter pen, marking key concepts and definitions.
- Summaries the main points in a key area by producing a wordlist, mind map or other mnemonic device.
- On areas that you find difficult, rework questions that you have already attempted, and compare your answers in detail with those provided in the study system.
- Rework questions you attempted earlier in your studies with a view to producing more 'polished' answers (better layout and presentation may earn marks in the exam) and to completing them within the time limits.
- Stay alert for practical examples, incidents, situations and events that illustrate the material you are studying. If you can refer in the exam to real-life topical illustrations you will impress the examiner and may earn extra marks.

Remember:

- 1 Take part in class discussion. State clearly follower not.
- 2 Switch off your Mobile.
- 3 Try all Home work.
- 4 Registered in our website: www.costmanagement.net.in
Do not talk during discussion, do not talk while I am answering on the board. Such offence following by washing, will lead to 3 class suspension.

Raise Question in Class:

1. Numerical mistake which I answer straight way or ask to check the problem or previous class note.
2. Technical Question: During this I will ask question on definition which I taught you. This is for checking your knowledge not to humiliate you in the class. If you find I wanted to humiliate, tell me. Remember, for a proper knowledge you have to surrender to your "Guru". Guru can punish you, but for your benefit.

General Rule of Solving Home-work:

- Step 1 First read the Class note
- Step 1: Carefully Reading of the problem to clear the story. Do not read the question first. Do not touch the Calculator. Give at least ½ hour in Step-I & Step-II.
- Step2: Read again paragraph wise & collect data, write it . Analyse it, whatever you like. This will help you to overcome the question " how to start the answer"?
- Step 3: Analysis according to technique which you fell most appropriate.
- Step 4: Give Final results according to the questions given. Question are related with mainframe in solution.

How to prepare before day of exam

1. Put maximum stress in revising the theory.
2. Do not try to revise all the problem. We have already solve 300 problems and examples, no one can revise it within 6 hours.
3. Try to check the technique of each chapter as given by me in your first class note of each topic.
4. For any other problem always contact me, except during the examination day time between 12 noon to 3 PM.

Basic Concept

1. What is cost & cost management?

Answer: Cost is measurement, in monetary terms, of the amount of resources used for the purpose of production of goods or rendering services.

Cost accounting is the application of accounting and costing principles, methods and techniques in the ascertainment of costs and the analysis of savings and/or excess as compared with previous experience or with standards.

CIMA defines Cost Accounting as “the establishment of budgets, standard costs and actual costs of operations, processes, activities or products, and the analysis of variances, profitability or the social use of funds.”

2. How prepare a Cost Sheet?

According to CAS – 4 (for detail refer the CD)

Statement of Cost of Production _____ manufactured / to be manufactured during the period _____

		Qty	
Q1	Quantity Produced (Unit of Measure)		
Q2	Quantity Dispatched (Unit of Measure)		
	Particular	Total cost (Rs.)	Cost/ unit (Rs.)
1.	Materials Consumed		
2.	Direct Wages and Salaries		
3.	Direct Expenses		
4.	Works Overheads		
5.	Quality Control Cost		
6.	Research & Development Cost		
7.	Administrative Overhead (relative to production activity)		
8.	Total (1 to 7)		
9.	Add: Opening stock of Work-in progress		
10.	Less: Closing stock of Work-in-progress		
11.	Total (8 +9 – 10)		
12.	Less: Credit for Recoveries /Scrap/By products /misc. income		
13.	Packing cost		
14.	Cost of production (11 –12 + 13)		
15.	Add: Inputs received free of cost		
16.	Add: Amortised cost of Moulds. Tools. Dies & Patterns etc., received free of cost		
17.	Cost of production for goods produced for captive consumption (14 + 15+ 16)		
18.	Add: Opening stock of finished goods		
19.	Less: Closing stock of finished goods		
20.	Cost of production for goods dispatched (17 + 18 – 19)		

This cost statement has been adopted by ICAI (Ref: Students' Journal Pg. 7 of July, 2004)

3. Outline the key attributes of an operational database

Answer: The key attributes of an operational database are:

- (1) Consistency of related information elements: Operating personnel are alert for information that is consistent with information they already possess. If information from different source about the transaction is consistent, this information, as well as the information system, has greater validity.
- (2) Timeliness: of transactions information and of managerial reports. Because of simultaneous updating of all records affected by a transaction and the frequent use of on-line transactions entry, database records are more likely than conventional files.
- (3) Back-up: detail provided by inquiry capability: Operations personnel refer to backup details to answer customer questions about account status. Also all managers can cite many instances when they have received highly summarized unexplained circumstances such as a production cost variance. Frequently the data needed exists in the computer system.
- (4) Data sharing: The sharing of a large pool of operations data among multiple user departments is possible with a database. Without a database, information about other department's activities probably would be available only several days after the end of each accounting period, if at all.

4. "Cost may be classified in a variety of ways according to their nature and the information needs of the management." Explain.

Answer: Costs can be classified according to their nature and information needs of the management in the following manner:

- i. By element: Under this classification costs are classified into (a) Direct costs and (b) Indirect costs according to elements viz., materials, labour and expenses.
- ii. By function: Hence costs are classified as: production cost; administration cost; selling costs; distribution cost; research cost; development cost, etc.
- iii. By behavior: According to this classification costs are classified as fixed; variable and semi variable costs. Fixed costs can be further classified as committed and discretionary.
- iv. By controllability: Costs are classified as controllable and non-controllable costs.
- v. By normality: Under this classification costs are segregated as normal and abnormal costs.

Management of a business house requires cost information for decision making under different circumstances. For example they required such information for fixing selling price, controlling and reducing costs. To perform all these functions a classification of cost according to their nature and information needs is an essential pre-requisite of the management.

5. Explain the concept of discretionary costs. Give three examples. Discuss, how control may be exercised over discretionary costs.

Answer. Discretionary cost can be explained with the help of following two important features.

- i. They arise from periodic (usually yearly) decisions regarding the maximum outlay to be incurred.
- ii. They are not tied to a clear cause & effect relationship between inputs & outputs.

Examples of discretionary costs includes : advertising, public relations, executive training, teaching, research, health care and management consulting services.

The noteworthy feature of discretionary costs is that managers are seldom confident that the "correct" amounts are being spent.

Control over discretionary costs: To control discretionary costs control points / parameters may be established. But these points need to be devised individually. For research and development function to control discretionary costs, dates may be established for submitting major reports to management. For advertising and sales promotion, such costs may be controlled by pre-setting targets. In the case of employees benefits, discretionary costs may be controlled by calling a meeting of employees union and making them aware that the company would meet only the fixed costs and the variable costs should be met by them.

6. Distinguish between 'Committed Fixed Costs' and 'Discretionary Fixed Costs'.

Answer : Committed fixed costs, are those fixed costs that arise from the possession of : (i) a plant, building and equipment (e.g. depreciation, rent, taxes, insurance premium etc.) or (ii) a functioning organisation (i.e. salaries of staff). These costs remain unaffected by any short-run actions. These costs are affected primarily by long-run sales forecasts that, in turn indicates the long-run capacity targets. Hence careful long range planning, rather than day-to-day monitoring, is the key to managing committed costs.

Discretionary fixed costs, (some called managed costs or programmed costs). These costs have two important features :

- i. they arise from periodic (usually yearly) decisions regarding the maximum outlay to be incurred, and
- ii. they are not tied to a clear cause-and-effect relationship between inputs and outputs. Examples of discretionary fixed costs includes – advertising, public relations, executive training, teaching, research, health care etc. These costs are controllable.

7. Distinction between Cost reduction and Cost management:

Cost reduction is the achievement of real and permanent in the unit cost of goods manufactured or services rendered without impairing or reducing the quality of the product. It uses the techniques like value analysis, work-study, standardization, simplification etc. It is a continuous process of critical cost examination, analysis and challenges of established standards. Each aspect of the business namely products, processes, methods, procedures is critically examined and reviewed with a view to improving the efficiency and effectiveness so that cost are reduced. It presumes the existence of concealed potential savings in norms or standards. It is a corrective action.

Cost management is a broader concept. It aims at optimal utilization of resources to enhance the operating income of the firm. It does not consider product attributes as given. It does not focus on cost independent of revenue. Cost management system establishes linkage between cost and revenues. It relates costs with product to have an insight into how various attributes generates revenue and create demand on resources. It provides information to manage product attributes to optimize resource utilization.

Traditional cost reduction systems focus on products, while cost management systems focus on products, markets, and customers.

Budgetary Control & Performance Measurement

Learning Objective:

1. Purposes of Budget
2. Revolution and application of budget according to their function
3. Modern development in Budgetary control system
4. Performance appraisal

Q1. Define Budget & Budgetary control. State the objectives of budget.

A budget is a financial and/or quantitative statement, prepared prior to a defined period of time, of the policy to be pursued during that period for the purpose of attaining a given objective & must be approved.

Essential features:

- (I) a budget may be expressed in terms of money or quantity, or both
- (II) it should be developed prior to the period during which it is to operate,
- (III) it is set for a definite period, and
- (IV) before its preparation, the objective to be attained and the policy to be pursued to achieve that objective and required to be laid down.

Budgeting lays emphasis on the necessity for advance decision on future course of action to be followed and points out the result which would accrue by following that course of action.

Objective :

- (a) A budget is a **blue print** of the desired plan of action or operation. Plans covering the entire organisation and all its functions like purchase, production, sales, financial management, research and development are expressed through budgets.
- (b) The budget serves as a **declaration of policies** and also defines the objective for executives at all levels of management.
- (c) Budgets provide a **means of co-ordination** of the business as a whole . In the process of establishing budgets, the various factors like production capacity, sales possibilities, and procurement of material, labour, etc. are balanced and co-ordinates so that all the activities proceed according to the objective.
- (c) Budgets are **means of communication**. Complex plans laid down by the top management are passed on to those who are responsible for putting them into action.
- (d) Budgets facilitate **centralised control** with delegated authority and responsibility. Grouped according to the responsibilities of different executive levels, they facilitate decentralisation of work.
- (e) Budgets are **instruments of managerial control** by means of which the management can measure performances in every part of the concern and take corrective action as soon as any deviations from the budgets come to light.

Budgetary control is defined as

- a. the establishment of budgets relating the responsibilities of executives to the requirements of a policy and
- b. the continuous comparison of actual with budgeted results, either to secure by individual action the objective of that policy or to provide a basis for its revision..

Limitations of Budgetary Control System:

Budgets may or may not be true, as they are based on estimates.

1. Budgets are considered as rigid document.
2. Budgets cannot be executed automatically
3. staff co-operation is usually not available during budgetary control exercise.
4. Its implementation is quite expensive.

Q2. What is programme budget?

Answer : This is a budgetary process meant to make government operation more effective and efficient. Developed in the U.S.A. in 1961, program budgeting is being used in the various departments of the U.S. Government. Some of the features of program budgeting that distinguish it from the conventional budgeting and performance budgeting are as follows : --

1. Program budgeting reconstructs budgets by accounting expenditure under output (Cash out flow) categories rather than objective categories. Budgets are established for each activity leading to the output such as defense, health, education etc.
2. Program budgeting is prospective; the other types of budget are retrospective. Program budgeting connotes planning in the real sense.
3. Programme budgeting is concerned with the purpose of work and not as much with the process of work. As a result, the programme budgeting are the programme of the top level management dealing with strategy.
4. Program budgeting extends beyond one financial year and depending upon the activity concerned, it may extend for a long term, say two or five years till the final output is achieved.
5. Program budgeting is closely associated with social cost-benefit (SCBA) analysis.

Q3. What is Performance Budgeting (PB) ?

Answer: A performance budget is one which presents the purposes and objectives for which funds are required, the costs of the programmes proposed for achieving those objectives, and quantities data measuring the accomplishments and work performed under each programme.

Thus PB is a technique of presenting budgets for costs and revenues in terms of functions. Programmes and activities are co-relating the physical and financial aspect of the individual items comprising the budget.

Q4. Zero base budget- definition & other questions .

Answer : ZBB is defined as 'a method of budgeting which requires each cost element to be specifically justified, as though the activities to which the budget relates were being undertaken for the first time. Without approval, the budget allowance is zero'.

Zero-base budgeting is so called because it requires each budget to be prepared and justified from zero, instead of simply using last year's budget as a base. Incremental level of expenditure on each activity are evaluated according to the resulting incremental benefits. Available resources are then allocated where they can be used most effectively.

The major advantage of ZBB exercises is that managers are forced to consider alternative way of achieving the objectives of their activity and they are required to justify to activities which they currently undertake.

ZBB is some times referred to as Priority-based budgeting. It does not apply exclusively to non-operating budgets, but it is particularly relevant in this context

Zero base budgeting is superior to traditional budgeting in the following manner :

- It provides a systematic approach for evaluation of different activities.
- It ensure that the function undertaken are critical for the achievement of the objectives.
- It provides an opportunity for management to allocate resources to various activities after a proper cost benefit analysis.
- It helps in the identification of wasteful expenditure and then their elimination.
- If facilitates the close linkage of departmental budgets with corporate objectives.
- It helps in the introduction of a system of Management by Objectives.

Describe the process of zero-base budgeting.

The zero base budgeting involves the following steps:

- (i) Corporate objectives should be established and laid down in details.
- (ii) Decide about the techniques of ZBB to be applied.
- (iii) Identify those areas where decisions are required to be taken.
- (iv) Develop decision programme and rank them in order of performance.
- (v) Preparation of budget, that is translating decision packages into practicable units/ items and allocating financial resources.

Limitations of ZBB

- (i) Various operational problems are likely to be faced in implementing the technique.
- (ii) The full support of top management is required.
- (iii) It is time consuming as well as costly
- (iv) It requires proper trained managerial staff

Q6. What is Rolling Budgets ?

Answer: Rolling budgets can be particularly useful when future events cannot be forecast reliably. A rolling budget is defined as 'a budget continuously updated by adding a further accounting period (month or quarter) when the earliest accounting period has expired. Its use is particularly beneficial where future costs and/ or activities cannot be forecast accurately.'

For example a budget may initially be prepared for January to December, year 1. At the end of the first quarter, i.e., at the end of March, year 1, the first quarter's budget is deleted. A further quarter is then added to the end of the remaining budget, for January to March, year 2. the remaining portion of the original budget is updated in the light of current conditions. This means that managers have a full year's budget always available and the rolling process forces them to continually plan ahead. A system of rolling budgets is also known as continuous budgeting.

Q7. Benchmarking**Definition**

Benchmarking is the continuous process of measuring products, services or activities against the best level of performance that may be found either inside or outside the organisation. It is a process of comparing a firm's activities with best practices.

The process involves establishment of benchmarks (targets or comparators) through whose use the levels of performance of the company is sought to be improved. Benchmarking is a tool for continuous improvement because after identifying a best practice performance, it becomes a target to beat.

Types of benchmarking :

- a. intra-group and
- b. inter-industry.

In the former case, groups of companies in the same industry agree that similar units within the co-operating companies will pool data on their processes. The processes are benchmarked against each other. Improvement task forces are established to identify and report “best practice” to all members of the group so that each participating company can achieve it and beat it.

In inter-industry benchmarking, non-competing firms with similar processes are identified and asked to participate in benchmarking exercise. The objective is to benefit from the experience of the other, and establish best practice in their common business processes.

The steps in benchmarking

1. Gather relevant data of participating departments or units, establish the benchmarks based on the best practices and communicate them to the relevant departments or participating units.
2. Measure actual performance to compare with the benchmarks.
3. Analyse the reasons for variations and report them to management for taking preventive and corrective actions.
4. Review the existing benchmarks to set new targets for continuous improvement.

Types of measurement

- a. financial or
- b. non-financial measure or both.

Examples of financial benchmarks are

- 1. standard cost,
- 2. target profit,
- 3. sales revenue,
- 4. desired cash flow, etc.

Examples of non-financial benchmarks are

- 1. Targets in terms of market share,
- 2. Customer satisfaction,
- 3. Reduction in machine down-time,
- 4. Target rate of return

Again, financial benchmark may be a part of the accounting system, e.g.

- a. standard costing,
- b. budgetary control and
- c. variance analysis

Bench marking code of conduct

Bench marking is the process of identifying and learning from the best practices anywhere in the world. It is a powerful tool for continuous improvement. To contribute to efficient, effective and ethical bench marking, individuals agree for themselves and their organization to be abided by the following principles for the benchmarking with other organizations.

Suggested benchmarking code of conduct:

- (i) Principle of legality
- (ii) Principle of exchange
- (iii) Principle of confidentiality
- (iv) Principle of use
- (v) Principle of first party contact
- (vi) Principle of third party contact
- (vii) Principle of preparation

Pre-requisites of Bench marking:

- (i) The objectives of bench marking should be clearly defined.
- (ii) Senior Managers should support bench marking and commit themselves for continuous improvement.
- (iii) The scope of the work should be appropriate in the light of the objectives, resources, time and experience of those involved.
- (iv) Sufficient resources should be made available to complete projects within the required time.
- (v) Bench marking teams should have the right skill and competencies.
- (vi) Stake holders, staff & others should be kept informed of the reasons of bench making

Q8. The theory of constraints (TOC) & Throughput accounting:

The theory of constraints (TOC) describes methods to maximize operating income when faced with some bottleneck and some non bottleneck operations.

The three measurements:

1. Throughput contribution = revenues minus the direct materials cost of the goods sold.
2. Investments = the 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 & wages, rent utilities, & depreciation.

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

The steps in managing bottleneck operations:

- Step 1: Recognize that the bottleneck operation determines throughput contribution of the entire system.
- Step 2: Find the bottleneck operation by identifying operations with large quantities of inventory waiting to be worked on.
- Step 3: Keep the bottleneck operation busy and subordinate all non bottleneck operations to the bottleneck operation. That is, the needs of the bottleneck operation determine the product schedule of non bottleneck operations.

The important concept behind TOC is that the production rate of the entire factory is set at the pace of the bottleneck the constraining resource. Hence, in order to achieve the best result TOC emphasizes the importance of removing bottlenecks or limiting factor. If they cannot be removed they must be coupled with in the best to be drawn to identify the bottlenecks or binding constraints.

TOC identifies three types of cost.

- Throughput contribution = Sales revenue -- direct material cost.
(Direct material cost includes purchased components and materials handling costs.)
- Conversion costs : These are all operating costs, excluding completely variable costs, which are incurred in order to produce the product i.e. labour and overhead, including rent, utilities and relevant depreciation.
- Investments which include all stock, raw material, work in progress, finished goods, research and development costs, cost of equipment and buildings, etc.

Throughput Accounting (TA) is a method of performance measurement which relates production and other costs to throughput. Throughput Accounting product costs relate to usage of key resources by various products.

It assumes that a manager has a given set of resources available. These comprise the existing buildings, capital equipment and labour force. Using these resources, purchased materials and components must be processed to generate sales revenue. To achieve this, maximum amount of throughput is required with the financial definition.

$\text{Sales revenue} - \text{Direct materials cost}$

The cost of all other is deemed at least time related rather than fixed.

Throughput is influenced by :

- Selling price
- Direct purchase price

- Usage of direct materials
- Volume of throughput.

Constraints on throughput :

- the existence of an uncompetitive selling price
- the need to deliver on time to particular customers

- the lack of product quality and reliability
- the lack of reliable materials suppliers
- the existence of shortage of production resources.

Q10. Fixed Budget & flexible Budget:

Distinction between Fixed and Flexible Budget

Fixed Budget	Flexible Budget
1. It does not change with actual volume of activity achieved. Thus it is known as rigid	It can be re-casted on the basis of activity level to be achieved. Thus it is not rigid.
2. It operates on one level of activity and under one set of conditions. It assumes that there will be no change in the prevailing conditions which is unrealistic.	It consists of various budgets for different levels of activity.
3. Here as all costs like – fixed, variable and semi – variable are related to only one level of activity so variance analysis does not give useful information.	Here analysis of variance provides useful information as each cost is analyzed according to its behaviour.
4. If the budgeted and actual activity levels differ significantly, then the aspects like cost ascertainment and price fixation do not give a correct picture	Flexible budgeting at different levels of activity, facilitates the ascertainment of cost, fixation of selling price and tendering of quotations.
5. Comparison of actual performance with budgeted targets will be meaningless specially when there is a difference between the two activity levels.	It provides a meaningful basis of comparison of the actual performance with the budgeted targets.

Q11. The Balanced Scorecard (for problems ref Pg. No 61)

Prior to the 1980s management accounting control systems tended to focus mainly on financial measures of performance. The inclusion of only those items that could be expressed in monetary terms motivated managers to focus excessively on cost reduction and ignore other important variables like product quality, delivery, reliability, after-sales service and customer satisfaction. These became key competitive variables, but not of these were measured by the traditional management accounting performance measurement system.

The **Balanced scorecard** helps top management evaluate whether lower-level managers have improved one area at the expense of others. For example, a manager at risk of not meeting operating profit goals may start to ship high-margin products and delay deliveries of low-margin products. The balanced scorecard will recognize the improvement in financial performance but will also reveal that operating profit targets were achieved by sacrificing on-time performance. Four perspectives are typically integrated in a balanced scorecard :

1. Customer perspective: The balance scorecard builds on established competitive strategies, such as customer orientation, short response times, total quality and teamwork. Many organizations already see themselves as customer oriented. However, the customer perspective of the balanced scorecard requires customers themselves to identify a set of goals and measures on factors which really matter to them. Performance measures such as time, cost, quality, performance and service should be developed by groups of managers working with customers to understand their primary requirements.
2. Internal perspective: The organisation must excel at certain internal processes, decisions and actions if it is to meet these customer requirements. The internal perspective must reflect the organization's core skills and the critical technology involved in adding value to the customer's business. The organization's overall goals have to be broken down into unit, departmental or workgroup measures which are influenced by employee actions. Clearly, this is a part of the same movement towards business processes which is being followed by activity – based costing and activity-based management.
3. Innovation & learning: So far, the customer and internal perspectives will have focused on the organization's current competitive position. The innovation and learning perspective is required in order to recognize that this is constantly seek to learn, to innovate and to improve every aspect of the organisation and its business just to maintain their competitive situation, let alone to improve in the future.
4. Financial perspective: The financial perspective covers traditional measures such as growth, profitability and shareholder value but are set through talking to the shareholders(s) direct. The customer, internal and innovation and learning perspectives, if correctly implement4ed, will not automatically result in financial improvement if the overall corporate strategy is not a fundamentally profitable one. The financial perspective looks at whether is resulting in bottom line financial improvement.

Only by combining, measuring and thinking in terms of all four perspectives can managers prevent improvements being made in one area at the expenses of another. The balanced scorecard forces managers to think in terms of those fundamental competitive issues which impact upon long-term, rather than short – term, profitability.

The Balance Scorecard
How do we look to shareholders?

Financial perspectives	
Goals	Measures
Survive	Cash flow
Succeed	Quarterly sales growth & operating income by division
Prosper	Increased market share & return on equity

How do customers See us?

What must We excel At?

Customer perspective	
Goals	Measures
New products	% of sales from new products
Responsive supply	% of sales from proprietary products.
Preferred supplier	On-time delivery (defined by customers)
Customer partnership	Share of key accounts' purchase
	Ranking by key accounts
	No. of co-operative engineering efforts.

Internal business perspective	
Goals	Measures
<u>Technology Capability</u>	<u>Manufacturing geometry v. competition</u>
<u>Manufacturing excellence</u>	<u>Cycle time Unit cost Yield</u>
<u>Design productivity</u>	<u>Silicon efficiency Eng. Efficiency.</u>
<u>New prod. introduction</u>	<u>Actual introduction schedule v. plan.</u>

Innovation & learning perspective	
Goals	Measures
<u>Technology leadership</u>	<u>Time to develop next generation</u>
<u>manufacturing learning</u>	<u>Process time to maturity</u>
<u>Product focus</u>	<u>% of products that equal 80% of sales</u>
<u>Time to market</u>	<u>new product introduction v. competition.</u>

Can we Continue to improve & create value?

Functional Budgets: Single product

1. A single product company estimated its sales for the next year quarter wise as under :

Quarter	Sales Units
I	30,000
II	37,500
III	41,250
IV	45,000

The opening stock of finished goods is 10,000 units & the Company expects to maintain the closing stock of finished goods at 16,250 units at the end of the year. The production pattern in each quarter is based on 80% of the sales of the current quarter & 20% of the sales of the next quarter.

The opening stock of raw materials in the beginning of the year is 10,000 Kg. and the closing stock at the end of the year is required to be maintained of 5,000 kg. Each unit of finished output requires 2 Kg. of raw materials.

The company proposes to purchase the entire annual requirement of raw materials in the first three quarters in the proportion and at the price given below :

Quarter	Purchase of raw materials % to total Annual requirement in equity	Price per kg. Rs.
I	30%	2
II	50%	3
III	20%	4

The value of the opening stock of raw materials in the beginning of the year is Rs.20,000. You are required to present the following for the next year, quarter-wise :

- (i) Production budget in units.
 - (ii) Raw material consumption budget in quantity.
 - (iii) Raw material purchase budget in quantity and value.
 - (iv) Priced stores ledger card of the raw material using FIFO.
2. Soloproducts Ltd. manufactures and sells a single product and has estimated a sales revenue of Rs.126 lakhs this year based on a 20% profit on selling price. Each unit of the product requires 3 lbs of material P and 1 ½ lbs of material Q for manufacture as well as a processing time of 7 hours in the Machine shop and 2 ½ hours in the Assembly Section. Overheads are absorbed at a blanket rate of 33.3333% of Direct Labour.

The factory works 5 days of 8 hours a week in a normal 52 weeks a year. On an average statutory holidays, leave and absenteeism and idle time amount to 96 hours, 80 hours and 64 hours respectively, in a year. The past performance (in Hours) of factory in last 3 years:

	<u>Machine Shop</u>	<u>Assembly shop</u>
In 2006	11,00,000	3,45,000
In 2007	10,30,000	3,20,000
In 2008	10,80,000	3,40,000

The other details are as under :	Rs.
Purchase price	Material P
	Material Q
	6 per lb
	4 per lb

Comprehensive Labour Rate	Machine Shop	4 per hour
	Assembly	3.20 per hour

No. of Employees : Machine Shop 600 & Assembly shop 180.

	<u>Finished Goods</u>	<u>Material P</u>	<u>Material Q</u>
Opening Stock	20,000 units	54,000 lbs	33,000 lbs
Closing Stock (Estimated)	?	30,000 lbs	66,000 lbs

You are required to calculate :

- The number of units of the product proposed to be sold.
- Purchases to be made of Materials P and Q during the year in Rupees.
- Capacity utilisation of Machine shop and Assembly Section, along with your comments.

Functional Budgets: Multi products

3. P. H. Ltd. has specialised in the manufacture of three kinds of sub-assemblies required by the manufacturers of certain equipments. The current pattern of sales of sub-assemblies is in the ratio (in units) of 1 : 2 : 4 for sub-assemblies P, Q and R respectively.

The sub-assemblies consist of the following components:

Sub-assembly	Selling price Rs. p.u.	<u>Requirement of components on per unit basis.</u>			
		Frame	Part X	Part Y	Part Z
P	430	1	10	2	8
Q	500	1	2	14	10
R	600	1	6	10	2
Purchase Price (Rs.)		40	16	10	6

The direct labour hours required per unit for the manufacture of each of the sub-assemblies are:

<u>Sub-assembly</u>	<u>Skilled Hours</u>	<u>Un-Skilled Hours</u>
P	4	4
Q	3	4
R	3	6
Wage rate per hour (Rs.)	6	5

The labourers work for 8 hours a day for 25 days a month. Variable overheads per sub-assembly are P Rs. 10, Q Rs. 8, R Rs. 7. The estimates of 'opening stock of sub-assemblies and components for the month of July 2007 are as under:

<u>Sub-assemblies</u>		<u>Components</u>	
P	600	Frames	2000
Q	1400	Part X	800
R	3200	Y	20000
		Z	8000

Fixed overheads budget per month is an under:

	Rs.
Production	15,80,000
Selling & Distribution	7,28,000
Administration	6,76,000

All fixed overheads are incurred evenly throughout the year. The target of profit for the current year is Rs. 120 lakhs before tax. The company has to plan to reduce the closing stock of sub-assemblies and components by 10 % as compared to the opening stock.

Prepare the following budgets for July 2008:

- Sales in quantities and value
- Production in quantities
- Material usage
- Material purchase in quantities and value
- Manpower budget for both categories of labour including wages payable.

4. Manufacturers Ltd. produce three products from three basic raw materials in three departments. The company operates a budgetary control system and values its stock of finished goods on a total cost basis. From the following data, you are required to produce for the month of July 2008 the following budgets:-

- Production
- Materials usage
- Purchases
- Profit and Loss Account for each product and in total

Budgeted data for July 2008			
Product	A	B	C
Sales	Rs. 15,00,000	Rs. 10,80,000	Rs. 16,80,000
Stock of finished products at July 1 st , 2008 in units	3,000	2,000	2,500
Department	I	II	III
Production overhead	Rs. 2,39,000	Rs. 2,01,300	Rs. 3,91,200
Direct Labour hours	47,800	67,100	65,200
Direct Material	M ₁	M ₂	M ₃
Stock at July 1 st 2008(units)	24,500	20,500	17,500

The company is introducing a new system of inventory control which should reduce stocks. The forecast is that stocks as at 31st July 2008 will be reduced as follows: Raw materials by 10% and finished products 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 product at a rate of 20% of production cost and selling and distribution cost is absorbed by products at a rate of 40% of production cost. Profit is budgeted as a percentage of total cost as follows:

Product A 25%, Product B 12 ½% and Products C 16 ⅔%.

Standard cost data, Per unit of Product :—

Product	Price p.u.	A	B	C
Direct Material :	Rs.	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) : Rs.		Hours	Hours	Hours
Department I	2.50	4	2	2
Department II	2.00	6	2	3
Department III	1.50	2	4	6
		Rs.	Rs.	Rs.
Other Variable costs		10	20	15

Selling Expenditure Budget

5. Pharma Ltd. sells Ayurvedic medicinal products through direct orders booked by salesman when they call on potential buyers and also through mail orders which arise out of sales campaign by salesman.

The company pays the salesman an incentive commission as 5% of sales on orders booked by them directly; 2% of sales on mail order sales in the territory of the particular salesman, Dispatch and billing expenses amount to 5% of sales revenue on all orders.

The sales budget for the coming year indicates the following mix:

Quarter	Total sales Rs.	Direct booking by salesman (%)	Mail order sales (%)
1	10, 00,000	80	20
2	12, 00,000	70	30
3	13, 00,000	75	25
4	15, 00,000	80	20

Fixed selling expenses for the budget year:

Sales salaries	1, 00,000	Advertising	1, 50,000
Travelling expenses	80,000		

Sales salaries and traveling are paid uniformly in each quarter. The advertisement expenses are incurred as under: 1st quarter-10%; 2nd quarter-50%; 3rd quarter-30%, 4th quarter-10%.

Required

- Prepare a Quarterly Budget of selling expenses for the year.
- It has been observed that 50% increase in Budgeted advertisement expenditure will double the quarter quantities of mail order sales. Although it would be at the cost of direct sales, it would also reduce traveling expenditure by 25%. However rates of commission to salesman would remain unaffected. Compute the effect of the proposal and suggest whether the same acceptable.

Cash Budget

6. The 1st January cash balance of the Jay Company is Rs. 5,000. Sales for the first four months of the year are expected to be as follows: January, Rs. 65,000; February, Rs. 54,000; March, Rs. 66,000; and April, Rs. 63,000.

On January 1, uncollected amounts for November & December of the previous year, are Rs. 13,500 & Rs. 39,150, respectively. Collections from customers follow this pattern; 55% in the month of sale, 30% in the month following the sale, 13% in the 2nd month following the sale, & 2% un-collectible.

Materials purchases for December were Rs. 10,000. Forecast purchases for the coming year are January, Rs. 12,500; February, Rs. 16,500; March, Rs. 13,000; and April, Rs. 14,000. Purchases are usually paid by the 10th of the month following the month of purchase. Other cash expenditures of Rs. 41,000 are forecast for each month.

Calculate :

- Expected cash collections during February
- Expected cash balance, February 1
- Expected cash balance, February 28.

7. Prepare cash budget for July - December from the following information :

(i) The estimated sales, expenses etc. are as follows :

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(Rs. in lacks)						
Sales	34	40	40	50	50	60	65
Purchase	24	16	17	20	20	25	28
Wages and Salaries	12	14	14	18	18	20	22
Miscellaneous	5	6	6	6	7	7	7
Interest Received	2	--	--	2	--	--	2
Sales of Shares	--	--	20	--	--	--	--

- (ii) 20% of the sales are on cash with 3% cash discount and the balance on credit. Sales in the month April & May was Rs. 44 & Rs.40 lakhs respectively.
- (iii) 1% of the credit sales are returned by the customers. 2% of the net receivable constituted bad debt losses. 50% of the good accounts receivable are collected in the month following the sales with 1% cash discount, 30% of the good accounts receivable are collected in the 2nd month following the sales and the rest in the 3rd month following sales.
- (iv) The time lag in the payment of misc. expenses and purchases is one month. Wages and salaries are paid fortnightly with a time lag of 15 days.
- (iv) The company keeps a minimum cash balance of Rs. 25 lakhs. Cash in excess of Rs. 27 lakhs is invested in 9% Govt. securities in the multiple of Rs. 1 lakh. Interest is receivable on monthly basis . Shortfalls in the minimum cash balance are made good by borrowings from banks in multiple of Rs. 2 lakhs & also repaid by same amount. The rate of interest is 12% p.a. (compound interest)
- (v) The opening cash balance is Rs.26 lakhs.

Bottleneck, Throughput & Theory of Constraints

8. The particulars are extracted from the books of Raj company:-

	Product A	Product B
	Per unit	per unit
Sales	Rs. 100	Rs. 120
Consumption of material:	2 Kg	3 Kg
Material Cost	Rs.10	Rs. 15
Direct wages cost	Rs.15	Rs. 10
Direct expenses	Rs. 5	Rs. 6
Machine Hours used	3	2
Overhead expenses :		
Fixed	Rs. 5	Rs. 10
Variable	Rs. 15	Rs. 20

Direct wages per hour is Rs. 5.

- (a) Comment on profitability of each product (both use the same raw material) when
- Total sales potential is limited;
 - Raw Material is in short supply;
 - Production capacity (in terms of machine hours) is the limiting factor.

(b) Assuming Raw Material as the key factor, availability of which is 10,000 Kg. and maximum sales potential of each product being 3,500 units, prepare Production Budget.

(c) In (b), if MHR is Rs. 8,400, find PBF

(d) If only one product is to sale, which product to sale?

9. 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:

Products	Aristocrat	Deluxe
(i) Maximum sales Potential in units	7,400	10,000
(ii) Product unit data :		
Selling price per unit	Rs. 90	Rs. 80
Machine hours per unit :		
Department A hours @ Rs. 40/hr.	0.50	0.30
Department B hours @ Rs. 60/hr.	0.40	0.45

(iii) Maximum capacity of Department A is 3,400 hours and of Department B is 3,840 hours.

(iv) Maximum quantity of direct materials available is 17,000 kg. each product requires 2 kg. of direct materials. The purchase price of the direct materials is Rs. 5 kg.

- You are required to find the optimum product mix.
- In view of the aforesaid production capacity constraints, the company has decided to produce only one of the two products during the year under review. Which of the two products should be produced and sold in the year under review to maximize the profit. State the number of units of that product and the resultant contribution.

10. 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)	Rs. 24	Rs. 20	Rs. 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.

11. The following data is to be used to answer questions (a), (b) and (c) below.
HG plc manufactures four products. The unit cost, selling price and bottleneck resource details per unit are as follows:

	Product W Rs.	Product X Rs.	Product Y Rs.	Product Z Rs.
Selling price	56	67	89	96
Materials	22	31	38	46
Labour	15	20	18	24
Variable overhead	12	15	18	15
Fixed overhead	4	2	8	7
	Minutes	Minutes	Minutes	Minutes
Bottleneck resource time	10	10	15	15

- (a) Assuming the labour is a unit variable cost, if the products are ranked according to their contribution, the most profitable product is
 (A) W (B) X (C) Y (D) Z
- (b) Assuming that labour is a unit variable cost, if budgeted unit sales are in the ratio W:2; X:3; Y:3; Z:4 and monthly fixed costs are budgeted to be Rs. 15,000, the number of units of W that would be sold at the budgeted breakeven point is nearest to
 (A) 106 units (B) 142 units (C) 212 units (D) 283 units
- (c) If the company adopted throughput accounting and the products were ranked according to 'product return per minute', the highest ranked product would be
 (A) W (B) X (C) Y (D) Z

12. Flopro plc make and sell 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 (Rs.)	2	40
Variable production overhead cost (Rs)	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 & B are Rs. 60 and Rs. 70 respectively.
- (iii) Maximum demand for each product is 20% above the estimated sales levels.
- (iv) Total fixed production overhead cost is Rs. 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 Flopro plc 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 (Rs.) of the maximum net profit.

- (c) The bottleneck situation detailed in (b) still applies. Flopro plc 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 (Rs.) which applied to the product mix in (a).

Required:

- (i) Calculate the mix (units) of products A and B which will maximize net profit and the value of that net profit.
- (ii) Calculate the throughput accounting ratio for product B which is calculated as:

$$\frac{\text{Throughput return per hour of bottleneck resource for product B}}{\text{Overall total overhead cost per hour of bottleneck resource.}}$$

- (iii) Comment on the interpretation of throughput accounting ratios and their use as a control device. You should refer to the ratio for Product B in your answer.

Budget Ratios:

1. **Efficiency Ratio = (Standard hours ÷ Actual hours) × 100**
2. **Activity Ratio = (Standard hours ÷ Budgeted hours) × 100**
3. **Calendar Ratio = (Available working days ÷ budgeted working days) × 100**
4. **Standard Capacity Usage Ratio =
(Budgeted hours ÷ Max. possible hours in the budgeted period) × 100**
5. **Actual Capacity Usage Ratio =
(Actual hours worked ÷ Maximum possible working hours in a Bud. period) × 100**
6. **Actual Usage of Budgeted Capacity Ratio =
(Actual working hours ÷ Budgeted hours) × 100**

13. Following data is available for T.T.D and Co:

Standard working hours	8 hours per day of 5 days per week
Maximum capacity	50 employees
Actual working	40 employees
Actual hours expected to be worked per four week	6,400 hours
Std. hours expected to be earned per four weeks	8,000 hours
Actual hours worked in the four week period	6,000 hours
Standard hours earned in the four week period	7,000 hours.

The related period is of 4 weeks. In this period there was a one special holiday due to national event. Calculate the following ratios :

- (1) Efficiency Ratio, (2) Activity Ratio, (3) Calendar Ratio, (4) Standard Capacity Usage Ratio, (5) Actual Capacity Usage Ratio. (6) Actual Usage of Budgeted Capacity Ratio.

Problems on Fixed & Flexible Budget & Performance Analysis

14. The budgeted level of activity of a production department of a manufacturing company is 5,000 hours in a period. But a technical study assumes overhead behaviour mentioned below :-

	<u>Rs.('00) Per hr.</u>	<u>Total in Rs.('000).</u>
Indirect wages, variable cost,	0.40	
Rent and Tax, fixed cost		320
Consumable supplies, variable	0.24	
Repairs : up to 2,000 hours		100
additional each extra 500 hrs up to 4,000 hrs.		35
additional 4,001 to 5,000 hrs		60
additional, above 5,000 hrs		70
Supervision up to 2,500 hrs		400
additional each extra 600 hrs up to 4,900 hrs		100
additional, above 4,900 hrs		150
Power variable up to 3,600 hrs	0.25	
for hrs above 3,600 additional cost,	0.20	
Depreciation up to 5,000 hrs		650
above 5,000 hrs.		820
Clearing up to 4,000 hrs		60
above 4,000 hrs		80
Lighting 2,100 to 3,500 hrs		120
3,501 hrs to 5,000 hrs		150
above 5,000 hrs		175

Prepare fixed budget and a flexible budget at 70%, 85% and 110% of budgeted level of activity in one statement.

15. V Ltd. manufactures a single product. The selling price of the product is Rs. 95 per unit. The following are the result obtained by the company during the last two quarters:

	Quarter 1	Quarter 2
Sales units	5,100	4,800
Production units	5,500	4,500
	Rs.	Rs.
Direct materials A	66,000	54,000
B	55,000	45,000
Manufacturing wages	1,56,750	1,38,000
Factory overheads	86,000	83,000
Selling overheads	79,000	73,000

The company estimates its sales for the next quarter to range between 5,500 units and 6,500 units, the most likely volume being 6,000 units. The manufacturing programme will match with the sales quantity such that no increase in inventory of finished goods is contemplated in the next quarter. The following price and cost changes will, however, apply to the next quarter:

- The price of direct material B will increase by 10%. There will be no change in the price of direct material A.
- The wage rates will go up by 8%. If the production volume increases beyond 5,500 units, overtime premium of 50% is payable on the increased volume due to overtime working to be done by the variable labour complement.
- The fixed factory and selling expenses will increase by 20% and 25% respectively.
- A discount in the selling price of 2% is allowed on all sales made at 6,500 units level of output. The selling price, however, will remain unaltered, if the volume of output is below 6,500 units.

While operating at a volume of output of 6,500 units in the next quarter, the company intends to quote for an additional volume of 2,000 units to be supplied to a Government department for its captive consumption. The working capital requirement of this order is estimated at 80% of the sales value of the Government order. The company desires a return of 20% on the capital employed in respect of this order.

Required:

- (i) Prepare a flexible budget for the next quarter at 5,500, 6,600 and 6,500 unit levels and determine the profit at the respective volumes.
- (ii) Calculate the lowest price per unit to be quoted in respect of the Government order for 2,000 units.

(May 2003)

16. The budgets for XYZ Ltd. for the first three quarters of operation are shown below :

Period Covered	Budgets Quarters I – III			Rs.('000)
	Q – I	Q – II	Q – III	
<u>Activity :</u>				
Sales (Units)	9	17	15	
Production (Units)	10	20	15	
<u>Costs (Rs.'000)</u>				
Direct Material				
A	60	120	90	
B	50	100	75	
Production Labour	180	285	230	
Manufacturing Overheads				
(Excluding Depreciation)	90	120	105	
Depreciation of Production Machinery	20	20	20	
Administration Expenses	25	25	25	
Selling & Distribution Expenses	38	54	50	

The figures shown above represent the costs structure of XYZ Ltd., which have the following major features :

Fixed element of any cost is completely independent of activity levels.

- (i) Any variable element of each cost displays a linear relationship with activity level, except that the variable labour cost become 50% higher for activity in excess of 19,000 units per quarter due to the necessity for overtime working.
- (ii) The variable element of selling and distribution expenses is a function of sales. All other costs with a variable element are a function of production volume.

Activity for each quarter is spread evenly throughout that quarter. In Quarter IV Production level will be set equal to sales level. Production and sales in this quarter is expected to range between 15,000 units and 21,000 units. The most likely volume is 18,000 units. In month 9 it will be possible to accurately estimate the sales for Quarter IV.

Cost structure will remain the same as in Quarters I to III except the following :

- (i) Variable wage rate will rise by 12½%.
- (ii) Variable labour input per unit of output will decrease, due to learning curve effect, such that 80% of the previous labour input per unit of output will be required in Quarter IV. The threshold for overtime working remains at 19,000 units per quarter.
- (iii) Fixed factory overheads and the fixed element of selling and distribution costs will each rise by 20% (The variable element of selling and distribution costs will be unaltered.)

Required :

- (i) Prepare a Statement to show, under each cost classification given in the budgets, the variable cost per unit and fixed costs which will be effective in Quarter IV.
- (ii) Prepare a flexible budget of production costs for the Quarter IV. (May '95 Q:4b)

17. The following are the details of the Budgeted and the actual cost in a factory for six months from January to June, 2007. From the figures given below you are required to prepare the production cost budget for the period from January to June, 2008.

	January - June, 2007	
	<u>Budget</u>	<u>Actual</u>
Production (units)	20,000	18,000
	Rs.	Rs.
Material cost	40,00,000	39,90,000
	(2,000 MT @ Rs. 2,000)	(1,900 MT @ Rs. 2,100)
Labour cost	8,00,000 (@Rs.20 per hour)	7,99,920 (@ Rs.22 per hour)
Variable overheads	2,40,000	2,16,000
Fixed overheads	4,00,000	4,20,000

In the first half of 2008, production is budgeted for 25,000 units. Material cost per metric tonne will increase from last year's actually by Rs.100 but is proposed to maintain the consumption efficiency of 2007 as budgeted. Labour efficiency will be lower by another 1% and labour rates will be Rs. 22 per hour. Variable and Fixed overheads will go up by 20% over 2007 actual.

You are required to prepare the production cost budget for the period January-June, 2008 giving all the workings. Also prepare a performance report for last year.

Absorption Costing: first technique of pricing

(Also known as Volume base costing, Traditional pricing technique or Normal pricing technique.)

Traditional absorption costing evolved in the early 1900s. In 1901 the British Federation of Master Printer set out to find a solution to the cost/ price problem. Twelve years later, in 1913, they issued The Printer's Cost Finding System, which was an absorption Costing system. Absorption Costing was not unknown at the time but was as revolutionary as activity based costing has been in more recent years. The Printers' federation helped to institutionalize absorption costing, as the printing industry was a leading high-tech industry at the time using state of the art technology, which other industries looked up to.

Rules & procedure for determining overhead recovery rate:

1. COLLECTION :

There are seven main sources of cost data relating to factory overheads (Actual)

1. Purchase day book ;
2. Overheads invoices ;
3. Stores requisitions. These three meant for collection of indirect materials cost.
4. Wages analysis book for indirect wages.
5. Cash book and petty cash book.
6. Journal proper.
7. Other registers like plant and machinery.

However for estimation purpose Budget is prepared for each functional area.

2. CLASSIFICATION :

There may be three broad categories of factory overheads.

1. Plant overheads: it is the overhead of top management which is at the head of all functional departments.
2. Overheads relating to production dept. or cost centre
3. Overheads relating to service dept.

All the factory overheads are to be classified to suit the purpose of cost accounting, whether item wise i.e. rent, insurance, depreciation etc., or function-wise. Standing order numbers are used for collecting the factory overheads. Cost Account numbers (known as **standing order no.**) are used for collecting the Administration, Selling and Distribution overheads.

3. COST ALLOCATION :

When items of cost are identifiable directly with some products or departments such costs are charged to such cost centers or functional areas. This process is known as cost allocation.

4. COST APPORTIONMENT :

In case of single product organization no apportionment is required as all the costs are divided by the total no. of units to get the recovery rate.

In case of multi product organization the overheads distributed amongst the cost centres on some predetermined basis. This method is known as cost apportionment.

The determination of suitable basis of apportionment is very important and usually following principles are adopted for such process:

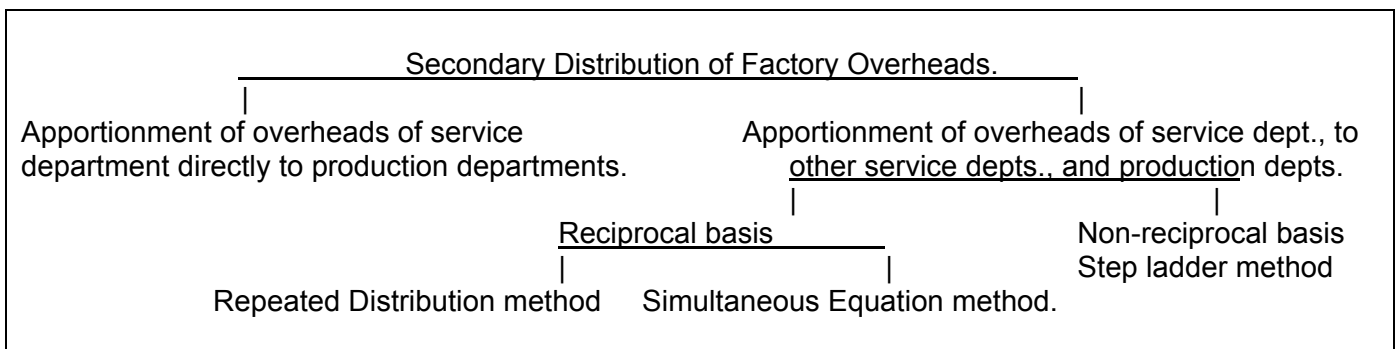
- (i) service or use,
- (ii) survey method,
- (iii) ability to bear.

A basis once adopted should be reviewed at periodic intervals to improve upon the accuracy of apportionment. The following tables indicates the various bases of apportionment for the usual items of factory overhead :

<u>Item of factory Overhead</u>	<u>Basis of apportionment</u>
1. Rent.....	Area or volume of building & etc

5. RE-APPORTIONMENT OR SECONDARY DISTRIBUTION. (Ref q-6)

This is done on the basis of service render by a service dept. to other service dept.



Remember:-

Cost of service = own cost + received from other service dept.

Composite machine hour rate = MHR + dir wages per machine hour

6. COST ABSORPTION or RECOVERY or CHARGED or ADDED or APPLIED

Recovery Rate = Budgeted overhead ÷ base (ref Q-5)

Bases are of four types

- | | |
|-----------------|-----------------|
| 1. Unit Basis | 3. MACHINE HOUR |
| 2. LABOUR COSTS | 4. LABOUR HOUR |

OVERHEAD Charged or Recovered or Applied or Absorbed = Recovery Rate x ACTUAL BASE

7. Under or Over recovery & its treatment

UNDER RECOVERY = ACTUAL OVERHEAD – OVERHEAD RECOVERED

Problem:

1. A factory has three production departments follow Job Costing under Absorption Costing. The policy of the factory is to recover the production overheads of the entire factory by adopting a blanket rate based on the total factory wages. The relevant budget for a year are given below:

Department	Direct Materials Rs.	Direct Wages Rs.	Factory Overheads Rs.	Direct Labour Hour	Machine Hours
Budget					
Machining	26,50,000	11,80,000	23,60,000	20,000	80,000
Assembly	31,70,000	13,50,000	41,40,000	1,00,000	10,000
Finishing	21,00,000	22,70,000	31,25,000	50,000	

The Administrative Overhead & Selling Overhead budgeted for the year are Rs. 18,56,000 & 22,75,000 respectively. 40% of Administration overhead are of production nature. Expected prevention quality cost is Rs. 9,23,000 & rework cost Rs. 2,40,000. These are considered as a part of production overhead. The factory adds 25% mark up.

The management wants to introduce departmental recovery rates instead of blanket rate.

The details of one of Job-014 produced during the month are as under:

Department	Direct material Rs.	Direct labour Hours	Machine hours.
Machining	1,200	60	180
Assembly	600	120	30
Finishing	300	40	10

Find the sale price of the product under present & proposed scheme of overhead recovery. :

2. Witco PLC produces two products X and Y. The manufacturing division consists of two producing (designated 1 and 2) and two service (designated 3 and 4) departments. The company uses a absorption costing system & predetermined overhead rates are used in the producing departments to absorb factory overhead to the products.

The rate for Dept. 1 is based on direct machine hours (DMH) and the rate for Dept. 2 is based on direct labour hours (DLH). The following budget and actual data are available :

Annual profit plan data...

- (i) Factory Overhead budgeted for the year Dept. 1 Rs. 8,50,000, Dept. 2 Rs. 7,25,000, Dept.- 3 Rs. 2,00,000 Dept.4. Rs. 1,50,000. Machine operators salaries are treated as overhead costs.
- (ii) Budget units to be produced : product X: 50,000 ; Y: 30,000
- (iii) Budgeted raw material cost per unit of product (all used in Dept.-I) Product X Rs. 40. Product Y Rs. 50. No materials is added in Dept. 2.
- (iii) Budgeted time required for production : direct machine hours in Dept. 1 for each unit of finished goods produced X – 1.5 , Product Y – 1.0 .
- (iv) Direct labour hours in Dept. 2 for each unit of finished goods. Product X - 2 hrs; Product Y – 2.5 hour.
- (v) Average wage rates budgeted in Dept. 2, Product X Rs. 24 hr. and Product Y Rs. 25 per hr.
- (vi) Allocation of service dept. cost to producing Depts.
Dept. 3 allocates $\frac{1}{2}$ to Dept. 1 and $\frac{1}{2}$ Dept. 2;
Dept. 4 allocates $\frac{2}{3}$ to Dept. 1 and $\frac{1}{3}$ to Dept. 2

January actual data :

- a. Units actually produced & in January – Product X 4,000 ; Y 3000
There was no opening stock of finished goods. Actual Sales for the month: X- 3,900 & Y- 2,860 units at price so fixed earlier.
- b. Actual direct machine hours in Dept. 1 Product X 6,100; Product Y 4,150
- c. Actual Costs incurred :

Dept.	Overhead	Raw material	Direct Hours	Labour Amount
1.	Rs. 77,000	X Rs. 1,63,000 Y Rs. 1,52,000		
2.	Rs. 68,000		X 8,200 Y 7,400	Rs. 1,97,300 Rs. 1,84,000
3.	Rs. 20,000			
4.	Rs. 16,000			

You are required to prepare a Performance report on the basis of budget cost & actual cost i.e. compute the budgeted cost for actual output and actual cost during month of January.

STANDARD COSTING

Learning Objective

1. **Importance of Standard**
2. **How to calculate standard cost**
3. **Measurement of performance or variances**
4. **Distinguish between Marginal costing & Absorption costing variances**

CIMA's terminology defines Standard Costing as follows:

Standard Costing: A control technique which compares standard costs and revenues with actual results to obtain variances which are used to stimulate improved performance. You will see from this definition that there are very close relationships between standard costing and budgetary control (the practice of making continuous comparison between budget and actual results). The both compare the actual results with the expected performance to identify any variances. The difference is that with standard costing the comparison is usually made at a unit level, that is, the actual cost per unit is compared with the standard cost per unit. The resulting variances may be analysed to show their causes and we will see how this is done later in this chapter.

In order to be able to apply standard costing it must be possible to identify a measurable cost unit. This can be a unit of product or service but it must be capable of standardizing: for example, standardized tasks must be involved in its creation. The cost units themselves do not necessarily have to be identical : for example, standard costing can be applied in some job costing situations where every cost unit is unique. However, the jobs must include standardized tasks for which a standard time and cost can be determined for monitoring purposes. In presence of Standard Costing, a budget is multiplication of Standard costing.

What is a Standard Cost?

Answer:

A Standard cost is a carefully predetermined unit cost which is prepared for each cost unit. It contains details of the Standard amount and price of each resource that will be utilised in providing the service or manufacturing the product.

A. Standard:

Standard: A benchmark measurement of resource usage, set in defined conditions. The definition goes on to describe a number of bases which can be used to set the standard, including:

- A prior period level of performance by the same organization;
- The level of performance achieved by comparable organizations;
- The level of performance required to meet organizational objectives.

Use of the first basis indicates that management feels that performance levels in a prior period have been acceptable. They will then use this performance level as a target and control level for the forthcoming period.

When using the second basis management is being more outward looking, perhaps attempting to monitor their organization's performance against 'the best of the rest'.

The third basis sets a performance level which will be sufficient to achieve the objectives which the organization has set for itself.

B. Ideal Standard:

Standards may be set at ideal levels, which make no allowance for normal losses, waste and machine downtime. This type of ideal standard can be used if managers wish to highlight and monitor the full cost of factors such as waste, etc., however, this type of standard will almost always result in adverse variances since a certain amount of waste, etc., is usually unavoidable. This can be very de-motivating for individuals who feel that an adverse variance suggests that have performed badly.

C. Attainable Standard:

Standards may also be set at attainable levels which assume efficient levels of operation, but which include allowances for factors such as normal loss, waste and machine downtime. This type of Standard does not have the negative motivational impact that can arise with an ideal standard because it makes some allowance for unavoidable inefficiencies. Adverse variances will reveal whether inefficiencies have exceeded this unavoidable amount.

D. Basic Standard:

A basic standard is one which is kept unchanged over a period of time. It is used as the basis for preparing more up-to-date standards for control purposes. A basic standard may be used to show the trend in costs over a period of time.

Setting Standard costs:

You have already seen that each element of a unit's standard cost has details of the price and quantity of the resources to be used. In this section we shall list some of the sources of information that may be used in setting the Standard costs.

A. Standard material price:

The sources of information include the following:

- a) Quotations and estimates received from potential suppliers.
- b) Trend information obtained from past data on material prices.
- c) Details of any bulk discounts which may be available.
- d) Information on any charges which will be made for packaging and carriage inwards.
- e) The quality of material to be used: this may affect the price to be paid.
- f) For internally manufactured components: the predetermined standard cost for the component will be used as the standard price.

B. Standard material usage:

The sources of information include the following:

- a) The basis to be used for the level of performance.
- b) If an attainable standard is to be used, the allowance to be made for losses, wastage, etc. Work study techniques may be used to determine this.
- c) Technical specifications of the material to be used.

C. Standard labour rate:

The sources of information include the following:

- a) The personnel department for the wage rates for employees of the required grades with the required skills.
- b) Forecasts of the likely outcome of any trades union negotiations currently in progress.
- c) Details of any bonus schemes in operations.

D. Standard labour times:

The sources of information include the following:

- a) The basis to be used for the level of performance.
- b) If an attainable standard is to be used, the allowance to be made for downtime, etc.
- c) Technical specifications of the tasks required to manufacture the product or provide the service.
- d) The results of work study exercises which are set up to determine the standard time to perform the required tasks and the grades of labour to be employed.

E. Production overhead costs:

Overhead absorption rates, represents the standard hourly rates for overhead in each cost centre. They can be applied to the standard labour hours or machine hours for each cost unit. The overheads will usually be analysed into their fixed and variable components so that a separate rate is available for fixed production overhead and for variable production overhead.

Updating Standards:

The main purpose of standard costs is to provide a yardstick against which actual performance can be monitored. If the comparison between actual and standard cost is to be meaningful then the standard must be valid and relevant. It follows that the standard cost should be kept as up to date as possible. This may necessitate frequent updating of standards to ensure that they fairly represent the latest methods and operations, and the latest prices which must be paid for the resources being used.

Standard costing in the modern industrial environment: It is mainly applied in ERP performance measurement.

There has recently been some criticism of the appropriateness of standard costing in the modern industrial environment. The main criticisms include the following:

- a) Standard costing was developed when the business environment was more stable and operating conditions were less prone to change. In the present dynamic environment, such stable conditions cannot be assumed.
- b) Performance to standard used to be judged as satisfactory, but in today's climate constant improvement must be aimed for in order to remain competitive.
- c) The emphasis on labour variances is no longer appropriate with the increasing use of automated production methods.

An organization's decision to use standard costing depends on its effectiveness in helping managers to make the correct decisions.

Standard costing may still be useful even where the final output is not standardized. It may be possible to identify a number of standard components and activities for which standards may be set and used effectively for planning and control purposes. In addition, the use of demanding performance levels in standard costs may help to encourage continuous improvement.

What is variance analysis?

Answer: A variance is the difference between the expected standard cost and the actual cost incurred. A unit standard cost contains detail concerning both the usage of resources and the price to be paid for the resources. Variance analysis involves breaking down the total variance to explain how much of it is caused by the usage of resources being different from the standard, and how much of it is caused by the price of resources being different for the standard.

These variances can be combined to reconcile the total cost difference revealed by the comparison of the actual and standard cost.

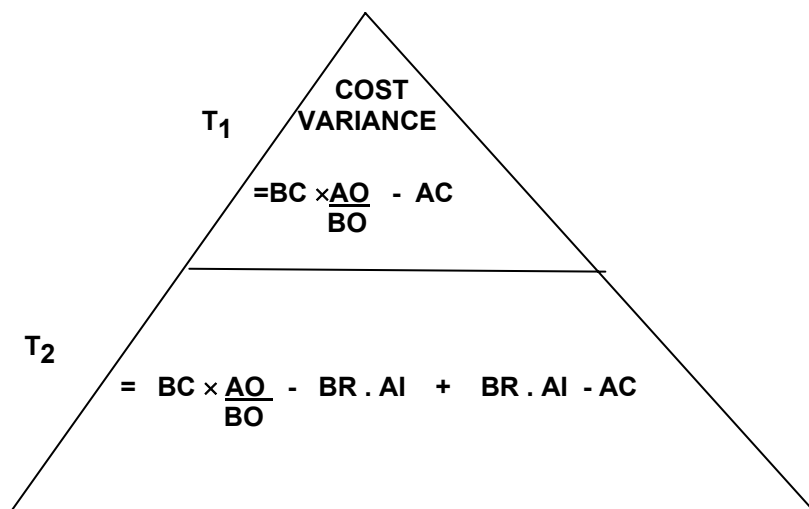
A variance is said to be favourable if it causes actual profit to be greater than budget; it is said to be adverse if it causes actual profit to be less than budget.

Variance are use to measure performance of cost. Different responsible managers:

Variance analysis are 2 types:

1. Variable cost Variance
2. Fixed cost variance

Rules for variable costs variances



Problems:

1. The standard cost per unit for the product M is worked out on this basis :

Direct materials 1.3 tons @ Rs.400 per ton.

Direct Labour 2.9 hours @ Rs.23 per hour.

Factory overhead 2.9 hours @ Rs.20 per hour.

Normal capacity is 2,00,000 direct Labour hours per month.

The factory overhead rate is arrived at on the basis of a fixed overhead of Rs.10,00,000 p.m. and a variable overhead of Rs.15 per direct labour hour.

In the month of May, 50,000 units of the product was started and completed. An investigation of the raw material inventory account reveals that 78,000 tons of raw material were transferred in to and used by the factory during May. These goods cost Rs.420 per ton. 1,50,000 hours of Direct labour were spent during May at a cost of Rs.25 per hour Factory overhead for the month amounted to Rs.34,00,000 of which rs.10,50,000 was fixed.

Compute and identify all variances under Material, Labour and overhead as favorable or adverse.

2. The following information is available from the records of Standcost Ltd. which follows the Partial Plan for accounting for standard costs, for October 2008 :-

		Rs.
Materials Purchased	: 10,000 pieces at Rs. 2.20 each	22,000
Materials Consumed	: 9,500 pieces at Rs. 2.20 each	20,900
Actual wages paid	: 2,480 hours at Rs. 2.50 per hour	6,200
Variable overhead incurred	:	3,000
Factory Overhead Incurred	:	11,000
Factory Overhead Budgeted	:	10,000

Units produced 900 units. These were sold at Rs. 50 per unit

Standard Rates and Price are :

Direct Material Rate	Rs. 2.00 per piece
Standard Input	10 pieces per unit
Direct Labour Rate	Rs. 2.00 per hour
Standard requirement	2.5 hours per unit
Variable overheads	Rs. 1 per hour
Fixed overheads	Rs. 4.00 per labour hour.

Required

- Show the Standard Cost Card.
- Compute Cost Variances for October 2008.
- Show the journal entries & ledger accounts.

Identify one or more departments in the Co. who might be held responsible for each variance.

3. Utopian Ltd. commenced business on Jan.1, 2007, and a system of standard costing was installed. The company manufactures one product of a standard type and the standard cost was fixed.

Standard price of materials	30 P. per Kg.
Standard quantity of materials	8 Kg. Per unit
Standard direct labour cost	Rs.10 per unit
Standard selling cost	Rs. 5 per unit

Factory overhead were estimated at Rs.60,000 for the year 2007. Normal operating time for the year was estimated at 2,000 hours and standard time for the production of one unit is determined as 12 machine hours. The company has twenty-four machines of a uniform type.

In Jan. 2008 it was found that the actual total operating time for 2007 was exactly 2,000 hours and all machines were fully employed for the whole of the time. The actual output for the year was 3,600 units. The actual quantity of material used was 30,000 kg. And the cost Rs.9,150.

The actual direct wages for 2007 amounted to Rs.40,000. Rate of pay did not vary from the estimated rate used in fixing the standard cost. The actual factory overheads for 2007 were Rs. 61,800 & selling cost Rs. 21,500. You are required

- to compute the standard cost per unit and the standard cost of the output.
- to set out the variance.
- To compute profit under partial plan & single plan. Sales price is Rs 45 p.u

Standard Costing: Journal entries under Partial Plan

	Amt. (Dr.)	Amt. (Cr.)
1. <u>Material Purchased:</u> MC/SLC A/c.....Dr. To GLA	Actual Cost	
2. <u>Direct Material issued for production:</u> Process/ Product/WIP A/c.....Dr. To SLC	"	
3. <u>Indirect material issued:</u> Production overhead control A/c.....Dr. To SLC	"	
4. <u>Paid Wages:</u> Wages Control A/c.....Dr. To GLA	"	
5. <u>Transfer- Direct & Indirect wages:</u> WIP A/c.....Dr. Production/Administration/Selling overhead A/c...Dr To Wages Control A/c	Direct wages indirect wages	
6. <u>Overhead incurred (other than material & labour):</u> Production/Administration/Selling overhead.....Dr To GLA	"	
7. <u>Production overhead transferred:</u> WIP.....Dr. To Production overhead control A/c	"	
8. <u>Administration overhead transferred:</u> a) <u>Of Production nature:</u> WIP.....Dr. To Administration overhead	"	
b) <u>Of Marketing nature:</u> Selling Overhead Control A/c.....Dr. To Administration overhead/ COS	"	
9. <u>Show the variances in WIP A/c:</u> a) <u>For adverse variance:</u>Variance A/c.....Dr. To WIP		
b) <u>For favourable variances:</u> WIP.....Dr. To.....Variance A/c		
10. <u>Transfer units produced to finished goods:</u> Finished goods control A/c (Actual output× Std. cost/unit).....Dr. Std. cost for Actual Output To WIP		

11. Transfer goods sold to COS A/c at Standard Cost:
COS A/c.....Dr. Standard Cost
 To Finished goods Control A/c
12. Transfer selling & distribution overhead to COS at Standard cost:
COS A/c.....Dr. Standard Cost
 To Selling and control A/c
13. Show the selling cost variance in selling and overhead control A/c
14. Transfer COS to P/L A/c:
Costing P/LDr. Standard Cost
 To COS

Amt. (Dr.) Amt. (Cr.)
15. Actual Sales:
GLA A/c.....Dr.
 To Costing P/L
16. The difference is known as margin.
17. Transfer all the variances to variance Control A/c:
 - a) If favourable
Favourable variance.....Dr.
 To Variance Control A/c
 - b) if adverse:
Variance Control A/c.....Dr.
 To Adverse Variance
18. The net amt. of variance control A/c is transferred to costing P/L for adjustment against the margin. If adverse:
Costing P/LDr.
 To Variance Control A/c
19. Calculate NP in Costing P/L and transfer it to GLA:
Costing P/L A/c.....Dr.
 To GLA

Journal entries under Single Plan

1. Purchase of Material and Show Variances:
- | | | |
|----------------------|-----|--|
| SLC | Dr. | (Std. rate × actual qty. purchase) |
| MPV A/c | Dr. | (Addl. Rate × actual qty. purchase) (Ad) |
| To GLA (Actual Cost) | | |
- If the variance is favourable:
- | | | |
|---------------|-----|------------------------------------|
| SLC A/c | Dr. | (Std. rate × actual Qty. purchase) |
| To GLA | | |
| GLA A/c | Dr. | (Mat. Price variance) |
| To MPV | | |

2. Show MUV in store ledger:
 MUV A/c (Adverse).....Dr.
 To SLC

3. Transfer direct material consumption to WIP:
 WIPDr. (Std. cost for actual. Output)
 To SLC

4. Direct wages paid and show the labour rate variance:
 Wages control A/c.....Dr. (Std rate× actual Hours)
 Labour rate variance A/c.....Dr.
 To GLA (Actual cost)

Amt. (Dr.) Amt. (Cr.)

5. Show efficiency variance in wages control:
 Efficiency Variance (Adverse).....Dr.
 To wages Control.

6. Transfer to WIP will be at std. wages:
 WIP.....Dr.
 To wages control A/c

7. a) Variable overhead incurred & show the expenditure variance in GLA:
 Overhead Control A/cDr. (Std. rate× actual Hrs)
 Expenditure Variance.....Dr. (Difference in rate× actual hrs)
 To GLA

- b) Fixed overhead incurred & show the expenditure variance in GLA:
 Overhead control A/cDr. (BFO)
 Expenditure varianceDr. (BFO –AFO)
 To GLA (Actual Cost)

- c) Show the other overhead variances in overhead control A/c

- d) Transfer to WIP:
 WIPDr. (Std. cost for actual output)
 To Overhead controls A/c

Rest of journals are same as Partial Plan.

Journal entries under Integral Account

- Amt. (Dr.) Amt. (Cr.)
1. Material purchase:
 SLCDr. (Actual cost)
 To Sundry Cr. Or Bank

 2. Show the price variance through SLC on the basis of purchase:
 MPV (Adverse).....Dr.
 To SLC

 3. Transfer consumption to WIP at Std. rate:
 WIPDr. (Std. rate ×actual Qty. consumed)
 To SLC

4. Finished goods will be transferred at std. cost:
 Finished Goods control A/cDr. (Std. cost for actual output)
 To WIP

- The difference of WIP A/c is material usage variance:
 MUV (if adverse).....Dr.
 To WIP

5. Pay the creditors:
 Sundry Creditors A/c.....Dr.
 To Bank

6. Wages Paid:
 Wages Control A/c.....Dr.
 To Bank

7. Show the labour rate variance in wages control A/c:
 Labour Rate variance (if adverse).....Dr.
 To Wages Control

8. Transfer direct wages to WIP:
 WIPDr. (Std. rate × actual Hrs.)
 To wages control

- 9) Show efficiency variance in WIP:
 Efficiency variance (Adverse).....Dr.
 To WIP

- 10) For overhead:
 - a) Overhead incurred:
 Overhead control A/c.....Dr.
 To Bank/expenses crs/Fixed Assets (for depreciation)

 - b) Show all the variances in overhead control A/c

 - c) Transfer to WIP will be at Std. cost for Actual output.:
 WIPDr. (Std. cost for AO)
 To Overhead Control A/c

Rest of journals are same as before

Missing Figure :

4. The standard cost card for a unit of product manufactured by a company is as under ;

Direct materials-	20 kg. @ Rs. 1.20	Rs. 24
Direct wages-	6 hrs. @ Rs. 6.00	Rs. 36
Overheads-	6 hrs. @ Rs. 2.00	Rs. 12

Profit margin is 20% of the selling price. Budgeted sales Rs. 54,000 per month. Actual data relating to April 2008 :

Sales	Rs. 46,750
Direct materials used	Rs. 15,000
Direct wages paid	Rs. 21,175

Analysis of variances : (in Rs.)		Favorable	Adverse
Direct materials	Price	...	600
	Usage	...	1,200
Direct wages	Rate	...	3,025
	Efficiency	1,650	...
Overheads	Expenditure		200
	Volume	...	600

You are required, from the data given to calculate the

i) Actual output (ii) Actual profit (iii) Actual price per kg. of material (iv) Actual rate per direct labour hour v) Amount of overheads absorbed (vi) Budgeted output (vii) Overheads capacity variance (viii) Overheads efficiency variance (ix) Sales price variance (x) Sales volume profit variance (xi) show profit reconciliation statement.

5. A company making a single standard product produces accounts for costing period as follows :

Direct Materials	3,960	Direct Wages	5,960
Variable Overheads	9,700	Fixed Overheads	5,200
Profit	4,880	Sales	29,700

The original budget was for 1,000 units per period, but during this period only 960 units were produced and sold. Standard direct wages rate is Rs. 6 per unit and standard variable overhead rate is Rs.10 per unit. Cost variances during this period were :

	Gains (Rs.)	Losses (Rs.)
Material Price	--	40
Material Usage	--	80
Wage Rate	100	--
Labour Efficiency	--	300
Variable Overhead Price	400	--
Variable Overhead Efficiency	--	500
Fixed Overhead Cost	--	200
Selling Price	900	--

Prepare for the period the original budget and budgeted cost of actual sales.

6. ABC Ltd. adopts a standard costing system. The standard output for a period is 20,000 units and the standard cost and profit per unit is as under:—

	Rs.
Direct Material 3 units @ Rs. 1.50	4.50
Direct Labour 3 Hrs. @ Re. 1.00	3.00
Direct Expenses	0.50
Factory overheads: Variable	0.25
Fixed	0.30
Administration overheads	<u>0.30</u>
Total Cost	8.85
Profit	<u>1.15</u>
Selling price (Fixed by Govt.)	<u>10.00</u>

The actual production and sales for a period was 14,400 units. There has been no price revisions by the Govt. during the period. The following are variances worked out at the end of the period:—

	Favourable Rs	Adverse Rs
Direct Material : Price		4,250
Usage	1,500	
Direct labour : Rate		4,000
Efficiency	3,200	
Factory overheads		
Variable—Expenditure	400	
Fixed—Expenditure	400	
Fixed—Volume		1,680
Administrative overheads :		
Expenditure		400
Volume		1,680

You are required to :

- Ascertain the details of actual costs and prepare a Profit and Loss statement for the period showing the actual profit/loss. Show workings clearly.
- Reconcile the actual profit with standard profit. (Nov –1981)

7. On 1st April, 2008, ZED Company began the manufacture of a new electronic gadget. The company installed a standard costing system to account for manufacturing costs. The standard costs for a unit of the product are as under :

	Rs.
Direct Material (3 kgs. At Rs. 5 per kg.)	15.00
Direct Labour (0.5 hour at Rs. 20 per hour)	10.00
Manufacturing overhead (75% of direct labour cost)	<u>7.50</u>
Total Cost	32.50

The following data was obtained from ZED Company's records for April, 2008 :

	Debit Rs.	Credit Rs.
Sales	--	1,25,000
Sundry Creditors (For purchase of D. materials in April 07)	68,250	--
Direct Material Price Variance	3,250	--
Direct Materials Usage Variance	2,500	--
Direct Labour Rate Variance	1,900	--
Direct Labour Efficiency Variance	--	2,000

The Actual Production in April 2008 was 4,000 units of the gadget, and the actual sales for the month was 2,500 units. The amount shown above for direct materials price variance applies to materials purchased during April, 2008.

Required :

- Standard direct labour hours allowed for the actual output achieved.
- Actual direct labour hours worked.
- Actual direct labour rate.
- Standard quantity of direct materials allowed (in kgs.)
- Actual quantity of direct materials used (in kgs.)
- Actual quantity of direct materials purchased (in kgs.)
- Actual direct materials price per kg.

8. Upasana Ltd. Manufactures paint. It uses a standard costing system (single plan) and the variances are reported to the management on fortnightly basis. A fire destroyed some important records of the company.

You have been able to collect the following information from the spoilt papers/ records and as a result of consultation with accounting personnel in respect of a fortnight:

- (a) The paint requires two types of raw material RM1 and RM2 The standard quantity of RM2 in final product is 5 liters and standard cost thereof is Rs.36 per liter.
- (b) The company purchased 200 kg. of RM1 and 550 liter of RM2 during that fortnight .
- (c) The standard wage rate is Rs. 24 per labour hour. Actual labour hours were 460 during that fortnight.
- (d) Variances as disclosed from some spoiled papers are:

(i) Price variance (RM2)	Rs. 1,320 (A)
(ii) Usage variance (RM1)	Rs. 240 (F)
(iii) Labour efficiency variance	Rs. 1,440 (A)

- (e) Some incomplete ledger entries for that fortnight reveal

(1)	Sundry Creditors		
		Purchase of raw materials	Rs. 25,440
(2)	RM2		
	Opening balance	3,600	
		Closing balance	8,280
(3)	RM1		
	Opening balance	0	3,600
		Closing balance	1,200
(4)	Work-in-progress		
	Opening balance	0	
	RM2	14,400	Closing balance 0
(5)	Wages		
	Paid & outstanding	10,350	

You have been asked to compute the meaningful variances to be presented before the management.(Key computation should form part of the answer).

9. The following uncompleted accounts appear in the ledger of MDX plc for March 2007. The company operates a standard costing system, values stock at standard cost, and use a single plant- wide standard labour rate of Rs. 6 per hour for all employees.

Raw materials

	Rs.		Rs.
Balance b/f	240	Price variance	460
Creditors	?	Work in progress	6,000
		Balance c/f	180

Wages control

	Rs.		Rs.
Gross wages	?	Wage rate variance	618
		Work- in- progress	?

Work- in- progress

	Rs.		Rs.
Raw materials	6,000	Labour efficiency variance	900
Wages control	?	Finished goods	34,720
Material usage variance	1,440		
Production overhead control	?		

Production overhead control

	Rs.		Rs.
Expenses- creditor	?	Balance b/f	345
Provision for depreciation	800	Work- in- progress	?
Volume variance	2,400	Expenditure variance	980
Balance c/f	260		

Data extracted from the standard cost card for MDX plc's only product is as follows:

		Rs./unit
Direct materials:	5 kg @ Rs.2.40/kg	12.00
Direct labour:	4 hours @ Rs.6/hour	24.00
Fixed overhead		20.00
Budget fixed overhead costs		Rs.10,000 per month.

Calculate:

- (i) The actual price paid per kilogram of materials;
- (ii) The actual output;
- (iii) The production overhead absorbed;
- (iv) The actual direct labour hours;
- (v) The cost incurred in respect of expense creditors;
- (vi) The actual labour rate paid per hour.

Equivalent Production : Always apply FIFO for computation of variance

10. Gemini Enterprises manufactures product A. it uses a standard costing system in which material price variance and labour rate variance are segregated at the point of purchase of material and the incurrence of labour cost respectively.

The standard cost card for product A shows the following details:-

		Rs. Per unit
Material	2 kgs at 3 per kg.	6
Labour	5 hrs. at Rs. 2 per hr.	10
Overhead	5 hrs. at Re. 1 per hr.	5
Selling cost		3
Standard cost		<u>24</u>

Overhead rate is Re. 1 per hour, the budgeted overhead being Rs. 2,000 for 2,000 budgeted hours. Other information for a month is as follows:-

Materials:

Opening stock	800 kgs. at Rs. 3 per kg.
Purchase	1,000 kgs. at Rs. 3.50 per kg.
Issued to production	900 kgs.

Direct labour:	1,850 hours at Rs. 2.20 per hour.
Overhead:	Rs. 2,100
Selling expenses	Rs. 1,500

During this months, 360 units are completed and in respect of 40 units, it is estimated that they are complete as to materials, but half complete as to labour and overhead. 300 units are sold at Rs. 30 per unit during the month. Prepare:-

- (a) Cost Control Accounts (b) Variance Accounts
(c) Trial Balance at the end of the month. (May 1991)

11. Goodwill Ltd. manufactures readymade shirts of a specific quantity in lots to each special order from its overseas customers.

The standard costs for one dozen of shirts are:	Rs.
Direct material (24 meters @ Rs. 11)	264
Direct labour (3 hours @ Rs. 49)	147
Overheads (3 hours @ Rs. 40)	<u>120</u>
Standard cost per dozen	<u>531</u>

During July, 2008 it worked on three order, for which the month's job cost records show :

Lot No.	Units	Materials used	Hours worked
45 (UK)	1,700 Doz.	40,440 Metres	5,130
46 (US)	1,200 Doz.	28,825 Metres	2,890
47 (CAN)	1,000 Doz.	24,100 Metres	2,980

Additional information :

- (a) The company bought 95,000 meters of materials during July at a cost of Rs. 10,64,000. The material price variance is recorded when materials are purchased. All inventories are carried at cost.
(b) Direct labour during July amt. to Rs. 5,50,000. The employees were paid at Rs. 50 p. h.
(c) Overheads during the month amounted to Rs. 4,56,000.

A total of Rs. 57,60,000 was budgeted for overheads for the year 2008-09, based on estimated production of the plant's normal capacity of 48,000 dozen shirts annually. Overheads at the level of production is 40% fixed & 60% variable. Overheads is applied on the basis of direct labour hrs.

There was no work in progress at the beginning of July. During July, lot nos. 45 and 47 were completed. All materials were issued for lot no. 46 which was 80% complete as regards conversion.

Required:

- Computation of standard cost of production of the shirts per dozen as well as in total for lot Nos. 45, 46 and 47.
- Find the variation in quantity of material used & labour hrs worked for each lot & in total.
- Calculate the material price variance; labour rate variance; variable overheads efficiency variance and fixed overheads volume variance.

12. A company manufactures a single product whose standard cost structure is as follows :-

Direct material 2.4 kgs, at Rs. 30 per kg ...	Rs.	72.00
Direct labour 6 Hours at Rs. 4 per hour ...	Rs.	24.00
Factory Overhead 6 Hours at Rs. 0.75 per hour ...	Rs.	<u>4.50</u>
TOTAL		<u>100.50</u>

The factory overhead is based on the following flexible budget :-

	<u>80%</u>	<u>90%</u>	<u>100%</u>	<u>110%</u>
Production (units)	<u>6,000</u>	<u>6,750</u>	<u>7,500</u>	<u>8,250</u>
Variable overheads (Rs.)	18,000	20,250	22,500	24,750
Fixed overheads (Rs.)	<u>10,250</u>	<u>10,750</u>	<u>11,250</u>	<u>11,750</u>
	<u>28,250</u>	<u>31,000</u>	<u>33,750</u>	<u>36,500</u>
Budgeted Production	7,300 units			
Actual data for the month of January 2007				

Materials used	19,240 kgs. at Rs. 31 per kg.
Direct labour	46,830 Hours at Rs. 4.20 per hour
Actual factory overhead	Rs. 36,340
Actual Production	7620 units

Details of Work-in-progress Opening ...120 units, materials fully supplied, 50% converted.
 Closing ... 100 units, materials fully supplied, 50% converted.
 Determine and analyse all the variances.

13. File and Smile Associates undertake to prepare income tax returns for individuals for a fee. Their advice to their clients is to pay the proper tax and relax. In order to arrive at the proper scale of fees and assess their own performance, they have a good system. They use the weighted average method and actual costs for financial reporting purposes. However, for internal reporting, they use a standard cost system. The standards, based on equivalent performance, have been established as follows :

Labour per return: 5 hrs. @ Rs. 40 per hr. Overhead per return: 5 hrs @ Rs. 20 per hr.

For March 2008 performance, budgeted overhead is Rs. 98,000 for the standard labour hours allowed. The following additional information pertains to the month of March 2008 :

March 1	Returns in Process (25% Complete)	200 Nos.
	Returns started in March	825 Nos.
March 31	Returns in Process (80% Complete)	125 Nos.

Cost data:

March 1	Returns in Process :Elements of Cost	
	Labour	Rs. 12,000
	Overheads	Rs. 5,000
March 1 to 31		
	Labour 4,000 hrs.	Rs.1,78,000
	Overheads	Rs. 90,000

You are required to compute:

- for each cost element, equivalent units of performance & the actual cost per equivalent unit.
- actual cost of returns in process on March 31.
- the standard cost per return.
- The total labour, labour rate and labour efficiency variances as well as total overhead volume and overhead budget variance.

14. A company manufacturing two products uses standard costing system. The following data relating to October, 2008 have been furnished to you :

Products	A (Rs.)	B (Rs.)
Standard Cost per Unit :		
Direct Materials	2	4
Direct Wages	8	6
Fixed Overheads	16	12
Unit processed In process :		
Beginning of the month : All materials applied and 50% complete in respect of labour and overheads	4,000	12,000
End of the month : All materials applied and 80% complete in respect of labour and overheads	8,000	12,000
<u>Units completed & transferred during the month</u>	<u>16,000</u>	<u>20,000</u>

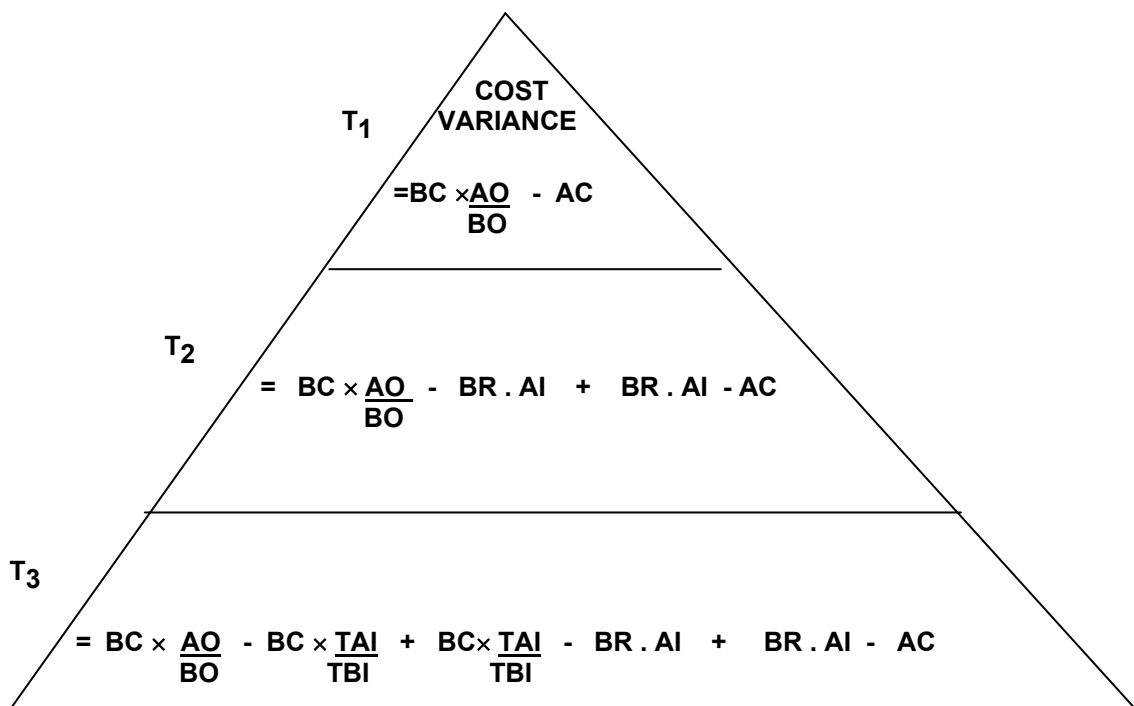
During the month , direct materials purchased at standard price amount to Rs.2,00,000 and the actual cost of which is Rs. 2,20,000. Direct materials used for consumption at standard price amount to Rs.1,75,000.

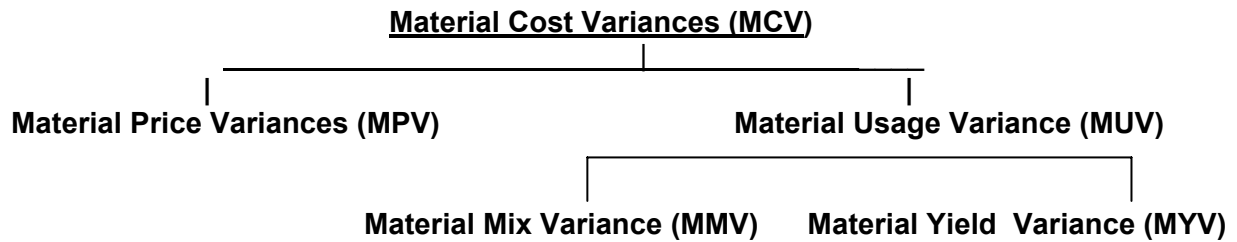
Direct wages for actual hours worked at standard wage rates were Rs. 4,20,000 and at actual wage rates were Rs. 4,12,000. Fixed overheads budgeted were Rs. 8,25,000 and the actual fixed overheads incurred were Rs. 8,50,000. Calculate all the variances & standard cost of work-in-process at the end of the month.

MATERIAL VARIANCE ANALYSIS:

Remember : (for cost variances)

Production Quantity = Output = Yield
= Input = Consumption





Important :

1. Prepare Cost Card
2. Calculate all variances Separately for each Material if asked in the problem.
3. If output is not given, consider it as one unit of output for material.

Material Variances:

15. A brass foundry making castings which are transferred to the machine shop of the company at standard price, uses a standard costing system. Basic standards in regard to materials, stocks which are kept at standard price are as follows

Standard mixture	70% Copper	30% Zinc
Standard price	Rs.2,400 per ton	Rs.650 per ton

Standard loss in melt 5% of input Figures in respect of a costing period are as follows :-

Commencing stock	Copper 100 tons	Zinc 60 tons
Finishing stock	Copper 110 tons	Zinc 50 tons

Purchases - Copper 300 tons cost Rs.7,32,500 Zinc 100 tons cost Rs.62,500

Material melted 400 tons. Casting produced 375 tons

Calculate, by FIFO valuation method, the individual ingredient price and mix variances, ingredient yield variance. Show SLC A/c.

16. Compute the missing data indicated by the question marks from the following

Particulars	A	B
Standard Price/kg	Rs. 12	Rs. 15
Actual Price/kg	Rs. 15	Rs. 20
Standard Input (kgs)	50	?
Actual Input (Kgs)	?	70
Material Price Variance	?	?
Material Uses Variance	?	Rs. 300 Adverse
Material Cost Variance	?	?

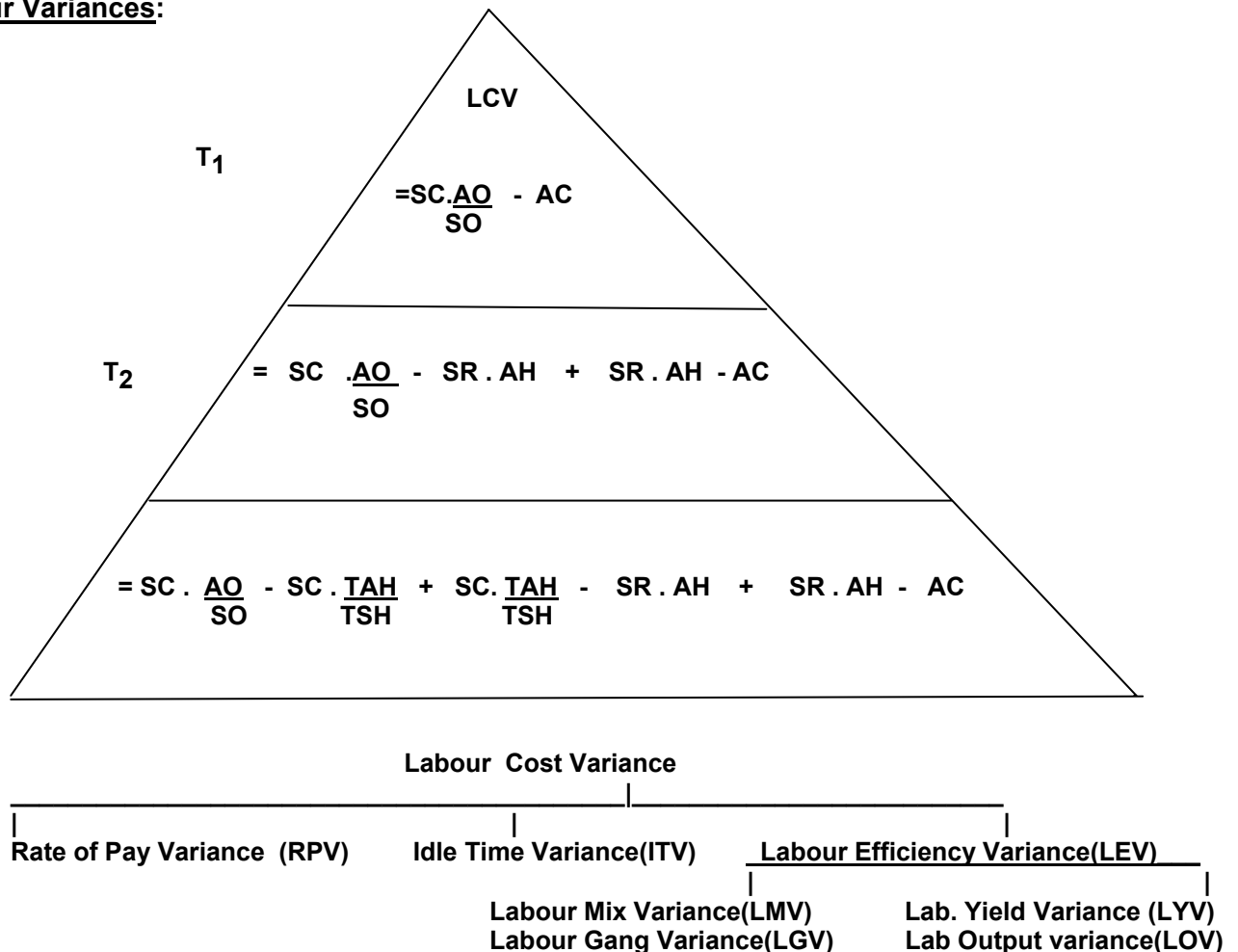
Material mix variance for both products together was Rs. 45 adverse.

Material Quality Cost Variance:

17. To produce 1,000 units of product X, the standard materials input is 1,200 units at a standard price of Rs. 6 per unit. The standard allows for rejects at the rate of 25% of input ; it is estimated that one-third of total rejects can be reworked at an additional standard cost of Rs. 2 per unit, Scrapped units can be sold for 50p each.

During the period just ended 19,500 units of X were produced. 24,000 units of materials were issued to production, actual rate was Rs. 8 per unit. 7,000 units were rejected on initial inspection and of these, 2,500 were reworked, at a cost of Rs. 5,100. The remainder were sold as scrap for 50p per unit. Calculate Quality cost variance, Mat Usage variance, Scrap realization variance, & Scrap rework variance.

Labour Variances:



In presence of idle time actual hour = Revised actual time + Idle Time. If output is not given, apply the definitions of Standard hours i.e. one labour hour = one unit

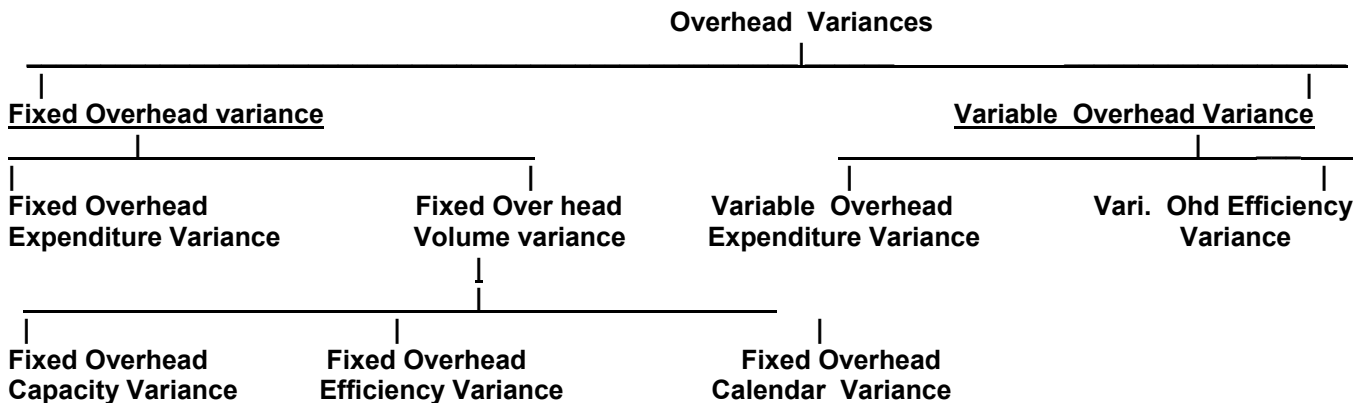
Problem

18. The standard & actual labour component engaged in a week for a job are under :

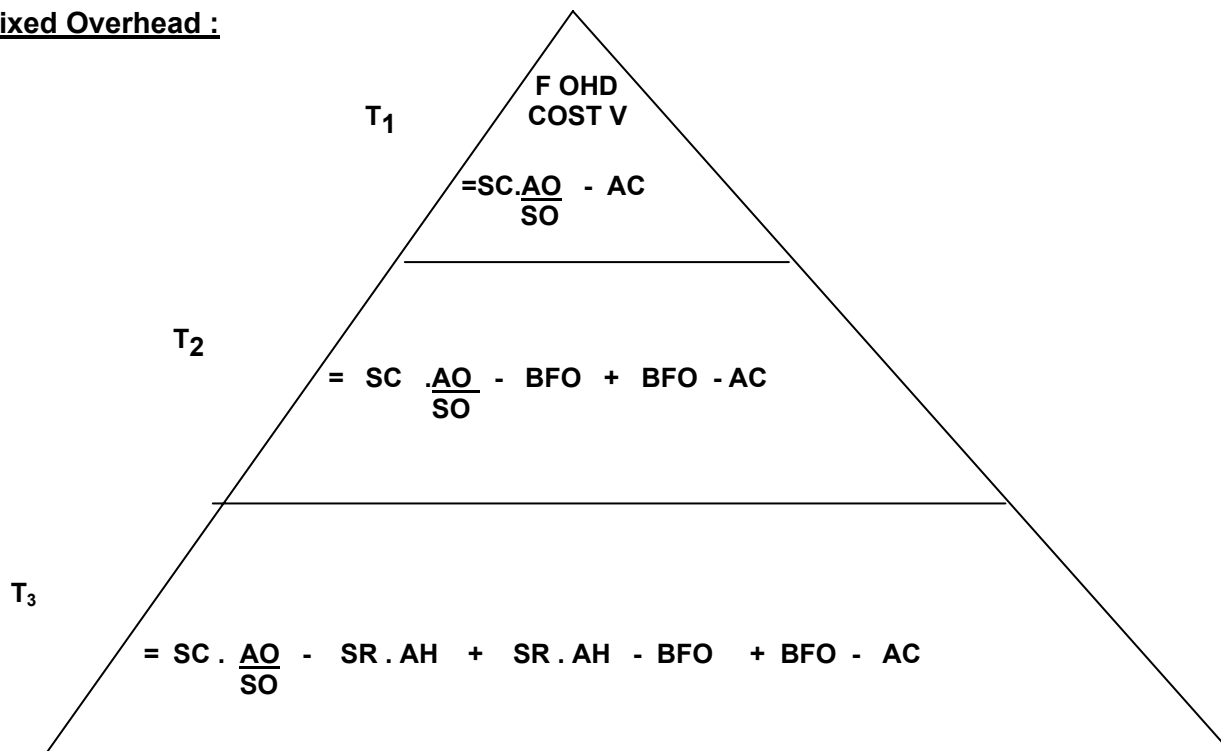
	Skilled workers	Semi-skilled workers	Unskilled workers
(a) Standard number of workers in the gang	32	12	6
(b) Standard wage rates per hour (Rs.)	3	2	1
(c) Actual number of workers employed in the gang during the week	28	18	4
(d) Actual wage rate per hour (Rs.)	4	3	2

During the 40-hour working week, the gang produced 1,800 standard labour hours of work. 200 hours of Skilled labour are getting a overtime premium of 150%. 30 hours of unskilled labour were lost due machine breakdown & treated as abnormal idle time. Calculate the different labour variances.

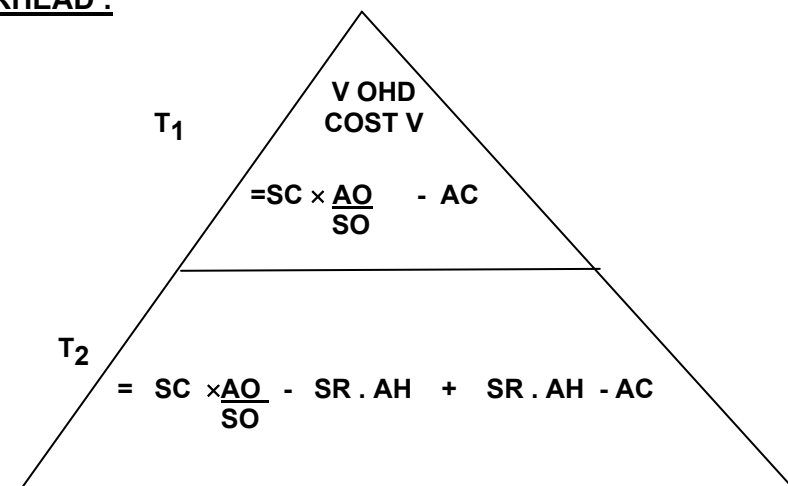
Overhead Variances: Always calculate overhead recovery or absorption rates on basis of budgeted activity level i.e. normal capacity. If nothing mentioned about the nature of overhead always consider it as fixed overhead.



Fixed Overhead :



VARIABLE OVERHEAD :



19. XYZ Ltd. has furnished you the following for the month of August :

		Budget	Actual
Output (units)		30,000	32,500
Hours		30,000	33,000
Fixed overhead	Rs.	45,000	--
Variable overhead	Rs.	60,000	--
Working days		25	26
Total factory Overhead			1,12,500

Calculate the variances Show the overhead control A/c.

20. F Manufacturing Ltd. uses the three variances method to analyse the manufacturing overhead variances. Manufacturing overhead variances for the fiscal year just were computed as follows :

Efficiency	Rs.36,000	Favourable
Volume	Rs.80,000	Favourable

The manufacturing overhead application rate for the year was Rs.160 per machine hours of which Rs.60 per machine hour was the variable component. The year end balance in the Manufacturing Overhead Control Account was Rs.16,50,000 and the standard machine hours for the year were 11,300.

From the above data compute :

- | | |
|--------------------------------------|---------------------------|
| (i) Budgeted Machine Hours | (ii) Actual Machine Hours |
| (iii) Applied Manufacturing Overhead | (iv) Expensive variance. |

(Nov 2000 Q 4b)

Multi-product with common input problems

21. From the data given below, calculate the MUV & MPV on purchase :

	X		Y	
	Qty. kg	Value Rs.	Qty. kg	Value Rs.
Raw Material Purchased	2,000	4,000	5,000	6,250
Issues to works stock	2,150	-	3,950	-
Works stocks of material :				
Opening	300	-	1,000	-
Closing	200	-	1,250	-
Standard price :	Rs. 1.90 per kg.		Rs. 1.30 per kg.	<u>Output</u>
Standard usage :Product A	1 kg.		1 kg	1,130 units
Product B	0.5 kg		1.kg.	2,550 units

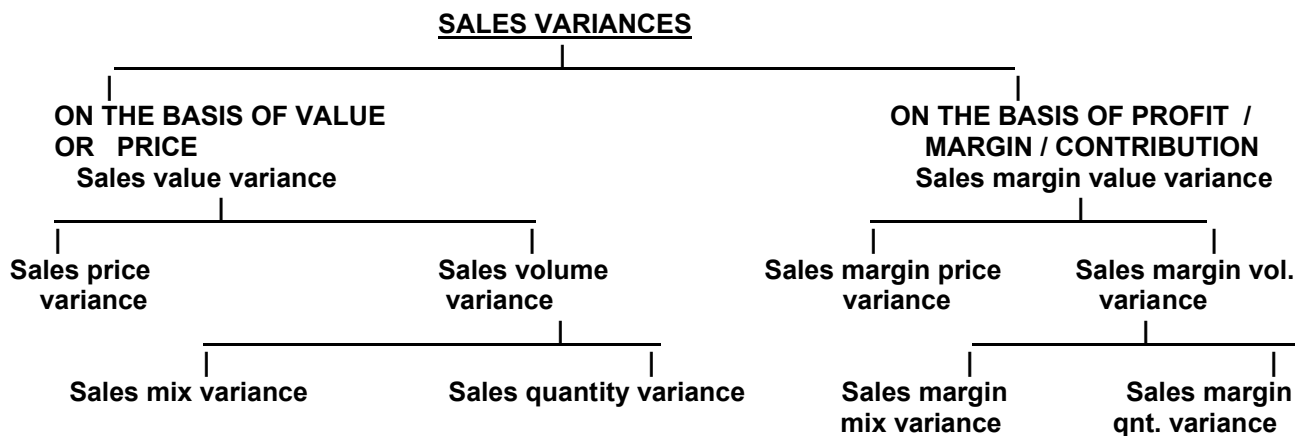
22. A factory manufactures two products A & B in 2 production departments X and Y, The standard costs are:

Production Department	X	Y
Standard wage rate per hour	Rs.3	Rs.4
Labour cost per unit Product A	3	5
Product B	4	4

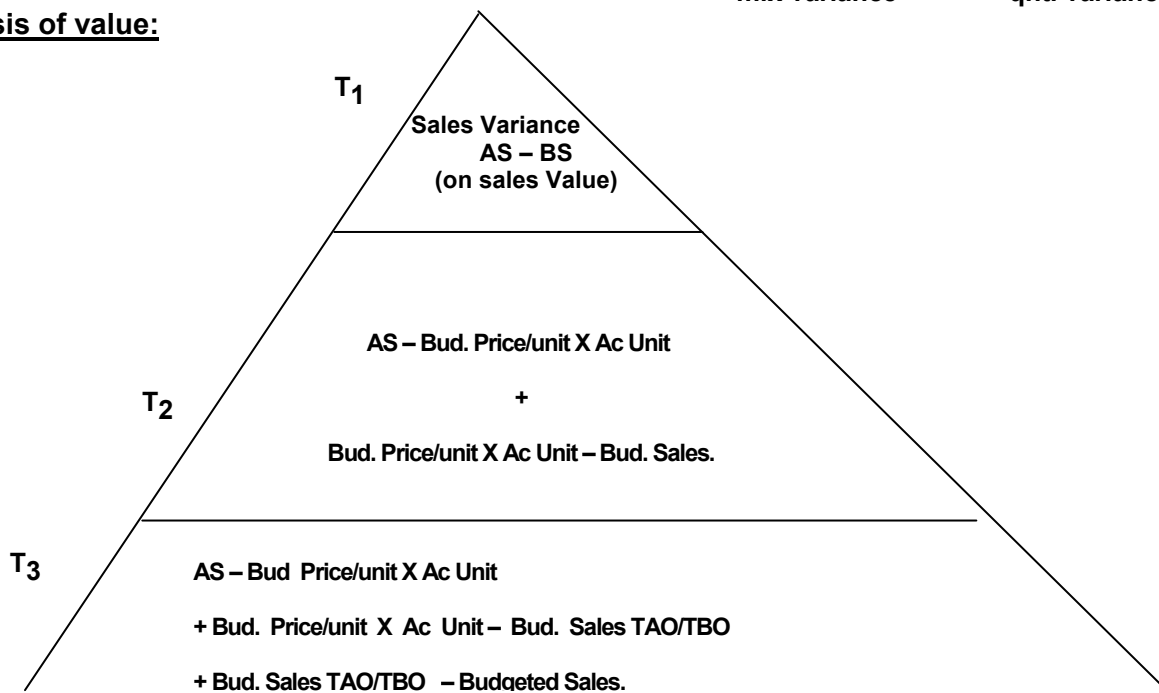
During a month of 200 hours,

Actual wages paid (Rs.)	92,000	1,30,000
Production in units product A	8,000	11,000
Product B	15,000	16,000

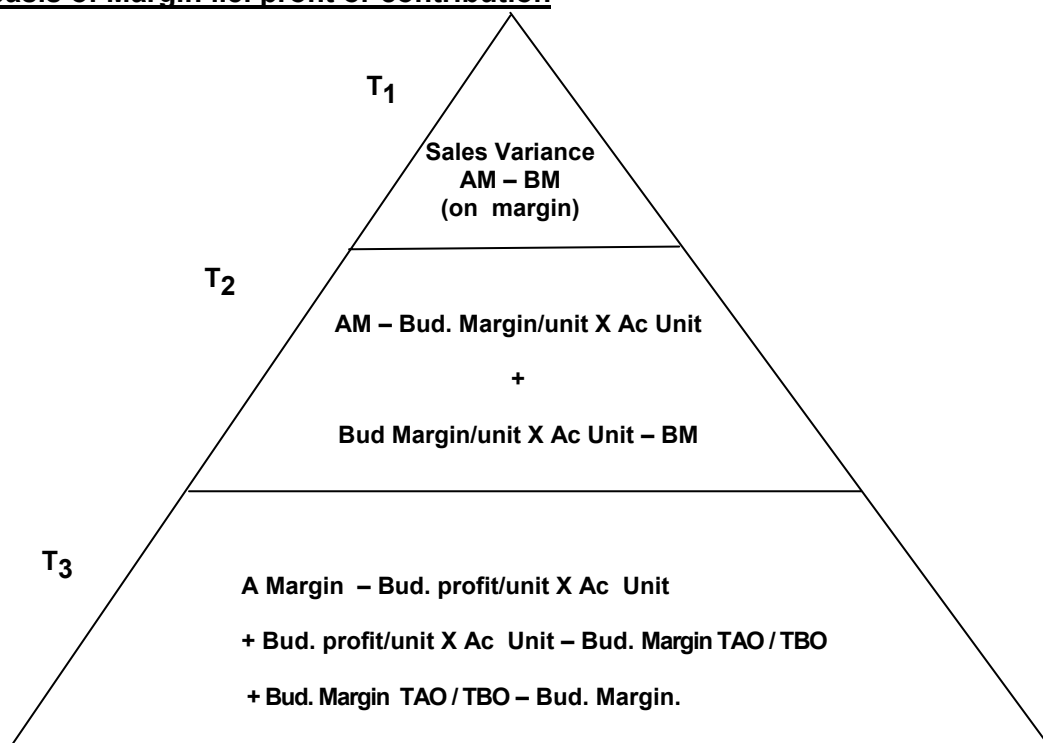
Throughout the period, the departments X and Y employed 150 and 160 direct workers respectively. In the department Y all workers are idle for 5 hrs due to accident during this period. Show LEV & LRV .



On the basis of value:



On the basis of Margin i.e. profit or contribution



Important :

1. **Standard Margin = Std. sales price - Standard cost**
Actual Margin = Actual sales price - Standard cost
2. **When both sale price & costs are given always calculate the Margin Variances.**
3. **Market Share & Size variance are the subset of the volume variance**

Market Share variance =

(actual sales units – budgeted share of actual market) std margin p.u.

Market Size variance =

(budgeted share of actual market – budgeted sales units) std margin p.u.

In case of more than one product std. Margin represents the weighted average.

Sales:

23. Compute the sales variances from the data given below:

Produce	Budgeted quantity units	Actual quantity units	Budgeted sale price per unit Rs.	Actual sale price per unit Rs.	Standard cost per unit Rs.
X	240	400	50	45	30
Y	160	200	25	20	15
Market potential	4,000	7,000			

24. Super Computers manufactures and sells three related PC Models:

- (1) PC – Sold mostly to college students
- (2) Portable PC – Smaller version of PC positioned as home computer
- (3) Super PC – Sold mostly to business executives.

Budget for 2008				
Selling price p.u..(Rs)		Variable Cost p.u.(Rs)	Contribution p.u.(Rs)	Sales units
PC	24,000	14,000	10,000	7,000
Portable PC	16,000	10,000	6,000	1,000
Super PC	1,00,000	60,000	40,000	2,000

Actual for 2008				
	Selling price Rs./unit	Variable Cost Rs. /unit	Contribution Margin Rs./unit	Sales Units.
PC	22,000	10,000	12,000	8,250
Portable PC	13,000	8,000	5,000	1,650
Super PC	70,000	50,000	20,000	1,100

Super computer derived its total unit sales budget for 2008 from the internal management estimate of a 20% market share and an industry sales forecast by computer manufacturers association of 50,000 units. At the end of the year the association reported actual industry sales of 68,750 units. Compute all the variances in individual product and total sales .

25. Saleswell Ltd. sells a range of products. For each quarter, sales quotas are fixed for each salesman and a 5% commission is given on actual orders booked in addition to a fixed monthly salary.

FOR THE QUARTER JANUARY-MARCH 2008

Salesmen	A (Rs.)	B(Rs.)	C(Rs.)	D(Rs.)
Commission earned	2,300	1,650	2,985	2,110
Standard Cost of Quota Sales	29,400	26,000	28,400	24,000
Sales Price Variance	600 (U)	6,000 (U)	2,300 (U)	2,700 (F)
Sales Volume Variance	800 (U)	1,000 (U)	14,000 (F)	500 (U)
Margin Volume Variance	900 (U)	1,400 (U)	4,270 (U)	1,800 (F)

You are required to :

- Compute the Sales Quota given to each salesman and their actual contribution made.
 - Rank the Salesmen according to performance, explaining the basis.
 - Comment on the use of commission as an incentive.
26. The sales performance of SATYA Ltd. a dealer in toy-products for 2006-07 was as follows :

Product Units	TV sets 40,000 Rs.	Washing m/cs 1,00,000 Rs.	Computers 1,80,000 Rs.	Total 3,20,000 Rs.
Revenue	3,20,000	4,80,000	5,00,000	13,00,000
Standard cost	2,00,000	3,00,000	3,60,000	8,60,000
Profit	1,20,000	1,80,000	1,40,000	4,40,000

The company is in the process of producing the budget for 2006-07 and, whilst the above actual figures are useful, it would like to know what was in the 2007-08 budget. Unfortunately this information seems to be lost and only one or two crumb of information have come to light, i.e. :

- sales margin quantity variance is Rs.33,333.33 (F);
- Average standard margin per unit Rs.1.6667;
- Budgeted sales (in unit) of washing machines were achieved;
- TV sets were sold at the standard selling price;
- The standard selling price of TV sets per-unit is as much as a unit of each of the other two product lines put together;
- Sales price variance is Rs.60,000 (A).

Produce the sales budget for 2007-08 showing (a) number of units, (b) unit price, (c) total cost, and (d) total profit for each item and in total. Show supporting calculations.

Reconciliation:

27. The standard cost sheet of a company based on the normal output of 30,000 units for a quarter is as under :

		Rs.
Direct Materials	4 kg. @ Rs. 2 per kg.	8.00
Direct Wages	6 Hours @ Rs. 4 per hour	24.00
Overheads	50% of Direct Wages	12.00
Total Costs		44.00
Profit		6.00
Selling Price		50.00

The budgeted fixed overheads amount to Rs. 1,44,000 per quarter and it is included in the overhead cost given above. On the basis of the budgeted activity of 36,000 units, the company estimated the profit for the second quarter of the year as under :

Direct Materials	Rs. 2,88,000
Direct Wages	8,64,000
Overheads	<u>4,32,000</u>
Total Costs	15,84,000
Sales	<u>18,00,000</u>
Profit	2,16,000

Actual data for the second quarter :

Production 25,000 units

Direct materials purchased 1,06,000 kg. at Rs. 2.25 per kg.

Direct material consumed 96,000 kg

Direct wages paid 1,60,000 hrs @Rs. 4.10 per hu. including abnormal idle time 6,000 hrs

Overheads Rs. 3,32,000 out of which Rs. 1,50,000 were fixed.

Sales 23,000 units at an average price of Rs. 51.50 per unit.

You are required to prepare an operating statement reconciling from budgeted profit.

28. The trading results of ZED Ltd. for 2006-07 and 2007-08 are as follows :

	2006-07 Rs.	2007-08 Rs.
Material	1,60,000	2,05,200
Wages	96,000	1,32,000
Variable Overheads	40,000	46,000
Fixed Overheads	<u>50,000</u>	<u>54,800</u>
Total costs	3,46,000	4,38,000
Profit	54,000	90,000
Sales	<u>4,00,000</u>	<u>5,28,000</u>

Selling price was enhanced by 10 % in 2007-08. Material prices and wages rates too have increased by 8 % and 12 % respectively. Prepare profit reconciliation statement.

29. Prepare a statement showing how much factor has contribution to the variation in profit.

Items	2007 Rs. in lakhs	2008 Rs. in lakhs
Sales	600	770
Direct Materials	300	324
Direct Wages	120	137
Variable Overhead	60	69
Fixed Overhead	80	150
Profit	<u>40</u>	<u>90</u>
Raw Mat. Consumed (in kg)	1,20,000	1,35,000
Direct Labour Hours	24,00,000	26,00,000

Sales price increase by 10%. Reconcile Profit for two years.

30. An Airline Company's budget and actual for the Quarter January to March, 2008 are as under :

	Rs. in Million	
	Budget	Actual
Income	200	209.0
Variable Costs	<u>120</u>	<u>145.2</u>
Contribution	80	63.8
Fixed Costs	<u>70</u>	<u>68.0</u>
Operating Profit (Loss)	10	(4.2)

The following further details are available :-

- (a) There was a 9% decrease in air-fare resulting in a 5% decrease in the income for the quarter.
- (b) Variable Costs like fuel, wages, catering etc. are increased by 10% over the budget. Prepare and analysis reconciling the budgeted and actual profits for the quarter.

Standard on Marginal & Absorption Costing

31. You have been provided with the following data for S plc. For September 2008.:

Accounting method :	Absorption	Marginal
VARIANCES	Rs.	Rs.
Selling price	1,900 (A)	1,900 (A)
Sales volume	4,500 (A)	7,500 (A)
Fixed overhead expenditure	2,500 (F)	2,500 (F)
Fixed overhead volume	1,800 (A)	n/a

During September 2008 production and sales volumes were as follows :

	Sales	Production
Budget	10,000	10,000
Actual	9,500	9,700

- Find (i) the standard contribution per unit ;
 (ii) the standard profit per unit & (iii) the actual overhead cost total.

32. ZED plc sells two products, the Alpha and the Beta. These are made from there different raw materials that are bought from local suppliers using a JUST-in-Time (JIT) purchasing policy. Products Alpha and Beta are made to customer order using a JIT manufacturing policy. Overhead cost are absorbed using direct labour hours as appropriate.

The following information relates to October 2008 :

	Alpha	Beta
Budgeted production (units)	2,400	1,800

The standard selling price is determined by adding a 100% mark-up to the standard variable costs of each product.

Standard variable costs per unit	Alpha Rs.	Beta Rs.
Direct materials X (Rs.5 per meter)	10.00	12.50
Direct materials Y (Rs.8 per liter)	8.00	12.00
Direct materials Z (Rs.10 per kg)	5.00	10.00
Direct labour (Rs.7 per hour)	14.00	10.50
Variable overhead costs	3.00	2.25

Actual data for October 2008 :

Direct materials X	10,150 metres	costing	Rs.48,890
Direct materials Y	5,290 liters	costing	Rs.44,760
Direct materials Z	2,790 kgs.	costing	Rs.29,850
Direct labour	9,140 hours paid	costing	Rs.67,980
Direct labour paid for	8,350 hours worked		
Fixed overhead	Rs.72,000.		
Variable overhead	Rs.14,300.		
Actual production	Alpha 3,000 units		
	Beta 1,500 units		

Sales variances

The following sales variances have been calculated :

	Absorption costing		Marginal costing	
	Alpha	Beta	Alpha	Beta
	Rs.	Rs.	Rs.	Rs.
Selling price	6,000 (A)	4,500 (F)	6,000 (A)	4,500 (F)
Sales volume	18,000 (F)	11,925 (A)	24,000 (F)	14,175 (A)

Required :

- Calculate the budgeted fixed overhead cost for October 2008.
- Calculate the budgeted profit for October 2008.
- Calculate the actual profit for October 2008.
- Prepare a statement, using absorption costing principles, that reconciles the budgeted and actual profits for October 2008. showing the variances in as much details as possible. Do not calculate materials mix and yield variances.

33. The executives of Something More Ltd. had several meetings among themselves and finalized the Budget for 2008 for submission to the Board of Directors. The budget envisaged an estimated revenue of Rs. 33 lakhs for the year. On a scrutiny of the budget the Board felt that there was scope for profit improvement at least to the extent of 10% on the budgeted revenue.

In 2007 the total sales of all companies in the industry were 10 lakhs units' out of which the Co.'s sales were 1 lakh units. For 2008, the Sales Manager had assumed the same total industry market volume & company's sales share. The board directed that this area of volume & penetration be re-examined & a profit improvement plan submitted in consultation with other executives.

The plan submitted after due consideration embodied the following :

- The total industry volume would grow in 2008 to 12 lakh units and the Co's penetration would be stepped up from the present 10% to 11%;
- The sales mix will be changed from 50% of each size unit to 60% of the larger and 40% of the smaller with a contribution of Rs.11 and Rs. 9 per unit respectively. The selling price would be so raised that an additional contribution of Rs. 0.50 per unit is available uniformly on all units;
- Additional expenses of Rs. 50,000 on advertisement. & sales promotion and Rs. 25,000 on sales force would be incurred during the year while a saving of Rs. 30,000 would be made in sales office administration. Improvements in the design of packaging are expected to cost Rs. 35,000;
- Curtailling credit terms would result in saving Rs.1 lakh, while larger finished goods inventories would cost Rs. 70,000 more. (The Co. borrows money at 18% per annum).

You are required to draw the Profit improvement plan in financial terms, spelling out separately the increase or decrease in profit due to volume, price, expenses and financing charges.

Standard in Service Sector

34. A practicing Doctor who had some vacant space in his chamber established a new specialist unit providing two types of health check-Primary and Advanced.

For primary check-up the service of only a trained nurse is required and it takes 30 minutes. In case a person wants an Advanced health check-up to be done after the Primary check up, he is referred to the Doctor and an additional 60 minutes are required for medical assessment by the Doctor. The Nurse and the Doctor work independently of each other. The standard labour rates are as under:

Trained Nurse	Rs. 200 per hour
Doctor	Rs. 500 per hour

In the first month, it was estimated that there would be 200 nos. of Primary Health check-up cases and 50 cases of Advanced Health check-up. The fixed overhead for the specialist unit for the month was budgeted at Rs. 30,000. These overheads were to be absorbed on the basis of per hour spent on check-up.

The actual results for the particular month were:

(a)	Check-ups carried out:	
	Primary health check-up	220 nos.
	Advanced health check-up	60 nos.
(b)	Time spent on check-up:	
	Trained Nurse	125 hours
	Doctor	70 hours
(c)	Amount spent on	
	Trained Nurse	Rs. 30,000
	Doctor	Rs. 42,000

You are required to

- Calculate standard cost of Primary Health Check-up and Advanced Health Check-up.
- Prepare an operating cost statement for the month for the specialist unit showing standard cost and actual cost with variances. (06/2005/02)

Planning & Operating Variances

35. Big plc set up a factory to manufacture and sell 'Advance', a new consumer product. The first year's budgeted production and sales were 1,000 units. The budgeted sales price and standard costs for 'Advance' were:

	Rs.	Rs.
Standard rate price (per unit)		200
Standard costs (per unit):		
Raw materials (10 kg at Rs. 10)	100	
Labour (6 hours at Rs. 8)	<u>48</u>	
		<u>(148)</u>
Standard contribution (per unit)		<u>52</u>
Actual results for the first year were:	Rs.'000	Rs. '000
Sales (1,000 units)		316
Production costs (1,000 units):		
Raw materials (10,800 kg)	194.4	
Labour (5,800 hours)	<u>69.6</u>	
		<u>(264)</u>
Actual contribution (1,000 units)		<u>52</u>

The managing director made the following observations on the actual results:

In total, the performance agreed with budget; nevertheless, in every aspect other than volume, there were large differences.

Sales were made at what was felt to be the highest feasible price, but we now feel that we could have sold for Rs. 330 with no adverse effect on volume. Labour costs rose dramatically with increased demand for the specialist skills required to produce the product, and the general market rate was Rs. 12.50 per hour-although we always paid below the general market rate whenever possible.

The raw material cost that was expected at the time the budget was prepared was Rs. 10 per kilogram. However, the market price relating to efficient purchases of the material during the year was Rs. 17.00 per kilogram.

It is not proposed to request a variance analysis for the first year's results. In any event, the final contribution was equal to that originally budgeted, so operations must have been fully efficient. Despite the managing director's reluctance to calculate it, you are requested to calculate the traditional variance analysis and Planning & Operational Variance. (St mat CIMA -114)

36. HT plc, a food manufacturer, produces a range of processed foods including a range of high-quantity soups which it sells to hotels and caterers. One of these, CC soup, has the following standard ingredient list for 100 liters of soup :

Ingredient	Volume (litres)	Standard Cost / litre Rs.	Standard cost Rs.
A	30	1.42	42.60
B	25	1.25	31.25
C	5	3.50	17.50
D	<u>45</u>	2.45	<u>110.25</u>
	<u>105</u>		<u>201.60</u>

During October 2008, HT plc produced 5,400 litres of its CC soups using the following:

Ingredient	Volume(lt)	Actual cost / litre (Rs.)
A	1,740	1.50
B	1,800	1.20
C	540	4.00
D	1,200	2.30

Required :

- Calculate, using the weighted averaged valuation method, the individual ingredient price and mix variances and the total ingredient yield variance for October 2008.
- HT plc uses a semi-automated processing unit to convert the ingredients of CC soup into the finished product. The standard variable processing costs for each 100 liters of CC soup are 0.8 processing hours at Rs. 240 each processing hour

During October 2008, the actual processing time was 37 hours at a total cost of Rs.9.250.

It has now been realised that a new, faster machine was operated in October 2008, which should have reduced the processing time required by 20%.

The fixed costs of the semi-automated processing unit are not considered to be a product related cost.

Required :

- Calculate the planning variable processing cost efficiency variance for October 2008.
- Calculate the operating variable processing cost expenditure and efficiency variances for October 2008.

BALANCE SCORECARD: Variance analysis

1. **Growth Component:**

- (a) Revenue effect = (Actual Output sold – Budgeted Output sold) Bud. Price/ unit
 (b) Cost effect = (Budgeted Input – Budget Input for Actual Output) Budgeted rate

Note : In case items of fixed cost nature , Budgeted Input for Actual Output = the Budget amount.

2. **Price Recovery Component:**

- (a) Rev. effect = (Actual Price – Budgeted Price) Actual Output sold
 (b) Cost effect = (Budgeted Rate – Actual Rate) Budgeted Input for Actual Output

3. **Productivity Component** = (Bud. Input for Actual Output- Actual Input) × Actual Rate

Note: Actual profit = budgeted profit + adjustment of the above 3 items

37. Following a strategy of product differentiation, Westwood Corporation makes a high-end Kitchen range hood, KE8. Westwood's data for 2007 & 2008 follows:

	2007	2008
1. Units of KE8 produced & sold	40,000	42,000
2. Selling price	Rs. 100	Rs. 110
3. Direct Materials (Sq. feet)	1,20,000	1,23,000
4. Direct material costs per Sq. foot	Rs. 10	Rs. 11
5. Manufacturing capacity for KE8 (units)	50,000	50,000
6. Conversion costs (Rs.)	10,00,000	11,00,000
7. Conversion costs per unit of capacity (Rs.)	20	22
(Row 6 ÷ Row 5)		
8. Selling and customer service capacity	30 customer	29 customers
9. Selling & customer service costs (Rs.)	7,20,000	7,25,000
10. Cost per customer of selling & customer		
Service capacity (Row 9 ÷ Row 8) (Rs.)	24,000	25,000

Westwood produced no defective units and reduced direct material usage per unit of KE8 in 2008. Conversion costs in each year are tied to manufacturing capacity. Selling & customer-service costs are related to the number of customers that the selling & service functions are designed to support.

Required:

- Describe briefly the elements you would include in Westwood's balanced scorecard.
- Calculate the growth, price-recovery, and productivity components that explain the change in operating income from 2007 to 2008.
- Suppose during 2008, the market size for high-end Kitchen range hoods grew at 30% in terms of number of units and all increases in market share (that is, increases in the number of units sold greater than 30%) are due to Westwood's product differentiation strategy. Calculate how much of the change in operating income from 2007 to 2008 is due to the industry-market-size factor, cost leadership, and product differentiation.

BENCH MARK : Variance Analysis :

38. The actual performance of two companies during 2007:

	<u>X & Co.</u>	<u>Y & Co.</u>
Output (units)	600	1,000
Material consume (Kg.)	1,200	2,100
Rate per kg. (Rs.)	8	8.10

The actual performance for 2008 were:

	<u>X & Co.</u>	<u>Y & Co.</u>
Output (units)	680	950
Material consumed (Kg.)	1,400	1,860
Rate per kg. (Rs.)	8.50	8.52

Material price was increased by 6% in 2008 due to International Shortage of material.

- (i) Identify the Benchmark for 2008
- (ii) Analyse the performance of 2008
- (iii) Find Benchmark for 2009.

Pricing & Pareto Analysis

Learning Objective

1. How to price the finished product
2. Detail knowledge product pricing
3. Policy, strategy & principle of product pricing
4. Pricing for new product
5. How to apply Pareto analysis

Pricing is primarily the top management's exercise in Profit Planning by Profit center. The necessity for pricing decision may arise when

- (i) a new product is to be placed in the market (Penetration or skimming),
- (ii) market cannot be penetrated at existing price or there is customers' resistance to the existing price,
- (iii) quotations or bids are to be made for the products or offers are received for purchase at a specific price, and
- (iv) some products are yielding profits lower than expected.
- (v) for inter departmental transfer

The basic four parameters of pricing are

1. Nature of product
2. Market condition
3. Strategies of competitors
4. Government Policies

Pricing Techniques are mainly on the basis of Absorption & Marginal :-

1. Absorption Costing or Volume Base Costing of pricing :
S.P.= total cost on absorption costing + mark up

2. Conversion cost method : (no profit on material)
S.P.= total cost + mark up on conversion cost

3. Return on investment method: (ROCE or ROI)

S.P.= total cost + mark up on capital employed .

If tax rate is given consider the return on after tax basis (i.e. PBT).

$$\text{So, } P = \frac{(C + xF) / U}{1 - xV}$$

P = Selling price

C = Total cost, i.e. factory cost and administration, selling and distribution costs

x = Rate of return desired on capital employed

F = Fixed capital employed (fixed assets)

V = Variable portion of capital employed (as percentage of sales units)

U = Annual Sales (Units)

4. Marginal Cost Method .
S.P.= total variable cost + mark up on variable cost
5. Differential Cost Method .
S.P.= Differential Cost + mark up
6. Standard Cost Method.
S.P.= Standard Cost + mark up

7. **Learning Curve Method or Efficiency curve method .**
S.P.= Static cost + Reducible cost + Mark up
8. **Activity Base Costing .**
S.P.= Prime cost + overhead on cost driver + mark up
9. **Target Costing:**
Target S.P. – req. profit + target cost
10. **Life Cycle Costing :**
S.P. = total cost on estimated life + mark up
11. **Loss Leader :** Where a product can be enriched by a series of optional extras, which a customers of the main product are at liberty to add on for additional advantages, the main product may be offered at a relatively low price. If the price is set below cost, the product becomes a 'loss leader'. It leads the customers to buy the extras or optional advantageous spare parts which are highly price.

When a product range consists of one or more main products and a series of related optional 'extract', which the customer can 'add on' to the main product, the supplier can set a relatively low price for the main product and a high one for the 'extras'. Obviously, the aim is to stimulate sufficient demand for the former to ensure the target return from sales of the latter. The strategy has been used successfully by aircraft engine, gas turbine manufacturers, who win an order with a very competitively priced main product that can only be serviced by their own, highly priced spare parts.

Gillette did not invent the safety razor but the market strategy Gillette adopted helped to build market share. Gillette razors were sold at 1/5 of the cost to manufacture them but only Gillette blades fitted and these were sold at a price of 5 cents. The blades cost only 1 cent to manufacture and so Gillette made large profits once it had captured the customer.

Theory:

1. **Explain the usefulness of Pareto analysis and the applicability to business situations.**

Pareto analysis is based on the 80.20 rule that was a phenomenon observed by Vilfredo Pareto. According to him 80% of wealth of Milan in Italy was owned by 20% of its citizens. The phenomenon can be observed in many different business situations & the management can follow it in various circumstances to direct management attention to the key control mechanism or planning aspects.

Usefulness of Pareto analysis: It helps to establish top priorities & to identify both profitable and unprofitable targets it helps to:

- (a) Prioritize problems, goals and objectives
- (b) Identify root causes
- (c) Select and define key quality improvement programs
- (d) Select key customer relations and service programs
- (e) Select key employee relations improvement programs
- (f) Select and define key performance improvement programs
- (g) Maximize research and product development time
- (h) Verify operating procedures and manufacturing processes
- (i) Product or services sales and distribution
- (j) Allocate physical, financial and human resources.

Applicability of Pareto analysis to business situations: The Pareto analysis is generally applicable to the following business situation.

- (i) *Pricing of a product:* In practice, it has been observed that 20% of products of a firm may account for 80% of total sales revenue. Under such circumstances the firm can adopt more sophisticated pricing method for small portion of products that jointly accounts for approximately 80% of total sales revenue. For the remaining 80% of the products the firm may use cost bases pricing method.

Pareto analysis thus helps the management of the firm to delegate the pricing decision for about 80% of its products to lower levels of management.

- (ii) *Customer profitability:* Customers can also be analyzed instead of products, for their relative profitability. It has been often found that 20% of customers may generate 80% of sales revenue profit. Such an analysis is useful for the evaluation of portfolio of customer profile.
- (iii) *Stock control:* Approximately 20% of the total investment in quantity of stock may account for about 80% of its investment. Since the number of items is small therefore the management of a firm may be able to control most of the monetary investment in them.
- (iv) *Applicability in activity based costing:* In ABC it is often said that 20% of an organisation cost drivers are responsible for 80% of the total overhead cost. By analyzing, monitoring and controlling those cost drivers that cause most cost a better control and understanding of overheads may be obtained.
- (v) *Quality control:* Pareto analysis seeks to discover from an analysis of defect report or customer complaints which "vital few" causes are responsible for most of the reported problems. Often 80% of underlying problems can usually be traced to 20% of the various underlying causes.

2. Discuss briefly the concept of Skimming Pricing Policy.

Answer: It is a policy of high price during the early period of a product's existence. This can be synchronized with high promotional expenditure and in the later years the prices can be gradually reduced. The reasons for following such a policy are :

- i. The demand is likely to be inelastic in the earlier stages till the product is established in the market.
- ii. The charging 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 year will tend to increase the sales.
- iii. This method is preferred in the beginning because in the initial periods when the demand for the product is not known the price covers in initial cost of production.
- iv. High initial capital outlays, needed for manufacture, result in high cost of production. Added to this, the manufacturer has to incur huge promotional activities resulting in increased costs. High initial prices will be able to finance the cost of production particularly when uncertainties block the usual sources of capital.

3. In what circumstances can penetration pricing policy be adopted?

Answers :The circumstances in which penetration policy should be adopted are as follows:

- (i) When the demand of the product is elastic to price, In other words, the demand of the product increases when price is low.
- (ii) When there are substantial saving on large-scale production. Here increase in demand is sustained by the adoption of low pricing policy.
- (iii) When there is threat of competition. The prices fixed at a low level act as an entry barrier to prospective competitors.

4. Explain different types of Competitive pricing?

Answer: Where a company sets its price mainly on the consideration of what its competitors are charging, its pricing under such situation is called competitive pricing. Two types of competitive pricing are:

- (i) **Going rate pricing** – Under this method, the firm tries to keep its price at the average level charged by the industry. Such pricing is useful where it is difficult to measure costs. Adoption of such pricing will not only yield fair return but would be least disruptive for industry's harmony. Under highly competitive conditions in homogenous product market (such as food; raw materials and textiles) the company has no pricing decision to make.
- (ii) **Sealed bid pricing** – competitive pricing is adopted in situations where firms compete for jobs on the basis of bids. The bid is the firms offer price, and it is a prime example of pricing based on the expectations of how competitors will price rather than on a rigid relation based on the concerns own costs or demand. The objective of the firm in bidding situation is to get the contract and therefore it tries to set its prices lower than the other bidding firms.

5. Explain the use of costs in pricing.

Answer: An important function of cost accounting is to ascertain costs to fix prices of the product. It is also popularly believed that price are fixed on the basis of cost plus profit. Generally, however, in the short period, costs do not have much influences on prices. However, in the long-run costs have a direct bearing on prices since supply will adjust itself to the demand. Price will then be equal to cost plus reasonable profit.

It should also be noted that through a single producer may not be able to influence prices of the product, collectively all the producers will affect the prices. The chief reasons why costs do not have much influences on price in the short period are the following

- (1) It is difficult to determine the cost of each product exactly specially if there are two or more products—then the apportionment of overheads will be more or less arbitrary and another method of absorption will mean a different figure of cost.
- (2) In case of joint products and by-products
- (3) In case of perfect competition, the immediate price may not at all be related to the cost, even for the industry as a whole unless the product can be stored for a long time. Perishable products must be sold for whatever they will fetch otherwise, there will be a total loss.
- (4) A monopolist may not care for costs at all while fixing prices, through he will not allow prices to fall below cost.
- (5) In case of many articles, chiefly cosmetics and medicines, price have to be much, much above cost, otherwise there will be not no sale.

Pricing on R.O.C. E.

1. An organisation manufactures a product, particulars of which are detailed below :

Annual production		20,000 units
Material cost	Rs.	60,000
Other variable costs		1,20,000
Fixed cost		40,000
Total cost		2,20,000
Apportioned investment	Rs.	2,00,000

Determine the unit selling price under each of the following strategies. Assume that the organization's tax rate is 25%.

- (i) 20% return on investment;
 - (ii) 30% mark-up based on total cost;
 - (iii) 20% profit on sales price;
 - (iv) 15% profit on list sales when trade discount is 35%;
 - (v) 40% mark-up based on incremental cost;
 - (vi) 50% mark-up based on value added by manufacturer.
2. Metal Products Ltd. have received an enquiry for the supply of 2,00,000 numbers of a special type of machine screw. Capacity exists for manufacture of the screws in the company's unit no.3, but a fixed investments of Rs. 60,000 and working capital to the extent of 25% of sales value will be required if the job is undertaken. The costs are estimated as follows :-
- Raw material - 20,000 lbs. @ Rs. 2.30 per lb. Labour hours, direct - 18,000, of which 2,000 would be overtime hours payable at double the labour rate. Labour rate - Re. 1 per hour. Factory Overhead - Re. 1 per direct labour hour. Selling and distribution cost - Rs. 23,000. Material recovered as scrap at the end of the operations is estimated at Rs. 2,000. The company expects a net return of 25 per cent on the capital employed.
- Prepare a cost and price statement indicating the price which should be quoted to the customer.
3. The profit for the year of Push On Ltd. Works out to 12.5% of the capital employed and the relevant figures are as under:-

Sales	Rs. 5,00,000	Direct Materials	Rs. 2,50,000
Direct Labour	Rs. 1,00,000	Variable Overheads	Rs. 40,000
Capital Employed	Rs. 4,00,000		

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

Find out by computing in details the cost and profit for next year, whether the proposal of Sales Manager can be adopted.

4. P.H Ltd, manufactures Product 'S' in departments A and B which also manufactures other products using the same machines. The particulars per unit of the Product 'S' are as under :

Direct Materials :	M 8 kg. at Rs. 3 per kg. used in Dept. A P 4 kg. at Rs. 5 per kg. used in Dept. B
Direct Labour:	2 hours at Rs. 2 per hours in Dept. A 3 hours at Rs. 10 per hour in Dept. B

Overheads :	Dept A	Dept. B
Methods of Recovery	Direct Labour	Direct Labour
	Hours	Hours
Overheads Rates		
Fixed	Rs. 6.00 per hour	Rs. 3.00 per hour
Variable	Rs.5.00 per hour	Rs. 2.00 per hour
Value of Plant & Machinery	Rs. 16 lacks	Rs. 8 lacks

Variable selling and distribution overheads relating to Product 'S' amount to Rs. 20,000 per month. The product requires a Working Capital of Rs. 3,00,000 at the target volume of 1,000 units per month occupying 25% of the practical capacity.

Required:

- Using the return on investment pricing formula, find the price of Product 'S' to yield a contribution to cover 24% rate of return on investment.
- If product 'S' is a well established product in the market, what should be the basis of fixation of Price. Set the minimum price of that basis.
- If product 'S' is a new product about to be launched in the market, what should be the basis of fixation of price. Set the minimum price on that basis.

5. A Company manufacturing agricultural Tractors has a capacity to produce 6,000 tractors annually. The capital employed in the project as on date is Rs. 20 cores. With increasing cost of production and reducing margins the company is fast narrowing its margin of safety. The return on capital employed fell from 10% in the previous year to 6% in the current year, i.e., the current year profit is Rs. 1.20 cores. The company wants to maintain the original cut off rate of 12% and various possibilities have been examined for this propose.

The company is at present manufacturing and marketing 6,000 tractors annually though there is imbalance in the plant. The company has the following major production departments with percentage capacity utilisation for the present production :

<u>Production Dept.</u>	<u>Capacity utilized</u>
Machine Shop	75%
Assembly Shop	100%
Heat treatment Shop	75%
Induction hardening	50%

The Company operates a single shift of 8 hours per day on an average for 300 days in a year. For technical reason the plant will have to operate on single shift basis only. The two alternatives which have emerged after a detailed study are :

- To hire out the surplus capacity in the productions shops for which constant demand exists. The following income and expenditure projections are drawn out :

	<u>Hire charges per hour</u>	<u>Incremental cost per hour</u>
	Rs.	Rs.
Machine Shop	10,000	2,000
Heat-treatment Shop	7,500	1,500
Induction-hardening	5,000	1,000

- To increase the installed capacity to 8,000 tractors by spending Rs. 2 cores on additional machinery for the assembly for the assembly shop. The incremental revenue from the additional sale will be Rs. 5,000 per tractor. The cost of additional finance will be 12% being the cost of existing capital employed. In addition tax benefits on an average will work out to 1% of additional investment Decide.

MARGINAL COSTING & C.V.P. ANALYSIS

Learning Objective:

It is a pricing technique followed at a time of depression. Here we have to calculate the variable cost of the product for the purpose of its CVP analysis.

So far in this text we have worked within the framework of a total costing system. With absorption costing, all stock items are valued at their full production cost. This includes fixed production overhead which has been absorbed using one of the bases which you learned about earlier.

In contrast, marginal costing values all stock items at their variable or marginal costs only. Fixed costs are treated as period costs and are written off in full against the contribution for the period.

Since the two systems value stocks differently, it follows that each will report a different profit figure for the period if stock levels alter.

The terms marginal costs and variable cost tend to be used interchangeably. In marginal costing the variable costs are matched against the sales value for the period to highlight an important performance measure: Contribution. **Contribution = Sales value- Variable Costs**

It is called contribution because it literally does contribution towards fixed costs and profit. Once the contribution has been calculated for the period, fixed costs are deducted to determine the profit for the period.

1. Mention the important factors to be considered in Marginal Costing Decisions.

Answer:

- i. Whether the product or production makes a contribution.
- ii. In the selection of alternatives, additional fixed costs if any should be considered.
- iii. The continuity of demand after expansion and its impact on selling price are to be considered.
- iv. Non-cost factors such as the need to keep labour force intact and government attitude are also to be taken into account.

2. What is CVP analysis and what purposes does it serve ? Explain.

Answer: Profit per unit of a product depends on its selling price and cost of sales. Total profit depends on sales volume which in turn depends inter alia on selling price. By and large cost also depends on volume of production. Thus, a close relationship exist between costs, volume and profit. Analysis of this relationship opens up an interesting and useful field for the management accountant. Cost-volume-profit analysis may be applied for profit planning, cost control, and decision making.

The following purposes are served by analysis of cost-volume-profit relationship :

- i. to forecast profit fairly accurately.
- ii. to set up flexible budgets.
- iii. To evaluate performance for control.
- iv. To ascertain the effects of costs of changes in volume for market expansion or contraction.
- v. To formulate price policies.
- vi. To know the amount of overhead costs that could be charged to productions costs at various levels of operation.

3. The assumptions of cost-volume-profit analysis are as follows:

- All variables remain constant per unit.
- A single product or constant sales mix.
- Fixed costs do not change.
- Profits are calculated on variable cost basis.
- Total costs and total revenues are linear functions of output.
- The analysis applies to relevant range only.
- Costs can be accurately divided into fixed and variable components.
- The analysis applies only to short-term horizon.

4. Break even point :

Break even point represents that volume of production where total cost equal total revenue resulting into a no-profit no-loss situation. If output falls below that point, there is loss and if output exceeds the point there is profit. Therefore at break even point.

Revenue = Total Cost

Sales = S = C = Fixed Cost + Variable Cost

Sales-variable Cost = Contribution = Fixed Cost

It can be concluded that at break even point the contribution earned just covers the fixed cost and at levels below the point contribution earned is not adequate to match the fixed cost and at levels above the point contribution earned more than recovers the fixed cost.

5. List out the assumptions of break-even analysis.

Answer. The assumptions underlying break even analysis are as below :

- i. All costs can be easily classified into fixed and variable components.
- ii. Both revenue and cost functions are linear over the range of activity under consideration .
- iii. Prices of output and input remain unchanged.
- iv. Productivity of the factors of production will remain the same.
- v. The state of technology and the process of production will not change.
- vi. There will be no significant change in the levels of inventory.
- vii. The company manufactures a single product.
- viii. In the case of a multi-product company, the sales mix will remain unchanged.

6. Discuss the main limitations of break-even chart.

Answer : The main limitations of break-even chart are as follows :

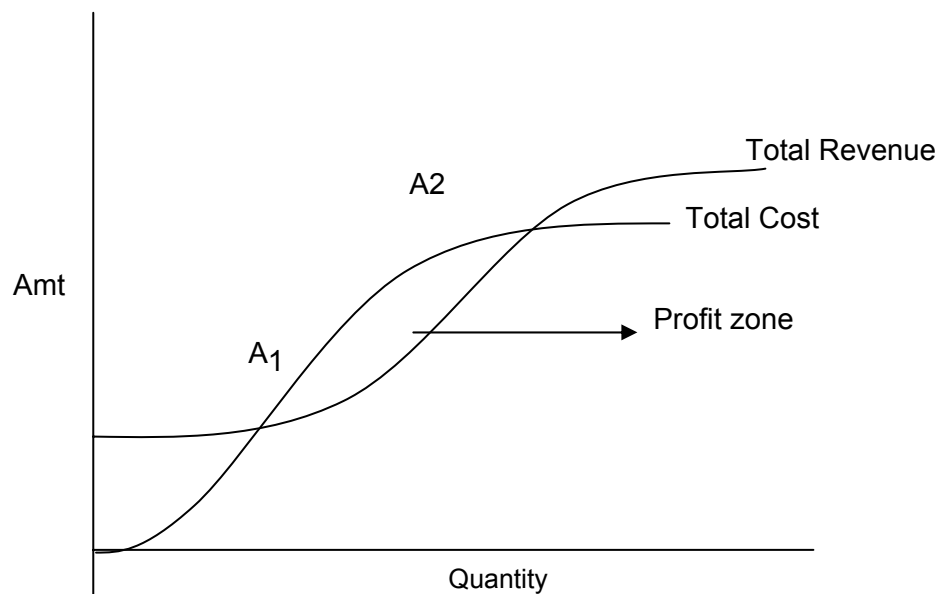
1. The variable cost line need not necessarily be a straight line because of the possibility of operation of law of increasing costs or law of decreasing returns.
2. Similarly the selling price will not be a constant factor. Any increase or decrease in output is likely to have an influence on the selling price.
3. When a number of products are produced, separate break-even charts have to be drawn. This poses a problem of apportionment of fixed expenses to each product.
4. Break-even charts ignore the capital employed in business which is one of the important guiding factor in the determination of profitability.
5. The preparation of break-even chart presumes that costs can be reliably divided into fixed and variable component. This is very difficult in practice.
6. The break-even chart presumes that production and sales will be synchronized at all points of time or in other words, the entire production will be sold. This may not be true in practice.

7. Briefly discuss Curvilinear CVP analysis.

In CVP analysis, the usual assumption is that the total sales line and variable cost line will have linear relationship, that is, these lines will be straight lines. However, in actual practice it is unlikely to have a linear relationship for two reasons, namely :

1. After the saturation point of existing demand the sales value may show a downward trend.
2. The average unit variable cost declines initially, reflecting the fact that, as output increases the firm will be able to obtain bulk discounts on the purchase of raw materials. When the plant is operated at further higher levels of output, due to bottlenecks and breakdowns the variable costs per unit will tend to increase.

The optimum profit is earned at the point where the distance between sales and total cost is the greatest. In the diagram A_1 and A_2 are the two break-even point



8. Margin of Safety :

Margin of safety is the difference between the sales or production at a particular level of activity and the break even sales a production. A large margin of safety indicates the soundness of the business and correspondingly a small margin of business indicates a not too-sound position. Margin of safety can be improved by lowering the fixed cost and variable costs, increasing the volumes of sales and production, increasing the selling prices or changing the product mix resulting into a better overall Profit/Volume ratio. **Margin of safety = Profit ÷ P/V ratio.**

9. Angle of Incidence :

It is the angle of intersection between the sales and the total cost lines. It indicates the profit earning capacity of the concern at a certain level of sales production. The larger the angle of incidence the more is the profit earning capacity and vice versa. It also provides an indication as to what extent the output & sales price may be varied to attain a desire level of profit. It gives an easy and clear idea to the profitability under different levels of activities & also for different product mix & is a simple visual aid to find out profit earning capacity without going in for any calculation.

10. Indicate any five circumstances under which you will permit to fix a price, which is less than the marginal cost of the product.

Answer: Circumstances under which a firm may fix a price less than the marginal cost of the product are as under :

- i. When goods are of perishable nature.
- ii. When the concern had already purchased huge quantities of raw materials and the prices of these materials is falling considerably in the market.
- iii. When competitors are to be eliminated from the market.
- iv. When a new product is to be introduced in the market.
- v. To obviate shut-down costs.
- vi. To push-up the sale of another highly profitable product.
- vii. To capture future market.
- viii. To capture foreign market.

11. Write notes on Key Factor

Answer: Every business aims to produce and sell unlimited units of the product manufactured by it. But it is not possible due to non-availability of some production factor. Such a factor is known as the key factor or Limiting factor or Short supply resource. In most of the cases 'sales' is the key factor. It determines the volume of output to be produced.

Sometime sales may not be the key factor but some other factor such as labour; machine capacity; material; finance etc. which may not be available in requisite quantity & will be a key factor. In other words, key factor is a factor that limits the quantum of activity of a firm at a particular time or over a period of time.

Key factor governs the decision "how much to produce".

In case, sales being the key factor, the profitability of the product is measured by computing its profit volume ratio.

When any other factor is the key-factor, the most profitable product will be that which would yield maximum contribution per unit of key factor. The profitability of any key-factor other than sales can be ascertained by using the following formula :-

Profitability (per unit) of key factor = Contribution ÷ Key factor

12. Distinguish between absorption costing and marginal costing.

Answer: Main points of distinction between Absorption Costing and Marginal Costing are as follows :

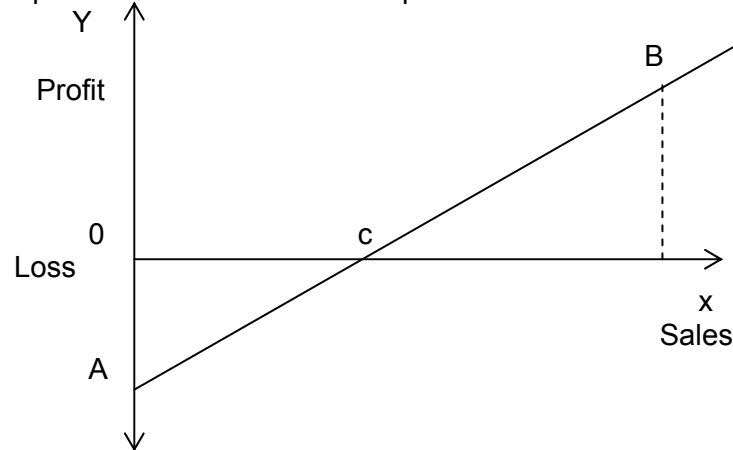
Absorption Costing	Marginal Costing
1. It is a total cost technique i.e. both variable and fixed costs are charged to products, processes or operations.	Here only variable costs are charged to product, processes or operations. Fixed costs are charged as period costs to the profit statement of the same period in which they are incurred.
2. Fixed factory overheads are absorbed by the production units on the basis of a predetermined fixed factory overhead recovery rate based on normal capacity. Under/over absorbed overheads are adjusted before arriving at the figure of profit for a particular period.	The cost of production under this method does not include fixed factory overheads and therefore, the value of closing stock comprises of only variable costs. No part of the fixed expenses is included in the value of closing stock and carried over to the next period.
3. Inspire of best possible forecast and equitable basis of apportionment/allocation of fixed costs, under or over recovery of fixed overheads generally arises.	Since fixed overheads are not included in the cost of production, therefore the question of their under/over recovery does not arise.
4. Managerial decisions under this costing technique are based on profit i.e. excess of sales value over total costs, which may at times lead to erroneous decisions.	Here decisions are made on the basis of contribution i.e. excess of sales price over variable costs. This basis of decision making Results in optimum profitability.

13. Profit graph

Profit graph is a special type of break – even chart which shows the profit or loss at different levels of output.

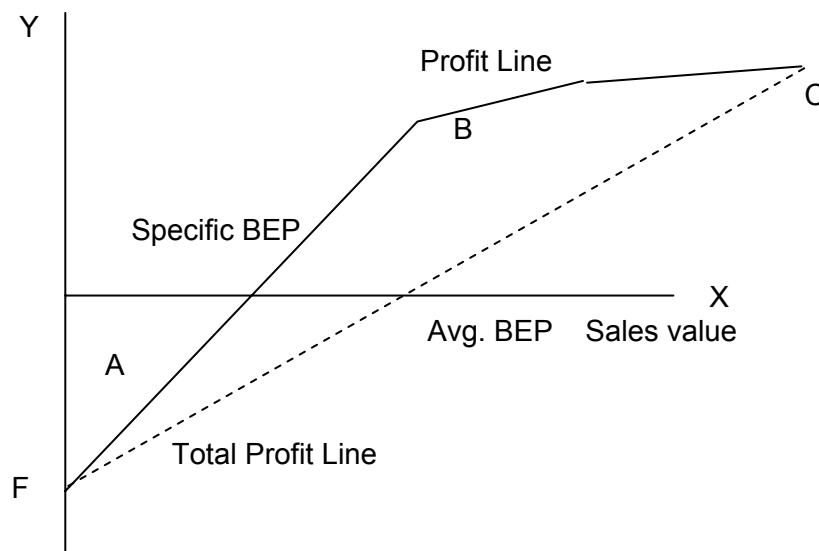
In the following example:

OA = Total fixed expenses C = Break even point



The profit or loss can be calculated by using following when sales are at zero, the total loss is equal to fixed expenses which is equal to OF. The loss diminishes as the output reaches C, the break – even point and the firm starts earning profits as the output increases beyond the break – even point. The total profit at output level of is equal to B.

When more than one product is manufactured, the Profit graph can be so drawn as to show the cumulative effects of the profit and losses.



To draw the above diagram , following steps are required --

Step-1: Compute P/V ratio for each product & give rank.

Step-2: Calculate cumulative sales & cumulative profit on the basis of the above ranking.

Step-3: Identify the points on the basis of cumulative sales (x) & cumulative profit (y). Join the points with same line and identify the specific BES.

Step-4: Join the start & end point with a single straight line to find arrange Break even sales

Formulae for calculations

1. Sales - Variable Cost = Contribution = Fixed Cost + Profit
2. P/V ratio (or C/S ratio)

= Contribution	÷ Sales
= Contribution per unit	÷ Selling price per unit
= Change in Contribution	÷ Change in Sales
= Profit	÷ Margin of Safety
3. Profit = (Sales × P/V ratio) - Fixed Cost = P/V ratio × Margin of Safety sales(Rs.)
 = Contribution p.u. × Margin of safety (in units)
4. Break-even Point
 - a. Break Even point (in units) = Fixed Cost ÷ Contribution per unit
 - b. Break Even Sales (in sales value) = Fixed Cost ÷ P/V ratio
 - c. with Step cost : apply the concept of apparent BEP
 - d. Composite BEP i.e. more than one product with common fixed costs
 - (i) With out limiting factor

BEP in units = Fixed cost ÷ Average contribution p.u.
 (when sales mix in units are given)

BEP in Rs. = Fixed cost ÷ composite P/V ratio
 (when sales mix in rupee are given)

where composite P/V ratio = $\sum [\text{Sales Mix} \times \text{P/V Ratio}]$
 - (ii) With limiting factor:

Find contribution per limiting factor & give rank. Find total contribution from 1st rank product. Calculate the amount of fixed cost still to recover. Whether it can be recovered by 2nd rank product or not ?
 - e. For Perishable product apply the same concept in case of opening stock with different variable cost.
 - f. BEP in case of process costing is expressed in terms of total raw material input
 - g. In capital budgeting, BEP is that sales volume where $\sum \text{discounted Cash in flow} = \sum \text{discounted Cash out flow}$. In case of perpetuity , the financing charge p.a.= CIF pa
 - h. Potential BE : On the basis of sales out of current period production only.
 - i. Multiple BE : Different BE due to change in sales price, variable costs & fixed costs for different production level.
 - j. Cash BEP = Cash fixed cost ÷ contribution p.u. So do not consider the sunk cost.
 - k. BEP for decision making purpose : Accept that proposal where BEP is lowest provided the profit can not be calculated.

Simple Problems :

1. Ronson Ltd. which makes only one product, sells 10,000 units of its product making a loss of Rs. 10,000. Variable cost per unit of the product is Rs. 8 and the fixed cost is Rs. 30,000.

Calculate (i) the number of units to break-even; (ii) the number of units to earn a profit of Rs. 6,000; (iii) the amount of profit from a sale of 20,000 units.

2. Maruti Uddoyge Painters paints any car for Rs. 1,500. In the year just ended, the firm made Rs. 75,000 profit before taxes. The company had fixed costs of Rs. 1,20,000 and variable costs of Rs. 1,200 per paint job. In the year just began, the firm expects its variable costs to rise by 20% as a result of increases in labour and materials.
- Suppose the firm decides to pass along its cost increase by raising its price. What would be the new rate if the firm wanted to maintain its income before tax at Rs. 75,000 per year and if the total demand remained at last year's level
 - Suppose the firm wanted to hold the line on price and push for more volume by staying open longer hours. How many paint jobs would be necessary to maintain profitability ?
3. A company producing a single product sells it at Rs.50 per unit. Unit variable cost is Rs.35 and fixed cost amounts to Rs.12 lakhs p.a. With this data you are required to calculate the following, treating each independent of the other
- Percentage increase/decrease in sales volume units off-set an increase of Rs. 3 in the variable cost per unit & a 10% increase in selling price without affecting existing profits quantum.
 - Quantum of advertisement expenditure permissible to increase sales by Rs.1.2 lakhs, without affecting existing profits quantum.
4. I co. & II co. have decided to merge into one company. The operating details of two companies are as follows:

	Company I	Company II
Percentage of capacity utilisation	90	60
Sales (Rs.)	5,40,00,000	3,00,00,000
Variable costs (Rs.)	3,96,00,000	2,25,00,000
Fixed costs (Rs.)	80,00,000	50,00,000

Assuming that these two companies merge into one, determine

- the break-even sales of the merged company :
 - the profitability of the merged company at the 80% level of capacity utilisation,
 - the turnover of the merged company required to earn a profit of Rs. 75,00,000, and
 - the percentage increase in selling price necessary to sustain an increase in fixed overheads by 5% when the merged company is working at a capacity to earn a profit of Rs. 75,00,000.
5. Calcutta Mahanagar, a local 'authority' whose area includes a holiday resort situated on the east coast, operates for 30 weeks each year, a holiday home which is let to visiting parties of children in care from other authorities. The children are accompanied by their own house mothers who supervise them throughout their holiday. From six to fifteen guests are accepted on terms of Rs. 100 present per week. No differential charges exist for adults and children. Weekly Costs incurred by the host authority are :

	<u>Rs. per guest</u>
Food	25
Electricity for heating and cooking.	3
Domestic (laundry ,cleaning etc.) expenses	5
Use of minibus.	10

Seasonal staff supervise and carry out the necessary duties at the home at a cost of Rs. 11,000 for the 30 week period. This provides staffing sufficient for six to ten guests per week but if eleven or more guests are to be accommodated, additional staff at a total cost of Rs. 200 per week are engaged for the whole of the 30-week period.

Rent, including rates of the property, is Rs. 4,000 per annum and the garden of the home is maintained by the council's recreation department which charges a nominal fee of Rs. 1,000 p. a.

You are required to tabulate the appropriate figures in such a way as to show the Breakeven point(s) and to comment on your figures.

6. A newspaper presently sales 1,00,000 copies of its morning daily. It wants to publish evening daily. Particulars are :

	Actual for Morning	Estimates for Evening
Sale price	Rs.2 per paper	Re.0.50 per paper
Variable cost	Rs.1.20 per paper	Re.0.22 per paper
Fixed cost	Rs.2.4 lakhs per week	Rs.10,000 per week

Sale of morning daily will fall @ 1 copy for-every 10 copies sold of evening daily. Calculate break-even sales for evening daily. What should the minimum price for evening daily.

7. Gemini Publishers Ltd. Is considering launching a new monthly magazine at a selling price of Rs. 10 per copy. Sales of the magazine are expected to be 5,00,000 a copy per month, but it is possible that the actual sales could differ quite significantly from this estimate.

The different methods of producing the magazine are being considered and neither would involve any additional capital expenditure. The estimated production cost for each of the two months of manufacture, together with the additional marketing and distribution costs of selling the new magazine, are given below:

	Method A (Rs)	Method B (Rs)
Variable costs	5.50 per copy	5.00 per copy
Specific Fixed cost	8,00,000 per month	12,00,000 per month

The following estimates of semi- variable costs have been available:

	Rs.	Rs.
2,50,000 copies	5,50,000 per month	4,75,000 per month
4,50,000 copies	6,50,000 per month	5,25,000 per month

It may be assumed that the fixed cost content of the semi – variable cost will remain constant throughout the range of activity shown.

The company currently sells a magazine covering related topics to those that will be included in the new publication, and consequently, it is anticipated that sales of this existing magazine will be adversely affected. It is estimated that for every ten copies sold of the new publication, sales of the existing magazines will be reduced by one copy.

Sales and cost data of the existing magazine are as shown below:

Sales	2,20,000 copies per month
Selling price	Rs. 8.50 per copy
Variable costs	3.50 per copy
Specified Fixed costs	8,00,000 per month.

	2007	2008
Gross Revenue (Fees Collected)	<u>Rs. 10,00,000</u>	<u>Rs. 15,00,000</u>
Costs: Valuation	4,00,000	6,00,000
Question Booklets	2,00,000	3,00,000
Hall Rent at Rs. 20,000 per day	80,000	80,000
Salary	60,000	60,000
Supervision Charges (one supervisor for every 100 candidates at the Rate of Rs. 500 per day)	40,000	60,000
General Administration Expenses	<u>60,000</u>	<u>60,000</u>
Total Cost	<u>8,40,000</u>	<u>11,60,000</u>
Net Revenue	<u>1,60,000</u>	<u>3,40,000</u>

You are required to compute:

- The budgeted net revenue if 4,000 candidates take up the entrance test in 2009.
- The break-even number of candidates.
- The number of candidates to be enrolled if the net income desired is Rs. 2,00,000

Multi Product Problems:

12. A Company is producing an identical product in two factories. The following are the details in respect of both the factories:

	Factory X (Rs.)	Factory Y (Rs.)
Selling Price per unit	50	50
Variable cost per unit	40	35
Fixed Cost	2,00,000	3,00,000
Depreciation include in above	40,000	30,000
Sales (units)	30,000	20,000
Production Capacity (units)	40,000	30,000

You are required to determine:

- Which factory is more profitable?
 - Cash BEP for each factory individually.
 - BEP for company as a whole, assuming the product mix can be altered as desired.
 - Consequences on profits and BEP if product mix is changed to 2:3 and total demand remain constant.
13. The following are the cost and the sales data for three products X, Y and Z.
- | Product | Selling price p.u.
Rs. | Variable cost p.u.
Rs. | % of Sales (Rs.) |
|---------|---------------------------|---------------------------|------------------|
| X | 400 | 240 | 20 |
| Y | 500 | 250 | 40 |
| Z | 850 | 595 | 40 |

Capacity of the manufacturer : Rs. 180 lakhs sales volume. Annual fixed cost : Rs. 25,50,000.

- Find the break-even point in rupees.
- Calculate profit or loss at 90% of capacity.

14. Major Ltd. manufactures a single product X whose selling price is Rs. 40 per unit and the variable cost is Rs. 16 p.u. If the Fixed Costs for this year are Rs. 4,80,000 and the annual sales are at 50% margin of safety, calculate the rate of net return on sales, assuming an income tax level of 40%.

For the next year, it is proposed to add another product line Y whose selling price would be Rs. 50 per unit and the variable cost Rs. 10 per unit. The total fixed costs are estimated at Rs. 6,66,600. The sales mix of X : Y would be 7: 3. At what level of sales next year, would the co. break even? Give separately for both X and Y the break even sales in Rs. 2 units.

BEP On Process Costing

15. In an oil-mill three processes are required to convert the raw material to chaff, oil & meal. In the first process (cleaning) the chaff is separated. In the second process (pressing) oil and cakes are produced.

The oil is transferred to finished stock and the cake is transferred to third process (grinding) where it is dried and ground into meal. For an input of 1000 kg. raw material, output are 475 liters of oil, 50 kg. chaff and 400 kg. meals. Raw materials purchase prices is Rs. 12 per kg. The Selling price of oil is Rs. 80 per liter. Selling prices of the chaff and meals are Rs. 20 and Rs. 200 per kg. respectively. The processing costs are as follows :-

	Variable costs	Total fixed costs per month Rs.
Process A	Rs. 10,000 per 1,000 kg.	1,32,000
Process B	Rs. 25,000 per 1,000 kg. cleaned material transferred to this process	3,00,000
Process C	Rs. 32,000 per 1,000 kg. of meal	4,00,000

There is no opening and closing stocks in any process. How many kg. of raw material input per month must be processed in order to break-even ?

BEP for Decision making purpose

16. You have been approached by a friend who is seeking your advice as to whether he should give up his job as an engineer, with a current salary of Rs. 15,000 per month and go into business on his own, assembling and selling a component which he has invented. He can procure the parts required to manufacture the component from a supplier.

It is very difficult to forecast the sales potential of the component, but after some research, your friend has estimated the sales as follows :

Between 600 to 900 components per month at a selling price of Rs. 250 per component.

Between 901 to 1,250 components p.m. at a selling price of Rs. 220 per component for the entire lot.

The costs of the parts required would be Rs. 140 for each completed component. However if more than 1,000 components are produced in each month, a discount of 5% would be received from the supplier of parts on all purchases.

Assembly costs would be Rs. 60,000 per month up to 750 components. Beyond this level of activity assembly costs would increase to Rs. 70,000 per month. Your friend has already spent Rs. 30,000 on development, which he would write-off over the first five years of the venture.

Required :

- Calculate for each of the possible sales levels at which your friend could expect to benefit by going into the venture on his own.
- Calculate the break - even point of the venture for each of the selling price.
- Advise your friend as to the viability of the venture.

BEP on DCF Technique

17. a. The investment for a project is Rs. 20 cr. The sale price p.u. Rs.400 & variable cost is Rs.240. the fixed cost p.a. is Rs. 23,00,000. The required rate of return is 12%. Find BEP for an life of 6 yrs.
- b. If the project building period is 2 years with 60% of capital will be invested in 1st year, what is the project BEP production & sale volume?
- c. If the life is unknown, what is the BEP?

18. A public company responsible for the supply of domestic gas has been approached by several prospective customers in a rural area adjacent to a high-pressure main. As a condition of its license to operate as a utility, the company is obliged to respond positively to current needs provided the financial viability of the company is not put at risk. New customers are charged Rs. 250 each for connection to the system.

Once a meter is installed, a standing charge of Rs.10 per quarter is billed. Charges for gas are levied at Rs.400 per 1,000 metered units.

A postal survey of the area containing, according to the rating authority, 5,000 domestic units, elicited a 40% response rate. 95% of those who responded confirmed that they wished to become gas users and expressed their willingness to pay the connection charge.

Although it is recognized that a small percentage of those willing to pay for connection may not actually choose to use gas, it is expected that the average household will burn 50 metered units per month. There will be some seasonal differences.

The company's marginal cost of capital is 17% pa and supplies of bulk gas cost the company Rs.0.065 per metered unit. Wastage of 15% has to be allowed for Determine what the maximum capital project cost can be to allow the company to provide the service required.

BEP for perishable product & Potential BEP

19. A Company produces formulations having a shelf life of one year. The company has an opening stock of 15,000 boxes on 1/1/2008 and expects to produce 75,000 boxes as was in the just ended year of 2007. Expected Sale would be 78,000 boxes. Costing department has worked out escalation in cost by 25% on variable cost and 12% on fixed cost for the year 2008.

Fixed costs are estimated at Rs.16,80,000. New price for 2008 is Rs.70/- per box while the sale price in 2007 was Rs. 60. Variable cost of the opening stock is Rs. 20 per box.

Find actual & potential BEP.

Marginal Vs. Absorption Costing:

20. PH Ltd. has a productive capacity of 2,00,000 units of product of BXE per annum, The Company estimated its normal capacity utilisation at 90% for 2007-08. The variable costs are Rs. 22 per unit & the fixed factory overheads were budgeted at Rs. 7,20,000 p.a. The variable selling overheads amounted to Rs. 6 per unit and the fixed expenses were budgeted at Rs. 5,04,000. The operating data for 2007-08 are as under :---

Production	1,60,000 units
Sales @ Rs. 40 per unit	1,50,000 units
Opening stock of finished goods	10,000 units

The cost analysis revealed an excess spending of variable factory overheads to the extent of Rs. 80,000. There are no variance in respect of other items of cost. Reconcile these two profits.

21. Exclusive Limited manufactures and sells a motor cycle called 'Eclubike' This is the only product it manufactures and sells. The following data relates to the company's activities for the quarters ended 30th September and 31st December 2008 ;

	Quarter ended	
	30/9/08	31/12/08
Production (number of units)	1,200	1,000
Sales m(number of units)	1,000	1,200

There was 200 units in opening stock on 1st July, 2008 valued at budgeted cost. The selling price of each unit is Rs.12,000. Variable costs per units are ;

	Rs.
Direct materials	1,500
Direct labour	1,300
Production expenses	<u>200</u>
	<u>3,000</u>

Budgeted production for the year is 4,800 units. Budgeted fixed production overheads for the year are Rs.3,600,000 and are absorbed using a pre-determined percentage of the total variable cost. Other fixed overheads are ;

	Quarter ended	
	30/9/08	31/12/08
Selling overheads	24,00,000	22,00,000
Distribution overheads	20,50,000	21,00,000
Administration overheads	16,00,000	17,00,000

You are required ;

- (a) to prepare separate profit statements in columnar format to clearly show the results of each quarter ;
 - (i) Under a marginal costing system ; and
 - (ii) Under an absorption costing system.
- (b) to reconcile the profits given by each system, for the two quarters separately, and in total if expense variance = 0.

CVP Sensitivity:

22. Pioneer Products, a sports goods manufacturer in collaboration with a software house, is considering the launch of a new sporting simulator based on videotapes linked to a personal computer. Two proposals are being considered. Both use the same production facilities and, as these are limited, only one product can be launched.

The following data are the best estimates the firm has been able to obtain :

	<u>Football Simulator</u>	<u>Cricket Simulator</u>
Annual volume (units)	40,000	30,000
Selling Price per unit	Rs.130	200
Variable Production Costs per unit	Rs. 80	100
Fixed Production Costs	Rs. 6,00,000	6,00,000
Fixed Selling & Admn. Costs	Rs. 4,50,000	13,50,000

The higher selling and administrative costs for the cricket simulator reflect the additional advertising and promotion costs expected to be necessary to sell the more expensive cricket system.

The firm has a minimum target of Rs. 200,000 profit per year for new products. The management recognises the uncertainty in the above estimates and wishes to explore the sensitivity of the profit on each product to changes in the values of the variables (volume, price, variable cost per unit, fixed costs).

You are required :

- (a) to calculate the expected profit from each product.
- (b) to calculate the critical value for each variable (i.e. the value at which the firm will earn Rs. 2,00,000). assuming that all other variables are as expected (express this as an absolute value and as a percentage change from the expected value),
- (c) to discuss the factors which should be considered in making a choice between the two products

Decision Making: Marginal, IRDC & DCF Approach

Learning objective

In this chapter we will check different types decision making problems as faced by top management on day-to-day operation basis. Management has to consider the best alternative situations so that the profit of the organisation will increase. Some of these are as follows:

1. product sales pricing & mix
2. limiting factors
3. multiple scarce resource problem
4. make or buy
5. selection of products, etc etc.

These are four techniques of Decision makings:

1. Relevant: Variable cost+ Opportunity Cost+ DCF approach
2. Limiting Factor
3. IR Vs DC
4. Indifferent point approach.

1. Relevancy of cost in the context of decision making :

Relevant costs are those costs which are affected by a decision. Relevance means pertinent to the decision in hand. The expected future costs which are essential and which differ by taking an alternative course of action are relevant costs. Examples of relevant costs are :

- Past costs are not relevant costs. (i.e. Sunk cost)
- Historical costs or sunk costs are not relevant.
- Variable costs are relevant costs.
- Fixed costs are not relevant. Unless discretionary
- Book value of an equipment is not relevant.
- Disposal value of an equipment is relevant.
- Fixed costs which differ by decision becomes relevant.

2. Indicate the major areas of short-term decisions in which differential cost analysis is useful.

Answer: Cost information is required both for short-term and long-run managerial problems. Differential costs are of particular use in short-term problems, which are non-repetitive, one time, ad-hoc problems. The following are the most common short-term problems and areas where differential cost analysis may be deployed.

- | | |
|---|--|
| 1. Accept – or –reject special may be deployed. | 2. Make – or – buy decisions. |
| 3. Sell – or –process decisions. | 4. Reduce – or – maintain price decisions. |
| 5. Add – or – drop production decisions. | 6. Operate -- or – shut down decisions. |

3. What are incremental costs and sunk cost? Discuss

Answer: Incremental costs: The difference in total cost between two alternatives or production level is an incremental cost. It is synonymous to differential cost. Incremental cost arise due to change of the level of activity. The change may be due to adding of a new product; change of channels of distribution, adding capacity etc. Incremental costs are not necessary variable in nature.

Sunk Cost: Cost which do not change under given circumstances and do not play any role in decision making process are known as sunk costs. They are historical costs incurred in the past. In other words, these are the costs which have been incurred by a decision made in past and cannot be changed by any decision made in the future. These costs are, however, best basis of predicting future costs. Amortisation of past expenses is the clearest kind of sunk cost.

4. What is meant by Incremental Revenue?

Answer: Incremental revenue is the additional revenue that arises from the production or sale of a group of additional units. It is one of the two basis concepts the other being incremental cost which go together with differential cost analysis. Incremental cost in fact is the added cost due to change either in the level of activity or in the nature of activity.

Marginal Costing vs. Differential Cost Analysis
Similarities

1. Both are techniques of cost analysis and presentation and are used for formulating policies and for taking management decisions.
2. When fixed costs remain same, both marginal costs and differential costs are the same. if variable cost per unit is constant

Dissimilarities

1. Differential costs apply to a fixed additional quantity of production while marginal costs apply to any additional unit.
2. The method of cost presentation may not be same under the two. For instance, marginal costs are ascertained on the basis of 'contribution approach' while differential costs may be ascertained under both absorption and marginal costing techniques
3. Under marginal costing, product costs do not include fixed costs while differential costs may include fixed costs which are common or traceable if the additional volume involves additional fixed cost outlay
4. Unlike marginal costing, differential cost analysis statements do not find their place in accounting records.
5. In marginal costing, unit contribution, p/v ratio, contribution per unit of limiting factor etc. are taken as yardsticks for evaluation of performance and marginal decisions. On the other hand, in differential cost analysis, differential costs are compared with incremental revenues for many policy decisions.

A. Limiting factor approach :**In case of single limiting factor**

- I. Calculate the variable production cost & check it with its purchase price .If purchase price is less than production cost , that product or component should be purchased.
- II. Identity the limiting factor with help of maximum production or demand .
- III. Calculate contribution per unit & contribution per limiting factor.
- IV. Give rank according to highest to lowest contribution / key factor
- V. Allocate the limiting resources in the following manner
 - a) First fulfill the minimum production requirement of the lower rank products if minimum sales condition is given in the problem.
 - b) Then allocate the maximum resource to the highest rank product .
 - c) If still there is excess resource available, then allocate it to 2nd rank product etc.
- VI. Fulfill the rest demand by purchasing it from outside
- VII. Prepare a profitability statement following the above product mix.

In case of more than one limiting factors

Apply solution technique of liner program model

B. Indifference point approach:

Indifference point = Change in Total cost or Fixed Costs ÷ Savings in variable costs

Distinction between Cost indifference point and Break-even point :

Cost indifference point : It is the point at which total cost lines under the two alternatives intersect each other.

Cost indifference point = Difference in fixed costs ÷ saving in variable cost.

Break-even point : It is the point where the total cost line and total revenue line for a particular alternative intersect each other.

Break-even point = Fixed costs ÷ Contribution per unit or the Fixed costs ÷ PV ratio.

The following are the main point of distinction

- (i) The cost indifference point is the activity level at which total cost under two alternatives are equal. Whereas break-even point is the activity level at which the total revenue from a product mix is equal to its cost.
- (ii) Cost indifference point is used to choose between two alternative processes for achieving the same objective. The choice depends on the estimated activity level. Break even point is used for profit planning.

C. Decision Making for Process Costing :

1. Joint costs i.e. pre-separation costs are considered as sunk cost.
2. For further processing apply the concept of IR Vs. DC.
3. For all proposals the current profit or contribution should be maintained.
4. Maximum payment for the new change is the increase contribution or profit
5. Always prepare the process flow chart.
6. Segregation of joint cost for product wise profit computation purpose.

D. Decision Making on Incremental revenue & Differential cost

Incremental revenue = the difference in total revenue

Differential cost = the difference in total revenue.

If IR > DC then the proposals are accepted

It is mainly applied in acceptance of an additional order & Limiting Factor analysis

Problems on Limiting Factor

1. The sales, cost, selling price and processing time of three different herbal drinks produced by a company for year just concluded are given below:

Product	Strong	Normal	Mild
Annual sales (no. of packs 250 gm)	6,000	5,000	1,000
Selling price (Rs./pack)	50	40	30
Unit cost (Rs./pack)	42	36	21
Processing time/ per pack (hrs)	1.5	1	2

The total processing hours available to the company is fully utilized for this sale. Fixed manufacturing overheads are fully absorbed in unit cost at rate of 200% of variable cost. For the coming year the demand for the three products has been estimated as under:

Strong- 6,000 packs

Normal- 6,000 packs

Mild-2,000 packs

Considering that the selling prices are fixed and the processing time can be switched from one product line to another, calculate the best production programme for next operating year indicating the increase in net profit that will result.

2. The following four products are prepared by an agricultural company-

	Potatoes	Turnips	Parsnips	Carrots
Area occupied, in acres	25	20	30	25
Yield /acre, in tonnes	10	8	9	12
	Rs.	Rs.	Rs.	Rs.
Selling price per tonnes	100	125	150	135
Variable costs per acre:				
Fertilisers	30	25	45	40
Seeds	15	20	30	25
Pesticides	25	15	20	25
Direct wages	400	450	500	570
Fixed overhead, per annum : Rs.54,000				

The land which is being used for the production of carrots and parsnips can be used for either crop, but not for potatoes or turnips. The land being used for potatoes and turnips can be used for either crop, but not for carrots or parsnips. In order to provide an adequate market service, the gardener must produce each year at least 40 tonnes each of potatoes and turnip and 36 tonnes each of parsnips and carrots.

- (a) You are required to present a statement to show:
- the profit for the current year;
 - the profit for the production mix which you would recommend.
- (b) It is possible to make the land presently suitable for Potatoes & Turnips, viable for growing all products if certain land development work is undertaken. This work will involve a capital expenditure of Rs. 6,000 per acre which a Bank is prepared to finance at the rate of interest of 5% p.a. The Fertilisers cost of the entire crop of carrots will decrease on an average by Rs. 2.60 per tonne.

Assuming that the other constraints continue, 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.

If maximum production of Carrots is 960 tons, find the most profitable product mix.

3. A company manufactures three products from an intermediate produced in its own plant. The downstream units at full capacity operations require one lakh kilos of intermediate. However, in view of certain constraints, this output would be affected by 25%. Intermediate is charged to user divisions at Rs. 10 per kilo inclusive of its variable cost of Rs. 8 per kg. Following particulars are furnished :

Downstream Units	A	B	C
Capacity (kgs.)	60,000	40,000	20,000
Intermediate required (kgs.)	66,000	20,000	14,000
Variable cost (Rs./kg.)	14	8	9
Fixed cost (")	3	5	3
Profit (")	3	2	4
Total Price (")	20	15	16

Constraints would prevail throughout the year and no other arrangement is possible to meet shortage. Company had an opening stock of 7,500 kgs. And minimum stock of 3,500 kgs. Has to be maintained in any case in the Downstream div. For economic reason, the Downstream plants have to be operated at a minimum of 70% capacity.

Required :

- i. To suggest the most profitable mix ;
- ii. To compute the loss of profit suffered as a result of main plant operating at 75% capacity ; and
- iii. To re-fix the price of the products so as to retain the same profit .

4. The operating results of B.M. Ltd. For the year 2007 were as under :

Product	Sales Mix %	P.V. Ratio %
A	40	20
B	10	6
C	30	12
D	20	10

Total sales value of all the products was Rs.80 lacks .Total fixed overheads amounted to Rs.10 lacks. The imported raw material content of each of the products represented 50% of the respective variable costs .

The forecast for the year 2008 is as under : The company can increase a 5% in the selling prices of all the products uniformly . The raw material cost will go up by 10% .The company will obtain an import quota of raw materials of the value of Rs.36 lacks . The maximum sale potentiality of any of the above four products is 40% of the 2008 sales value.

Required : Set a product mix to maximize profits in 2008 & Prepare a statement showing the profitability of 2008.

5. Dolls & Company are specialists in the manufacture of dolls for children . They manufacture and market four types of dolls patented under the names ; Dolly , Molly , Jolly , Polly and a doll-dress sewing kit . They required your assistance as a Cost Accountant for determining the appropriate sales and product mix of their products for the coming year . From the production standards established , market forecasts and pricing policies , you get the following data : -

Doll's Name	Estimated Demand for next year Units	Standard Material Cost per Rs./ unit	Standard Labour Cost per Rs/Unit	Established Net Price per Unit Rs.
Dolly	50,000	1.40	0.80	5.20
Molly	42,000	0.70	0.50	2.40
Jolly	35,000	2.70	1.40	8.50
Polly	40,000	1.00	1.00	4.00
Sewing Kit	3,25,000	0.60	0.40	3.00

To promote sales of the dolls, there is a 15% discount offered in the established price of a kit, purchased at the same time along with a doll & it is expected that all customers will avail this benefit .

The labour rate of Rs. 2.00 per hour is expected to continue without change in the next year. The plant has an effective capacity of 1,30,000 labour hours on a single shift basis. Present equipment can produce all of the products . Overtime worked is paid at double the normal rate.

Next year's Fixed Cost is estimated at Rs.30,000 in the factory , Rs.20,000 in Administration and Rs. 50,250 in Selling and Distribution. Other variable costs will be equivalent to 50% of Standard Direct Labour Cost. The Co. has a very small inventory of the products that can be ignored .

You are required to draw a conservative estimate for next year of the total contribution that would be made by each product line and the net income that would be earned by the company.

The Company is at present having some industrial relations problem and if this continues in the next year , it would not then possible to arrange for overtime work . Anticipating that eventuality, you are required to suggest a product-mix that would absolutely minimize the drop in the income already envisaged. With that product – mix work out product wise contribution and the new net income that would be earned as a result .

Make or Buy i.e. outsourcing:

6. Apple Ltd. Produces three produces– A. B and C, from the same manufacturing facilities. The cost and other details of the three products are as follows.

	A	B	C
Selling price/unit (Rs.)	200	160	100
Variable cost/unit (Rs)	120	120	40
Maximum production per month (units)	5,000	8,000	6,000
Maximum demand per month (units)	2,000	4,000	2,400

Total hours available for the month 200 hours. Fixed expenses/month Rs.2,76,000. The processing hours cannot be increased beyond 200 hours per month.

You are required to

- Purchase price: A Rs.114, B Rs.122, C Rs.45 ,hours available 160 hrs, compute maximum contribution?
 - If purchase price of C Rs. 41 p.u. in above question I, find best mix.
7. The following is the quarterly budget of a company engaged in the manufacture of a range of products:

Products	A	B	C	D
Sales Units	3600	5600	5200	3000
Selling Price/Unit (Rs.)	1000	1200	2300	2000
D. Materials/Unit (Rs.)	425	555	1275	1045
D. Labour/Unit (Rs.)	180	180	280	265
Variable overheads/Unit (Rs.)	240	240	480	400

Fixed overheads per quarter Rs. 30,70,000. Variable overheads rate is Rs. 8 per hour. In order to stimulate demand, the company proposes to launch an advertisement campaign at a cost of Rs. 2 lakhs. It is expected that the proposed advertisement campaign will increase the sales as under:

Products	A	B	C	D
Increase in Sales Units to	4000	6200	5700	3300

The production capacity is limited to 7,53,000 hour in the quarter. Products A & C can be purchase & sold. The purchase prices of the products A & C respectively are Rs. 890 & Rs. 2,200.

Determine whether the investment in advertisement campaign should be made or not; Compute the profit arising from the implementation of the advertisement program.

Problem on Bottleneck:

8. A company manufactures two products, A and B using imported raw materials. The selling price of these products are: A Rs. 144, B Rs. 216. The standard cost data are as under:

Product		A (Rs.)	B (Rs.)
Raw Materials	P	15	20
	Q	5	20
Direct Wages @ Rs. 4/- per hour			
Department	1.	24	36
	2.	12	24
	3.	36	—
	4.	—	48
Variable Overheads		16	14
Fixed Overheads per annum		Rs. 2,50,000	

The Company operates a 8-hour shift for 300 days in a year and the number of workers engaged in each department is given below

Department	1	2	3	4
No. of workers	45	24	27	36

Required :-

- (i) How many units of each product should be manufactured and what is the resultant maximum profit if the number of employees cannot be increased or transferred from one department to another.
- (ii) If only one product is to be manufactured by the company.
 - (a) Which of the products should be manufactured to yield optimum profit and;
 - (b) What is the amount of such profit if the availability of both the imported raw materials in total is limited to Rs. 1,80,000.

9. A company manufacture two products P and Q. Both the products pass through the company's two department, A and B. The market demand for a month is 2,500 unit of P and 2,000 units of Q. The company has a normal capacity of 600 hours in department A and 520 hours in department B per month. Overtime is acceptable up to 50% of normal hours in each department. The details relating to the products are as under:

Product	P	Q
Direct materials cost per unit (Rs.)	10	5
Fixed overheads per month	18,000	6,400
Departments	A	B
Direct labour time p.u, (Minutes)		
Product : P	6	12
Q	18	12
Direct Wages rate per hour		
Normal time	Rs. 10	12
Overtime	Rs. 15	18

In the event of the company not being able to fulfill the demand for want of capacity, the balance quantity of the products can be sold by buying from a sub-contractor. Who has agreed to supply product P at Rs. 18 and product at Rs. 12 per unit.

Required :

- (i) Calculate the quantity of each product to be manufactured and / or to be sub-contracted in a most way of fulfilling the market demand
- (ii) Present a statement showing the total costs involved in your solution in (i) above.

(May 2001 Q 1)

Cost Indifference Approach : between two or more machines & with slab cost

10. Standard Pumps Ltd. is manufacturing Petrol and Diesel operated pumps. The company wants to have a customer survey before marketing the pumps. You are asked to workout the economics of choice between the two types of pumps. The company provides you the following .

	Petrol Operated Pump 'X'	Diesel Operated Pump 'Y'
Selling Price Rs.	80,000	1,24,000
Cost of fuel per Liter Rs.	40.00	25.00
Operating Hours per Liter	20.00	40.00

Using above data answer following questions :-----

- a. How many hours the pumps should run so that the customer willing to buy is indifferent in choice between X and Y ? Assume that fuel cost has linear function with respect to time .
- b. Assuming the price of X remains unchanged , and the customer wants to run the pump for 12,800 hours , how much he will be willing to pay for Y ?
- c. If Standard Pump Ltd. offers to convert a Petrol operated Pump to Diesel operated one after 18,000 hrs. of operation of the former , how much customer will be willing to pay for this modification of the pump?
- d. If there is a saving of Rs.33,500 in operating cost of Y over its life , how many hours the customer should expect to run the pumps so as to be indifferent in choice ?
- e. If there is a restriction on the fuel supply to the extent of 750 litres for both Petrol & Diesel what will be customer's preference either for Petrol operated or Diesel operated one ?
- f. Do you suggest any other point that should be considered for choice between alternatives apart from above ?

11. S. M Ltd. is engaged in the manufacture of Plastic bottles of standard size. The factory has eight machines of identical size each, capable of producing 50 bottles per hour. The variable cost per bottle is Rs. 0.40 and the selling price is Rs. 1.00 each.

The Co. has received an offer from another firm for manufacture of 50,000 units of a plastic molded toy. The price per toy is Rs. 6.00 & the variable cost is Rs. 4.80 each. In the case the company takes up the job, it has to meet the expenses of making a special mould required for the manufacture of the toy. The cost of the mould is Rs. 20,000. The company's time study analysis shows that the machines can produce only 20 toys per hours. The company has a total capacity of 10,000 machine hours during the period in which the toy is required to be manufactured. The fixed costs excluding the cost of construction of the mould during the period will be Rs. 21,000. The Co. has an order for the supply of 3,75,000 bottles during the period.

Required :

- a. Do you advice the company to take up the order for manufacturing plastic moulded toys during the time it has an order in its books for the supply of 3,75,000 bottles.
- b. If the orders for the supply of bottles increase to 5,00,000 bottles, will you advise the company to accept the order for the supply of plastic moulded toys ? State the reason
- c. As associate company of S M Ltd. has idle capacity and is willing to take up the whole or part of the manufacturing of the plastic moulded toys on subcontracting basis. The subcontract price inclusive of the cost of construction of mould is Rs. 5.60 per toy. Determine the minimum expected excess machines hour capacity needed to justify producing any portion of the toy order by the company itself rather than subcontracting.
- d. The company expected that it would be left with an excess capacity of 1,600 machine hours during the period. Consequently, it accepted the toy order and subcontracted the balance requirements of the toys to meet the order. Later, the demand for bottles increased to 4,50,000 units for the period. Since the company had accepted the toy order to fill 1,600 machines hours, it could meet the demand for bottles only to the extent of 8,400 machines hours. Work out the loss which the company suffered is not being able to predict the demand for bottles accurately.

12. A company manufacturing a highly successful line of cosmetics intends to diversify the product line to achieve fuller utilisation of its plant capacity. As a result of considerable research made the company has been able to develop a new product called "EMO".

EMO is packed in tubes of 50 gram capacity and is sold to the wholesalers in cartons of 24 tubes at Rs. 240 per carton. Since the company uses its spare capacity for the manufacture of EMO, no additional fixed expenses will be incurred.

Share of fixed allocated overhead 4,50,000 per month. The company estimates the production on sale of EMO at 3,00,000 tubes per month and on the basis the following cost estimates have been developed:

	Rs. per carton
Direct Materials	108
Direct wages	72
Overheads	54
Total costs	234

After a detailed market survey the company is confident that the production and sales of EMO can be increased to 3,35,000 tubes per month and ultimately to 4,50,000 tubes per month.

The company at present has a capacity for the manufacture of 3,00,000 empty tubes and the cost of the empty tubes if purchased from outside will result in a saving of 20% in material and 10% in direct wages and variable overhead costs of EMO. The price at which the outside firm is willing to supply the empty tubes is Rs. 1.35 per empty tube. If the company desires to manufacture empty tubes in excess of 3,00,000 tubes, a new machine involving an additional fixed overheads of Rs. 30,000 per month will have to be installed.

Required:

- (i) State by showing your workings whether the company should make or buy the empty tubes at each of the three volumes of production of EMO namely, 3,00,000; 3,50,000 and 4,50,000 tubes.
- (ii) At which volume of sales will it be economical for the company to install the additional equipment for the manufacture of empty tubes?
- (iii) Evaluate the profitability on the sale of EMO at each of the aforesaid three levels of output based on your decision and showing the cost of empty tubes as a separate element of cost.

Incremental Revenue and Differential Cost Approach

13. A Company has a capacity of producing 1,00,000 units of a certain product in a month. The Sales Department reports that the following schedule of sales prices is possible.

Volume of Production	60%	70 %	80%	90%	100%
Selling price per unit Re	0.90	0.80	0.75	0.69	0.63

The variable cost of manufacture between these levels is Re. 0.15 per unit.
Fixed cost Rs. 40,000.

- (a) Prepare a statement showing incremental revenue and differential cost at each stage. At which volume of production will the profit be maximum?
- (b) If there is a bulk offer at Re. 0.50 per unit for the balance capacity over the maximum profit volume for export and price quoted will not affect the internal sale, will you advise accepting this bid and why?
- (c) What should be the minimum price for an offer of 20,000 units & capacity can not be increased.

14. A box manufacturing Company is at present operating at the 80% capacity level, the production being 15,000 units per annum. The following relevant figures are obtained from the Company's budget at different capacity-utilisation levels:

	Capacity-utilisation level	
	80%	100%
	Rs.	Rs.
Sales	20,00,000	25,00,000
Variable overheads	2,25,000	2,50,000
Semi-variable overheads	1,05,000	1,11,000
Fixed overheads	4,00,000	4,70,000
Output (in units)	15,000	18,750

The management expects a profit margin of 10% on sales.

You are required to work out the differential cost of producing the additional 3,750 units by increasing the capacity utilisation level to 100 per cent. What is the minimum price for this additional 3,750 units?

15. The News Paper Group is to commence publication of a weekly leaflet called SENSATION. They have ascertained that printing costs will be as follows:

Number of copies	5,000	6,000	7,000	8,000	9,000
Cost (Rs.)	1,250	1,440	1,662	1,840	1,900

Additional costs will be 10 p delivery cost for each copy ordered and a 15% commission payable on each copy sold. Any unsold copies are considered worthless. The management has as yet not decided on a selling price for the leaflet and has ascertained that demand will be as follows at the following prices :

Price (p)	55	60	65	70	75
Demand	9,000	8,000	7,000	6,000	5,000

- (a) Calculate the number of copies that the management should order and the selling price that it should set.
- (b) Assuming that 9,000 copies had been ordered and the selling price set as 65 paise, advise the management whether to accept an up-country order at 25 paise per copy for 2,000 copies. Local demand is expected to fall by 10% as a result of accepting the offer.
16. ABC plc is about to launch a new product. Facilities will allow the company to produce up to 20 units per week. The marketing department has estimated that at a price of Rs.8,000 no units will be sold . but for each Rs.150 reduction in price one additional unit per week will be sold.

Fixed costs associated with manufacture are expected to be Rs.12,000 per week. Variable costs are expected to be Rs.4,000 per units for each of the first 10 units; thereafter each units will cost Rs.400 more than the preceding one.

The most profitable level of output per week for the new product is

A	10 units	B	11 units	C	13 units
D	14 units	E	20 units		

17. A company manufactures two products 'AB' and 'CD' by utilising 25% and 40% of its total capacity respectively. The cost data per unit for 2007– 08 are as under :

	'AB'	'CD'
Production & sales (units)	<u>5,000</u>	<u>10,000</u>
Selling price	Rs. 80	Rs. 100
Direct material	10	30
Direct labour (Rs. 5 per hour)	25	20

Variable overheads are 100% on wages. Fixed overheads for 2006–07 amounted to Rs. 2,25,000.

During 2007-08 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 2007– 08. For the same volume of output as was in 2007– 08, 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 2008-09 to improve profitability :

- Utilise the balance capacity to produce 'AB' and to sell this increased production at the existing selling price of Rs. 80.
- Utilise the balance capacity to produce 'CD'. While doing so the efficiency will down by 16% on account of newly recruited labour in respect of this increased production. Fixed selling and distribution expenses of Rs. 50,000 will have to be spent to sell this additional output.
- Introduce new product 'EF' to utilise the balance capacity. One unit of 'EF' can be manufactured in 7 labour hours. Direct material will cost Rs. 40 per unit. Its selling price per unit will be Rs. 145. variable overheads will maintain same ratio to wages as for other two products. To boost the sales of 'EF' special advertising expenses of Rs. 30,000 will be spent.

The present allocation of 25% and 40% capacity for 'AB' and 'CD' cannot be changed and only the spare capacity is required to be used for production under the aforesaid proposals :

Required :

- Present a statement of Profit for 2007– 08 .
 - Using incremental revenue and differential cost approach, find out which proposal is more profitable for 2008-09.
 - Present a statement of profit for 2008-09 based on above recommendation. Nov 95 Q-3
18. Hitech Ltd. makes two products-CROWN and PEAK. Both the products use the same labour force, the size of which is restricted to 38,000 hours per month. CROWN needs two hours per unit to make whereas PEAK needs one hour. The estimated manufacturing and selling expenses etc. are as follows :

Production and Sales	<u>CROWN</u>		<u>PEAK</u>	
Nos. per month	6,000	8,000	20,000	24,000
Costs p.m. (Rs.)	8,50,000	10,50,000	16,00,000	18,40,000

The company is considering pricing options in a highly competitive market. It has estimated sales demand at various selling prices as under :

CROWN		PEAK	
Selling Price per unit (Rs.)	Sales Demand per month (Nos)	Selling price per unit (Rs.)	Sales Demand per month (Nos)
138	6,000	81.50	20,000
136	7,000	81.00	21,000
134	8,000	80.50	22,000
132	9,000	80.00	23,000
130	10,000	78.00	24,000
127	11,000	76.00	25,000

Required :

(a) What would be the profit maximising selling price and monthly sales quantity for each product, if direct labour was available in unlimited supply ?

(b) Given the restriction of 38,000 hours per month, what is the profit maximising sales price and quantity for each product ? Also solve it by method of combination.

19. Sellaway Ltd. manufactures and markets 2 products A and B, the demand in the market of which fluctuates with the prices quoted. As a result of the deliberations of its recent Sales Conference the following data was agreed upon as a working basis :-

Product	A			B		
Selling price p,u, Rs.	32	30	28	22	20	18
Demand p.m. units	900	1,000	1,500	1,600	2,000	3,000

8 labour hours are required to produce product A and 4 labour hours to produce product B and the maximum capacity of the factory is restricted to 20,000 labour hours per month.

	A (Rs.)	B (Rs.)
Direct Material	4	3
Direct Labour	6	5
Variable Overheads	10	6

Fixed overheads are Rs. 32,400 per quarter. You are required to compute the possible combinations and arrival at a proper price mix for maximum profitability.

Also work out the profitable price mix of the product A and B in the ratio of 3:2.

Process Costing

20. A Company is able to obtain 2,00,000 kgs. of A and 4,00,000 kgs. of B from the input of 6,00,000 kgs of a raw-material 'F'. The selling prices of these outputs one A = Rs. 6 per kg.; B = Rs. 4.50 per kg.; The processing Costs are

	Rs.
Raw Materials: 6,00,000 x 2	12,00,000
Variable processing costs	6,00,000
Fixed processing costs	2,00,000
Total	20,00,000

The company has three proposals for consideration :-

- Product A can be further processed by mixing it with other purchased materials. The entire quantity of the resultant product 'P' can be sold at Rs. 13 per kg. Each kg. of 'P' requires one kg. of A and the processing costs amount to Rs. 16,00,000.
- There is an offer to purchase an additional quantity of 40,000 kgs. of Product 'B' at a price of Rs. 3.50 per kg. The existing market for 'B' will not be affected by this proposal. All the production of Product A can be sold at a uniform price.

- c) A new raw material has just become available. The processing costs will remain the same but the process will now yield 2 kgs. of A for every 3 kgs. of Product B. The total quantity of the new raw material available is limited to 6,00,000 kgs.

Required :-

- i) Find the original profit on sale of A and B.
- ii) Evaluate the proposal for further processing of 'A' into 'P'.
- iii) In the case of proposal b) the increased quantum of 'A' will reduce its selling price. Find the minimum average price of 'A' that will sustain the increased quantum of sales.
- iv) Evaluate proposal c) and find the maximum price the company can afford to pay for the new raw material.

21. Each unit of a chemical Xylol processed in Department I Jointly yield two units intermediate P and one unit of intermediate Q. Intermediate P has to be further processed in Department 2 to make it a saleable product A, while unprocessed P would be a waste, Intermediate Q is sold as is to another company.

The selling prices are Rs. 500 per unit of A and of Rs. 400 per unit of Q. The processing of Xylol and P requires a common product facility at the rate of 60 minutes per unit of Xylol and 20 minutes per unit of P. The processing costs are Rs. 600 per unit of Xylol and Rs. 200 per unit of P. For the coming production period, the supply of Xylol is limited to 3,000 unit and the production capacity to 4,500 hours.

Required

- (i) Find the optimum production plan and the overall profitability.
- (ii) Which resource restricts the achievement of a "profit" target of Rs. 12 lakhs ?
- (iii) Suggest a way of achieving this target.

Export Incentive

22. Vacuum tubes Ltd. is producing 5,000 T.V. tubes per annum. Each T.V. tube is sold at Rs.1,600 per unit and has variable cost of Rs.1,550. Annual fixed cost burden of the Company is Rs.3 lacks. Present capacity is used up to 60%.

The unit has received an offer from a foreign buyer for 2,500 T.V. tubes. The management wants your advise regarding the minimum price that can be quoted to the foreign buyer so that capacity utilisation is increased and loss is avoided.

Following additional information has been supplied to you by the management.

The export business will fetch following additional benefits which have to be considered in calculating the quotation of F.O.B. price.

10% cash assistance on F.O.B. price realisation as an incentive from Govt.

The excise duty content in the inputs will be refunded by way of duty drawback by Govt. This will be 5% of F.O.B. price.

Govt. will issue an import license up to 10% of F.O.B. realisation. The import License can be sold in market at a premium of 100%. The license can also be used for importing Printed Circuit Boards which can be sold at 20% profit on cost price.

Please advise the bare minimum F.O.B. price for the T.V. Tube to break even if :-

- (a) the import license is sold in market.
- (b) The import license is used for importing Printed Circuit Boards.

23. 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 :

- (a) 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.
- (b) C will procure the balance of materials in India.
- (c) 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 Rs. 3 crores.
- (d) Z will also be entitled to a 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.
- (e) C will furnish to Z detailed quarterly returns.

Other information available :

- (i) FOB price agreed Rs. 510.
Exchange rate to be adopted Rs. 1 = Rs. 47.059
[Note : In making calculations, the final sum maybe rounded to the next rupee].
- (ii) Insurance and freight -- Rs. 500 per imported kit ;
- (iii) Customs duty leviable is 150% of the CIF prices ; but as a concession, the actual rate livable 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 Rs. 2,000 per personal computer.

Required : Calculated 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.

General Problems

24. SM Ltd. is engaged in the manufacture of a range of consumer products. The sales are made through its own authorised agents who are paid a commission of 20% on the selling price of the products. The company has prepared the following budget

	Rs. lakhs
Sales	225.00
Production costs :	
Prime costs and variable overheads :	78.75
Fixed overheads	36.25

Selling costs :	
Agents commission	45.00
Sales office expenses (Fixed)	2.00
Administration costs (Fixed)	30.00
Total costs	192.00
Profit	33.00

The company, after the finalisation of the above budget, is faced with a demand from its agents for an increase in their commission to 22% of selling price. The company is therefore contemplating to dispense with the services of agents and instead employ its own sales force. In that event the company expects to incur the following costs :

	Rs. lakhs	
Sales Manager's Salary and expenses	7.50	
Salesmen's expenses, including traveling expenses	2.00	
Sales office costs (in addition to the present costs)	5.00	
Interest and depreciation on sales dept. vehicles	<u>3.50</u>	18.00

In addition to the above it will be necessary to hire 40 salesmen at a salary of Rs. 40,000 per annum each plus a commission of 5% on sales plus car allowance of Re. 1 per kilometers to cover vehicle costs except interest and depreciation which has already been considered above.

Assuming that the company decides in favour of employing its own sale force, you are required to answer the following questions :

- For the same volume of sales as envisaged in the budget, what is the maximum average kilometer per annum that the salesmen could travel if the company is to achieve the same budgeted profit as it would have obtained by retaining the agents and granting them the increased commission which they had demanded.
- At what level of sales would the original budgeted profit be achieved if each salesman were to travel an average of 14,000 km. Per annum. Assume all other assumptions inherent in the budget are maintained.
- What is the maximum level of commission on sales that the company could afford to pay if it wished to achieve a 16% increase in its original budgeted profit and expected a 16% increase in sales at the budgeted selling prices and an average of 16,000 km per annum of travel by each salesman.

25. A company manufactures and markets its product Rosin. The company which is presently operating at a capacity of 75% sells 6,000 tonnes of Rosin in the domestic market. The cost structure based on the current production is :

		Rs./tonne
Selling price		45,000
Raw materials	100% Variable	30,000
Wages & Salary	60% Variable	7,000
Stores & Spares	66 2/3% Variable	300
Packing materials	100% Variable	300
Repairs & Maintenance	50% Variable	400
Power & Fuel	80% Variable	2,500
Depreciation	100% Fixed	1,000
Other Overheads	20% Variable	<u>500</u>
Total Costs		<u>42,000</u>
Profit		3000

One-sixth of the requirement of raw materials is imported. The company until recently experienced no difficulty in importing its requirements of raw materials at cost. In view of the present policy of the Government, the company has now to export its product to earn its requirements of foreign exchange for importing raw materials. In case the company decides to export its products, it will be eligible to obtain foreign exchange entitlements to the extent of 40% of the export sales value.

Alternatively, the company can go in for purchase of foreign exchange in the open market at a premium of 50% and consequently the imported raw material cost will increase to that extent. The company has therefore under its consideration a proposal for utilisation of the balance capacity of its plant for export at a price of Rs. 35,000 per tonne. The special export expenses are estimated at Rs. 200 per tonne.

- i) Present a statement of overall profitability broken into profitability under domestic sales and export sales.
- ii) Advise whether the company should go in for export business or not.
- iii) What price adjustment is required in the domestic sales to achieve the overall average profit of Rs. 3,000 per tonne as per the cost sheet.

26. Elec. Ltd. is engaged in the manufacture of four products in its factory. The production and sales volume is much lower than the normal volume and so there is a substantial unfavourable variance in the recovery of overheads. The sales and cost data for a year are as under :—

	Products (Rs. in lakhs)				Total
	A	B	C	D	
Sales	400	500	200	100	1200
Direct Materials	64	70	32	7	173
Direct Wages	88	165	60	18	331
Factory Overheads	128	172	120	24	444
Selling & Admn. Overheads	80	100	40	20	240
Total Costs	360	447	252	69	1128
Profit/Loss	40	53	–52	31	72
Unabsorbed overheads					48
Net Profit					24

50% of the factory overheads is variable at normal operating volume and the variable selling and administration overheads account for 5% of sales.

Of the total sales of product 'C' half of the volume is used in the market for applications in which product 'D' can be substituted. Thus if product 'C' is not available the sales of product 'D' can be increased by Rs. 100 lakhs without any change in the fixed selling expenses.

Of the total sales of product 'C' about 25% is sold in conjunction with product 'A'. The customers will not be able to substitute product 'D' and so the sales of product 'A' will be reduced by 12.5% of the present level if product 'C' is withdrawn.

In the event of total discontinuance of product 'C', the fixed factory and selling and administration overheads will be reduced by Rs. 20 lakhs. Alternatively if the production and sales of product 'C' is maintained to the extent of 25% of the present level as service to product 'A', there will be a reduction in the fixed costs to the extent of Rs. 10 lakhs.

You are required to :—

- a) Prepare statements to show the financial implications of:
 - (i) continuance of Product 'C'
 - (ii) Total discontinuance of product 'C'
 - (iii) Continuance of product 'C' only as service to customers using product 'A' whose business will otherwise be lost.
- b) Make your recommendations on the course of action to be taken by the company with such comments as you may like to offer.

May 1985 q-1

27. Jai Textiles Ltd. has been having low profits. A special task force appointed for reviewing performance and prospects has the following to report:-

The company has 1,200 looms working 2 shifts per day. There are 25 sections of 48 looms each. Each section has 24 weavers and a jobber. Thus there are 1,250 direct labourers, other than indirect labourers and service hands. The working time is between 7 a.m. and 12 mid-night, comprising 2 shifts of 8 hours each, with half hour interval between shifts. The production is 18 lakhs meters per month and the realisation is Rs. 3 per meter. The average wage of the direct laborer is Rs. 800 per month and the fixed costs amount to Rs. 1,75,000 per month. The production cost is Rs. 2.25 per meters in addition to direct wages.

The following suggestions are to be considered:-

- (i) Labour productivity can be improved by changing the layout of the machines.
 - (ii) Given the space available, with the proposed change in layout, only 1,008 looms can be re-installed, with 48 looms in each section.
 - (iii) Technically, a section of 48 looms can be run with 12 weavers, a helper and a jobber. It will be necessary to increase the wage of direct labour, for such section's by Rs. 110 per head per month. There will be some drop in production per loom. The company is not for retrenchment of labour.
 - (iv) The company can run a third shift between 12 mid – night and 7 a.m., with a half hour interval. However, for the six and half hours' work, eight hours' wage will have to be paid.
 - (v) Only 18 lakh meters can be sold at the present price of Rs. 3 per meter. There is an export offer for 4.5 lakh meters at Rs. 2.70 per meter.
 - (vi) As an initial step, the company can switch to 3 shift working, with 12 sections having 25 direct labourers each and 9 sections having 14 direct labourers. In future the management will reduce the no. of worker in desire level. The production, with three shift working will be 22.5 lakh meters. Additions to fixed costs will amount to Rs. 50,000 per month.
- Advice. Nov 1991 q-4

Decision Making On D.C.F.

28. A Limited Company is manufacturing a product 'Hindon' with the help of a group of machines having a book value of Rs. 65,000 after deducting depreciation on straight line basis. The company is considering the replacement of these machines by new ones. The new machines would cost Rs. 1,00,000 while the old machines could be sold only for Rs. 45,000. The new machines would have a life of four years. The existing machines could also be kept in operation for four more years provided it would be economical to do so. The scrap values of both the new and old machines would be zero after four years.

The current costs per unit of manufacturing 'Hindon' on the existing and new machine would be as under :

	Existing Machines		New Machines
Materials	Rs. 22.00		Rs. 20.00
Labour (32 hours @ Rs.1.25)	40.00	(16 hrs.@Rs.1.25)	20.00
Variable Overhead(32 hours @ Re.0.25)	<u>8.00</u>	(16 hrs @Re 0.625)	<u>10.00</u>
	70.00		50.00

The present sales of 'Hindon' are 1,000 units per annum @ Rs. 90 each. In the event of new machines being purchased, the output would increase to 1,200 units and selling price would stand reduced to Rs. 80.

A Limited requires a minimum rate of return on investment at 20% per annum (ignore tax) in money terms. materials costs, overhead costs and selling prices will increase at the rate of 15% per annum. Labour costs would increase by 20% per annum. it may be assumed that receipts and payments would accrue at the end of each year. Advise .

29. GFM produces two products-a main product Cp and a co-product Dg. For their main product Cp there is a 100% buy-back arrangement with their foreign collaborators.

Recently GFM doubled their capacity and with this their production capacity for the co-product Dg increased to 10,000 MT p.a. Fortunately there was an unprecedented increase in demand for Dg and price too has increased significantly to Rs.1,000 per tonne. However, with delicensing and liberalization more and more units for manufacturing Cp and Dg are being set up in the country.

GFM, therefore, anticipates stiff competition for Dg from next financial year. For maintaining sales at current level (i.e. 10,000 MT per year) GFM will have to drop the price by Rs.50 per MT every year for the next 5 years when prices are likely to stabilise at pre-boom level of Rs.750 per MT.

The Vice-President (Marketing) who, sensing this situation, has just completed a market study, suggests that the Company revive an earlier project for converting Dg into Dp grade and starting with 1,000 MT from next year increase production of Dp in stages of 1,000 MT every year by correspondingly reducing Dg.

The Production Manager estimates that the additional variable cost for Dp will be Rs.200 per MT. V.P. (Marketing) feels that Dp can be sold at Rs.1,500 per Mt but in the first two years a discounted price of Rs.1,400 in year 1 and Rs.1,450 in year 2 will have to be fixed. With partial conversion into Dp, the drop in price of Dg can also be contained at Rs.25 per MT instead of Rs.50 envisaged. Production facilities for Dp involves a capital outlay of Rs.50 lakhs.

Present the projected sales volume and price of products Dg and Dp for the next 5 years under two alternatives. If GFM normally appraises investment @ 12% p.a. and if cash beyond 5 years from investment are ignored advise whether Dp should be produced.

30. A Ltd. has set up a treatment plant at Surat. The company uses raw material 'X' to convert into finished product 'XA' after treatment in its plant having a capacity to treat 60,000 tonnes of 'X' per annum. There is no loss of raw material in the treatment process. The variable costs of treatment are Rs. 5 per tonne and the annual fixed costs amount to Rs. 7,50,000.

The company owns a fleet of vehicles to transport 260 lakhs tonnes – kms of 'X' to the factory site. The fixed costs of maintain these vehicles amount to Rs. 10,40,000 per annum and the variable costs amount to 8 paise per tonne –km. The company delivers 'XA' to customers through another transport agency at 15 paise per tonne – km., subject to a minimum annual payment of Rs. 1,25,000. facilities for hiring the transport for incoming of 'X' and outgoing of 'XA' are also available through Global Transport Co. at a cost of 18 paise per tonne –km.

The company has three sources of procurement of raw material 'X', the relevant details being :

	Source of Procurement		
	Town A	Town B	Town C
Quantity available (tonnes p.a)	9,000	8,000	45,000
Distance from Surat (kms.)	300	250	500
Price offered (per tonne)	Rs. 90	Rs.110	Rs. 78

The company has demand of its finished product 'XA' from the following customers :

Customer	Demand (tonnes p.a.)	Price (per tonne)	Delivery terms	Distance from Surat (kms.)
		Rs.		
L	6,000	200	At customer's site	9
M	6,000	188	Ex – factory Surat	--
N	15,000	170	Ex – factory Surat	--
O	9,000	150	Ex – factory Surat	--
P	10,000	192	At customer's site	22
Q	9,000	220	At customer's site	14
R	<u>10,000</u>	200	At customer's site	25
	<u>65,000</u>			

You are required to recommend the best proposal for the purchase of raw material 'X'; the break – up of sale of finished product 'XA'; and transport plan for incoming and outgoing goods with a view to maximise the profit.

Also present a statement to show net profit as per above recommendation. (Nov 1995 Q-4)

Activity Base Costing (ABC)

Learning objective

1. **Why ABC? Show the flow chart from Budget to Job Cost Sheet.**
2. **Activity cost analysis & selection of cost driver**
3. **Product pricing on the basis of activity analysis**
4. **Performance measurement with standard costing**

The emergence of ABC systems:

During the 1950s the limitations of traditional product costing systems began to be widely publicised. These systems were designed decades ago when most companies manufactured a narrow range of products, and direct labour and materials were the dominant factory costs. Goetz (1949) advocated ABC principles first.

- Traditional product costing systems were designed when most companies manufactured a narrow range of products.
- Direct materials and direct labour were the dominant cost factors of production. Then their ratio with overhead was 100:20.
- Companies were in sellers' market.
- Overheads were relatively small & distortions due to inappropriate treatment were not significant.
- Cost of processing information was high.

Today companies produce a wide range of products. Overheads are considerable importance.

- Simple methods of apportioning overheads on direct labour or machine hour basis are not justified as dir cost : overhead is 100: 800.
- Intense global competition calls for correct costing of products to avoid errors in decision making. i.e. apply the cause & effect relationship.
- Traditional systems can measure volume related costs.
- Non volume related activities like material handling, set up etc. are important and their costs cannot be apportioned on volume basis.

Benefits

ABC is more expensive than the traditional system. So a cost-benefit analysis is desirable. The benefits of ABC are many.

1. In ABC managers focus attention on activities rather than products because activities in various departments may be combined and costs of similar activities ascertained e.g. quality control, handling of materials, repairs to machines, etc
2. Costs are identified with activities and then allocated to products or services, based on appropriate cost drivers. So more accurate product/service costs are obtained Since overhead or indirect costs occupies a significant proportion of the total costs of the firm, the overall impact of allocation of indirect costs to products/ services more accurately is significant.

3. Managers manage activities and not products. Change in activities lead to changes in costs. Therefore, if the activities are managed well, costs will fall and resulting products will be more competitive.
4. To manage activities better and to make wiser economic decisions, managers need to identify the relationships of activities & costs in a more detailed & accurate manner.
5. ABC highlights problem areas that deserve management's attention and more detailed analysis.

Some important activities & cost driver :

<u>Activity</u>	<u>Cost Driver</u>
Machine set-up	Number of set up / set up hrs Number of production runs
Purchase materials	Number of orders placed Number of components
Warehousing	Items in stock/ wt. / volume
Material handling	Number of moves or parts Number of material moves
Inspection	Inspection per item
Quality testing	Hours of test time
Receiving material	Number of receiving orders
Packing	Number of packing orders
Store delivery	Number of store deliveries
Research & Development	Number of research projects Personal hours on a project Technical complexities of projects.
Customer Service	Number of service calls. Hours spent on servicing product
Engineering	Production order
Designing cost	No. of New job or production order

Weakness of ABC

ABC is not free from certain weakness. They are mentioned below:

1. ABC fails to encourage managers to think about changing work processes to make business more competitive.
2. ABC does not conform to generally accepted accounting principles in some areas. For example, ABC encourages allocation of such non-product costs as research and development to products while committed product costs such as factory depreciation and not allocated to products.

3. Using ABC for short-run decisions may sometimes prove costly in the long run. In a competitive environment (when other companies may be willing to meet the customers' needs); long term profits may suffer due to elimination of small orders.
4. ABC does not encourage the identification and removal of constraints creating delays and excesses.

Activity Based Management (ABM)

Activity Based Management (ABM) is a further development on activity based costing (ABC).

ABC refers to cost attribution to cost units on the basis of benefit received from indirect activities e.g. material ordering, material handling, machine setups, quality assuring, customer support services etc. For each such activity, it is necessary to identify a cost driver that causes incurrence of cost relating to that activity. For example, hours spent on testing for a quality assurance activity may be used as application base of cost driver for this activity.

ABM analyses and manages cost drivers to manage costs. In that process ABM also analyses value added and non- value added activities in order to eliminate non-value added activities and simplify or improve upon value added activities.

ABM involves:

1. Identification of the major activity areas.
2. Determination of the cost driver for each activity that may used as cost application base.
3. Creation of cost pools for collection of activity costs having the same cost driver.
4. Cost drivers link activities & resources consumption to generate less arbitrary costs for decision-making.

Activity Based Budgeting (ABB)

Activity-based budgeting is a process of planning and controlling the expected activities for the organisation to derive a cost-effective budget that meets forecast workload and agreed strategic goals. An activity-based budget is a quantitative expression of the expected activities of the firm, reflecting management's forecast of workload and financial and non-financial requirements to meet agreed strategic goals and planned changes to improve performance.

Thus, the key elements of ABB are:

- type of work/activity to be performed;
- quantity of work/activity to be performed; and
- cost of work/activity to be performed.

ABB focuses on the activity/business processes. Resources required are determined on the expected activities and workload. The objective is to bring in efficiency into the system. So, in the process of budget preparation, many key questions, need to be addressed and properly answered

Different categories of activities

Four different categories of activities that drive the expenses at product cost level are

- Unit level activities
- Batch level activities
- Product level activities
- Facility level activities

Problems :

1. The particulars relating to two products are given below. Product A is a new undeveloped product with production and quality problems requiring many engineering changes. Product B is, however, a mature product and does not, therefore, require much engineering attention.

	Product A	Product B
Units produced	200	200
Engineering change notices per product line	20	6
Unit cost per engineering change notice	Rs. 2,500	Rs. 2,500
Machine hours per unit	4	6
Material handling cost per unit	Rs. 2,610	Rs. 6,090

Compute overhead cost per unit of each product using the traditional machine hour rate method & ABC.

2. F plc supplies pharmaceutical drugs to drug stores. Although the company makes a satisfactory return, the directors are concerned that some orders are profitable and others are not. The management has decided to investigate a new budgeting system using activity based costing principles to ensure that all orders the accept are making a profit.

Each customer order is charged as follows. Customers are charged the list price of the drugs ordered plus a charge for selling and distribution costs (overheads). A profit margin is also added, but that does not form part of this analysis.

Currently F plc uses a simple absorption rate to absorb these overheads. The rate is calculated based on the budgeted annual selling and distribution costs and the budgeted annual total list price of the drugs ordered.

An analysis of customers has revealed that many customers place frequent small orders with each order requesting a variety of drugs. The management of F plc has examined more carefully the nature of its selling and distribution costs, and the following data have been prepared for the budget for next year.

Total list price of drugs supplied	Rs. 8 m	
Number of customer orders	8,000	
Selling and distribution costs	Rs. '000	cost driver
Invoice processing	280	see note 2
Packing	220	size of package – see note 3
Delivery	180	Number of deliveries – see note 4
Other overheads	<u>200</u>	Number of orders
Total overheads	<u>880</u>	

Notes:

- Each order will be shipped in one package and will result in one delivery to the customer and one invoice (an order never results in more than one delivery).
- each invoice has a different line for each drug ordered. There are 28,000 invoice lines each year. It is estimated that 25% of invoice processing costs are related to the number of invoices, and 75% are related to the number of invoice lines.
- packing costs are Rs. 32 for a large package, and Rs. 25 for a small package.
- The delivery vehicles are always filled to capacity for each journey. The delivery vehicles can carry either 6 large packages or 12 small packages (or appropriate combinations of large and small packages). It is estimated that there will be 1,000 delivery journeys each year, and the total delivery mileage that is specific to particular customers is estimated at 350,000 miles each year. Rs. 40,000 of delivery costs are related to loading the delivery vehicles, and the remainder of these costs are related to specific delivery distance to customers.

The management has asked for two typical orders to be coated using next year's budget data, using the current method, and the proposed activity – based costing approach. Details of two typical orders are shown below:

	Order A	order B
Lines on invoice	2	8
Package size	Small	Large
Specific delivery distance	8 miles	40 miles
List price of drugs supplied	Rs. 1,200	Rs. 900

Required

- (a) Calculate the charge for selling and distribution overheads for order A and order B using:
 - (i) The current system; and
 - (ii) The activity – based costing approach.
 - (b) Write a report to the management of F plc in which you
 - (i) assess the strengths and weaknesses of the proposed activity – based costing approach for F plc; and
 - (ii) recommend actions that the management of F plc might consider in the light of the data produced using the activity – based – costing approach.
3. During the last twenty years, KL's manufacturing operation has become increasingly automated, with computer-controlled robots replacing operatives. KL currently manufactures over 100 products of varying levels of design complexity. A single, plant-wide overhead absorption rate (OAR), based on direct labour hours, is used to absorbed overhead costs.

In the quarter ended March 2008 , KL's manufacturing overhead costs were :

	<u>Rs.('000)</u>
Equipment operation expenses	125
Equipment maintenance expenses	25
Wages paid to technicians	85
Wages paid to store men	35
Wages paid to dispatch staff	<u>40</u>
	<u>310</u>

During the quarter, Rapier Management Consultants were engaged to conduct a review of KL's cost accounting systems. Rapier's report includes the following statement :

'In KL's circumstances, absorbing overhead cost in individual products on a labour-hour absorption basis is meaningless. Overhead costs should be attributed to products using an activity-based costs (ABC) system. We have identified the following most significant activities :

1. receiving component consignment from suppliers ;
2. setting up equipment for production runs ;
3. quality inspections;
4. Dispatching goods orders to customers.

Our research has indicated that, in the short term, KL's overhead are 40% fixed and 60 per cent variable. Approximately half the variable overheads vary in relation to direct labour hours worked and half vary in relation to the number of quality inspections. This model applies only to relatively small changes in the level output during a period of two years or less'.

Equipment operation and maintenance expenses are apportionable as follows : components stores (15%), manufacturing (70%) and goods dispatch (15%)

Technician wages are apportionable as follows : equipment maintenance (30%) setting up equipment for production runs (40%) and quality inspections (30%).

During the quarter :

- a total of 2,000 direct labour hours were worked (paid at Rs.12 per hours);
- 980 component consignment were received from suppliers;
- 1,020 production runs were set up;
- 640 quality inspection were carried out; and
- 420 goods orders dispatched to customers.

KL's production during the quarter included components r, s, and t. The following information is available.

Component	r	s	t
Direct labour hours worked	25	480	50
Direct materials costs	Rs.1,200	Rs.2,900	Rs.1,800
Component consignment received	42	24	28
Production runs	16	18	12
Quality inspections	10	8	18
Goods orders dispatched	22	85	46
Quantity produced	560	12,800	2,400

In April 2008 a potential customer asked KL to quote for the supply a new component (z) to a given specification. 1,000 units of z are to be supplied each quarter for a two-year period. They will be paid for in equal installments on the last day of each quarter. The job will involve an initial design cost of Rs.40,000 and production will involve 80 direct labour hours, Rs.2,000 materials, 20 component consignments, 15 production runs, 30 quality inspections and 4 goods dispatches per quarter.

KL's sales director comments: 'Now we have a modern ABC system, we can quote selling prices with confidence. The quarterly charges we quote should be the forecast ABC production cost of the units plus the design cost of the z depreciated on a straight-line basis over the two years of the job- to which we should add a 25 per cent mark-up for profit. We can base our forecast on costs experience in the quarter ended March 2008.

Requirements

- Calculate the unit cost of components r, s and t, using KL's existing cost accounting system (single-factory, labour-hour).
- Explain how an ABC system would be developed using the information given. Calculate the unit cost of components r, s and t, using this ABC system.
- Calculate the charge per quarter that should be quoted for supply of component z in a manner consistent with the sales director's comments. Advise KL's management on the merits of this selling price, having regard to factors you consider relevant.

Note : KL's cost of capital is 3 % per quarter. The annual value @3% in 8 quarters = 7.0197

- S & P Products plc purchases a range of foods quality gift and household products from around the world. It then sells these products through "mail order" or retail outlets. The company receives "mail order" by post. Telephone and internet. Retail outlets are either department stores or S & P Products plc's own small shops. The company started to set up its own shops after recession in the early 1990s and regards them as the flagships of its business; sales revenue has gradually built up over the last 10 years.

There are now 50 departmental stores and 10 shops.

The company has made goods profits over the last few years but recently trading has been difficult. As a consequence, the management team has decided that a fundamental reappraisal of the business is now necessary if the company is to continue trading.

Meanwhile the budgeting process for the coming year proceeding. S & P Products plc uses an activity-based costing (ABC) system and the following estimated cost information for the coming year is available:

Retails outlets costs

Activity	Cost driver	Rate per cost driver Rs.	<u>Number each year for each outlet</u>	
			department store	own shop
Telephone Request to S & P	Calls	15	40	350
Sales Visit to shops & Stores by sales staff	Visits	250	2	4
Shop orders	Orders	20	25	150
Packing	Deliveries	100	28	150
Delivery to shops	Deliveries	150	28	150

Staffing, rental and service costs for each of S & P Product plc's own shops cost on average Rs. 300,000 a year.

Mail order costs :

Activity	Cost driver	Rate per cost driver		
		Post	Telephone	internet
Processing "mail order"	Orders	Rs. 5	Rs. 6	Rs. 3
Dealing with "mail order" Queries	Orders	4	4	1
Packing and deliveries for "mail orders" – cost per package Rs.10	Packages	Number of packages 2	per order 2	1

The total number of orders through the whole "mail order" business for coming year is expected to be 80,000. The maintenance of the internet link is estimated to cost Rs.80,000 for the coming year.

Other Information	Department Store	Own shop	Post	Telephone	Internet
Sales revenue per outlet	Rs.50,000	Rs.1,000,000			
Sales revenue per order			Rs.150	Rs.300	Rs.100
Gross margin : mark-up on Purchase cost	30%	40%	40%	40%	40%
Number of outlets	50	10			
Percentage of "mail orders"			30%	60%	10%

Expected Head Office and warehousing costs for the coming year :

	Rs.
Warehouse	2,750,000
IT	550,000
Administration	750,000
Personnel	<u>300,000</u>
	<u>4,350,000</u>

Required :

- (i) Prepare calculation that will show the expected profitability of the different types of sales outlet for the coming year.
- (ii) Comment briefly on the results of the figures you have prepared.

5. Ah! Big & Complex (ABC) Electronics makes audio player model AB 100. This model has 80 components. ABC sells 10,000 units each month at Rs. 3,000 per unit. The cost of manufacturing is Rs. 2,000 per unit or Rs. 200 lakhs per month for the production of 10,000 units. Monthly manufacturing costs incurred are as follows:

	(in Rs. Lakhs)
Direct materials costs	100.00
Direct manufacturing labour costs	20.00
Machining costs	20.00
Testing costs	25.00
Rework costs	15.00
Ordering costs	0.20
Engineering costs	19.80

Labour is paid on piece rate basis, therefore, ABC considers, direct manufacturing labour costs as variable cost.

The following additional information is available for AB 100:

- Testing and inspection time per unit is 2 hours
- 10 per cent of AB 100 manufactured are reworked
- It currently takes 1 hour to manufacture each unit of AB 100.
- ABC places two orders per month for each component. Each component is supplied by a different supplier.

ABC has identified activity cost pools and cost drivers for each activity. The cost per unit of the driver for each activity cost pool is as follows:

Manufacturing Activity	Description of activity	cost driver	cost per unit of cost driver
Machining costs	Machining components	Machine hours of Capacity	Rs. 200
Testing costs	Testing components and finished Products. (each unit of AB 100 is Tested individually)	Testing hours	Rs. 125
Rework costs	Correcting and fixing errors and Defects	units reworked	Rs. 1,500
Ordering costs	ordering of components	Number of orders	Rs. 125
Engineering costs	Designing and managing of Products and processes	engineering hrs.	Rs. 198

Over a long-run horizon, each of the overhead costs described above varies with chosen cost drivers. In response to competitive pressure ABC must reduce the price of its product to Rs. 2,600 and to reduce the cost by at least Rs. 400 per unit. ABC does not anticipate increase in sales due to price reduction. However, if it does not reduce price it will not be able to maintain the current sales level. ABC currently outsource the rework on defective units. Ignore income tax. Assume that the cost per unit of each cost driver for AB 100' continues to apply to 'AB 200.'

Cost reduction on the existing model is almost impossible. Therefore, ABC has decided to replace 'AB 100' by a new model 'AB 200', which is a modified version of 'AB 100'. the expected effect of design changes are:

- The number of components will be reduced to 50.
- Direct materials costs to be lower by Rs. 200 per unit.
- Machining time labour costs to be lower by 20%.
- Direct Manufacturing labour costs to be lower by Rs. 20 per unit.
- Testing time required to be low by 20%.
- Rework to decline to 5%
- Machining capacity and engineering hours capacity to remain the same.

Required:

- Compare the manufacturing cost per unit of AB 100 and AB 200.
- Determine the immediate effect of design change and pricing decision on the operating income of ABC.

Activity with Standard Costing

6. Frolin Chemicals Ltd. Produces FDN. The Standard ingredients of 1 kg. of FDN are:

0.65 kg. of ingredient F	@ Rs. 4.00 per kg.
0.30 kg. of ingredient D	@ Rs. 6.00 per kg.
<u>0.20</u> kg. of ingredient N	@ Rs. 2.50 per kg.
<u>1.15</u> kg	

Production of 4,000 kg. of FDN was budgeted for April. The production of FDN is entirely automated and production costs attributed to FDN production comprise only direct materials and overheads. The FDN production operation works on a JIT basis and no ingredient or FDN inventories are held.

Overheads were budgeted for April for the FDN production operation as follows:

Activity	Total amount
Receipt of deliveries From suppliers	(Standard delivery quantity is 460 kg) Rs. 4,000
Dispatch of goods To customers	(Standard dispatch quantity is 100 kg) <u>Rs. 8,000</u> <u>Rs. 12,000</u>

In April, 4,200 kg. of FDN were produced and cost details were as follows:

- Materials used:
2,840 kg. of F, 1,210 kg of D and 860 kg of N
Total cost Rs. 20,380
- Actual overhead costs:
12 supplier deliveries (cost Rs. 4,800) were made, and 38 customer dispatches (Cost Rs, 7,800) Were Processed.

Frolin Chemicals Ltd.'s budget committee met recently to discuss the preparation of the financial control report for April, and the following discussion occurred:

Chief Accountant: 'The overheads do not vary directly with output and are therefore by definition "Fixed". They should be analyzed and reported accordingly:

Management Accountant: 'The overheads do not vary with output, but they are certainly not fixed. They should be analyzed and reported on an activity basis.'

- (a) prepare a variance analysis for FDN production costs in April: separate the material cost variance into price, mixture and yield components; separate the overhead cost variance into expenditure, capacity and efficiency components using consumption of ingredient F as the overhead absorption base;
- (b) Prepare a variance analysis for FDN production overhead costs in April on an activity basis;

LIFE CYCLE COSTING

Learning Objective

1. **Identify the different phases of life cycle**
2. **identify the time period**
3. **Application of it product pricing**

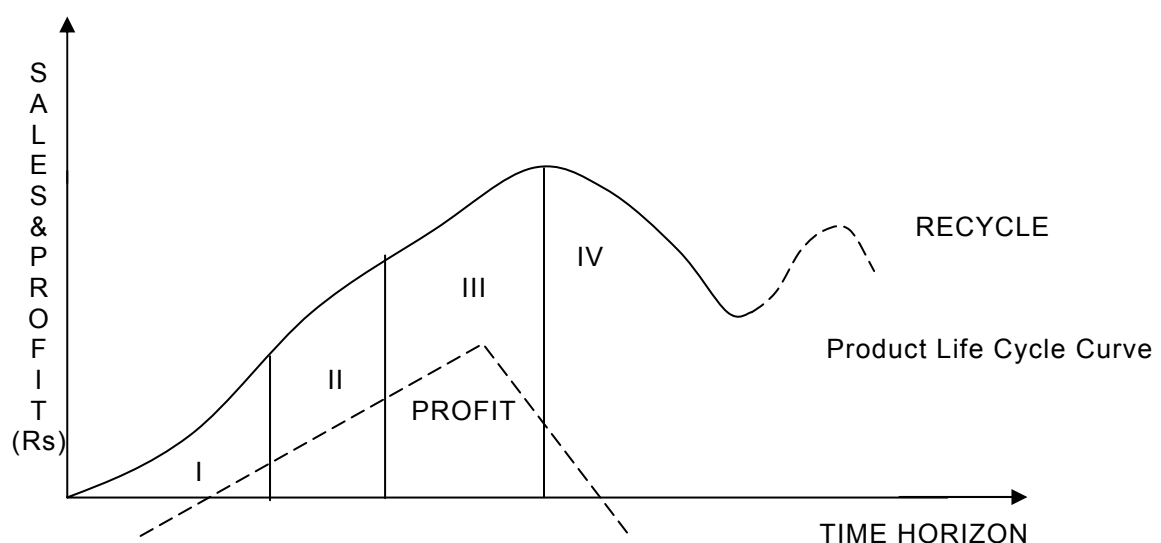
Life cycle costing is a methodology for calculating the whole cost of a system from inception to disposal. The system will vary from industry to industry and could for instance be a building, a ship, a weapon system or a power station. Whatever the system, the life cycle costing technique will be the same, the major items of cost will be defined through its life. These items could include research and development, construction, operation and maintenance and disposal.

The items may be further subdivided until the cost of each element can be defined as a mathematical equation. At a simple level this may be the number of man-hours multiplied by a cost rate. The elements of cost will then be added together to give the total cost for each item and a grand total for the system through its full life. As the project develops you will want to alter your life cycle cost analysis model accordingly and you will also want to carry out sensitivity studies and cost trade off studies. Each of these will require a recalculation of the model.

So, Life cycle costing is a technique which takes account of the total cost of making a product or owning a physical asset, during its economic life.

The production and sale of many products follow a cycle over their economic lives. Normally, sales start out slow, expand rapidly as the product is popularised and then drop off rapidly as a better product becomes available or a new product emerges in the market. Therefore, each product takes a number of years (accounting periods) to complete the cycle. The figure given below shows through different phases in the life cycle, a product too has similar phases.

Phases of Life Cycle: Revenue & Profit



Stage I	Introduction (childhood)
II	Growth (Adulthood)
III	Maturity (Manhood)
IV	Decline (Old age and death)

The length of the product cycle is governed by the rate of

- (a) technological change
- (b) market acceptance and
- (c) competition.

The concept of life cycle costing involves:

- (a) identify product life cycle and estimating number of units to be produced per period over the life cycle of the product;
- (b) estimating the costs involved for the same; and
- (c) determining the average cost of production over the product life.

Importance:

Product life cycle costing is important for the following reasons:

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

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

Stages of product life cycle

- (i) Market research: It identified – the products which customers wants, how much they are prepared to pay for it and how much quantity they intend to buy.
- (ii) Specification: It provides details such as required life; maximum permissible maintenance costs, manufacturing costs, units required, delivery date, expected performance of the product.
- (iii) Design: Proper drawings and process schedules are defined.
- (iv) Prototype manufacture: Prototype may be used to develop the product and eventually to demonstrate that it meets the requirements of the specifications.
- (v) Development: Testing and changing to meet the requirements after the initial run as a product when first made rarely meets the specification.

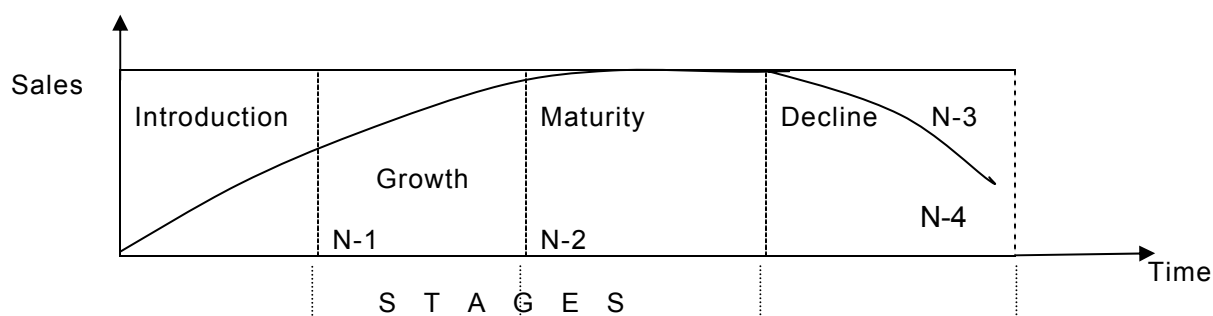
- (vi) Tooling: Tooling up for production means building a production line, building expensive jigs, buying the necessary tool and equipments.
- (vii) Manufacture: It involves the purchase of raw material and components., use of labour to make and assemble the product.
- (viii) Selling: Stimulating and creating demand for the product when the product is available for sale.
- (ix) Distribution: The product should be distributed to the sales outlets and to the customers.
- (x) Product support: The manufacturer or supplier should make sure that spares and expert servicing facilities are available for the entire life of the product.
- (xi) Decommissioning: When a manufacturing product comes to an end, the plant used to build the product must be sold or scrapped.

Benefit of product life-cycle costing.

- i) It results in earlier action to generate revenue or to lower costs than otherwise might be considered. There are a number of factors that needs to be managed in order to maximize return on a product.
- ii) Better decisions should follows from a more accurate and realistic assessment of revenues and costs, within a particular life cycle stage.
- iii) It can promote long term rewarding in contrast to short term profitability rewarding.
- iv) It provides an overall framework for considering total incremental costs over the entire life span of a product.

Uses of PLC :

- (i) as a Planning tool, it characterises the marketing challenges in each stage and poses major alternative strategies. i.e. application of Kaizen.
- (ii) as a Control tool, the launched PLC concept allows the company to measure product performance against similar products launched in the past.
- (iii) as a Forecasting tool, it is less useful because sales histories exhibit diverse patterns and the stages vary in duration.

Summary of the characteristics

Low Sales	Rapidly Rising Sales	Peak Sales	Declining Sales	Sales
High Cost Per Customer	Average Cost per Customer	Low cost Per Customer	Low cost Per Customer	Cost
Negative	Rising Profit	High Profit	Decline Profit	Profits
Innovators	Early Adopters	Middle Majority	Laggards	Customer
Few	Growing Number	State Number	Declining Number beginning to Decline	Competitors (Same Level)

Problems : identify the life cycle with equation

- Bogus Electricals Ltd. (BEL) launches a deluxe type walkman in the market. The market research study reveals that a demand of 20,000 units/month of such Walkman thus launched, exist. The variable cost/units of it is Rs. 640 and the total fixed overhead is Rs. 20,00,000 per month. The selling price is 125% of the variable cost. The company adopts a policy of penetrating pricing. The demand of the walkman per month is given by the equation $Q_1 = 2,000 t_1 - 50 t_1^2$, where Q is the demand in unit and t is the time in months from its introduction in the market. When 50% of the market has been penetrated, the company changes its pricing policy to 150% of the variable cost for the subsequent months. The profit earned during maturity stage is Rs. 12 crores.

A competitor, Worthless Electricals Ltd. (WEL) then enters the market with a peoples' band Walkman having a demand function of $Q_2 = 2500 t_2 - 30 t_2^2$. When people is introduced, the demand in the market rises to 21,500 units/month. Deluxe's price is reduced to Rs.880 to combat the price of people at Rs. 880 each. When people is introduced, the demand of deluxe declines, the total market demand remaining the same. When the sale of deluxe drops around 1,500 units/month, BEL discards the product.

Determine the Product Life cycle of deluxe.

Application of DCF & Probability

2. AZ p.l.c. supports the concept of technology or life cycle costing for new investment decisions covering its engineering activities. The final side of this philosophy is now well establish and its principles extended to all other areas of decision making.

The company is to replace a number of its machines and the production Manager is torn between the Exe machine, a more expensive machine with a life of 12 years, and the Wye machine with an estimated life of 5 years. The pattern of maintenance and running costs differs between the two types of machine and relevant data are shown below.

	Exe	Wye
Purchase price	Rs. 19,00,000	Rs. 13,00,000
Trade-in-value	30,000	30,000
Annual repair costs	20,000	20,600
Overhaul costs	(at year 8) 43,000	(at year 2) 27,000
Estimated financing costs averaged over machine life	10% p.a.	10% p.a.

You are required to recommend figures, which machine to purchase, stating any assumptions made.

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

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

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

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

You are required to advice whether the company should purchase a new machine or not.

PLC with ABC

4. The budget for the production, planning and Development Department of 'Obba plc', is currently prepared as part of a traditional budgetary planning & control system. The analysis of costs by expenses type for the period ended 30th Nov. 2007 where this system is in use is as follows:
The company now feels that an Activity Based Budgeting approach should be used. A number of activities have been identified for the production. Planning and Development Department. An investigation has indicated that total budget and actual costs should be attributed to the activities on the following basis:

	Budget %	Actual %	Budgeted Cost Driver
Activities			
1. Routine/ scheduling – new products	20	16	200 runs
2. Routing/scheduling – existing products	40	34	100 runs
3. Remedial re-routing/scheduling	5	12	100 rework
4. Special studies – specific orders	10	8	direct
5. training	10	15	3,000 LHR
6. Management & administration	15	15	Labour cost
			Rs.20,00,000

Required:

- (a) Prepare two budget control statements for the production planning and Development Department for the period ended 30th November, 2007 which compare budget with actual cost and show variances using an activity based analysis
- (b) Other activities have been identified and the budget quantified for the three months ended 31st March 2008 as follows:

Activities	Cost Driver Unit basis	Unit of cost Driver	cost (Rs. '000)
Product design	design hours	8,000	2,000 (See note 1)
Purchasing	purchase orders	4,000	200
Production	machine hours	12,000	1,500 (see note 2)
Packing	volume (cu. m.)	20,000	400
Distribution	Weight (kg)	1,20,000	600

Note 1: this includes all design costs for new products released this period.

Note 2: this includes a depreciation provision of Rs. 3,00,000 of which Rs. 8,000 applies to 3 months' depreciation on a straight line basis for a new product (NPD). The remainder applies to other products.

New product NPD is included in the above budget. The following additional information applies to NPD:

- (i) Estimated total output over the product life cycle: 5,000 units (4 year life cycle).
- (ii) Product design requirement: 400 design hours. Number of production run 3.
- (iii) Output in quarter ended 31st March, 2008, 250 units. Material cost Rs 170 p.u & labour cost is Rs. 50 per hour. The product required 3 hours
- (iv) Equivalent batch size per purchase order: 50 units
- (v) Other product unit data: production time 0.75 machine hours: volume 0.4 cu. Meters; weight 3 kg., 4 rework.

Required:

Prepare a unit cost for product NPD using an activity based approach which includes an appropriate share of life cycle costs using the information provided in above.

Value Analysis or Value Engineering or Value Chain

Learning Objective

1. how to identify the value added activity
2. how to rectify the non –value added activity
3. application in profit planning & cost reduction

Value analysis is a systematic interdisciplinary examination of factors affecting the cost of a product or service in order to devise means of achieving the specified purpose at the required standard of quality and reliability at the target cost.

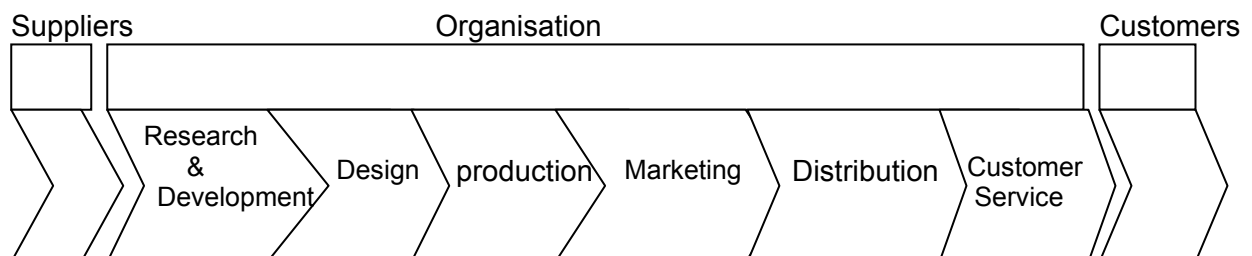
The aim of value engineering is to achieve the assigned target cost by

- (i) Identifying improved product designs that reduce the product's cost without sacrificing its utility and/or
- (ii) Eliminating unnecessary functions that increase the product's costs and for which customers are not prepared to pay extra.

Value analysis or value engineering is one of the most widely used cost reduction techniques. It can be defined as a technique that yields value improvement.

It investigates into the economic attributes of value. It attempts to reduce cost through

- a. design change,
- b. modification of material specification,
- c. change in the source of supply and so on.



It emphasizes on finding new ways of getting equal or better performance from a product at a lesser cost without affecting its quality, function, utility and reliability. For example, the function of a fastener is to join two or more parts. Value analysis examines the value of this function in terms of alternative methods such as welding, taping stapling, etc. in view of the stress and vibrations involved in a specific application.

In value analysis each and every product or component of a product is subjected to a critical examination so as to ascertain its utility in the product, its cost, cost benefit ratio, and better substitute etc. When the benefits are lower than the cost, advantage may be gained by giving up the activity concerned or replacing it for betterment. The best product is one that will perform satisfactorily at the lowest cost.

The various steps involved in value analysis are :

1. identification of the problem;
2. collecting information about function, design, material, labour overhead costs, etc., of the product and finding out the availability of the competitive products in the market; and
3. exploring and evaluating alternatives and developing them.

In other words value analysis brings out clearly the areas where the cost of a product can be reduced by pointing out :

1. Unnecessary items, components in a product to be removed.
2. Possibility of substitution with reduced cost without affecting its quality.
3. Possibility of overall simplification in design manufacture etc. of a product.

1. Competitive advantage of value chain approach

Most of the firms define value chain as mission of creating product or services. For these firms, the products or services generated are more important than any single step within their value chain. These firms use the value chain approach to better understand and identify which segment, distribution channel, price point, product differentiation, selling proposition and value chain configuration will yield them the greatest competitive advantage.

The way the value chain approach helps these firms to assess competitive advantage includes the use of following steps of analysis:

- (i) Internal cost analysis--to determine the sources of profitability and the relative cost position if internal value creating processes.
- (ii) Internal differentiation analysis--to understand the sources of differentiation (including the cost) within internal value creating processes, and
- (iii) Vertical linkage analysis--to understand the relationships & associated costs among external suppliers & customer in order to maximize the value delivered to customers & to minimize cost.

This type of analysis is not mutually exclusive. In fact, firm begin by focusing on their internal operations and gradually widening their focus to consider their competitive position within their industry. The value chain approach used for assessing competitive advantage is an integral part of the strategic planning process.

2. Internal Differentiation Analysis:

The value chain approach is also used by organizations to identify opportunities for creating and sustaining superior differentiation. In this situation, the primary focus is on the customer's perceived value of the productions and service

As with internal cost analysis, internal differentiation analysis requires firms to first identify their value – creating processes and primary cost drivers. They are then ready to perform a differentiation analysis using the following guidelines:

1. Identify the Customers' value – creating processes;
2. Evaluate differentiation strategies for enhancing customer value; and
3. Determine the best sustainable differentiation strategies.

Guidelines

1. Identify the customers' value – creating process: To pursue a superior differentiation strategy, a firm's processes must enhance those of its customers. Thus, a firm should carefully study the value – crating processes of its customers.

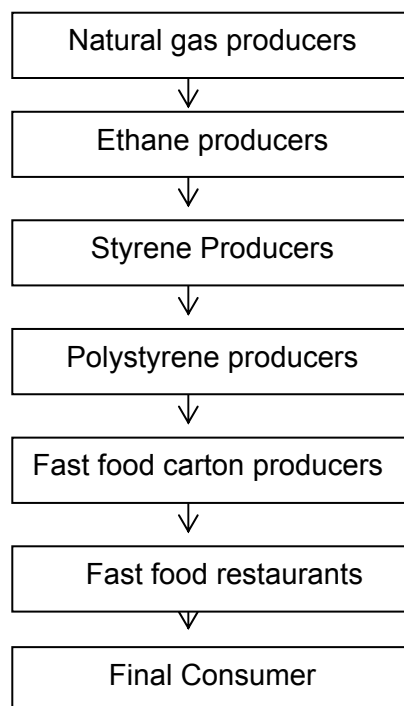
2. Evaluate differentiation strategies for enhancing customer value: The key to successful differentiation under the value – chain approach is to identify the value creating processes that distinguish a firm's products or services from those of its competitors. In making this distinction, customer value is emphasized.

3. *Determine the best sustainable differentiation strategies:* For a firm to achieve superior differentiation, it must utilize the best mix of resources in creating value for its customers. In order to priorities as sources of differentiation, a company must determine what attributes of each process enhance customer value.

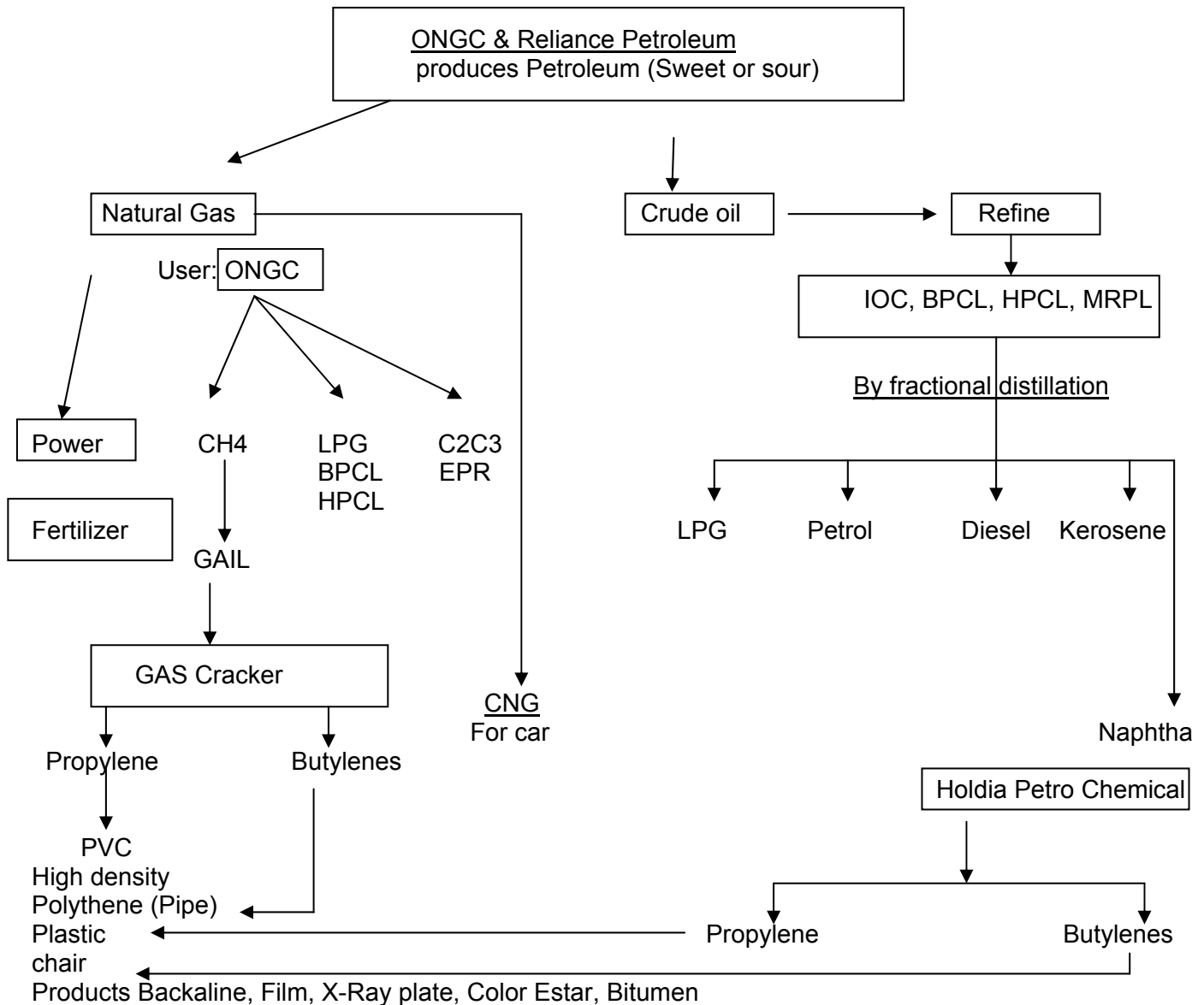
3. Vertical linkage Analysis

Linkages among value creating processes do not end with the activities within a firm. The greatest competitive advantage may come out of linkages between a firm's value creating activities and those of its suppliers, channels or users.

Vertical linkage analysis is a much broader application of inter cost & difference analysis that includes all upstream & downstream value creating processes throughout the industry. Vertical linkage analysis considers all links from the source of raw materials to the disposal and/or recycling of the product. Exhibit outlines the vertical links involved in the production of "fast food" containers.



Vertical linkage can reveal which activities are the most (and least critical to competitive advantage (or disadvantage). For example, Swiss watchmakers succeeded for years as relatively small, labour – intensive assemblers. Then came the 1970s and the advent of low cost, mass – produced watches. The Swiss responded by restructuring their industry to gain economies of scale similar to those enjoyed by their global competitors.

Vertical linkage of Petroleum Industry**4. Enhancement of customer value through differentiation :**

- Product features – that are esthetically appealing or functionally superior. For example, the Mercedes – Benz automobile accomplished that feat so well for years that its name became synonymous with the highest level of quality – people would describe a product as the “Mercedes – Benz” of its category.
- Marketing channels – that provide desired levels of responsiveness, convenience, variety and information for example;
 1. Designing distinctive cans for customers may assist their own marketing activities.
 2. consistent can quality lowers customers canning costs by avoiding breakdowns and holdups on their canning lines.
 3. By maintaining high stocks and offering speedy delivery, customers can economize on their own stock – holding (they may even be able to move to a just – in – time system of can supply).
 4. Efficient order processing can reduce customers ordering costs.
 5. capable and fast technical support can reduce the costs of breakdowns on canning lines.

- Service and support—tailored to end—user & channel member sophistication and urgency of need.
- Brand or image positing—that lends greater appeal to the Co.'s offerings on critical selection criteria. For many years, this quality image has allowed the American Expresses Co. to command a significant price premium in the highly competitive financial services market.
- Price—including both net purchase price and cost savings available to the customer through the use of the product and service.

5. Core Competencies Analysis

Industry structure analysis is well suited to describing the what of competitiveness, i.e., what makes one firm or one industry more profitable than another. But understanding the particulars of such advantages as low cost, quality, customer service and time to market may still leave some questions which still largely unanswered. For example, why do some companies seem able only to observe and follow?

Thus, industry structure analysis must be supplemented by an equally explicit core competence focus. Organizations need to be viewed not only as a portfolio of products or services, but also as a portfolio of core competencies.

Core competencies are created by superior integration of technological, physical and human resources. They represent distinctive skills as well as intangible, invisible, intellectual assets and cultural capacities. Cultural capabilities refer to the ability to manage change, the ability to learn and team working. Organizations should be viewed as a bundle of a few core competencies, each supported by several individual skills.

Core competencies are the connective issue that holds together a portfolio of seemingly diverse businesses. Core competence – based diversification reduces risk and investment and increases the opportunities for transferring learning and best practice across business units.

For instance, Microsoft's only factory asset is its human imagination. This company has excelled in inventing new ways of using information technology for a wide variety of end users. In contrast, using its core competence in information processing,

6. Limitations of value chain analysis

1. Non – availability of Data: Internal data on costs, revenues and assets used for Value Chain Analysis are derived from financial information of a single period. For long – term strategic decision – making, changes in cost structures, market prices and capital investments etc. may not be readily available.
2. Identification of Stages: Identifying stages in an industry's Value Chain is limited by the ability to locate at least one firm that participates in a specific stage. Breaking a value stage into two or more stage when an outside firm does not compete in these stages is strictly judgment.
3. Ascertainment of Costs, Revenue and Assets: Finding the Costs, Revenues and Assets for each Value Chain activity poses/ gives rise to serious difficulties. There is no scientific approach and much depends upon trial and error and experimentation methods.
4. Identification of Cost Drivers: Isolating cost Drivers for each Value – creating activity, identifying Value Chain Linkages across activities, and computing supplier and customer profit margins present serious challenges.
5. Resistance from Employees: Value Chain Analysis is not easily understandable to all employees and hence may face resistance from employees as well as managers.

Problem:

1. ACE Ltd has applied Value Analysis during last year. The financial controller of ACE Ltd. has prepared the following estimates of working results after applying the benefit of value engineering for the year ending 31st March, 2008:

Direct Materials	Rs. / units	16.00
Direct Wages	Rs. / units	40.00
Variable Overheads	Rs. / units	12.00
Selling Price	Rs. / units	125.00
Fixed Expenses	Rs.	6,75,000 per annum
Sales	Rs.	25,00,000 per annum

During the year 2008-09, various steps in value analysis are implemented:

1. Identification of the problem of low labour efficiency; As a result of re-engineering of business processes, the overall direct labour efficiency will increase by 12%, but the wage rate will go up by 5%.
2. Collecting information about function, design, materials, labour, overhead costs, etc., of the product and finding out the availability of the competitive products in the market. It is expected that the materials prices and variable overheads will go up by 10% and 5% respectively.
3. Exploring and evaluating alternatives and developing them as a result fixed overheads are also expected to increase by Rs. 1,25,000.

The VP– Manufacturing states that the same level of output as obtained in 2007-08 should be maintained in 2008-09 also and efforts should be made to maintain the same level of profit by suitable increase the selling price.

The VP–Marketing states that the market will not absorb any increase in the selling price. On the other hand, he proposes that publicity involving advertisement expenses as given below will increase the quantity of sales as under :

Advertisement Expenses (Rs.)	80,000	1,94,000	3,20,000	4,60,000
Additional units of Sales	2,000	4,000	6,000	8,000

Required :

- (a) Present an Income Statement for 2007-08.
- (b) Find the revised price and the percentage of increase in the price for 2008-09, if the views of the VP–Manufacturing are accepted.
- (c) Evaluate the four alternative proposals put forth by the VP–Marketing. Determine the best output level to be budgeted and prepare an over-all Income Statement for 2008-09 at that level of output.

(May 1999 Revised)

Target Costing

Learning Objective

1. how to find target cost for a new product
2. how to apply the concept for existing product

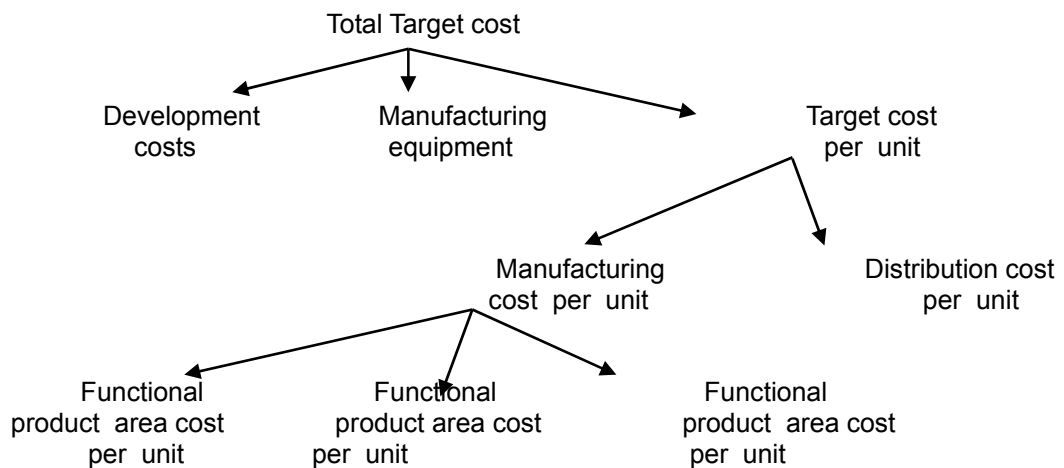
Implementation Target Pricing and Target Costing: There are four main steps in developing target prices and target costs. The steps are illustrated by using an Provalue example.

Step 1 : Develop a Product That Satisfies Needs of Potential Customers

Step 2 : Chose a Target Price

3 : Derive a Target Cost p.u. = Target Price - Target Operating Income p.u

Step 4 : Perform Value Engineering to Achieve Target Cost.



Remember the total estimated cost as computed from above cost estimation on the basis of life cycle $\leq$ target cost

Target costing support system

It should be clear that target cannot operate in isolation; support systems are needed to feed it information. Kato (1993) listed the support systems needed in order to operate target costing successfully. They are as follows.

1. Sales pricing support systems : These are market research system, which have the following qualities :

- An ability to decompose product function into sub-function and supply information on that basis.
- Facilities to convert the value placed on each function into price.
- A value-price conversion table or database.
- A market research toolbox with various forecasting techniques.
- Simulation function (what-if, sensitivity analysis, etc.)

2. Target profit computation support systems

- Support mechanisms for strategy formulation, profit planning, human resource management and capital investment decision making.
- Product portfolio planning systems, which can calculate the optimal product mix in the future.
- Profit decomposition systems for each product.

3. Research and development support systems

- Computer graphics, computer aided design (CAD), computer aided engineering (CAE), etc.

At the initial design stage of a product, the considerable space occupied by the drawing tables of a typical design office has been replaced by computer terminals, and the time taken to work through an initial engineering drawing-and, more importantly, rework the drawing-has shortened dramatically as a result of the software currently available. Computer aided design (CAD) allows huge numbers of alternative configurations to be built in at the design stage of a product. The advanced graphics facilities of the typical CAD programme enable the draughtsman not only to move parts around the design, and instantly appreciate the effect of these changes on the finished product, but also to manipulate the drawing.

- Project management system to monitor and aid R&D activities based on expert systems or artificial intelligence (AI).

4. Research system for infusing target costs into products.

- Value engineering (VE) – in Japan these are based on cost tables reduction databases. (Cost tables are widely used in Japan and agencies exist to provide relevant data to different industries. The tables are extremely important and help accurate cost predictions and allow for a series of 'what if' question to be asked.)
- Variety reduction.

Cost definition on the basis of Value Addition

A **value added cost** is a cost that, if eliminated, would reduce the actual or perceived value or utility (usefulness) customers obtain from using the product or service. Examples are costs of specific product features and attributes desired by customers. For "Provalue", these features and attributes are adequate memory, desired preloaded software, clear images on the monitor, and prompt customer service.

A **non-value-added cost** is a cost that, if eliminated, would not reduce the actual or perceived value or utility (usefulness) customers obtain from using the product or service. It is a cost that the customer is unwilling to pay for. Examples of non-value-added costs are costs of producing defective products and machine breakdowns. Successful companies keep non-value added cost to a minimum.

Activities and their costs do not always fall neatly into value-added or non-value added categories. Some costs, such as supervision and production control, fall in a **gray area** because they include mostly value-added but also some non-value added aspects. Despite these troublesome gray areas, attempts to distinguish value-added from non-value added costs provide a useful overall framework for value engineering.

Problems

1. A company has the capacity of production of 80,000 units and presently sells 20,000 units at Rs.100 each. The demand is sensitive to selling price and it has been observed that every reduction of Rs.10 in selling price the demand is doubled. What should be the target cost at full capacity if profit margin on sale is taken as 25%?
What should be the cost reduction scheme by applying value engineering, if at present 40% of cost is variable with same % of profit ? If Rate of Return is 15%, what will be maximum investment at full capacity?
2. Bee manufacturing company sells its product at Rs. 1,000 per unit. Due to competition its competitors are likely to reduce price by 15%. Bee wants to respond aggressively by cutting price by 20% and expects that the present volume of 1,50,000 units p.a. will increase to 2,00,000. Bee wants to earn a 10% target profit on sales. Based on a detailed value engineering the comparative position is given below:

	Existing	Target
Direct material cost per unit	Rs. 400	Rs. 385
Direct manufacturing labour per unit	55	50
Direct machinery costs per unit	<u>70</u>	<u>60</u>
Direct manufacturing cost per unit (Total)	<u>525</u>	<u>495</u>
Manufacturing overhead:		
No. of orders (Rs. 80 per order)	22,500	21,250
Testing hours (Rs. 2 per hour)	4,500,000	3,000,000
Units reworked (Rs. 100 per unit)	12,000	13,000

Manufacturing overheads are allocated using relevant cost drivers. Other operating cost per unit for the expected volume are estimated as follows:

Research & development	Rs. 20
Design and processing	30
Marketing	100
Customer service	15

Calculate target costs per unit and target costs for the proposed volume showing break-up of different elements.

3. Avery inc, manufacture two component parts for the television industry:
 - Tvez: Annual production and sales of 50,000 units at a selling price of Rs. 40.60 per unit
 - Premia : Annual production and sales of 25,000 units at a selling price of Rs. 60 per unit.

Avery includes all R & D and design costs in engineering costs. There are no marketing, distribution or customer – service costs.

The direct and indirect cost incurred by Avery on Tvez and Premia are as follows:

Part	Tvez	Premia	Total
Direct materials cost (Variable)	8,50,000	6,00,000	14,50,000
Direct manufacturing labour costs (variable)	3,00,000	2,00,000	5,00,000
Direct machining costs (see note)	1,50,000	1,00,000	2,50,000
Indirect manufacturing costs			
Machine set up costs			86,250
Testing costs			4,87,500
Engineering costs			<u>4,50,000</u>
Total costs			<u>32,23,750</u>

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

Avery's management identifies the following activity cost pools, cost drivers for each activity and the cost per unit of cost driver for each overhead cost pool:

Manufacturing Activity	Description of activity	cost driver	cost per unit of cost driver
Set up	Preparing machine to manufacture a new batch Of products	set up hrs	Rs. 25 per set up hour
Testing	Testing components and final product (Avery tests Each unit of Tvez & Prima individually	Testing hrs	Rs.2 per testing hours
Engineering	Designing products & processes and ensuring Their smooth functioning	complexity of product & Processes	costs assigned to products by special study.

Additional information is as follows:

Part	Tvez	Premia
Production batch sizes	500 units	200 units
Set up time per batch	12 hours	18 hours
Testing & inspection time per unit of production produced	2.5 hours	4.75 hours
Engineering costs incurred on each product	Rs. 1,70,000	Rs. 2,80,000

Avery is facing competitive pressure to reduce the price of Tvez & has set a target price of Rs. 34.80, well below its current price of Rs. 40.60. The challenge for Avery is to reduce the cost of Tvez. Avery's engineers have proposed new product design and process improvement for the "new Tvez" to replace Tvez. The new design would improve product quality, and reduce scraps and waste. The reduction in prices will not enable Avery to increase its current unit sales. However, if Avery does not reduce prices, it will lose sales.

The expected effects of new design relative to Tvez are as follows:

- Direct materials costs for new Tvez are expected to decrease by Rs. 2.00 per unit
- Direct manufacturing labour costs for new Tvez are expected to decrease by Re. 0.50 p.u.
- Machining time required to make new Tvez is expected to decrease by 20 minutes. It currently takes 1 hours to manufacture 1 unit of Tvez. The machines will be dedicated to the production of new Tvez.
- New Tvez will take 7 set up hours for each set up.
- Time required for testing each unit of new Tvez is expected to be reduced by 0.5 hour.
- Engineering costs will be unchanged.

Assume that the batch sizes are the same for New Tvez as for Tvez. If Avery requires additional resources to implement the new design, it can acquire these additional resources in the quantities needed. Further assume the costs per unit of cost driver for the new Tvez are the same as those for Tvez.

Required:

1. Calculate the full cost per unit for Tvez and Premia using activity – based costing.
2. What is the mark up on the full cost per unit for Tvez?
3. What is Avery's target cost per unit for New Tvez if it is to maintain the same markup percentage on the full cost per unit was it had for Tvez?
4. Will the New Tvez design achieve the cost reduction targets that Avery has set? Explain.
5. What price will Avery charge for New Tvez if it uses the same markup percentage on the full cost per unit for new Tvez as it did for Tvez?

List the possible management actions that Avery should take regarding New Tvez.

4. Sterling Enterprises has prepared a draft budget for the next year as follows:

Quantity	10,000 units
Sales price per unit	30
Variable costs per unit: Direct Materials	8
Direct Labour	6
Variable overhead (2 hrs × Re. 0.50)	1
Contribution per unit	15
Budgeted Contribution	1,50,000
Budgeted Fixed costs	1,40,000
Budgeted Profit	10,000

The Board of Directors is dissatisfied with this budget, and asks a working party to come up with an alternate budget with higher target profit figures.

The working party reports back with the following suggestions that will lead to a budgeted profit of Rs. 25,000. The company should spend Rs. 28,500 on advertising, but the target sales price up to Rs. 32 per unit. It is expected that the sales volume will also rise, inspite of the price rise, to 12,000 units.

In order to achieve the extra production capacity, however, the work force must be able to reduce the time taken to make each unit of the product. It is proposed to offer a pay and productivity deal in which the wage rate per hour is increased to Rs. 4. the hourly rate for variable overhead will be unaffected.

Ascertain the target labour time required to achieve the target profit.

J.I.T. , M.R.P. & E.R.P.

Learning objective

Idea of modern inventory & production management as compare to the traditional concept

Just –in-time(JIT) production (also called lean production) is a “ demand- pull” manufacturing system in which each component in a production line is produced immediately as need in which by the next step in the production line. In a JIT production line, manufacturing activity at any particular workstation is promoted by the need for that station’s output at the following station. Demand triggers each step of the production process, starting with customer demand for a finished product at the end of the process and working all the way back to the demand for direct materials at the beginning of the process. In this way, demand pulls and order through the production line.

The demand-pull features of JIT production systems, achieve close coordination among workstations. It smoothes the flow of goods, despite low quantities of inventory. JIT production systems aim to simultaneously

- (1) meet customer demand in a timely way
- (2) with high-quality products and
- (3) at the lowest possible total cost.

Companies implementing JIT production systems manage inventories by eliminating (or least minimizing) them. There are five main features in a JIT production system :

- ◆ Organize production in manufacturing cells, a grouping of all the different types of equipment used to make a given product. Materials move from one machine to another where various operations are performed in sequence. Materials—handling costs are minimized.
- ◆ Hire and retain workers who are multi-skilled so that they are capable of performing a verity of operations and task. These tasks include minor repairs and routine maintenance of equipment. This training adds greatly to the flexibility of the plant.
- ◆ Aggressive pursue total quality management (TQM) to eliminate defects. Because of the tight links stages in the production line, and the minimum inventories at each stage, defect arising at one stage quickly affect other stages. JIT creates an urgency for solving problems immediately and eliminating the root cause of defects as quickly as possible.
- ◆ Place emphasis on reducing setup time. Reducing setup time makes production in smaller batches economical which in turn reduce inventory levels. Reducing manufacturing lead time enables a company to respond faster to changes in customer demand.
- ◆ Carefully selected suppliers who are capable of delivering quality materials in a timely manner. High-quality goods and make frequent deliveries of the exact quantities specified on a timely basis. Suppliers often deliver materials directly to the shop floor to be immediately placed into production.

Features, benefits, Pre-requisites & Effect of JIT?**Features :**

- a) Low or Zero inventories; emphasis on operation from source to customer .
- b) Emphasis on customer service and timing.
- c) Short of operations.
- d) Flexibility of operations.
- e) Efficient flow
- f) Use of kanban and Visibility.

Benefits :

- a. Reduce inventories and WIP
- b. Reduce space requirements, set up time
- c. Shorter throughput times
- d. Greater employees involvement, participation and motivation
- e. Smooth work force
- f. Greater productivity
- g. Improved product /service quality
- h. Improved customer service and smaller batch size.
- i. More uniform loading of facilities.

Pre –requisites of JIT:

- | | |
|------------------------------|-----------------------------|
| (i) Low variety | (ii) Demand stability |
| (iii) Vendor reliability | (iv) Defect free materials. |
| (v) Good communication | (vi) Preventive maintenance |
| (vii) Total quality control. | |

Desirable factor of JIT :

- | | |
|-----------------------------|---------------------------|
| (i) Management commitment | (ii) Employee investment. |
| (iii) Employee flexibility. | |

Effect of using JIT (Just in Time) in Inventory Control.

- i. saves cost due to lead time
- ii. saves cost due to holding inventory like insurance, spoilage, obsolescence etc.
- iii. does away with locking up of funds in inventory
- iv. helps very much in working capital management

Back flushing in a JIT system

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

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

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

- (i) The total production quantity entered into the system must be absolutely correct, if not, then wrong components and quantities will be subtracted from the stock.
- (ii) Abnormal scrap must be diligently tracked and recorded. Otherwise materials will fall outside the back flushing system and will not be charged to inventory.
- (iii) Lot tracing is impossible under the back flushing system. This is required when a manufacturer needs to keep records of which production lots were used to create a product in case all the items in a lot need be recalled.
- (iv) The inventory balance may be too high at all times because the back flushing transaction that relieves inventory usually does so only once a day, during which time other inventory is sent to the production process. This makes it difficult to maintain an accurate set of inventory records in the warehouse.

Traditional Inventory Management :

1. Identify the levels Minimum level, Maximum level, Re-order level

2. Compute $EOQ = \sqrt{\frac{2 \times \text{Annual consumption} \times \text{ordering cost per order}}{\text{Carrying cost per unit per annum}}}$

3. Total ordering & carrying cost = total relevant cost

$$= \sqrt{2 \times \text{Annual consumption} \times \text{ordering cost per order} \times \text{carrying cost p.u. p.a.}}$$

4. Stock Out Cost: Select that level where total of annual carrying or storing cost and stock out cost is minimum.

Stock out cost = $\sum$ ROL $\times$ Probability $\times$ Stock-out cost p.u.

Storing cost = increase in stock $\times$ storing cost p.u. p.a.

Traditional Problems:

1. The Heavy Nitro Company is considering the optimal batch size for re-order of concentrated sulfuric acid. The Management Accountant has supplied the following information :

The purchase price of H_2SO_4 is Rs. 800 per gallon. The clerical and data processing costs are Rs. 100 per order. All the transport is done by rail. A charge of Rs. 4,000 is made each time the special line to the factory is opened. A charge of Rs.20 per gallon is also made. The company uses 40,000 gallon per year. Maintenance costs of stock are Rs. 25 per gallon per year.

Each gallon requires $\frac{1}{2}$ sq.ft of storage space. If warehouse space is not used, it can be rented out to Manganese Ltd. at Rs. 200 per sq.ft. p.a.. Available warehouse space is 1,000 sq. ft. The short of overhead costs being Rs. 1,20,000 p.a. Assume that all free warehouse space can be rented out.

Calculate the economic re-order size. & total inventory cost.

2. The stock control policy is that each stock items will order twice a year. The materials manager, however, wishes to introduce a policy in which for each item of stock, reorder levels and EOQ is calculated. For one of the item X, the following information is available :

Forecast annual demand	3,600 units
Cost / unit	Rs. 100
Cost of placing an order	Rs. 40
Stock holding cost	20% of average stock value
Lead time	1 month

It is estimated by the materials manager that for item X, a buffer stock of additional 200 units should be provided to cover fluctuations in demand. If the new policy is adopted, calculate for stock items X :

- the reorder level that should be set by the materials manager ;
- the anticipated reduction in the value of the average stock ;
- the anticipated reduction in total inventory cost in the first and subsequent years.

(Nov 2001 Q-4)

3. 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

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	Rs.	2.00	0.80
Order placing costs per order	Rs.	15.00	15.00
Carrying costs p.a.		20%	20%

Required:

- Prepare a budget of production and requirements of components for the next year.
- Find the economic order quantity.
- 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)

4. A company is considering the possibility of purchasing from a supplier a component it now makes. The supplier will provide the components in the necessary quantities at a unit price of Rs. 9. Transportation and storage costs would be negligible.

The company produces the component from a single raw material in economic lots of 2,000 units at a cost of Rs. 2 p.u. Average annual demand is 20,000 units. The annual holding cost is Rs. 0.25 p.u. & the minimum stock level is set at 400 units. Direct labour costs for the component are Rs. 6 per unit, fixed manufacturing overhead is charged at a rate of Rs. 3 per unit based on a normal activity of 20,000 units. The company also hires the machine on which the components are produced at a rate of Rs. 200 per month. Should the company make the component?

Just-In-Time

5. X Video Company sells package of blank video tapes to its customer. It purchases video tapes from Y Tape Company @ Rs. 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 quality merchandise. Annual demand of X Video Co. 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 its costs Rs. 2 per order. The relevant insurance, material handling etc. Rs. 3.10 per package per year.

X Video Co. has to decide whether or not to shift 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 1,000 packages 13 times a year with additional amount of Rs. 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 videotape packages under a JIT purchasing policy. In the event of a stock out X Video Co. has to rush order tape packages which costs Rs. 4 per package. Comment whether X Video Company to implement JIT purchasing system.

Z Co. also supply video tapes in 50 units per order. It agrees to supply @ Rs. 136 per packages under JIT delivery system. If video tape purchased from Z Co., relevant carrying cost would be Rs. 3 per package against Rs. 3.10 in case of purchasing from Y tape Co. However Z Co. doesn't enjoy so sterling 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 Rs. 8 from stock out.
- Customer would likely return 2% of all packages due to poor quality of the tape and to handle this return a additional cost of Rs. 25 per package.

Comment whether X Video Co. places order to Z co.

6. X Ltd. Manufactures and distributes three types of car (the C1, C2, and C3). Each type of car has its own production line. The company is worried by extremely difficult market condition and forecasts losses for the forthcoming year.

Current operations: The budgeted details for next year are as follows:

	C-1 Rs.	C-2 Rs.	C-3 Rs.
Direct materials	2,520	2,924	3,960
Direct labour	<u>1,120</u>	<u>1,292</u>	<u>1,980</u>
Total direct cost per car	<u>3,640</u>	<u>4,216</u>	<u>5,940</u>
Budgeted production (cars)	75,000	75,000	75,000
Number of production runs	1,000	1,000	1,500
Number of order executed	4,000	5,000	5,000
Machine hours	10,80,000	18,00,000	16,80,000

Annual overheads:

	Fixed (Rs.'000)	Variable (Rs.)
Set ups	42,660	13,000 per production run
Materials handling	52,890	4,000 per order executed
Inspection	59,880	18,000 per production run
Machining	1,44,540	40 per machine hour
Distribution and warehousing	42,900	3,000 per order executed

Proposed JIT system

Management has hired a consultant to advise them on how to reduce costs. The consultant has suggested that the company adopts a just in time (JIT) manufacturing system. The introduction of JIT system would have the following impact on costs (fixed and variable):

Direct labour	Increase by 20%
Set ups	Decrease by 30%
Materials handling	Decrease by 30%
Inspection	Decrease by 30%
Machining	Decrease by 15%
Distribution & Ware housing	Eliminated

Required:

- Based on the budgeted production levels, calculate the total annual savings that would be achieved by introducing the JIT system.
- The following table shows the price/ demand relationship for each type of car per annum.

C-1		C-2		C-3	
Price (Rs.)	Demand	Price (Rs.)	Demand	Price (Rs.)	Demand
5,000	75,000	5,750	75,000	6,500	75,000
5,750	65,000	6,250	60,000	6,750	60,000
6,000	50,000	6,500	45,000	7,750	45,000
6,500	35,000	7,500	35,000	8,000	30,000

Assuming that X Ltd. Adopts the JIT system and that revised variable overhead cost per car remains constant (as per the proposed JIT system budget), calculate the profit maximizing price and output level for each type of car.

- Investigations have revealed that some of the fixed costs are directly attributable to the individual production lines and could be avoided if a line is closed down for the year. The specific fixed costs for each of the production lines, expressed as a percentage of the total fixed costs, are:

C-1	4%
C-2	5%
C-3	8%

Determine the optimum production plan for the forthcoming year (based on the JIT cost structure and the prices and output levels you recommended in answer to requirement (b)).

Materials Requirement Planning (MRP) system

Materials requirements planning (MRP) is a “push-through” system that manufactures finished goods for inventory on the basis of demand forecasts.

MRP uses:

- (1) demand forecasts for the final products;
- (2) a bill of materials outlining the materials, components, and subassemblies for each final product and ;
- (3) the quantities of materials, components , finished products, and product inventories to predetermine the necessary outputs at each stage of production.

Taking into account the lead time required to purchase materials and to manufacture components and finished product, a master production scheduled specific the quantity and timing of each item to be produced. Once schedule production states, the output of each departments is pushed through the production line whether it is needed or not. The result is often an accumulation of inventory at workstations that receive work they are not yet ready to process.

Requirements for operation of a MRP system

- (i) **Master production schedule** : It specifies the quantity of each finished unit of products to be produced along with the time at which each unit will be required.
- (i) **Bill of materials file** : This file specifies the sub-assemblies, components and materials requirement for each item of finished goods.
- (ii) **Inventory file** : It maintains details of items in hand for each sub-assemblies, omponents and materials required.
- (iii) **Routing file** : This file specifies the sequence of operations required to manufacture components sub-materials required.
- (v) **Master parts file** : It contains information about the production time of sub-assemblies and components produced internally and lead time for externally procured items.

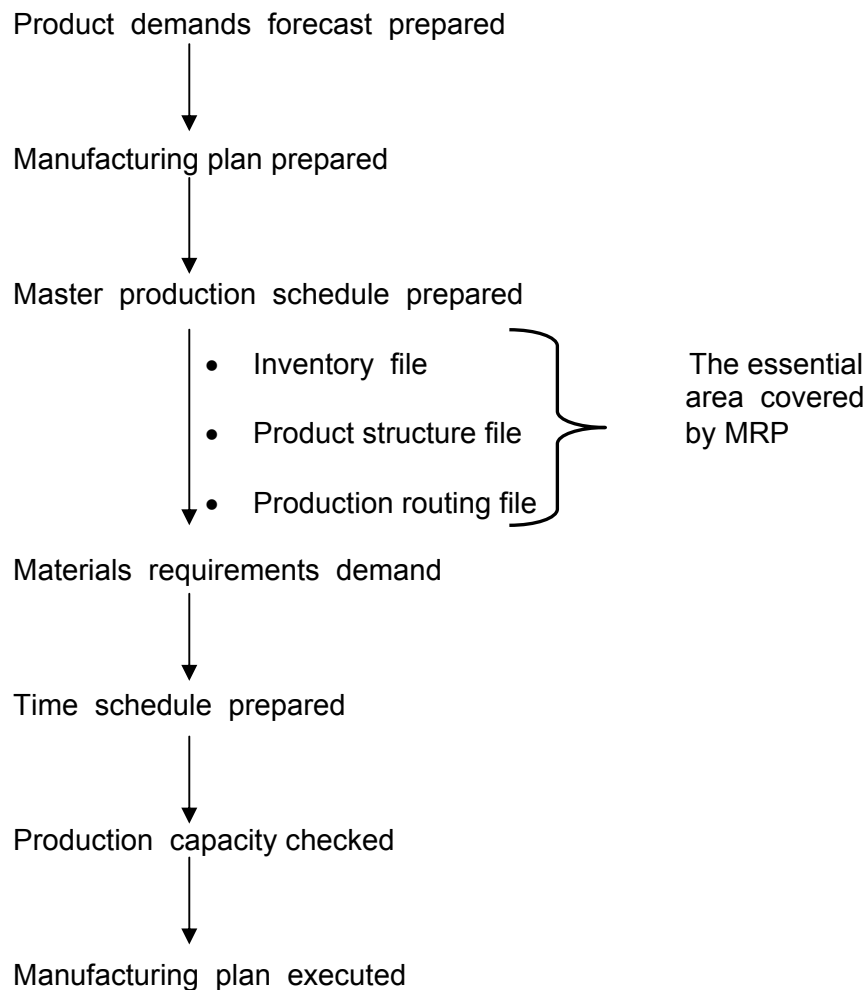
Objectives of MRP :

- It determines the quantity and timing of finished goods demanded.
- It determines time phased requirements of the demand for materials, components and sub assemblies over a specified planning time horizon.
- It computes the inventories, work – in – progress batch sizes and manufacturing and packing lead times.
- It controls inventory by ordering components and materials in relation to orders revived rather than ordering them from stock level point of view.

MRP- II

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 :

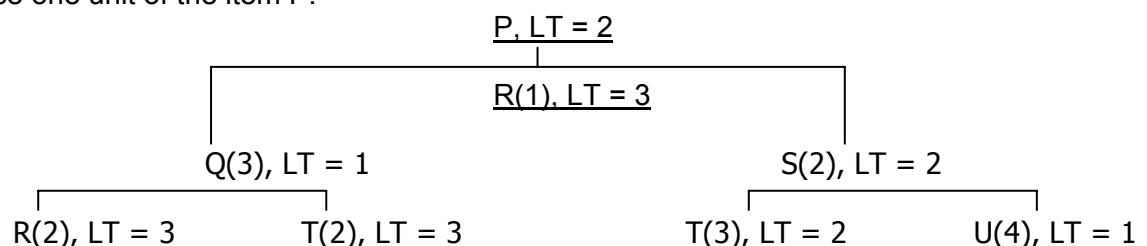


From that document, a manufacturing, plan is developed based upon inputs from purchasing & production. Adjustments may be necessary to allow for production rates. Possible inventory levels in seasonal trades & the size of the workforce. The manufacturing plan leads into a detailed master production schedule 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.

Problems

- The sketch below illustrates the lead times and the quantities needed of various components to produce one unit of the item P.



Based on the above, find out the time schedule of the requirements if 50 units of the end product P are required to be shipped on day, 8. Specify in particular how many units of the following items are required and by what day the order should be enclosed for T, U, & Q.

2. Jayanagar Chair Co., (JCC) makes office chairs mainly with a steel frame, Plastic-thread work and two beautifully carved wooden arm-rests. The latter are procured from a wood turning shop which supplies JCC with a lead time of five weeks and in a lot size of 2,000 arm-rests. As per JCC's customers' requirements, the delivery schedule for completed chairs is :

Week No.	1	2	3	4	5	6	7	8	9	10
No. of Chairs Required		200	200			150	500	700	300	380

The wooden chair handles are almost the last item to go into JCC's chairs and the lead time for the final assembly of the chair can be taken as one week.

There are 50 completed chairs in stock in JCC's finished goods' warehouse and 800 wooden handles in the plant's store. Due to the orders placed earlier, 2,000 wooden handles are scheduled to arrive in week 4. A safety stock of 50 wooden handle is recommended.

Draw a MRP for the wooden handles.

ENTERPRISE RESOURCE PLANNING (ERP)

Enterprise Resource Planning (ERP) is the latest high-end solution which information technology has lent to business application. The ERP solution seek to streamline and integrate operation process and information flows in the company to synergies the resources of an organisation namely men, material, money and machine though information.

Enterprise resource planning software or ERP attempts to integrate all departments and functions across a company into a single computer system that can serve all those different departments particular needs. In fact ERP combines all computerised departments together with the help of a single integrate software program that runs off a single database so that various department can more easily share information and communicate with each other.

The need for ERP:

Most organisation across the world have realised that in a rapidly changing environment, it is impossible to creates and maintain customer designed software package which will cater to all their requirements and be up-to-date. Realising the requirement of user organisations, some of the leading software companies have designed Enterprise Resource Planning software, which offers an integrated software solution to all the function of an organisation.

Components of ERP :

To enable the easy handling of the system, ERP has been divided the following core subsystems, sales and marketing, master scheduling, materials requirements planning, capacity requirement planning, bill of materials, purchasing, shop floor control, accounts payable/receivable , logistic, assets management and financial accounting.

Features of ERP

- ERP facilities company—wide Integrated Information System covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory, accounts, human resources, purchases etc.
- ERP perform core activities and increases customers service, thereby augmenting the corporate image.
- ERP bridge the information gap across organisations.
- ERP provides complete integration of system not only across departments but also across companies under the same management ;
- ERP is the solution for better project management.

- ERP allows automatic introduction of the latest technologies like Electronic Fund Transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video conferencing, E—commerce etc.
- ERP eliminates most business problems like materials shortages, productivity enhancements, customer service, cash management, inventory problems, quality problems, prompt delivery etc.
- ERP not only addresses the current requirement of the company but also provide the opportunity of continually improving and refining business Processes.
- 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 and thus improve their business processes.

Benefits of ERP

1. Product Costing : Determination of cost of products correctly, is quite critical every industry. ERP supports advances costing methods, including standard costing, actual costing and activity—based costing. Additionally, all costing methods and information can be fully integrated with finance.
2. Inventory Management : ERP can be used in multi-national, multi – company, and multi—site manufacturing and distribution environments. This system simplifies complicated logistics by allowing one to plan and manage companies in different countries as a single unit and its advanced functionality allows one to process product and financial information flows in several different ways.
Inventory reporting supports all reporting of specific & general types of stock transaction such as various types of stock transfers, re-classification, ID changes & physical inventory results.
3. Distribution & Delivery: Flexibly & efficiently to deliver the right product from the right warehouse to the right customer at the right time. To the customer, the most important element is quality of one-time delivery. It doesn't matter how well a product is made if arrives late. It requires application of automatic or manual load planning, transportation planning for in-house vehicles or third party agents, EDI support for transport booking, confirmation & dispatch.
4. E – Commerce : Internet enables ERP to act efficiently (Case Study : Wal-Mart) ,
5. Automatic Control : It ensure automatic quality control procedure.
6. Sales Service : It ensures better after sales service.
7. Improvement in Production Planning : It improved production planning.
8. Quick response: It enables quick response to change in business operations & market conditions.
9. Cumulative Edge's: It helps to achieve competitive advantages by improving business process.

Reasons for implementation of ERP

1. Improve a company business performance : ERP automates the tasks involved in performance a business process – such as order fulfillment which involves taking an order from a customer, shipping it and billing for it. With ERP, When a customer service representative takes an order from a customer, he or she has all the information necessary to complete the. Everyone else in the company sees the same computer screen and has access to the single database that holds the customer's new order. When one departments finishes with the order is at automatically routed via the ERP system to the next department.
2. Standardize manufacturing processes : Manufacturing companies --- especially those with an appetite for mergers and acquisitions --- often find that multiple business units across the company make the same widget using different methods and computer systems,

Standardizing those processes and using a single, integrated computer system can save time, increase productivity & reduce headcount.

3. **Integrate Financial data:** As the CEO tries to understand the company's overall performance, he or she may find many different versions of the truth. Finance has its own set of revenue numbers, sales has another version, & the different business units may each have their own versions of how much they contributed to revenues. ERP creates a single version of the truth that can't be questioned because everyone is using the same system.
4. **To standardise HR information :** Especially in companies with multiple business units, HR may not have a unified, simple method for tracking employee time and communicating with them about benefits and services. ERP can fix that.

COSTING OF SERVICE SECTOR

The application of Service Costing:

Service costing can be applied to service provided to customers outside the organisation, for example, the services supplied by transport operations, hospitals and hotels.

It can also be applied to internal services and functions which do work for other departments within the same organisation. For example, service costing can be applied to the services supplied by the canteen, the maintenance department and the personal function.

Establishing a suitable cost unit:

Many of these services produce an intangible 'output', that is, their output cannot be physically seen & touched. In order to maintain effective cost control it is essential to establish a measurable cost unit for which we can ascertain and monitor the costs, e.g.

- | | | |
|-------|-----------------------|--|
| (i) | Hotel | : bed-night or room-night. |
| (ii) | Hospital | : in patient day. |
| (iii) | Haulage contractor | : ton-Kilometer (Absolute or commercial) |
| (iv) | Passenger transport | : Passenger Kilometer |
| (v) | Power house | : Kilo watt hour (KWH) or MWH |
| (vi) | Educational institute | : No. of students |

Establishing the cost per unit:

Once a suitable cost unit has been selected, the cost for each unit can be determined using the same average method as for continuous operations:

Average cost p.u. of Service =

$$\text{Total Costs incurred in period} \div \text{Number of units of service supplied in the period}$$

The instantaneous & perishable nature of services:

Many services are provided instantaneously rather than for inventory (stock); for example, a restaurant meal is cooked as it is ordered by the customer. This brings with it particular management problems of planning and control but it does mean that the incidence of WIP is very low, that is, it is rarely necessary to value part-finished units of service at the end of an accounting period.

Many services also 'perish' immediately; for example, if a cinema seat is vacant when a film is showing it cannot be stored in inventory (stock) for a later sale. The opportunity to gain revenue from that seat at that particular showing of the film has been lost forever. Therefore, capacity utilization becomes a very important issue for managers in many service organisation.

Pricing by service sector:

The service provided by service sector has no physical existence, a value is to be fixed and billed for its clients. Most of the service organisations use a form consisting of time and material pricing to arrive at the price of a service. Service companies such as appliance repair shops, automobile repair business, calculate their prices by using two computations, one for labour and other for materials and parts. A mark-up percentage may also be added to the cost of labour, materials and parts to arrive at the price to be billed. For professionals, direct labour costs and apportioned overhead and indirect costs are considered for pricing.

Problem for adoption of ABC system in service organization –

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

Customer costing

can be introduced in a company engaged in courier service where the costs to serve the customers vary with the type of service selected by customers (how fast the package is to be delivered), the destination, weight, size of package and whether the package is to be collected from customers' location or will be dropped at the office of the courier firm. The firm could use an efficient system of internet strategy to accomplish the tasks like preparing labels at the customers' site, arranging of pick up, dropping at the destination and tracking and tracing packages. The system calculates the freight charges, invoices customers daily and produces customized reports. These parameters can be used with the objective of determining customer profitability and based on the costs involved in handling each customer, the firm can even offer volume discounts to customers who use the services heavily.

Problems :

1. The Ludford Hotel and conference centre is used for conference bookings and private guest bookings. Conference bookings use some bedrooms each week, the balance being available for private guests.

Data has been collected relating to private guest bookings (i.e. non-conference bookings), which are summarised below for a ten-week period

Week	Double rooms available Private guest booking	Number of guests'	Average stay (nights)
1	55	198	2.1
2	60	170	2.6
3	72	462	1.4
4	80	381	3.2
5	44	83	5.6
6	62	164	3.4
7	80	348	2.6
8	54	205	1.7
9	80	442	1.8
10	24	84	3.2

Some of the costs for private guest booking vary with the number of guests, regardless of the length of their stay, while others vary with the number of rooms available in any week.

Variable cost per guest Rs.17.50

Variable cost per week per room available Rs.56.00

The general fixed cost for private guest bookings per week is Rs.8,100. The hotel charges Rs.30 per person per night for accommodation for private guest bookings.

Requirements:

- (a) Calculate the total cost per guest night for private guest bookings over the ten-week period.
- (b) Calculate the occupancy percentage over the ten weeks for the private guest bookings.
- (c) Calculate the contribution and profit for private guest bookings for the ten-week period.

2. The management of New Hotel has prepared the budget, which shows the following room occupancy :

	<u>Average %</u>
January-March	45
April-June	60
July-September	90
October-December	55

Revenue for the year is estimated to be Rs. 30,00,000 and arises from three profit centers :

Accommodation	45 %
Restaurant	35 %
Bar	<u>20 %</u>
Total	<u>100%</u>

The accommodation revenue is earned from several different categories of guest, each of which pays a different rate per room. The three profit centers have the following percentage gross margins:

	<u>Accommodation</u>		<u>Restaurant</u>		<u>Bar</u>	
	%	%	%	%	%	%
Revenue		100		100		100
Wages	20		30		15	
Cost of Sales	--		40		50	
Direct costs	<u>10</u>	<u>30</u>	<u>10</u>	<u>80</u>	<u>5</u>	<u>70</u>
		<u>70</u>		<u>20</u>		<u>30</u>

Fixed costs for the year are estimated to be Rs. 5,65,000. Capital Employed is Rs. 70,00,000. To improve the Return on Capital Employed (ROCE) two suggestions have been made :

- i) to offer special two-night holidays at a reduced price of Rs. 25 per night. It is expected that those accepting the offer would spend an amount equal to 40% of the accommodation charge in the restaurant, and 20% in the bar. The gross margin percentages for the three profit centers would remain same as above.
- ii) to increase prices. Management is confident that there will be no drop in volume of sales if restaurant prices are increased by 10% and bar prices by 5%. Accommodation prices would also need to be increased.

a. calculate the budgeted return on capital employed before tax ; and

b. calculate;

- i) how many two-night holidays would need to be sold each week in the three off-peak quarters to improve the return on capital employed by a further 4% above the percentage calculated in a) above.
- ii) by what percentage the prices of accommodation would need to be increased to achieve the desired increase in ROCE shown in b) i) above.

3. Mr. Philips 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 season were as under:

	Gift shop		Restaurant		Lodge (Rs.'000)	
	Amt.	%	Amt	%	Amt.	%
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 & taxes	1,920	4	6,400	10	36,000	20
Depreciation	2,880	6	8,000	12 ½	39,600	22
Salaries	4,800	10	4,800	7 ½	25,200	14
Electricity charges	<u>960</u>	<u>2</u>	<u>3,200</u>	<u>5</u>	<u>13,500</u>	<u>7 ½</u>
Total	<u>39,360</u>	<u>82</u>	<u>64,000</u>	<u>100</u>	<u>1,28,700</u>	<u>71 ½</u>
Profit	<u>8,640</u>	<u>18</u>	<u>---</u>	<u>-</u>	<u>51,300</u>	<u>28 ½</u>

Additional information:

- 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.
- Insurances and Taxes and depreciation are for the entire of twelve months.
- Salaries paid are for the season period except a Chowkidar for the lodge who is paid for the full year at Rs. 4,000 per month.
- Electricity charges include fixed charges of Rs. 640, Rs. 1,920 and Rs. 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 and restaurant. Fixed electric charges are for the season except in case of lodge where Rs. 6,900 is for the season and Rs. 3,000 for the entire period of twelve months.

Mr. Philips is interested in increasing his net income. The following two options are under his considerations:

- To continue the operations during the season period only by inserting advertisement in newspapers thereby occupancy rate to 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 Rs. 1,20,000.
- 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 Chartered Accountant would you like to suggest him any other alternative based upon the above figures, which can adopted to earn more net profit? (use incremental revenue and cost approach).

- Car Services Ltd. (CSL), renders motor vehicle breakdown recovery service to its members. It attracts new members through a television advertising campaign that encourages potential clients to telephone a free call number for further information and the opportunity to immediately enroll with a credit card. Members are offered the choice of three levels of annual service contract in descending order of coverage and price: Gold, Silver and Standard.

The telephone enquires come through to a call centre staffed by CSL employees at the company's premises who are paid a basic salary and a bonus for each new member that they successfully enroll.

Located in the same building on another floor is the Car Hospital (CH) team who take the calls from the stranded motorists and arrange for a franchised garage to deal with the breakdown. These garages are independently owned and CSL pay them a fee for every callout that they undertake.

CSL has recently (after January 2007) commenced employing trained mechanics on enhanced salaries to dispense technical advice to members on the telephone in the hope that a proportion of the call-outs to franchised garages will be avoided. Detailed information on costs, revenues, business activity and staff is displayed in the following tables.

Table 1: Cost, Revenue & business Activity data	Gold	Silver	Standard
Annual subscription fee	Rs. 120	Rs. 80	Rs. 65
Probability of a member's requiring The call out service during the year	0.25	0.4	0.3
Fee paid to garage per call out	Rs. 80	Rs. 70	Rs. 50
Number of members	47,500	59,000	1,21,000
% of members who represent new members during the year	20%	30%	40%
Specific fixed administration	Rs. 9,73,000	Rs. 9,26,000	Rs. 14,28,200

The general fixed overhead of the business is Rs. 35,00,000 for the year (this excludes the CH and call centre staff costs).

Table 2 : Call Centre Data

- The call centre operates for eight hours per day, five days a week for 52 weeks per year.
- The 50 staff employed all work a 40 hour week
- 10% of the call centre staff are absent at any one time because illness, holidays etc.
- Each call centre employee receives an annual salary of Rs. 10,000 and a bonus for each new member that they enroll. Bonus paid per new member:

Gold – Rs. 24 Silver – Rs. 22 Standard – Rs. 20
- During their period on duty each call centre employee manages to deal on average with four telephone enquires per hour. Assume that all potential customers only make one call. Potential customers can only apply via the call centre and only a minority of the calls results in an enquiry being converted into a member.

Table 3: Employment details for the Car Hospital team

1. The CH is composed of 12 members, of which two are trained motor mechanics.
2. Salaries of non mechanically trained staff Rs. 15,000 per annum. Salaries of mechanically trained staff Rs. 20,000 per annum.

Calculate the total profit of the company.

5. A drug treatment day center run by a charity organisation wishes to improve the quality of its service to patients by the addition of extra facilities.

After much research it has drawn up a 'short list' of five separate possible improvements and has assessed their outcomes using the following criteria:

Criterion A:	Reduced average number of waiting hours per month per patient.
Criterion B:	Increased percentage frequency of seeing patients when they attend.
Criterion C:	Reduced average number of 'months to cure' per patient.
Criterion D:	Increased percentage frequency of patient attendance at the centre.

The assessed outcomes are:

Improvement Reference number	Extra facilities	outcome according to criterion			
		A	B	C	D
		Hours	%	Months	%
1.	Increase medical staff by 2 doctors and 1 nurse	4.8	35	1	5
2.	Increase counseling staff by 2 counselors and 1 nurse	6	20	1.25	10
3.	Taxi service to bring patients to and from the centre	2	12	0.75	22
4.	Extend by 20 hours per month the time the centre is open	4	30	1.5	10
5.	Introduce group counseling sessions	--	10	1.75	15

At present the center is open for 160 hours per month and deals with 3,000 patients.

The proposed improvement will have no effect on the number of patients seen. The professional staff currently employed are 5 doctors, 7 counselors and 4 nurses.

The taxi service is expected to be used by 60% of patients with an average attendance of once per month. Each taxi will carry an average of 1.2 patients and the cost to the center will be Rs. 0.20 per mile. Total distance that patients are expected to be carried per attendance are:

Percentage of patients:	20	40	40	100
Miles:	10	20	30	-

The costs of extra facilities would be:

	Cost p.a.	Associated capital Equipment costs*
Doctor's salary	Rs. 8,22,000	Rs. 5,00,000
Doctor's expenses	3,00,000	----
Counsellor's salary	7,16,000	2,00,000
Counsellor's expenses	1,50,000	----
Nurse's salary	2,70,000	1,00,000
Nurse's expenses	2,00,000	----

* These costs are depreciated over five years on a straight – line with no residual value.
Extra administration / establishment costs are Rs. 200 per month per person.

If hours are extended beyond 160 per month, overtime will need to be paid at a premium of 25% on salaries (but not expenses) and an extra Rs. 4,000 per annum will be incurred for administration / establishment costs.

Group counseling sessions will require:

- A. 1 specialist counselor costing Rs. 3,000 p.a. more than ordinary counselors*
- B. 1 assistant counselor costing Rs. 2,000 p.a. less than ordinary counselors*
- C. 1 nurse

* capital costs will be the same as for ordinary counselors.

You are required to: Calculate for each improvement the incremental cost: Per patient per month.
(Ref: Bank)

6. A large manufacturing company has a captive power plant as part of its main works facilities. The company generates its requirements of energy in this plant for 24 hours. The following details are available:-

	Steam	Electricity
(i) Production in Million units	13.5	750
(ii) Fuel: (Rs. Millions)	--	3.5
Boiler Coal	108.0	
Pitch	32.4	
(iii) Utilities: (Rs. Million)		
Steam		90.00
C.O./B.F. Gas	121.5	
Electricity	21.6	
Water, Compressed air etc.	13.5	15.0
(iv) Fixed Costs (Departmental & Allocated Costs)	40.50	15.0

Power can be purchased from the State Electricity Board at 18 paisa per unit. Recently the State Electricity Board has announced a lower tariff for power supply during the hours 10 P.M. to 6 A.M. at 12 paisa per unit. Decide. (75% of the Cost of utilities as variable)

(Nov. 1978 Q:2)

Total Quality Management (TQM)

Learning Objective

1. how to apply quality check
2. identify quality related costs
3. application of quality cost in decision making

TQM may be defined as the continues improvement in quality , productivity & effectiveness obtained by establishing responsibility for process as well as output.

TQM is a philosophy & a movement rather than a body of technique. There are many alternative models & definitions of TQM.

Definition of Quality: (Check carefully how the definitions changes from Seller's market to Buyer's market)

1. The first definition given was quality is **conforming to specifications**. Generally the specifications are set by the producers.
2. The Second definition given for quality was **fitness for use**. A product which is usable and conforms to all the specifications given, will generally be a good product. But a good product, which is not saleable, will not be appreciated. To sell a product it is necessary to incorporate customers, viewpoint. A customer will buy a product only if the cost, reliability, aesthetics, etc. suit his conditions. Hence customer focus has to be given prime importance and even in defining the quality, customer focus has to be stressed.
3. The third definition given for quality was **customer satisfaction**. A product, which satisfies the customer, will have a great market. The customer will also be happy that the product of his choice is being given to him. A person will be satisfied if all his needs are fulfilled.

The following factors are the commonly expressed "satisfaction" of the Customer:

- | | |
|--|---------------------------|
| (i) Utility value | (ii) Affordable cost |
| (iii) Longer life | (iv) Reliable performance |
| (v) Product look | (vi) Ease of maintenance |
| (vii) Prompt after sales service, etc. | |

4. The fourth definition given to quality was **delighting the Customer**. Delightment is one step ahead of satisfaction. A delighted customer is definitely in a different, better planed as compared to a satisfied customer. When the product fulfils both the expressed and unexpressed, i.e., explicit and implicit needs of the customers, he is delighted. The industries decided that they should work towards delighting the customer by providing them the products which will fulfill both their expressed and unexpressed needs. Such a status will ensure good business and help in producing quality goods.

1. Quality as a competitive weapon

Many companies throughout the world e.g. Hewlett–Packard & Ford Motor Co. British Telecom & Toyota; & Samsung in Korea–view total quality management is providing an important competitive edge, because a quality focus reduce costs & increase customer satisfaction.

International quality standards have emerged. e.g. ISO: 9000, developed by the International Organisation for Standardization, is set of five international standards for quality management adopted by more than 115 countries. ISO 9000 was created to enable companies of effectively document and certify their quality system elements.

To ensure that their supplier deliver high-quality products at competitive costs, some companies such as DuPont and General Electric, are requiring their suppliers to obtain ISO 9000 certification. Thus, certification and an emphasis on quality are rapidly becoming conditions for competing in the global marketplace.

Although quality refers to wide variety of factors ---such as fitness for use, customer satisfaction, and the degree to which a product conforms to design specification and engineering requirements – but the focus is on two basis aspects of quality :

Quality of design: It refer to how closely the characteristic of a product or service meets the needs and wants of customers. Suppose customers of photocopying machines want copies that combine copying, fixing, scanning and electronic printing. Photocopying machines that fail to meet these customer needs fail in the quality of their design.

Conformance quality: It refer to the performance of a product or service relative to its design and product specifications. For example, if a photocopying machine mishandles paper or breaks down, it fails to satisfy, conformance quality. Product not conforming to specification must be required, reworked, or scrapped at an additional cost to the organisation. If nonconformance errors remain after the product is shipped and the product breaks down at the customer site, even greater repairs costs as well as the loss of customer goodwill (often the highest quality cost of all) may result.

2. Six Sigma (6σ)

Continuous improvement can be brought in to the organizational culture by introducing continuously changing, planned targets. One such target can be six sigma accuracy. The Sigma accuracy means the process is 99.99998% accurate. That is the process will/can produce only 0.002 defects per million. This is the structural meaning of six sigma. However in quality practice 6σ means 3.4 parts per million (PPM).

Six sigma is a statistical measure used to ensure quality of products and services. The six sigma academy has developed a break through strategy consisting of measure, analyze, improve and control, that allows companies to make exceptional bottom-line improvements. In addition to the material and labour savings, which flow directly to the bottom line, a company engaged in six sigma can expect to see:

- Improved customer satisfaction
- Reduction cycle time
- Increased productivity
- Reduction in total defect
- Improved process flow

Six Sigma Capability Chart

Sigma	Parts per million
6σ	3.4 defects per million
5σ	233 defects per million
4σ	6,210 defects per million
3σ	66,807 defects per million
2σ	3,08,537 defects per million
1σ	6,90,000 defects per million

In a six Sigma organization employees assess their job functions with respect to how they improve the organization.

3. How does Total Quality Management (TQM) facilitate value addition in an organisation ?

Total quality Management (TQM) is defined as a set of concepts and Tools for getting all employees focused on continuous improvements in the eyes of the customer.

Since TQM focuses the attention of an organisation on quality, thus it helps to provide the customer with much higher quality prudent expenditure on cost of preventing errors can often lead to large reduction in cost of failure and consequently lead to reduce the total cost. The organisations constantly strive for improvement so that more and more value can be added through improved quality of product at lower cost.

Six C_s of TQM:

Commitment: If a TQM culture is to be developed, so that quality improvement becomes a normal part of everyone's job, a clear commitment, from the top must be provided. Without this all else fails. It is not sufficient to delegate 'Quality' issues to a single person since this will not provide an environment for changing attitudes and breaking down the barriers to quality improvement. Such expectations must be made clear, together with the support and training necessary to their achievement.

Culture: Training lies at the centre of effecting a change in culture and attitudes. Management accountants, too often associate 'creativity' with 'creative accounting' and associated negative perceptions. This must be changed to encourage individual contributions and to make 'quality' a normal part of everyone's job.

Continuous improvement: Recognition that TQM is a 'process' not a 'programme' necessitates that we are committed in the long term to the never-ending search for ways to do the job better. There will always be room for improvement, however small.

Co-operation: The application of Total Employee Involvement (TEI) principles is paramount. The on-the-job experience of all employees must be fully utilised and their involvement and co-operation sought in the development of improvement strategies and associated performance measures.

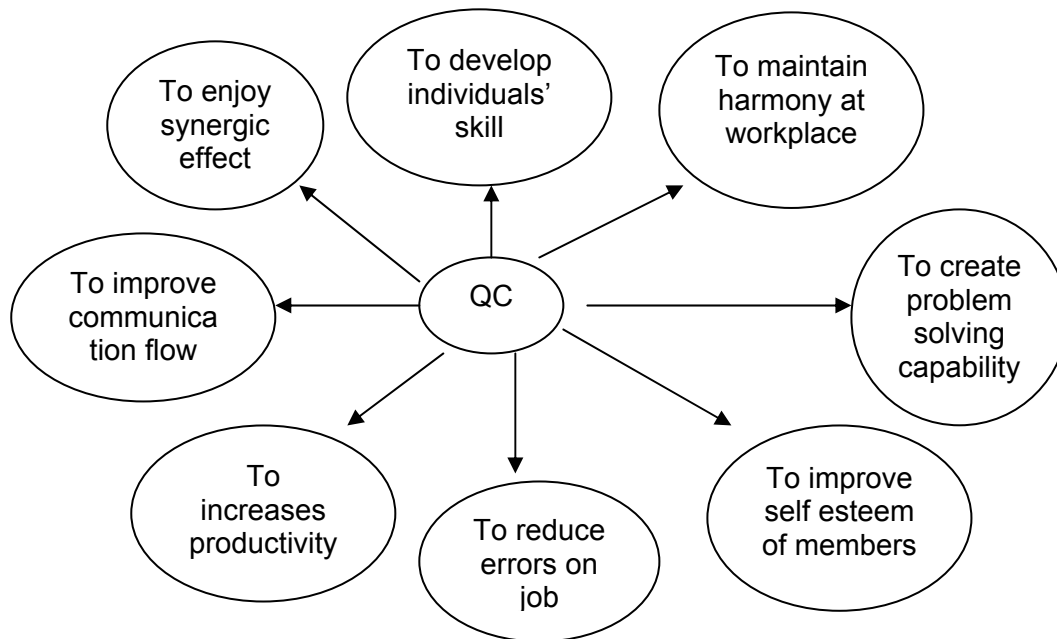
Customer focus: The needs of the customer are the major driving thrust; not just the external customer (in receipt of the final product or service) but the internal customer's (colleagues who receive and supply goods, services or information). Perfect service with zero defects in all that is acceptable at either internal or external levels. Too frequently, in practice, TQM implementations focus entirely on the external customer to the exclusion of internal relationships; they will not survive in the short term unless they foster the mutual respect necessary to preserve morale and employee participation.

Control: Documentation, procedures and awareness of current best practice are essential if TQM implantation are to function appropriately. The need for control mechanisms is frequently overlooked, in practice, in the euphoria of customer service and employee empowerment. Unless procedures are in place improvements cannot be monitored and measured nor deficiencies corrected.

Difficulties will undoubtedly be experienced in the implementation of quality improvement and it is worthwhile expending procedure that might be adopted to minimize them in detail.

4. Quality Circle Philosophy

Quality Circle is a group activity, practiced at regular intervals, which focuses on quality practices. By quality practice, it is meant teamwork, two work communication between top and bottom cadres, use of scientific methods for analysis, continuous problem solving, humanitarian approach, continuous up gradation of work related knowledge and recognition for good work. Quality circle philosophy incorporates all the aforesaid factors. Hence it is recommended that the quality circle be introduced in the organisation for building the quality culture.



Quality Circle is a structured activity. Effectiveness of the QC depends on the following factors.

- Commitment of top management
- Following the rule of the game.
- Rewarding system prevalent in the organisation.

5. Cost of quality

To compete successfully in today's global competitive environment companies are becoming 'customer-driven' and making customer satisfaction an overriding priority. Customers are demanding ever-improving levels of service regarding:

- | | |
|---|-----------------|
| a. cost, | b. quality, |
| c. reliability, | d. delivery and |
| e. the choice of innovative new products. | |

Cost of quality is often viewed as the cost of non-conformance of the product to set specifications. This helps the management of focus on target of reducing total cost related to the quality of the product or service.

Usually cost of non-conformance is classified into

- | | |
|-----------------------------|------------------------------|
| 1. Cost of prevention. | 2. Cost of appraisal |
| 3. Cost of internal failure | 4. Cost of external failure. |

Cost of prevention :--

- i) Cost of engineering / technical studies for improved production processes.
- ii) Cost of equipments to produce products to specified quality standards.
- iii) Costs of obtaining improved raw materials and suppliers training.
- iv) Costs associated with training of operators.
- v) Costs of preventive maintenance programme.
- vi) Apply OHSM

Cost of appraisal :

- i) Costs of inspecting raw materials and purchased parts.
- ii) Costs of inspection of finished products and segregating defectives.
- iii) Costs of quality audits.
- vi) Costs of field tests.

Cost of internal failure : They include costs incurred before the product is dispatched to the customer,

- i) Costs of manufacturing losses (scrap, re-work, upgrade).
- ii) Costs of production capacity (downtime).
- iii) Costs of interference in production schedule.
- iv) Costs of technicians' time spent in fault investigation.
- v) Costs of discounts on sales of sub-standard products.

Cost of external failure :--

- i) Costs associated with distribution of inferior quality products to customers.
- ii) Cost of handling customer complaints.
- iii) Cost of customer 'displeasure'.
- iv) Costs of claims, warranty, and replacement.
- v) Freight on and repairs to returned goods.
- vi) Warranty replacement,
- vii) Repairs of returned products
- viii) costs arising from a damaged company reputation., loss of image and prestige of the firm.

Increase in the cost of prevention reduce cost of appraisal, internal failure, and external failure. Similarly, increases in cost of appraisal reduce the cost of internal failure, and external failure. Similarly, increase in cost of appraisal reduce the cost of internal failure. Therefore, all these cost should be viewed together rather than in isolation.

6. Critical success factors of TQM :

- The focus should be one customer needs.
- Everyone within the organization should be involve in TQM.
- The focus should be on continuous improvement.

- The aim should be to design and produce quality products.
- Introduce an effective performance measurement system that measures continuous improvements from the customer's perspective.

- Existing rewards and performance measurements should be renewed to encourage quality improvements.
- Appropriate training and education should be given so that everyone is aware of the aims of TQM.

7. Simo Chart

The term 'Simo Charts' stands for simultaneous motion cycle charts. These are used in advanced motion study. A Simo chart is used to record against a time scale the work performed by an operator. It shows each work by color, sequence and duration together with parts of the body or machines affected by them. Simo charts are used for operations of short duration performed rapidly and films are taken of operations so as to project the in slow motion to study the movements.

Each Simo chart has two columns, one for left arm movements and the other for right arm movements. Each column in turn may be sub – divided under headings such as upper arm, lower arm, wrist, thumb, first finger, etc. the time for each work can be arrived at by using a special clock which may be measured in unit equal to 1/2000 minutes.

Problems:

1. Bright Glow Ltd (BGL) uses multicolor moulding to make plastic lamps. The moulding operation has a capacity of 2,00,000 units per year. The demand for lamps is very strong. BGL will be able to sell whatever output quantities it can produce at Rs. 40 per lamp.

BGL can start only 2,00,000 units into production in the Moulding department because of capacity constraints on the moulding machines. If a defective unit is produced at the moulding operation, it must be scrapped, and the scrap yields no revenue. Of the 2,00,000 units started at the moulding operation, 30,000 units (15%) are scrapped. Scrap costs, based on total (fixed and variable) manufacturing costs incurred up to the molding operation equal Rs. 25 per unit as follows:

Direct materials (Variable)	Rs. 16 per unit
Direct manufacturing labour, setup labour and materials – handling Labour (Variable)	Rs. 3 per unit
Equipment, rent and other allocated overhead including inspection	
And testing cost on scrapped parts (Fixed)	Rs. 6 per unit
Total	Rs. 25 per unit

BGL's designers have determined that adding a different type of materials to the existing direct materials would reduce scrap to zero, but it would be increased the variable costs by Rs. 4 per lamp in the Moulding department.

Should the company use the new materials? Show your calculations.

2. A company has a continuous manufacturing process involving an output of 6 tonnes per hour valued at Rs. 70 per tonne. Process wages cost Rs. 60 per hour and raw materials is Rs. 35 per tonne of the product. Regular maintenance cost is Rs. 750 per week.

The company is experiencing breakdowns due to mechanical faults averaging 25 hours a week, costing Rs. 7,500 to repairs. It is estimated that these breakdown can be reduced or eliminated if additional maintenance on the following scale were undertaken.

Breakdown hours per week	0	5	10	15	20
Maintenance costs (Rs)	23,000	13,000	6,500	3,000	1,500
Repairs costs (Rs.)	0	2,500	3,000	5,000	6,500

Process Labour during stoppages can be used elsewhere up to 10 hours per week. You are required to:

- The optimum amount of maintenance to be undertaken each week:
 - Compute the additional net revenue that will be resulting from the optimal level, compared with the present level.
3. Tarty Inc. sells 3,00,000 V-262 valves to the automobile and trade industry. It has a capacity of 1,10,000 machine hours and can produce three valves per machine-hour. V-262's contribution margin per unit is Rs. 8. Tarty sells only 3,00,000 valves because 30,000 valves (10% of the good valves) need to be reworked. It takes 1 machine-hour to rework 3 valves so that 10,000 hours of capacity are lost in the rework process. Tarty's rework costs are Rs. 2,10,000, consisting of:

Direct materials and Direct rework Labour (Variable costs)	Rs. 3 per unit
Fixed costs of equipment, rent, and overhead allocation	Rs. 4 per unit

Tarty's process designers have come up with a modification that would maintain the speed of the process and would ensure 100% quality and no rework. The new process would cost Rs. 3,15,000 per year. Decide.

4. A manufacture has an order for one lakh units. With his present equipment they cost 80 paise each to make and there is a 6% fraction defective. However he may install special controls which together with their cost of development, cost Rs. 18,000. His variable cost per unit, then falls to 60 paise each; but the process may be less reliable. How much less reliable can the process be, before he should reject the special controls ?
5. A company producing and selling a range of consumer durable appliances has its after-sales service work done by local approved sub-contractors.

Some of the appliances are so large and bulky that repair / service work can only be done at the customers' homes. Other are small enough for sub-contractors to take them back to their local repair shop, and re-deliver them to the customer.

There is a list price to customer for the labour content of any work done and for materials used. However, the majority of the after-sales service work is done under an annual maintenance contract taken out by customers on purchasing the product; this covers the labour content of any service work to be done, but customers pay for materials used.

Any labour or material needed in the first six months are provided to customer free of charge under the company's product guarantee and sub-contractors are allowed by the company a fixed sum of 3.5% of the selling price for each appliances to cover this work. These sums allowed proved closely in line with the work needed over the past few years. The price structure is ;

Materials : Price to sub-contractor : Company cost plus 10%
 Price to customer : Sub-contractor's price plus 25%

For labour : Price to sub-contractor :
 Work done under maintenance contract : 90% of list price
 Ad hoc work (i.e. work with out maintenance contract) : 85% of list price

Records show that 60% by value of the work has to be carried out at customers' homes, while the remainder can be done anywhere appropriate. The annual income that the company currently receives from sub-contractors for the area in which the experiment is to take place is :

	Rs.
Labour-- under maintenance contract	30,000
-- ad hoc	12,000
Materials-- under maintenance contract	18,000
-- ad hoc	<u>6,000</u>
	66,000

The company expects the volume of after-sales work in this yr. will remain same as of last year.

The company is considering the following options :

1. Set up a local service centre at which it can service small appliances only. Work at customers' houses would continue to be done under sub-contract.
2. Set up a local centre to act only as a base for its own employees who would only service appliances at customers' homes. Servicing of small applicant would continued to be done under sub-contract.
3. Set up a local combined service centre plus base for all work. No work would be sub-contracted.

If the company were to do service work, annual fixed costs are budgeted to be:

	Option-1	Option-2	Rs('000) Option-3
Establishment costs	40	15	45
Management costs	20	15	30
Storage staff costs	10	10	15
Transport costs	8	65	70
Repair / service staff	<u>70</u>	<u>180</u>	<u>225</u>
Total	<u>148</u>	<u>285</u>	<u>385</u>

You are required

- (a) to recommend which of the three options the company should adopt.
- (b) comment critically in respect of non-financial feature.

6. 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 period 1, the planned information relating to the production of component X through the dedicated facilities is as follows:

- (i) Each unit of component X has input materials; 3 units of materials A at Rs. 18 per unit and 2 units of materials B at Rs. 9 per unit.
- (ii) Variable cost per unit of component X (excluding materials) is Rs. 15 per unit worked on.
- (ii) Fixed costs of the dedicated facilities for the period: Rs. 1,62,000.
- (iv) It is anticipated that 10% of the units of X worked on in the process will be defective and will be scrapped.
- (v) It is estimated that customers will require replacement (free of charge) of faulty units of component 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 periods 1 to 3 for component X are shown in Appendix below. No changes have occurred from the planned price levels from materials, variable overhead or fixed overhead costs.

Required:

- (a) Prepare an analysis of the relevant figures provided in Appendix to show that the period 1 actual results were achieved at the planned level in respect of (i) quantities and losses and (ii) units cost levels for material and variable costs.
- (b) Use your analysis from (a) in order to calculate the value of the planned level of each of internal and external failure costs for period 1
- (c) Actual free replacement of components X to customers were 170 units and 40 units in periods 2 and 3 respectively. Other data relating to periods 2 and 3 is shown in Appendix .

Burdoy plc authorized additional expenditure during period 2 and 3 as follows:

Period 2: Equipment accuracy checks of Rs. 10,000 and staff training of Rs. 5,000.

Period 3: Equipment accuracy checks of Rs. 10,000 plus Rs. 5,000 of inspection costs; also staff training costs of Rs. 3,000 on extra planned maintenance of equipment. P.T.O.

Required:

- (i) Prepare an analysis for EACH of periods 2 and 3 which reconciles the number of components invoiced to customers with those worked – on in the production process. The analysis should show the change from the planned quantity of process losses and changes from the planned quantity of replacement of faulty components in customer hands; (All relevant working notes should be shown)
- (ii) Prepare a cost analysis for EACH of periods 2 and 3 which shows actual internal failure costs, external failure costs, appraisal costs and prevention costs;
- (iii) decide whether the quality costs are to be incurred or not in period 2 & 3.

Appendix : Actual statistics for component X

	Period 1	Period 2	Period 3
Invoiced to customers (units)	5,400	5,500	5,450
Worked on in the process (units)	6,120	6,200	5,780
Total costs:			
Materials A and B (Rs.)	4,40,640	4,46,400	4,16,160
Variable costs of production (Rs) (excluding materials costs)	91,800	93,000	86,700
Fixed costs (Rs.)	1,62,000	1,77,000	1,85,000

7. Carlon Ltd. makes and selling a single product, the unit specifications are as follows:

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

Carlon Ltd. requires to fulfill 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.

Carlon 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 meter 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 Rs. 2,50,000 per period	4. Reduction of 40% of the existing cost.

- | | |
|--|-------------------------------------|
| 5. production Qty. is increased to allow for the down grading of 12.5% of the production units at the final inspection stage. Down graded units & return 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 a/c for 5% of units actually delivered 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 & Distribution total – Rs. 6,00,000 per period. | 9. Reduction by 10% of the existing |
| 10. Prevention programme costs Rs. 2,00,000. | 10. increase to Rs. 6,00,000 |

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

Required:

- (a) Prepare summaries showing the calculation of (i) Total production units (pre-inspection), (ii) purchase of Materials X (square metres), (iii) Gross Machine hours.
- (b) In each case, the figures are required for the situation both before and after the implementation of the Quality Management Programme so that orders for 5,000 product units can be fulfilled.
- (c) Prepare Profit & Loss account for Carlon Ltd. for the period showing the profit earned both before and after the implementation of the Total quality programme. May 2005 Q-1

Decision Making : Relevant Costing

Relevant Costs:

Relevant costs are those which will be affected by the decision being taken. All relevant costs should be considered in management decision-making. If a cost will remain unaltered regardless of the decision being taken, then it is called a non-relevant cost.

Non relevant Cost:

Costs that are not usually relevant in management decisions include the following:

- (a) Sunk or past costs, that is money already spent that cannot now be recovered. An example of a sunk cost is expenditure that has been incurred in developing a new product. The money cannot be recovered even if a decision is taken to abandon further development of the new product. The cost is therefore not relevant to future decisions concerning the product.
- (b) Absorbed fixed overheads that will not increase or decrease as a result of the decision being taken. The amount of overhead to be absorbed by a particular cost unit might alter because of the decision; however, this is a result of the company's cost accounting procedures for overheads. If the actual amount of overhead incurred by the company will not alter, then the overhead is not a relevant cost.
- (c) Expenditure that will be incurred in the future, but as a result of decisions taken in the past that cannot now be changed. These are known as committed costs. They can sometimes cause confusion because they are future costs. However, a committed cost will be incurred regardless of the decision being taken and therefore it is not relevant. An example of this type of cost could be expenditure on special packaging for a new product, where the packaging has been ordered and delivered but not yet paid for. The Company is obliged to pay for the packaging even if they decide not to proceed with the product; therefore it is not a relevant cost.
- (d) Historical cost depreciation that has been calculated in the conventional manner. Such depreciation calculations do not result in any future cash flows. They are merely the book entries that are designed to spread the original cost of an asset over its useful life.
- (e) Notional costs such as notional rent and notional interest. These are only relevant if they represent an identified lost opportunity to use the premises or the finance for some alternative purpose.

In these circumstances, the notional costs would be opportunity costs. This explanation will become clearer when you learn more about opportunity costs later in this chapter.

Example 1 :

- (a) The salary to be paid to a market researcher who will oversee the development of a new product. This is a new post to be created specially for the new product but the Rs. 12,000 salary will be a fixed cost. Is this cost relevant to the decision to proceed with the development of the product?
- (b) The Rs. 2,500 additional monthly running costs of a new machine to be purchased to manufacture an established product. Since the new machine will save on labour time, the fixed overhead to be absorbed by the product will reduce by Rs. 100 per month. Are these costs relevant to the decision to purchase the new machine?

- (c) Office cleaning expenses of Rs. 125 for next month. The office is cleaned by contractors and the contract can be cancelled by giving one month's notice. Is this cost relevant to a decision to close the office?
- (d) Expenses of Rs. 75 paid to the marketing manager. This was to reimburse the manager for the cost of travelling to meet a client with whom the company is currently negotiating a major contract. Is this cost relevant to the decision to continue negotiations?

Opportunity Costs: An opportunity cost is a special type of relevant cost. It is defined in the CIMA Terminology as 'the value of the benefit sacrificed when one course of action is chosen, in performance to an alternative. The opportunity cost is represented by the foregone potential benefit from the best rejected course of action.'

With opportunity costs we are concerned with identifying the value of any benefit foregone as the result of choosing one course of action in preference to another.

Steps in determination of Opportunity Cost :

1. Identify the proposals
2. Compute cash in & cash out for each individual proposals. (Individual assets)
3. Select that proposal which produces highest Net Income
4. Now for a new use or proposal that highest net income will be lost.

So this loss of highest income is opportunity cost for the new proposal. This is known as Shadow price. Opportunity cost arises only when the resources or inputs are limited.

Remember :

1. Present profit has to be maintained
2. All these cost reports are for top management to bargain with the customer

Example 2:

The best way to demonstrate opportunity costs is to consider some examples:

- (a) A company has some obsolete material in stock that it is considering using for a special contract. If the material is not used on the contract it can either be sold back to the supplier for Rs. 2 per ton or it can be used on another contract in place of a different material that would usually cost Rs. 2.20 per ton. Opportunity cost for Special contract?
- (b) Chris is deciding whether or not to take a skiing holiday this year. The travel agent is quoting an all-inclusive holiday cost of Rs. 675 for a week. Chris will lose the chance to earn Rs. 200 for a part-time job during the week that the holiday would be taken.

Find the relevant cost of taking the holiday.

Examples 3:

Ram is the Auditor of "X LTD". The Managing Director of the Co. asks for his advice on the following problems :-

The "X Ltd" produces a variety of products each having a number of component parts. Product "B" takes 5 hours to produce on Machine No. 99, working to full capacity. "B" has a selling price of Rs. 50 and a marginal cost of Rs. 30 per unit. : "A-10" a component part could be made on the same machine in 2 hrs. for a marginal cost of Rs. 5 p. u. The supplier's price is Rs. 12.50 per unit. Should the company make or buy "A-10"? Assume that machine hour is the limiting factor. Solve by opportunity cost approach. Also Solve by differential approach & Lt. factor approach.

4. Management company follows the flexible budgeting system and the position at 70% level of production is as follows :

Production	40,000 units
Direct wages	Rs. 60,000
Direct material	80,000
Overhead:	
Fixed	84,000
Variable	<u>42,000</u> 2,66,000

The selling price per unit is Rs. 8.65.

In the present market conditions there is hardly any chance for selling more locally. A special export order, for 8,000 units @ 6.50 per unit is received.

- Would it be prudent for the company to accept the order at this price?
- What is the price beyond which it would be profitable accept this order ?
- If export order is for 20,000 units, & capacity can not be increased above 100 % & the export order has to be accepted in full , what will you decide?
- What maximum order quantity can be accepted at this export price ?

5. A.K. manufacturing Company is producing a Product X for the home market. The normal capacity is to produce 1,25,000 units. The estimates for the year 2008 for the home market for both the selling prices are as under :

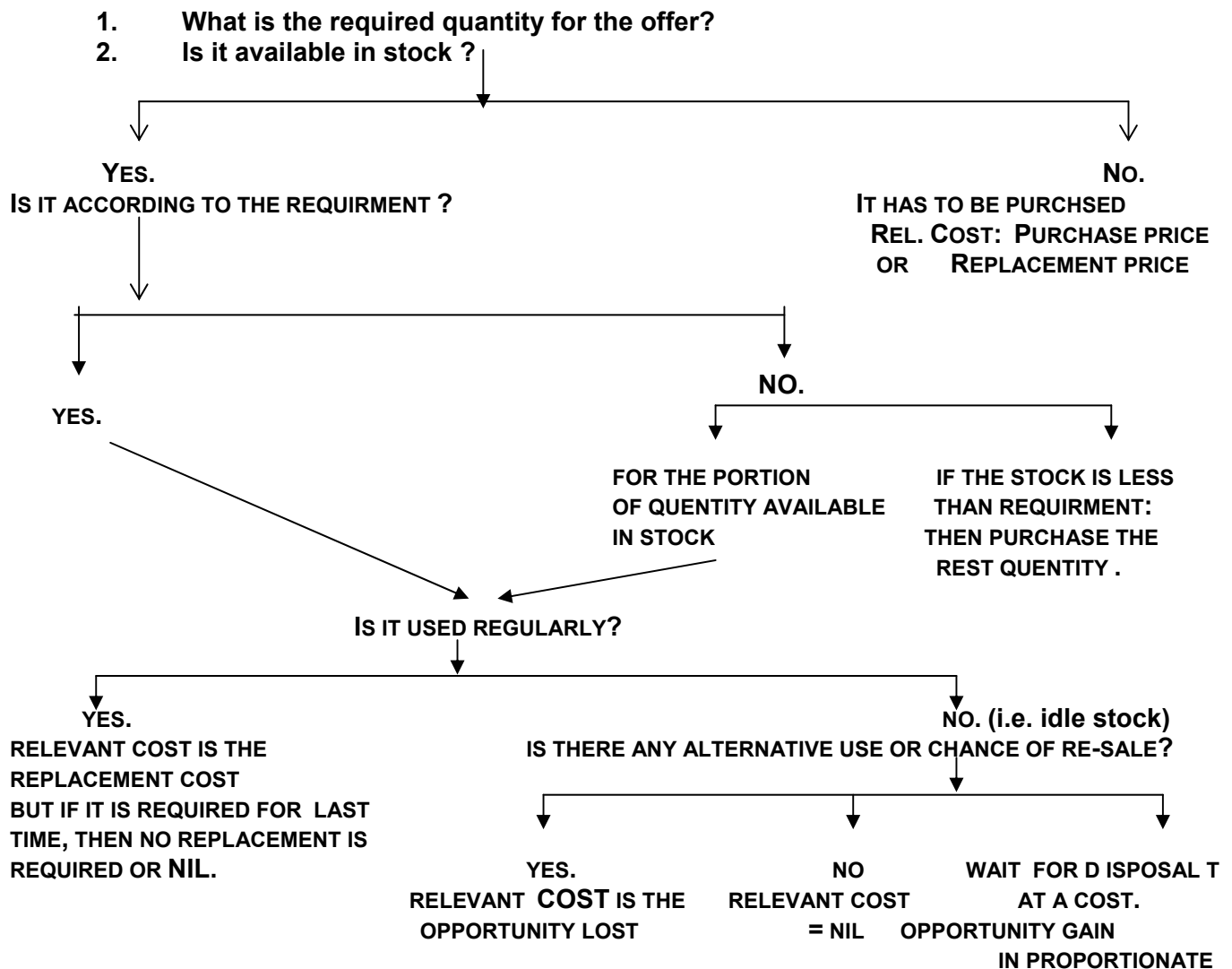
	Estimated Production and Costs	Est. Full Capacity Production and Costs
Sales (units)	1,00,000	1,25,000
Sale Price per units (Rs.)	4,00	3.75
Fixed Cost:		
Production (Rs.)	1,00,000	1,05,500
Selling and Distribution (Rs.)	10,000	11,000

Variable Cost : Production Rs. 2.00 per unit. Selling and Distribution Rs. 0.20 per unit. The Sales Manager finds that there is a market in the foreign country for 25,000 units @ 3.75 per unit. The cost of exporting the goods to the foreign country is Rs. 0.50 per unit. Should the Company entered into the foreign market or Go for the domestic production? Find the minimum sale price for the export order.

6. Star Bicycle Company, produced and sold 1,10,000 bicycle annually, under the brand name 'Smart' with a price tag Rs. 899. Like all other players in the industry, Star too was running under capacity. The manufacturing cost of these cycles was-material Rs. 300, labour Rs. 200 and Manufacturing Rs. 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 Rs. 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 Star as design of 'Jeet' will exactly be same as that of 'Star' with only some cosmetic changes. To produce 'Jeet' however, Rs. 6,00,000 additional fund will be required on an average. Further it estimated that sale of 'Jeet' through the store will reduce the sale of 'Star' 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%.

Relevant Material Cost for the offer

Important Definitions : Replacement price, Market price, Quick Sale price & Cost time use.

7. For an offer would require the following materials-

Material Cost	Required Total units	Already in stock units	Book Value of units in stock Rs./Unit	Realisable value Rs./ Unit	Replacement Rs./Unit
A	1,200	700	35	40	60
B	1,350	1,600	25	22	45
C	800	700	30	25	40
D	200	160	14	6	19
E	400	500	17	--	28
F	360	300	39	--	67

- Material A & B is used regularly by X Ltd. and if stocks are required for this job, they would need to be replaced to meet other production.
- Materials C and D are in stock as a result of over purchase. C has no other use but D could be used in another job as substitute demand for 350 units of material P, which currently cost Rs. 4.5 per unit (of which the company has no units in stock at the moment).
- Material E & F are toxic materials & was purchased for a separate contract (not accepted). It should be disposed off at a cost of Rs. 3,500 & 8,000 respectively, if not used in this contract. Find the relevant cost of material.

8. Your company regularly uses material X and currently has in stock 200 kg. for which it paid Rs.500 two weeks ago. If this were to be sold as raw materials it could be sold today for Rs. 0.5 per kg. You are aware that the materials can be bought on the open market for Rs.3.25 per kg. but it must be purchased in quantities of 1000 kg.

You have been asked to determine the relevant cost of 600kg. of materials X to be used in a job for a customer.

9. Q plc. Makes two products – Quone and Qutwo from the same raw materials. The selling price and cost details of these are as shown below :

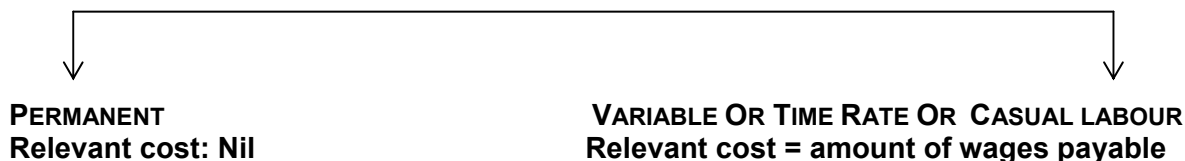
	Quone Rs.	Qutwo Rs.
Selling price	<u>20.00</u>	<u>18.00</u>
Direct materials (Rs.2.00 / kg.)	6.00	5.00
Direct labour	4.00	3.00
Variable overhead unit	<u>2.00</u>	<u>1.50</u>
	<u>12.00</u>	<u>9.50</u>
contribution per unit	8.00	8.50

The maximum demand for these products is

Quone : 500 units per week; Qutwo: unlimited number of units per week.

If materials were limited to 20,000kg. per week what is the shadow price (opportunity cost) of these materials?

Relevant Labour Cost What is the nature of labour force?



DEFINITIONS : MONTHLY RATED, MAN MONTHS & MAN-HOURS

10. A company is considering accepting one-year contract which will require four skilled employees. The four skilled employees could be recruited on one-year contract at a cost of Rs.40,000 per employee. The employees would be supervised by an existing manager who earns Rs.60,000 per annum. It is expected that supervision of the contract would take 10% of the manager's time.

Instead of recruitment new employees, the company could retain some existing employees who currently earn Rs.30,000 p.a. The training should cost Rs.15,000 in total. If these employees were used they would need to be replaced at a total cost of Rs.1,00,000, find the relevant cost.

11. Show a problem on idle time

OVERHEAD

1. Variable overhead : always relevant
2. Fixed overhead : Discretionary fixed costs are always relevant
Committed fixed costs are always Non-relevant
If only overhead recovery rates are given, consider it Non-relevant, as it is a part of overhead ABS. e.g. Rs. per LHR, Rs./MHR,....% of Direct wages.

Relevant cost of Plant

12. A machine which originally cost Rs.10,000 has an estimated life of 10 years and is depreciated at the rate of Rs. 1,000 per year. It has been unused for some time. In this special job machine is required for two months. The current net realizable value of the machine is Rs. 8,000, if it is used for the job, its value is expected to fall to Rs. 4,600. The net book value of the machine is Rs. 8,000. Routine maintenance of the machine currently costs Rs. 4,200 per month. With use, the cost of maintenance and repairs would increase to Rs. 9,800 for the production period. What is the relevant "depreciation" cost ?
13. (a) Two machines namely Machine Type 'X' and Machine Type 'Y' are required to produce a new product AXE (life one year), Machine Type 'X' is in regular use on different products (capacity 100 % utilised) and Machine Type 'Y' is now idle. If AXE is not produced Machine Type 'Y' can be sold immediately. The management is planning for an expansion Programme with machine X in near future.

The relevant data relating to each type of machine are as under :

		At the start of the year Rs.	At the close of the year Rs.
Type 'X'	Replacement Cost	1,60,000	1,20,000
	Resale value	1,20,000	94,000
Type 'Y'	Replacement Cost	26,000	48,000
	Resale value	22,000	21,000

- (b) Find the relevant cost if there is no expansion plan in the above problem.

Responsibility accounting:

It refers to a control system of management accounting and reporting. The basis of Responsibility Accounting is the creation/recognition of various responsibility/decision centres in an organisation. The individual managers of these centres are made responsible for the insurance and control of costs relating to their responsibility centres.

The main feature of responsibility accounting is that it is more concerned with control of costs than their determination. The system would trace costs (revenues, assets and liabilities) to the individual managers who are primarily responsible for making decisions about the costs under review. In other words, the executive in charge of every responsibility centre would have authority to incur costs relating to his responsibility centre and accountable to them. If he does not have the authority to incur costs he will also not be responsible for their control.

The performance of the managers of the various responsibility centres is judged by assessing how far they have been able to monitor those costs which were under their control. This is done by furnishing the department heads with performance reports from time to time. These reports will exclude all apportioned and policy costs not subject to their control. Thus responsibility accounting is based on the principle that an executive will be held accountable only for those acts over which he has control.

Responsibility Accounting system can be tailored according to the needs of an organisation. An effective system of responsibility accounting would require that the responsibility of each executive is clearly defined. He should know, what he is required to do and what performance is expected of him.

Pre-requisites for responsibility accounting :

- (i) The area and authority of each responsibility centre should be clearly defined.
- (ii) The goal should be clearly stated to each manager.
- (iii) The performance report of a responsibility centre should include only the revenues, expenses, profit and investments which are to be controlled by the executive of that centre.
- (iv) The items which may require management's attention like variance should be highlighted in the performance report for each responsibility centre.
- (v) The help of managers of responsibility centre may be sought while establishing the goals of the centre.

Classification of responsibility centers

Cost Centre : The smallest unit of an organisation. A cost center manager is responsible for the costs incurred there & can charge this cost at the time of transferring to other responsibility centre. Cost Centre are of two types – production & service. A Cost Centre can not charge overhead on the basis of absorption costing & profit.

Profit Centre : A production / Service unit of an organisation headed by an individual fully responsible for all costs, revenues and profitability of its operations is known as a profit centre. The individual is authorised to plan and look after production, financial and accounting activities of the centre. A concern may be divided into a number of profit centre. Generally a department is considered as a profit centre if its total production is demanded by the outsiders. Hence a profit centre is empowered to charge the sales price for an inter-division transfer. A Profit Centre can not distribute its profit without the consent of Investment Centre.

Revenue Centre: A sales center , e.g. a show room

Investment Centre : A centre whose managers are normally accountable for sales revenue and expenses but in addition they are also responsible for some capital investment decisions and are thus able to influence the size of the investment. Return on investment (ROI) and Residual Income (RI) are usually used to evaluate the performance of investment centres.

Merit of profit centre

1. It makes its managers responsible for the profit performance – achieving the budgeted amount of profit during a period.
2. Under profit centre concept the whole organisation is divided into a number of divisions, the performance of each division is measured in terms of both the income and the costs.
3. Managers in each division have freedom in making decisions. They need not obtain approval from corporate headquarters for every expenditure.

Disadvantages of profit centres:

1. Division may compete with each other and may take decisions to increase profits at the expenses of other divisions thereby overemphasizing short term results.
2. It may adversely affect co-operation between the divisions and lead to lack of harmony in achieving organisational goals of the company. Thus it is hard to achieve the objective of goal congruence.
3. It may lead to reduction in the company's overall total profits.
4. There may be higher cost of common activities following decentralized structure than for centralised structure. It may thus result in duplication of staff activities.

5. 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.
6. Series of control reports prepared for several departments may not be effective from the point of view of top management.
7. It may under utilise corporate competence.
8. It leads to complication associated with transfer pricing problems.
9. It becomes difficult to identify and define precisely suitable profit centres.
10. It confuses division's result with manager's performance.

Problems:

1. 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 Rs. 2,50,000 and progress payments of Rs.1,34,300 have been received from the customer prior to the liquidation. The sales department has found another company willing to buy the machine for Rs.1,24,000 once it has been completed.

To complete the work, the following costs would be incurred :-

- (a) Material A - these was bought at a cost of Rs. 4,500. They have no other use, and if the machine is not finished, they would be sold for scrap for Rs. 3,500 .

Material-B : Book value Rs. 60,000. This material, which has just been received, is extremely toxic and if not used on the project would have to be disposed of by special means (for resale purpose) , at a cost of Rs. 15,000.

- (b) Further labour costs would be Rs. 9,000. Labour is in short supply, and if the machine is not finished, the work-force would be switched to another job, which would earn Rs. 40,000 in revenue, and incur direct costs (not including direct labour) of Rs. 18,000 and will incur a fixed overhead of Rs. 8,000.

- (c) Consultancy fees Rs. 4,000. If the work is not completed, the consultant's contract would be canceled at a cost of Rs. 2,500. Rs.1,000 is paid so far .

- (d) General overheads of Rs. 23,000 would be added to the cost of the additional work.

- (e) Research Staff-Rs. 64,000 : A decision has already been taken that this will be the last major piece of research undertaken, and consequently when work on the project ceases the. Staff involved will be made redundant. Redundancy and severance pay have been estimated at Rs. 1,25,000. rate of interest is 5% p.a. The project will take 4 months to complete.

- (f) Machinery : The following machines are required to complete the offer :

Z-200 costs Rs.6,000 CBX costs Rs.45,000

It transpires that the CBX. will also do the job of the CB-500 as well as complete this machine. Co. uses a CB-500 in existing business and it is due to be replaced at a cost of Rs.30,000. The resale value of Z-200 is Rs.2400 at the end of its use for this project
Should the new customer's offer be accepted? Prepare a statement showing the economics of the proposition.

2. C. Ltd. is a civil engineering company based at Calcutta. Contracts are carried out under the supervision of project managers who are sent out from Head Office and remain on site for the duration of the contract. The project manager recruits local labour, and arranges for plant and materials to be provided by Head Office.

Sometime ago, the company successfully tendered for two contracts which have now become mutually exclusive. It is currently considering which of those to accept. Both jobs would last for 12 months. The following information about cash contract is as available:

	Nagpur Rs. ('000)	Delhi Rs. ('000)
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 store (at cost)	20	24
Contracted for	-	36
To be ordered (at current cost)	40	34
Labour required :		
Project managers' 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 material 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 costs would further decrease the cash inflow 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 canceled. The scrap value would be 10% of cost, and costs of transport etc. would be paid by the scrap merchant. It is likely, however, that the materials 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 purposes.

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 subcontracted out by Head Office for Rs. 2,000 per annum.

6. Head Office administration costs are fixed at Rs. 25,000 for the coming year. This excludes project managers' Salaries.

Required:

(a) Present the data to management in a form which will assist in making the decision as to which job to undertake .

(b) Comment on the appropriateness of the approach used in your analysis.

(c) List briefly any other factors which ought to be considered before finally making the decision in this case

3. You have received a request from EXE plc provide a quotation for the manufacture of a specialised piece of equipment. This would be a one-off order, in excess of normal budgeted production. The following cost estimate has already been prepared :

	Note	Rs.
Direct materials :		
Steel 10m ² @ Rs 5.00 per m ²	(1)	50
Brass fittings	(2)	20
Direct labour :		
Skilled 25 hours @ Rs 8.00 per hour	(3)	200
Semi-skilled 10 hours @ Rs 5.00 per hour	(4)	50
Overhead 35 hours @ Rs.10.00 per hour	(5)	350
Estimating	(6)	<u>100</u>
		770
Administration overhead @ 20% of production cost	(7)	<u>154</u>
		924
Profit @ 25% of total cost	(8)	<u>231</u>
Selling price		<u>1,155.</u>

Notes :

- The steel is regularly used, and has a current stock value of Rs 5.00 per sq. metre. There are currently 100m² in stock. The steel is readily available at a price of Rs 5.50 per sq. meter.
- The brass fittings would have to be bought specifically for this job : a supplier has quoted the price of Rs 20 for the fittings required.
- The skilled labour is currently employed by your company and paid at a rate of Rs 8.00 per hour. If this job were undertaken it would be necessary either to work 25 hours overtime which would be paid at time plus one half OR reduce production of another product which earns a contribution of Rs 13.00 per hour.
- Semi-skilled labour is presently under-utilised, and at present 15 hours per week are recorded as idle time.
- The overhead absorption rate includes power costs which are directly related to machine usage. If this job undertaken, it is estimated that the machine time required would be ten hours. The machines incur power costs of Rs. 75 per hour. There are no other overhead costs which can be specifically identified with this job.
- The cost of the estimating time is that attributed to the four hours taken by the engineers to analyse the drawings and determine the cost estimate given above.
- It is company policy to add 20% on to the production cost as an allowance against administration costs associated with the job accepted.
- This is the standard profit added by your company as part of its pricing policy.

Required :

- (a) Prepare, on a relevant cost basis, the lowest cost estimate that could be used as the basis for a quotation. Explain briefly your reasons for using EACH of the values in your estimate.
- (b) There may be a possibility of repeat orders from EXE plc which would occupy part of normal production capacity. What factors need to be considered before quoting for this order ?

4. Polymix manufactures chemical compounds and has been offered the opportunity to produce 4,200 drums of a car polishing agent 'G' at a price of Rs. 100 per drum.

The specification of each drum of 'G' is as follows:

Direct materials:

Waxing agent	20 kg
Mixer	10 liter
Polymer	1 liter

Direct labour.

Skilled	2 hours at Rs 4 per hour
Unskilled	6 hours at Rs. 2 per hour

Investigation reveals the following information: skilled labour is under-utilised at Polymix just now, but it is company policy not to retrench skilled labour. Acceptance of the contract for 'G' would reduce the idle time paid to skilled operators, which is now treated as a non-production overhead expense. Unskilled labour is considered to be a variable cost.

Material required for 'G' contract would be drawn from stock. The wax is used by Polymix in several production processes and would need to be replaced. The mixture is in stock, having been purchased for another contract, which has been canceled and is now awaiting sale. 10,000 liters of Polymer is currently in stock but is considered obsolete and toxic. Polymix has made arrangements to dispose of this Polymer at a cost of Rs. 10,000 to the company.

Material cost data	<u>Wax</u>	<u>Mixer</u>	<u>Polymer</u>
Book value per kg/ liter in stock	Rs. 0.80	Rs. 3.00	Rs. 40
Replacement cost	Rs. 1.00	Rs. 3.20	No longer made
Net realisable value	Rs. 0.90	Rs. 2.50	

Variable production overheads are estimated at Rs. 2.5 /- per direct labour hour for all products. The 'G' project requires supervision by an experienced chemist and Mr. R. Rao has been persuaded by a fee of Rs. 34,000 to defer his early retirement for six months to complete the 'G' contract. He normally earns Rs. 60,000 a year and had hoped to retire on a pension of 50% of his salary.

Fixed factory overheads are absorbed by a single recovery rate applied to all departments based on productive labour-hours. Estimates for next year's activity, which exclude the 'G' contract, show overheads of Rs. 6,00,000 and hours of 3,00,000. These fixed costs would increase by Rs. 32,000 if the contract is accepted .

Polymix already produce a car polish under the trade name 'Polydip'. If 'G' contract is accepted, sales of Polydip would be reduced by 5,000 drums and the consequent reduction in production would reduce budgeted fixed overheads by Rs. 28,000 in the forthcoming year. The details of Polydip per drum is: price Rs. 40, Material, 12 kg of wax, and labour, four hours of unskilled operative time.

Advise the management of Polymix.

5. 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 Durables & 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 materials	Rs. 5,60,000	
Direct labour	4,00,000	
Variable overhead	1,40,000	
Fixed overhead	3,00,000	
Fixed selling and distribution overhead	1,00,000	<u>15,00,000</u>

Notes :

- (a) If the negotiation with Steady Enterprises fails, part of the material used may be dealt as :

(a-i) Brass materials – could be sold as scrap for Rs. 1,00,000.

(a-ii) Steel materials – could be sold as scrap for Rs. 26,000, but to sell it as scrap some 100 hours labour will be hired at Rs. 10 per hour to bring to saleable condition.

(a-iii) Balance materials will have to be removed at a cost of Rs. 5,000, but will have a 'nil' sale value.

- (b) Price quoted to Durables & Co., was Rs. 18,00,000

- (c) To cater to Steady Enterprises' needs, the alteration cost will be :

	<u>Department M</u>	<u>Department A</u>
Direct materials	Rs. 10,000	Rs. 5,000
Direct labour	10 men for 2 months @ Rs. 3,000 per man-month	6 women for 2 months @ Rs. 2,000 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 sale for Rs. 3,000. The present market prices for the materials for M and A are Rs. 12,000 and Rs. 6,000 respectively.

(c-ii) Department M is currently working at full capacity, earning a contribution of Rs. 3 towards fixed overhead and profit per Re. 1 of labour.

(c-iii) 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 Rs. 2,000 a month as wages. In order to utilise its labour, Department A undertakes some off-loading work for Rs. 32,500 per month from a sister concern when the workload in Department A falls below 50% capacity. Variable cost associated with the off-loading work is Rs. 4,000 per month. The conversion work for Steady Enterprises will mean 25% additional workload for Department A for two months.

- (d) The pattern & specifications of the original machine could be sold to a customer for Rs. 60,000.
- (e) For supervision of the job for Steady Enterprises, a temporary Supervisor would be needed for 2 months at an agreed salary of Rs. 10,000. He will be a person deputed by Steady Enterprises. The company charges all indirect and supervisory salaries to fixed overhead.
- (f) Durables & Co. has already made an earnest money deposit of Rs. 1,80,000 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.

Required : Engineers Ltd. Seeks your advice for the minimum price, based on relevant costs only, for the quotation it will make to Steady Enterprises.

6. Auer Company had received an order for a piece of special machinery from Jay Company. Just as Auer Company completed the machine, Jay Company declared bankruptcy, defaulted on the order, and forfeited the 10% deposit paid on the selling price of Rs. 72,500. Auer's manufacturing manager identified the costs already incurred in the production of the special machinery for Jay as follows:

	Rs.	Rs.
Direct materials used		16,600
Direct labour incurred		21,400
Manufacturing overhead applied:		
Variable	10,700	
Fixed	<u>5,350</u>	16,050
Fixed selling and administrative		<u>5,405</u>
Total cost		59,455

Another company, Kaytell Corp., would be interested in buying the special machinery if it is reworked to Kaytell's specifications. Auer offered to sell the reworked special machinery to Kaytell as a special order for a price of Rs. 68,400. Kaytell has agreed to pay the net machinery to the specifications of Kaytell are as follows:

	Rs.
Direct materials	6,200
Direct labour	<u>4,200</u>

A second alternative available to Auer is to convert the special machinery to the standard model. The standard model lists for Rs. 62,500. The additional identifiable costs to convert the special machinery to the standard model are:

	Rs.
Direct material	2,850
Direct labour	<u>3,300</u>

A third alternative for the Auer Company is to sell, as a special order, the machine as is (i.e. without modifications) for a net price of Rs. 52,000. However, the potential buyer of the unmodified machine does not want it for 60 days. The buyer offers a Rs. 7,000 down payment with final payment upon delivery.

The following additional information is available regarding Auer's operations:

Sales commission rate on sales of standard models is 2% while the sales commission rate on special orders is 3%. All sales commissions are calculated on net sales price (i.e., list price less cash discount, if any).

Normal credit terms for sales of standard models are 2/10, n/30 (2/10 means a discount of 2% is given if payment is made within 10 days; n/30 means full amounts is due within 30 days). Customers take the discounts except in rare instances. Credit terms for special orders are negotiated with the customer.

The application rates for overhead are as follows:

Manufacturing		
Variable	50%	of direct-labour cost
Fixed	25%	of direct-labour cost
Selling and administrative:		
Fixed	10%	of cost of production.

Normal time required for rework is one month. A surcharge of 5% of the sales price is placed on all customer requests for minor modifications of standard models. Auer normally sells a sufficient number of standard models for the company to operate at a volume in excess of the breakeven point. Auer does not consider the time value of money in analyses of special orders and projects whenever the time period is less than one year because the effect is not significant.

Required

1. Determine the contribution that each of the three alternatives will add to the Auer Company's before-tax profits.
 2. If Kaytell makes Auer a counteroffer, what is the lowest price Auer Co. should accept for the reworked machinery from Kaytell? Explain your answer.
 3. Discuss the influence that fixed-factory overhead cost should have on the sales prices quoted by Auer Company for special orders when (a) a firm is operating at or below the breakeven point; (b) a firm's special orders constitute efficient utilisation of unused capacity above the breakeven volume.
7. Reel and Roll Ltd., manufactures a range of films extensively used in the cinema industry. The films, once manufactured are packed in circular containers and stored in specially constructed crates lined with "protecto". These crates are manufactured and maintained by a special Department within the company and the Departmental costs last year are as under :-

		Rs.
Direct Materials (including "protecto")		1,40,000
Direct Labour		<u>1,00,000</u>
Overheads :		2,40,000
Department Manager	16,000	
Depreciation of machine	30,000	
Maintenance of machine	7,200	
Rent (portion of warehouse)	9,000	
Other Miscellaneous costs	<u>31,500</u>	<u>93,700</u>
		3,33,700
Administration Overhead (20% of direct costs)		<u>48,000</u>
		<u>3,81,700</u>

1. Pack Knack Associates have approached the Reel & Roll Ltd. offering to make all the crates required on a four year contract for Rs. 2,50,000 p.a. and /or to maintain them for a further Rs. 50,000 p. a.

The following data are relevant: for the offer: –

- (i) The machine used in the department cost Rs. 2,40,000 four years ago and will last for four more years. It could be currently sold for Rs. 70,000.
- (ii) A stock of "protecto" was acquired last year for Rs. 2,00,000 and one-fifth was used last year and included in the material cost. It originally cost Rs. 1,000 per ton, but the replacement cost is Rs. 1,200 per ton, and it could be currently sold for Rs. 900 per ton.

- (iii) The Department has acquired warehouse space for Rs. 18,000 per annum. It uses only one-half of the space; the rest is idle.
- (iv) If the department were closed, the Manager will be transferred to another department; but all the labour force will be made redundant, and the terminal benefits to be met will amount to Rs. 15,000 per annum. In that event, pack knock Associates will undertake to manufacture and maintain the crates.

2. If Reel and Roll Ltd. continued to maintain the crates, but left their manufacture to pack-knock Associates:-

- (i) The machine will not be required
- (ii) The manager will remain in the department
- (iii) The warehouse space requirements will not be reduced
- (iv) Only 10 per cent of all materials will be used
- (v) Only one worker will be dispensed with and taking the terminal benefit to be met into account, the saving will be Rs. 5,000 per annum.
- (vi) The miscellaneous costs will be reduced by 80 per cent.

3. If Reel and Roll Ltd., continued to manufacture the crates but left their maintenance to Pack Knock Associates:-

- (i) The machine will be required
- (ii) The manager will remain in the department
- (iii) The warehouse space will be required
- (iv) 90% of all the materials will be required
- (v) The labour force will continue
- (vi) The miscellaneous costs will be reduced by 20%. Advice

8. A firm produces 10,000 product units a month. Each unit requires 2 kg. of X at Re 1/- per kg. 1 tonne of Y at Rs. 6 and Component Z at Rs. 2. These prices are all fixed by contract with the firm. To terminate the supply contracts, the firm must give 2 months' notice to supplier X, three months to supplier Y and one month to supplier Z.

Materials supplied could be sold onward on the following terms:

<u>Unit</u>	<u>Sales price</u>	<u>Unit variable selling costs</u>	<u>Unit contribution Rs.</u>
X per kg	Re. 1/-	Rs. 1.20	(0.20)
Y per tonne	Rs. 4.80	Rs. 3.20	1.60
Z	Rs.1.90	Rs. 1.50	0.40

The firm must pay its suppliers during the notice periods but need not take delivery of the materials if it chooses not to. Variable conversion costs to the firm are Rs. 25 an hour for 100 hours a month on the product in question. Among the fixed overheads are machines on hire at Rs. 20,000 a month on a hire contract subject to three months notice of termination.

The product could be supplied in a finished condition by M. Ltd. , which indicated a price of Rs. 8 per unit would be charged for 10,000 units a month. Should the firm continue to make the product or buy? What is the best time to give notice to suppliers and the best time to switch from making to buying.

9. Shortflower Ltd. Currently publish, printing and distribute a range of catalogues and instruction manuals. The management have now decided to discontinue printing and distribution and concentrate solely on publishing. Longplant Ltd. will print and distributed the range of catalogues and instruction manuals on behalf of Shortflower Ltd. commencing either at 30th June or 30th November . Longplant Ltd. will received Rs.65,000 per month for a contract which will commence either at 30th June or 30th November .

The result of Shortflower Ltd. for a typical month are as follows :

	Publishing Rs.000	Printing Rs.000	Distribution Rs.000
Salaries and wages	28	18	4
Materials and supplies	5.5	31	1.1
Occupancy costs	7	8.5	1.2
Depreciation	0.8	4.2	0.7

Other information has been gathered relating to the possible closure proposals :

- (i) Two specialist staff from printing will be retained at their present salary of Rs.1,500 each per month in order to fulfill a link function with Longplant Ltd. One further staff member will be transferred to publishing to fill a staff vacancy through staff turnover, anticipated in July. This staff member will be paid at his present salary of Rs.1,400 per month which is Rs.100 more than that of the staff member who is expected to leave. On closure all other printing and distribution staff will be made redundant and paid an average of two months redundancy pay.
- (ii) The printing department has a supply of materials (already paid for) which cost Rs.18,000 and which will be sold to Longplant Ltd. for Rs. 10,000 if closure takes place on 30th June . Otherwise the material will be used as part of the July printing requirements. The distribution department has a contract to purchase pallets at a cost of Rs.500 per month for July and August. A cancellation clause allows for non-delivery of the pallets for July and August for a one-off payment of Rs.300. Non-delivery for August only will required a payment of Rs.100. If the pallets are taken from the supplier, Longplant Ltd. has agreed to purchased them at a price of Rs.380 for each month's supply which is available. Pallet costs are included in the distribution material and suppliers cost stated for a typical month.
- (iii) Company expenditure on apportioned occupancy costs of printing and distribution will be reduced by 15% per month if printing and distribution departments are closed. At present, 30% of printing and 25% of distribution occupancy costs are directly attributable costs which are avoidable on closure, whilst the remainder are apportioned costs.
- (iv) Closure of the printing and distribution department will make it possible to sub-let part of the building for a monthly fee of Rs.2,500 when space is available.
- (v) Printing plant and machinery has an estimated net book value of Rs.48,000 at 30th June. It is anticipated that it will be sold at a loss of Rs.21,000 on 30th June . If sold on 30th November the prospective buyer will pay Rs.25,000.
- (vi) The net book value of distribution vehicles at 30th June is estimated as Rs.80,000. They could be sold to the original supplier at Rs. 48,000 on 30th June . The original supplier would purchase the vehicles on 30th November for a price of Rs. 44,000.

Required :Using the above information, prepare a summary to show whether Shortflower Ltd. should close the printing and distribution departments on financial grounds on 30th June or on 30th November.

Problems on Responsibility Accounting

10. 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 specifications 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 an estimate of material requirements as per the specifications. The cost estimates worked out are as under:

	Rs.
1. Steel sheets 5,000 kg. at Rs. 15 per kg.	75,000
2. Steel Rods 1,000 kg. at Rs. 10 per kg.	10,000
3. Bearing, hardware items etc.	15,000
4. Employees Costs :	
Monthly rated -grade A 1,400 hours at Rs. 10	14,000
Monthly rated grade B 3,100 hours at Rs. 8	24,800
5. Overheads:	
Fabrication shop 500 hours at Rs. 20	10,000
Welding shop 300 hours at Rs. 43	12,900
Planning Engineers 200 hours at Rs. 15	3,000
Design Engineers 100 hours at Rs. 15	<u>1,500</u>
Total	<u>1,66,200</u>

Following additional information is available.

- The stocks of steel sheets are more than sufficient and were purchased a year ago @ Rs.15. Present market price of this item is Rs. 25 per kg.
- The steel rods were purchased five years back at Rs. 10 per kg. Present purchase price is Rs. 18 per kg. This material is already declared as non-moving and can be sold in market as such at Rs. 12 per kg. or can be substituted for alloy steel rods which are presently costing Rs. 13 per kg.
- The labour force is always moved from job to job depending on urgency. It is likely that the above job, if accepted, will have to be done by grade-A workers alone.
- The fabrication shop is treated as profit center. a transfer price of Rs. 20 per hour is used for charging to other shops in the workshop. The fabrication shop also does jobs for outsiders whom Rs. 28 per hour are charged. The transfer price fixed by welding shop is Rs. 43 per hour. The transfer prices are calculated as under :

	<u>Fabrication</u> In Rs.	<u>Welding</u>
Variable cost machine hour	7	19
Departmental Fixed Costs	6	20
Profit	<u>7</u>	<u>4</u>
Transfer Price	<u>20</u>	<u>43</u>

- The hourly rates of planning/design engineers, are Rs. 10 per hour. However, for outside Consultancy works, it is a practice to charge Rs. 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.

- Companies GP, GR, GS and GT are members of a group. GP wishes to buy an electronic control system for its factory and in accordance with group policy, must obtain quotations from companies inside and outside the group.

From outside of the group the following quotations are received :

- Company A quoted Rs. 32,200.
- Company B quoted Rs. 33,000 but would buy a special unit from GS for Rs. 13,000. To make this unit, however, GS would need to buy parts from GR at a price of Rs. 7,500.
- The inside quotation was from GS whose price was Rs. 48,000. This would require GS buying parts from GR at a price of Rs. 8,000 and units from GT at a price of Rs. 30,000. However, GT would need to buy parts from GR at price of Rs. 11,000.

Additional data are as follows :

- GR is extremely busy with work outside the group and has quoted current market prices for all its products.
- GS cost for the GP contracts including purchases from GR and GT total Rs. 42,000. For the company B contract it expects a profit of 25% on the cost of its own work.
- GT prices provide for a 20% profit margin on total costs.
- The variable costs of the companies in respect of the work under consideration are :
 - GR - 20% of selling price.
 - GS - 70% of own cost (excluding purchases from other group companies).
 - GT - 65% of own cost (excluding purchases from other group companies).

You are required, from group point of view, to recommend, with appropriate calculations, whether the contract should be placed with GS or Company A or Company B.

Cost Approach Basis

12. As a result of change in consumer preference the company of which you are the management accountant finds that certain materials in stock which were bought for Rs. 7,000 a few years ago have not moved for a long time. The current replacement price of these materials is Rs. 8,000. If these materials were disposed off by sale, they would fetch a net realisable value of Rs. 4,000 only.

The company has the opportunity of carrying out a one-time (job No. 101) which can utilize these materials and yield a revenue of Rs. 16,000. The additional costs other than the cost of these materials, chargeable to this job will amount to Rs. 14,200. This charge includes the apportionment of general administration overheads amounting to Rs. 3,800 but the incidence of all other expenses is dependent upon the execution of Job 101.

Alternatively the materials in question could be used as a substitute for other materials in another regular Job (Job 208). The materials so replaced will otherwise cost Rs. 6,000. These costs have been included in the viability of Job 208 which is expected to yield an additional net benefit of Rs. 11,000.

The Company has thus three alternatives namely :

- (i) use of the materials in Job 208
- (ii) use the materials in Job 101 and carryout Job 208 by buying in the materials required
- (iii) Sell the materials and carryout Job 208 by buying in the materials required.

You are required to :

- (a) State with reasons the costs which are non-relevant to the decision of alternative choices
- (b) Evaluate the three alternatives given above by using the concepts of
 - (1) incremental cost and benefit analysis
 - (2) opportunity cost and benefit analysis

13. The CS group is planning its annual marketing conference for its sales executives and has approached the VBJ Holiday company (VBJ) to obtain a quotation.

VBJ has been trying to win the business of the CS group for some time and is keen to provide a quotation which the CS group will find acceptable in the hope that this will lead to future contracts. The manager of VBJ has produced the following cost estimate for the conference:

	Rs.
Coach running costs	2,000
Driver costs	3,000
Hotel costs	5,000
General overheads	<u>2,000</u>
Sub total	12,000
Profit (30%)	<u>3,600</u>
Total	<u>15,600</u>

You have considered this cost estimate but you believe that it would be more appropriate to base the quotation on relevant costs. You have therefore obtained the following further information.

Coach running costs represent the fuel costs of Rs. 1,500 plus an apportionment of the annual fixed costs of operating the coach. No specific fixed costs would be incurred if the coach is used on this contract. If the contract did not go ahead, the coach would not be in use for eight out of the ten days of the conference. For the other two days a contract has already been accepted which contains a significant financial penalty clause. This contract earns a contribution of Rs. 250 per day. A replacement coach could be hired for Rs. 180 per day.

Driver costs represent the salary and related employment costs of one driver for 10 days. If the driver is used on this contract the company will need to replace the driver so that VBJ can complete its existing work. The replacement driver would be hired from a recruitment agency that charges Rs. 400 per day for a suitably qualified driver.

Hotel costs are the expected costs of hiring the hotel for the conference. General overheads are based upon the overhead absorption rate of VBJ and are set annually when the company prepares its budgets. The only general overhead cost that can be specifically identified with the conference is the time that has been spent in considering the costs of the conference and preparing the quotation. This amounted to Rs. 250.

Required:

Prepare statement showing the total relevant cost of the contract. Explain clearly the reasons for each of the values in your quotation and for excluding any of the cost (if appropriate)

Transfer Pricing

Learning Objective

- 1. How to fix the transfer pricing**
- 2. identify & solve the conflict between group objective & divisional profit**
- 3. objective of multinational transfer pricing**

Transfer price is the price at which goods or services are transferred from one unit of a concern to the other. Various methods of pricing used for the purpose have been enumerated as below :-

- i. At cost or variants of cost e.g., actual manufacturing cost; standard cost; full cost and full cost plus mark up
- ii. At market price
- iii. At bargained or negotiated prices.

Pricing at cost :

- a. Actual manufacturing cost : According to this method goods or services are transferred at their actual cost of production. It is a simple and useful method for units where responsibility of profit performance is centralised.
- b. Standard cost : Transfers of goods and services takes place at their standard cost. Variances if arise are usually absorbed by the supplying unit but sometimes they may be transferred to the user unit as well.
- c. Full Cost : It means the sum total of expenses viz., cost of production, selling and distribution, administration, research and development which is used as a transfer price. The use of this method does not permit the internal unit to earn profit by transferring goods and services internally, but permits them to do so while dealing with outsiders.
- d. Full Cost plus : The supplying unit transfers goods and services at full cost plus (some mark-up). The mark-up added to full cost is either expressed as a percentage of full cost or of capital employed. Selling expenses here are recovered by the supplying unit without incurring them, specially when the good/services are transferred internally. Due to this defect the use of this method is not appreciated by the internal receiving units.

Market price method :

Under this method the transfer prices of goods/services transferred to other units/divisions are based on market prices. In a competitive market goods/services cannot be transferred to its users at a higher price. Such a competitive market provides an incentive to efficient production. The main limitations of this method are :

- i. Difficulty in obtaining just market prices.
- ii. Difficulty in determining the elements of selling and distribution expenses 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 profit centre, receiving the goods.

Bargained/Negotiated prices method :

Each decentralised unit is treated as an independent unit and such units decide the transfer price by bargaining or negotiations. Divisional managers have full freedom to purchase their requirement from outside if the price quoted by their sister unit are not acceptable to them. A system of negotiated price develops business like attitude amongst divisions of the company. The buying division may be tempted to purchase from outside sources if the outside prices are lower than the internal division's price. In order to avoid any reduction in overall profits of the company, the top management may impose restrictions on the external purchase / sale of goods.

Limitation of negotiated method of transfer pricing

- a. A system of negotiated prices develops business like attitude amongst divisions of a company. This attitude may tempt the managers to purchase their requirements from outside sources, even by, ignoring the overall interest of the company.
- b. Agreed transfer price between divisions of a company, will depend on the negotiating skills and bargaining power of the managers involved and the final outcome may not be close to optimal level.
- c. Conflict between divisions of a company may arise while negotiating about transfer price and the resolution of such conflicts may require sufficient management time.
- d. Measurement of divisional profitability may depend on the negotiating skills of the managers who have unequal bargaining power.
- e. Deciding about negotiated transfer price between the divisions of a company, is time-consuming exercise for the managers involved.

International Transfer Price.

From a financial management standpoint, one of the distinguishing characteristics of the multinational Corporation (MNC) is its ability to move money and profits among its affiliated companies through internal transfer mechanisms. These mechanisms include transfer prices on goods and services trade internally, inter-company loans, dividend payment, leading (speeding up) and lagging (slowing down) inter-company payments, and fee and royalty charges.

Transfer pricing is a device used by MNCs to price inter- corporate exchange of goods, services, technology, and capital in a manner designed to maximise overall after-tax profit. These products and factor flows range from intermediate and finished goods to less tangible items such as management skills, trademark, and patents.

Apart from tax- saving, transfer pricing may be used to serve for the following objectives:

- i) Positioning of funds in locations that will suit corporate working capital policies.
- ii) Reducing exchange exposure and circumventing exchange controls, restrictions on profit repatriation so that transfers from affiliates to the parent can be maximised.
- iii) Reducing customs duty payments and overcoming quota restrictions on imports.
- iv) “ Window dressing” operations to improve the apparent, i.e. reported financial position of an offshoot so that its credit rating may be enhanced.

Dual Pricing

The dual pricing methods 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.

Two- part tariff pricing:

With the system all transfers are made at marginal cost but the supplying division charges the receiving division a fixed fee for the privilege of obtaining the transfers at such a low price. The fixed fee should cover the supplying division's fixed costs and allow it to earn an adequate profit. This system also has a number of drawbacks, two of which are as follows: 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.

Main objective

- To foster commercial attitude among executives who are responsible for the performance of profit centers.
- To optimise the profit of the concern over a short period.
- To optimise the allocation of the concern's financial resources.

Find profit when TP is given

1. Bharat Petroleum has three divisions. Each operates as a profit center:

- 1) Production Division- manages the production of crude oil from an oil field near Uran, Mumbai
- 2) Transportation Division- manages the operation of a pipeline that transports crude oil from the Uran area to Haldia, WB.
- 3) Refining Division-manages a refinery at Haldia that processes crude oil into gasoline. (For simplicity, assume that gasoline is the only salable product made by the refinery, and that it takes two barrels of crude oil to yield one barrel of gasoline.)

The data summarize the variable and fixed costs of each division are as.

PRODUCTION DIVISION OF BHARAT PETROLEUM

Variable costs per Barrel of Crude oil	= Rs. 2	Market price per Barrel of Crude oil
Fixed costs per Barrel of Crude oil	= Rs. <u>6</u>	to Third Parties = Rs. 12
Absorption Costs per Barrel of Crude oil	= Rs. <u>8</u>	

TRANSPORTATION DIVISION OF BHARAT PETROLEUM

Variable Costs per Barrel of Crude oil	= Rs. 1
Fixed Costs per Barrel of Crude oil	= Rs. <u>3</u>
Absorption Costs per Barrel of Crude oil	= Rs. <u>4</u>

REFINING DIVISION OF BHARAT PETROLEUM

Variable Costs per Barrel of Gasoline	=	Rs. 8	Market Price per Barrel of
Fixed cost per Barrel of Gasoline	=	Rs. <u>6</u>	Crude Oil Delivered to
Absorption Costs per Barrel of Gasoline	=	Rs. <u>14</u>	Haldia Refinery by 3 rd Parties = Rs 18

External Sale Market price per Barrel of Gasoline Sold to Third Parties = Rs. 54.

The fixed costs per unit are based on estimates of total budgeted volume of crude oil to be produced and transported, and total gasoline to be produced in the current year. The pipeline from Uran to Haldia can carry 40,000 barrels of crude oil per day. The Refining Division has been operating at capacity using oil from Bharat's Production Division (on average 10,000 barrels per day) and oil brought from other producers (on average 20,000 barrels per day) at Rs. 18 per barrel. Find the effect on division operating income of using the following three transfer pricing methods for a series of transactions involving 100 barrels of crude oil produced by Bharat's Production Division:

Method A : 150% of variable costs, where variable costs are the cost of the transferred-in product plus the division's own variable costs.

Method B : 125% of absorption costs, where absorption costs are the cost of the transferred in product plus the division's own variable and fixed costs

Method C : Market price methods. Comment on the basis of each pricing methods.

Profit with Load

2. M. Ltd. has two divisions- Division 1 and Division 2. Division 2 can buy from Division 1 or from outside suppliers. Division 1 can sell at the market price all the output that it can produce. The profit statement for the year for the company as a whole appears as follows:

Profit Statement for the year ended December 31

		Rs.	Rs.
Total Sales			1,80,000
<u>Cost of goods sold:</u>			
Opening Stocks			
<u>Manufacturing Costs:</u>			
Raw materials	Division 1	40,000	
Labour	Division 1	30,000	
Overhead	Division 1	20,000	
Process Suppliers	Division 2	15,000	
Labour	Division 2	20,000	
Overhead	Division 2	<u>10,000</u>	
Cost of goods available for sale		1,35,000	
Deduct Closing Stock at cost			
	Division 1	--	
	Division 2	<u>10,000</u>	<u>1,25,000</u>
Gross profit			55,000
Operating expenses:			
Sales and Admn. Exp.	Division 1	11,000	
Sales and Admn. Exp.	Division 2	12,000	
Head Office overheads		<u>14,000</u>	<u>37,000</u>
Net profit before tax			<u>18,000</u>

Closing stock of Rs. 10,000 are valued at the cost of production incurred in Division 1. This stocks are as yet unprocessed. The market value of unprocessed is Rs. 12,000. The sales for the year can be broken down as follows:

Division 1	Rs. 40,000
Division 2	<u>Rs. 1,40,000</u>
	<u>Rs. 1,80,000</u>

The market value of the unprocessed material actually transferred from Division 1 to Division 2 (exclusive of the closing stock) was Rs. 1,00,000.

Required:

- Prepare division profit statement that might be used to evaluate the performance of the two division managers.
- Explain the transfer pricing policy you have used in preparing the statement and the state whether it is suitable for decision making purposes.

On I.R.D.C.

- All Play Ltd. has two divisions, A and B. A transfers all its output to B, which finishes the work. Costs and revenues at various levels of capacity are as follows :

Outputs	600	700	800	900	1,000	1,100	1,200
Cost of Div A (Rs.)	600	700	840	1,000	1,200	1,450	1,800
Net revenues of Div B(Rs.) (Selling price- own cost)	2,950	3,250	3,530	3,780	4,000	4,200	4,350

If A.P. Ltd. wish to select a transfer price in order to establish A and B as profit centers, what transfer price would motivate the managers of A and B together ?

The transfer price is set at Rs. 2.10 per unit. Comment on this proposal.

On limiting factor

- Division RF is a profit centre which produces three products X, Y and Z. Each product has an external market.

	X	Y	Z
External market price per unit	Rs. 48	Rs. 46	Rs. 40
Variable cost of production in division RF	Rs. 33	Rs. 24	Rs. 28
Labour Hours required per unit in division RF	3	4	2

Product Y can be transferred to Division BG, 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 RF, Division BG could buy similar product on the open market at a slightly cheaper price of Rs. 45 per unit.

- What will be the minimum transfer price, if the total labour hours available in Division RF are : (i). 3800 hours ? (ii). 5600 hours ?
- If 330 unit of Y are to be transferred what should be the minimum transfer price if only 3,800 labour hours are available?

Find the Transfer Price

5. P.H. Ltd. has two manufacturing departments organised 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 chemvax but at present its sales are limited to 2,000 tonnes to outside market and 1200 tonnes to the Processing unit.

The transfer price for the year 2007 was agreed at Rs. 400 per tonne. This price has been fixed in line with the external wholesale trade price on 1st January 2007. However due to heavy competition the Basic unit has been forced to reduce the wholesale trade price to Rs. 360 per tonne with effect from 1st June 2007. 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 2007 but the same was turned down by the Basic unit.

The Processing unit refines chemvax and packs the output known as Colour-X in drums of 50 kgs. each. The selling price of Colour - X is Rs. 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 Rs. 32 per drum. In that event it can buy the additional 800 tonnes of chemvax from the Basic unit whose capacity can be fully utilised. The outside market will not however absorb more than the present quantity of 2,000 tonnes. The cost data relevant to the operations are :

	<u>Basic unit (Rs.)</u>	<u>Processing unit (Rs.)</u>
Raw Materials/tonne	70	Transfer price
Variable Costs/tonne	140	170
Fixed costs/month	(Rs) 3,00,000	1,20,000

Required :

Prepare statements showing the estimated profitability for June 2007 for each unit and the company as a whole on the following bases

- At 80% and 100% capacity utilisation of the Basic unit at a market price and transfer price to the Processing unit of Rs. 400 per tonne.
- At 80% capacity utilisation of the Basic unit at the market price of Rs. 360 per tonne and the transfer price to the Processing unit of Rs. 400 per tonne.
- At 100% capacity utilisation of the Basic unit at the market price and transfer price to the Processing unit of Rs. 360 per tonne.
- Comment on the effect of the Company's transfer pricing policy on the profitability of the Processing unit. What should be the transfer price?

General problem

6. A Company is organised into two large divisions. Division A produces a component which is used by division B in a final product. The final product is sold for Rs. 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 Rs. 220. Division B however, can buy the component from the outside market at Rs. 200 each. The variable costs of Division A is Rs. 190 and fixed costs Rs. 20 per component. The variable costs of Division B in manufacturing the final product by using the component is Rs. 150 (excluding the component cost).

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

- (i) If there are no alternative uses for the production facilities of A, will the company benefit if Division B buys from outside suppliers at Rs. 200 per component?
- (ii) If internal facilities of A are not otherwise idle and the alternative use of the facilities will give an annual cash operating saving of Rs. 30,000 to Division A, should Division B purchase the component from outside suppliers?
- (iii) If there are no alternative uses for the production facilities of Division A and the selling price for the component in the outside market drops by Rs. 15 should Division B purchase from outside suppliers?

7. MCP plc specializes in providing marketing, data collection, data processing and consulting service. The company is divided into divisions that provide services to each other and also to external clients. The performance of the Divisional Managers is measured against profit targets that set by central management.

During October, the consulting division undertook a project for AX plc. The agreed fee was Rs.15,500 and the costs excluding data processing were Rs.2,600. the data processing , which needed 200 hours of processing time, was carried out by the Data Processing (DP) division. An external agency could have been used to do the data processing, but the DP division had 200 chargeable skilled hours available in October.

The DP division provides data processing services to the other division and also external customers. The budgeted costs of the DP division for the year ending 31st December 2008. Which is divided into 12 equal monthly periods are as follows:

Variable costs :	Rs.
Skilled labour (5,400 hours worked)	120,000
Semi-skilled labour	96,000
Other processing costs	60,000
Fixed costs	240,000

The costs are recovered on the basis of chargeable skilled labour hours (data processing hours) which are budgeted to be 90% of skilled labour hours worked. The DP division's external pricing policy is to add a 40% mark-up to its total budgeted cost per chargeable hour.

During October 2008. Actual labour costs incurred by the DP division were 10% higher than expected but other costs were 5% lower than expected.

Required :

- (a) Calculating the total transfer value that would have been charged by the DP division to the Consulting division for the 200 hours on its AX plc project, using the following bases :
 - (i) actual variable cost ;
 - (ii) standard variable cost + 40% mark-up ;
 - (iii) market price.
- (b) Prepare statement to show how the alternative values calculated in answer to requirement (a) above would be reflected in the performance measurement of the DP division and the Consulting division.

On ROCE basis:

8. The relevant data for a period in respect of one of the Divisions of an enterprise, manufacturing a single product, are as follows :

Product cost		
Variable	Rs.2 per unit	
Fixed	Rs.80,000	up to 2,80,000 units
	+10,000	above 2,80,000 units
Assets		
Working capital	Rs.1,00,000	
Fixed assets	Rs.2,00,000	

The desired rate of return on the capital employed by the enterprise is 30% & the Divisional Manager has fixed the selling price of the product at Rs.2.5 p.u. Present demand is 2,80,000 units.

- (i) Calculate the number of units which the Division should produce and sell in order to achieve the target return.
- (ii) The product is also used as raw material in another Division of the same enterprise. It is proposed that out of the total units should be manufactured as at (i) above, 80,000 units will be transferred at a price subject to discussion between the two Divisional Managers. The transferee is insisting that the price be fixed at Rs.2.30 per unit, which is the price at which it can be procured from the market outside. On the other hand, the transferor states that if no transfer is made and production is curtailed accordingly, there will reduction in fixed cost to the extent of RS.10,000.

You give your comments regarding the proposed transfer price of Rs.2.30 per unit.

- (iii) (a) In case it is agreed that the transfer to the other Division be made at a price of Rs.2.30 per unit, at what price should the transferor sell the remaining units so as to maintain the desired return of 30% ?
- (b) Alternatively, how many more units should it produce assuming that this will not entail any change in the fixed cost, the asset cost or the selling price.

9. 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 know:

Fixed Overhead	Rs. 5 lakhs
Variable Cost	Re. 1 per unit
Average Assets:	
Sundry Debtors	Rs. 2 lakhs
Inventories	Rs. 5 lakhs
Plant & Equipments	Rs. 5 lakhs

Find Target Price.

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' Div. 'A' wants a price of Rs. 4 per unit of 'x' but Division 'B' is prepared to pay Rs. 2 p.u. 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 Rs. 2 lakhs and fixed overhead by Rs. 25,000. You are required to advise the most profitable course of action for Division 'A'.
Nov 1997

10. CTD Ltd. has two divisions—FD and TM. FD is an iron foundry division which produces moulding that have a limited external market and are also transferred to TM division. TM division uses the moulding to produce a piece of agricultural equipment called the “TX” which is sold externally. Each TX requires one moulding. Both divisions produce only one type of product.

The performance of each Divisional Manager is evaluated individually on the basis of the residual income (RI) of his or her division. The company's average annual 12% cost of capital is used to calculate the finance charges. If their own target residual income is achieved, each Division Manager is awarded a bonus equal to 5% of his or her residual income. All bonuses are paid out of Head Office profits.

The following budgeted information is available for the forthcoming year :

	TM division TX per unit	FD division Moulding per unit
	Rs.	Rs.
External selling price	500	80
Variable product cost	366*	40
Fixed production overheads	<u>60</u>	<u>20</u>
Gross profit	74	20
Variable selling and distribution cost	25	4 **
Fixed administration overhead	<u>25</u>	<u>4</u>
Net profit	<u>24</u>	<u>12</u>
Normal capacity (units)	15,000	20,000
Maximum production capacity (units)	15,000	25,000
Sales to external customers (units)	15,000	5,000
Capital employed	Rs. 1,500,000	Rs. 750,000
Target RI	Rs. 105,000	Rs. 85,000

* The variable production cost of TX includes the cost of an FD moulding.

** External sales only of the moulding incur a variable selling and distribution cost Rs.4 per unit.

FD division currently transfer 15,000 moulding to TM division at a transfer price equal to the total production cost plus 10%, Fixed cost are absorbed on the basis of normal capacity.

Required

- (a) Calculate the bonus each Divisional Manager would receive under the current transfer pricing policy and discuss any implications that the current performance evaluation system may have for each division and for the company as a whole.
- (b) Both Divisional Managers want to achieve their respective residual income targets. Based on the budgeted figures, calculate
 - (i) The max. transfer price per unit that the Divisional Manager of TM division would pay.
 - (ii) The minimum transfer price p.u. that the Divisional Manager of FD would accept.

LEARNING CURVE

Learning objective

You will be able to know the behaviors of non-linear cost at the completion of this chapter. For this you have to follow

- 1. Computation of learning equation**
- 2. Application of learning in time & cost**
- 3. Pricing of product with learning**
- 4. Application of Standard costing**
- 5. Application of learning table.**

A **Learning curve** is a function that measures how labour-hours per unit decline as units of production increase because workers are learning and becoming better at their jobs. Managers use learning curves to predict how labour-hours, or labour costs, will increase as more units are produced.

The aircraft assembly industry first documented the effect that learning has on efficiency. In general, as workers become more familiar with their tasks, their efficiency improves. Managers learn how to improve the scheduling of work shifts. Plant operators learn how best to operate the facility. As a result of improved efficiency, unit costs decrease as productivity increases, and the unit-cost function behaves non-linearly. These non-linearities must be considered when estimating and predicting unit costs.

Managers are now extending the learning curve notion to other business functions in the value chain, such as marketing, distribution, and customer service, and to costs other than labour costs. The term experience curve describes this broader application of the learning curve. An Experience curve is a function that measures the decline in cost per unit in various value chain functions such as marketing, distribution, and so on, as units produced increase.

Experience curves

Experience curves are very similar to learning curves. Learning curves deal only with labour hours and therefore labour cost reducing by a set percentage. But experience curves cover all costs and yet they are very similar in percentage terms to learning curves. All costs reduce with experience to some extent. Material costs may decrease slightly with quantity discounts etc., but will not decrease by a large amount. Variable overheads often follow the pattern of direct labour and so may decrease in a similar way. Fixed overheads will decrease per unit as more units are made and can also decrease by a substantial amount per unit.

Uses of Learning curve.

- i. L.C. helps in analysing cost-volume profit relationship and is useful for cost estimates and forecasting
- ii. L.C. helps in budgeting and profit planning
- iii. L.C. helps in pricing, particularly in a tender when it is known that the tender consists of several repetitive jobs
- iv. L.C. helps design engineers in making decision, based upon expected rates of improvement.
- v. L.C. helps in setting standards in learning phase
- vi. L.C. knowledge helps in manpower planning for contract of long duration or for repetitive clerical work.
- vii. LC suggest great opportunities for cost reduction to be achieved by improving learning.
- viii. LC concept provides a means of evaluating the effectiveness of training programs

Limitations to the usefulness of the learning curve:

1. The learning curve is useful only for new operations where machines do not constitute a major part of the production process. It is not applicable to all productions. E.g. new and experienced workmen.
2. The learning curve assumes that the production will continue without any major interruptions. If for any reason the work is interrupted, the curve may be deflected or assume a new slope.
3. Changes other than learning may effect the learning curve. For example, improvement in facilities, arrangements, and equipment as well as personnel morale and performance may be factors influencing the curve. On the other hand, negative developments in employee attitudes may also affect the curve and reverse or retard the progress of improvement.
4. The characteristic 80 percent learning curve as originally obtaining in the air force industry in U.S. A. has been usually accepted as the percentage applicable to all industries. Studies show that there cannot be a unique percentage which can be universally applied.

Factors affecting Learning Curve:

1. While pricing for bids, general tendency is to set up a very high initial labour cost so as to show a high learning curve. This makes the learning curve useless and sometimes misleading.
2. The method of production, i.e. whether it is labour oriented or machine oriented influences the slope of the learning.
3. When labour turnover rate is high management has to train new workers frequently. In such situations the company may never reach its maximum efficiency potential. One of the important requisites of the learning curve concept is that there should be uninterrupted flow of work. The fewer the interruptions, the greater will be the improvement in efficiency.
4. Changes in a product or in the methods of production, designs, machinery, or the tools/used affect the slope of the learning curve. All these have the effect of starting learning a fresh because of new conditions. If the changes are frequent, there may be no learning at all.
5. Also other factors influencing the learning curve are labour strikes, lock outs and shut downs due to other cause also/affect the learning curve. In each such case there is interruption in the progress of learning.

As far as possible the effects of above factors should be carefully separated from the data used to establish the curve. The effects of these factors must also be separated from the actual costs used to measure the performance. Unless this is done analysis of the projected cost or the actual cost will not be meaningful.

Technique :**1. learning Equation**

$$y = ax^b$$

y = the average time per unit for x units

a = the time for the first unit

x = the cumulative number of units

b = the learning coefficient = log of learning % ÷ log 2

$$\text{So, } \log y = \log a + b \log x$$

2. The learning % is applicable with the time of 1st unit when production volume is doubled.
3. Total time = $x \cdot y = x \cdot ax^b = a \cdot x^{1+b}$
4. Apply the concept of Static cost & Reducible cost while prepare the Cost Sheet .

Problems :

1. A Company developing a new product makes a model for testing, and then a demonstration model and then goes for regular production. The time taken to make the model is 300 hours and from past experience of similar models, it is known that a 90% learning curve applies. The average time for each of the first two production models will be.

(1)	270 hours	(2)	243 hours	
(3)	216 hours	(4)	219 hours	Find the correct one with calculation.

2. Z plc experiences difficulty in its budgeting process because it fails to find the rate of learning effect as new products are introduced. An order for 32 units of a new product has been received by Z plc. So far, 14 have been completed; the first unit required 40 direct labour hours and a total of 240 direct labour has been recorded for the 14 units. The production manager expects an 80% learning effect for this type of work.

The company uses standard absorption costing. The direct costs attributed to the Centre in which the unit is manufactured and its direct materials costs are as follows:

Direct materials	Rs. 30.00 per unit.
Direct labour	Rs. 6.00 per hour.
Variable overhead	Rs. 0.50 per direct labour hour
Fixed overhead	Rs. 6,000 per four – week operating period.

There are ten direct employees working a five – day week, eight hours per day. Personal and other downtime allowances account for 25% of the total available time
The company usually quotes a four – week delivery period for orders.

You are required to

- (i) Determine whether the assumption of an 80% learning effect is a reasonable or not.
 - (ii) Use the cost data given to produce an estimated product cost for the initial order, examine the problems which maybe created for budgeting by the presence of the learning effect.
3. (a) Your Company has been approached by a customer to supply four units of a new product made to the customer's individual specification. The company experiences a 90% learning rate. The estimated labour time for the first unit of this product is 150 hours and the Company's direct labour cost is Rs. 25 per hour. Estimate the labour cost for this order.
- (b) After receiving the first order, if the customer places a repeat order what will be the labour cost for the second order.
- (c) If the customer had ordered all eight units at the same time, calculate the labour cost per unit for the combined order.
- (d) What will be the loss if 8 units are ordered & cancel the order after receiving 4 units ?
- (e) What will be the loss if 2 units are ordered 1st & delivered, then another 6 units are ordered & cancel the order after receiving 2 units of the 2nd order ?

Learning on Batch Costing

4. Engine Ltd. manufacture engine mountings for wide-bodied airliners. They have been asked to bid on a prospective contract for 90 engine mountings for the Jumbo jet aircraft. They have just completed an initial run of 30 of these mountings at the following costs :-

	Rs. In lacs
Direct materials	20
Direct labour (6000 hours @ Rs. 400)	24
Tooling Cost (re-usable)	3
Variable Overhead (Rs. 50 per labour hour)	3
Fixed Overhead (Re. 100 per labour hour)	<u>6</u>
	<u>56</u>

An 80% learning curve is thought to be pertinent in this case. The marketing director believes that the quote is unlikely to be accepted if it exceeds Rs. 110 lakhs and as the Company are short of work, he believes the contract to be vital. You are required to comment whether is it worth accepting at Rs.110 lacs. State your assumptions clearly.

6. AB Limited, which has a fairly full order book, is approached by a customer with the offer of a contract for a model that is a variant, in terms of dimensions and materials used, of one of its existing products.

Though the customer expects to pay normal price for the model, he wants AB Limited to take account of an 80% learning curve in its price calculations; this level has been shown to be reasonable in AB Limited's industry for relevant work.

The prospective contract is for a total of 464 units made up of an initial order of 160 units, two subsequent orders of 80 units each, and three subsequent orders of 48 units each.

AB Limited estimates the following costs for the initial order :

Direct materials :	Rs. per unit
P .. 8 metres	at 3.50 per metre
Q .. Rs. 160 p.u. ..	at 40 per kg.

Contract cost+ Overhead:

Department :	1	4 hours ..	at Rs. 25 per hour
	2	50 hours..	at Rs.45 per hour

The nature of the work in the two production departments is as follows :

Department 1 Uses highly automatic machines. Although the operators on these machines need to be fairly skilled, their efficiency only affects the quality of the work but can have little impact on the quantity of this department's output which is largely machine controlled.

Department 2 is partially mechanised, whilst the skill of operators is a major determinant of the volume of output.

The terms of the contract price allow for :

Direct materials cost	plus	2.5 % profit margin
Conversion cost	plus	12.5 % profit margin

You are required to calculate the price per unit for :

- (I) the initial order of 160 units ;
- (ii) the second, third and fourth orders, if given successively but without guarantee of further orders ;
- (iii) the whole contract of six orders if given from the start but on the same basis of production and delivery.

NB : An 80% learning curve on ordinary graph paper would show the following relationship between the x axis (volume) and y axis (cumulative average price of elements subject to the learning curve) :

x	y%	x	y%
1.0	100	2.1	78.9
1.1	96.9	2.2	77.8
1.2	93.3	2.3	76.8
1.3	93.7	2.4	76.0
1.4	89.5	2.5	74.9
1.5	87.6	2.6	74.0
1.6	86.1	2.7	73.2
1.7	84.4	2.8	72.3
1.8	83.0	2.9	71.5
1.9	81.5	3.0	70.7
2.0	80.0	3.1	70.0

Learning on the basis of DCF

7. Cosy Comforts Ltd. makes household appliances. It is now examining a three-year old contract to make electrical bread toasters for sale through a departmental store. During the entire contract period, it will receive for its toaster a fixed price of Rs. 300 per piece for whatever quantity it can produce in the 3 years. Skilled labour is the constraint and this cannot be increased above that currently available in the Company for making the toaster.

Capital investment required	Rs.	30,50,000 payable down cash with nil scrap value
Additional overhead	Rs.	25,000 per annum
Material	Rs.	30 per toaster
Labour (skilled)	Rs.	25 per hour.

The production manager envisages a learning curve effect for labour in the form of $y = ax^{-0.3}$ where y = average labour hours per unit, a = labour hours per first unit and x = cumulative production. He estimates that the first toaster will take 10 hours to produce and the fixed amount of skilled labour available will enable 5000 toasters to be produced in the first year. Assume all cash inflows to arise at year end and the cost of capital is 15%. What is your advice ?

8. A company is considering investing in a project with the following characteristics :
- Equipment is to be purchased costing Rs. 70,000, payable at once and having a life of five years with no residual value. The equipment's used to produce one type of product whose sales are budgeted as follows :

Year to 30 th June	2008	2009	2010	2011	2012
No. of units	20	40	50	30	10 = Total 150

- The selling price of the units is to be Rs.4,000 each.
- Costs of units are :

Direct materials	Rs.1,200 each
Variable production overhead	50% of direct wages
Variable selling and administration overhead	10% of selling price.
- Direct wages are paid at Rs.3 per hour. The first unit to be produced is budgeted to take 1505.3 man-hours of work and an 80% learning curve applies to direct wages.
- Fixed overhead relating to this project is Rs.12,000 per annum
- The company requires a 12% DCF return on its investments.

You are required to calculate whether or not the project meets the company's investment criterion, based on :

- (i) the average direct wages rate for the whole quantity of units budgeted to be sold ;
- (ii) the direct labour times expected to be required in each individual year ; Ignore tax.

NB : An 80% learning curve on ordinary graph paper would show the following relationship between the x axis (volume) and y axis (cumulative average cost of elements subject to the learning curve) :

X	Y%	X	Y%
1	100.00	70	25.48
2	80.00	80	24.40
10	47.65	90	23.40
20	38.13	100	22.71
30	33.46	110	22.03
40	30.50	120	21.41
50	28.39	130	20.86
60	26.77	140	20.38
		150	19.93

Variance analysis on Learning

9. A firm has developed a product for which the following standard cost estimates have been made for the first batch to be manufactured in Month 1.

	Standard costs for the batch
	Rs.
500 labour hours @ Rs 8 per hour	4,000
55 units of direct materials @ Rs 100 per unit	5,500
Variable overhead 500 hours @ Rs 15 per hour	<u>7,500</u>
	17,000

From experience the firm knows that labour will benefit from a learning effect and labour times will be reduced. This is expected to approximate to an 80% learning curve.

In addition, the growing expertise of labour is expected to improve the efficiency with which materials are used. The usage of materials is expected to approximate to a 95% learning curve.

The actual production for the first three months was as follows :

Month 1	5 batches
Month 2	11 batches
Month 3	16 batches

During Month 3 the following results were recorded :

Labour hours	2,048
Direct wages	Rs 19,660
Direct materials (670 units)	Rs 67,870
Variable overhead	Rs 32,768

You are required to compute the variance of month 3

- (a) to calculate the learning coefficient for materials ;
- (b) to derive the Standard Cost Month 3;
- (c) to calculate what variance in month 3;

Learning on the basis of I.R.D.C.

10. DKS manufacturers several production including the U. Production scheduling constraints require that one batch of Us is produced each quarter. The production of a batch of 12,000 U has been scheduled for the quarter ending March 31, 2006. Any production surplus to current requirements will be added to stock.

Budgeted fixed costs associated with U are Rs. 1,20,000 per quarter. The standard variable cost for U is Rs. 15 at the level of output schedule for the quarter. Most of the variable costs are labour related and it is known that U involves an 80% learning curve.

In December 2005, DKS management term meet to discuss selling price for the coming quarter A market survey on demand for U is presented to the meeting :

Price per U (Rs.)	25	30	35	40	45
Sales of Us per quarter	11,750	11,500	8,750	7,500	6,000

You are required to calculate the optimum batch size for the production of the U and the optimum selling price for the U if this batch size is adopted.

Notes : Assume that on an 80% learning curve the average hours per U at any given batch size may be determined from the following equation :

$$h = a / B^{0.322} \quad \text{which } h = \text{Cumulative average hours per U}$$

$$\text{(Same as } b = ax^{-0.322} \quad a = \text{hours per U as part of batch of one U}$$

$$= a/x^{0.322} \quad b = \text{batch size in question}$$

General Problems

11. Maximarine plc builds boats. Earlier this year the company accepted an order for 15 specialized 'Crest' boats at a fixed price of Rs. 1,00,000 each. The contract allows four months for building and delivery of all the boats and stipulates a penalty of Rs. 10,000 for each boat delivery late.

The boats are built using purchased components and internally manufactured parts, all of which are readily available. However, there is only a small team of specialized technicians and boatyard space is limited, so that only one boat can be built at a time. Four boats have now been completed and as maximarine plc has no previous experience of this particular boat the building time have been carefully monitored as follows:

Boat number	Completion time (days)
1	10.00
2	8.1
3	7.4
4	7.1

Maximarine plc has 23 normal working days in every month and the first four boats were completed with normal working. Management is now concerned about completing the contract on time.

The management accountant's estimate of direct costs per boat, excluding labour costs, is as follows:

	Rs. '000
Purchase components	40
Manufacturing parts	15
Other direct expenses	5
	<u>60</u>

Direct labour costs are Rs. 2,500 per day for the normal 23 working days per month. Additional weekend working days at double the normal pay rates can be arranged up to a maximum of 7 days per month (making 30 possible working days per month in total). Overheads will be allocated to the contract at a rate of Rs. 3,000 per normal working day and no overheads will be allocated for overtime working.

Required:

- (a) Using the completion time information provided, calculate the learning rate showing full workings.
- (b) Calculate whether it would be preferable for Maxmarine plc to continue normal working or to avoid penalties by working weekends. Support your calculations with any reservations or explanations you consider appropriate. Demand per month is 10,000 units after initial phase.

QT-- Bank

12. Q plc. has recently developed a better quality of DVD recorder. Market research discovered that the price demand relationship for the item during the initial launch phase will be as follows:

Price (Rs.)	Demand (units)
100	10,000
80	20,000
69	30,000
62	40,000

production of the DVD recorder would occur in batches of 10,000 units, and the production director believes that 50% of the variable manufacturing cost would be affected by a learning and experience curve. This would apply to each batch produced and continue at a constant rate of learning up to a production volume of 40,000 units when the learning would be complete. Thereafter, the unit variable manufacturing cost of the product would be equal to the unit cost of the fourth batch. The production director estimates that the unit variable manufacturing cost of the first batch would be Rs. 60 (Rs. 30 of which is subject to the effect of the learning and experience curve, and Rs. 30 of which is affected), whereas the average unit variable manufacturing cost of all four batches would be Rs. 52.71. There are no non-manufacturing variable costs associated with the DVD recorder.

Required:

- (i) Calculate the rate of learning that is expected by the production director.
- (ii) Calculate the optimum price at which Q should sell the DVD recorder in order to maximise its profits during the initial launch phase of the product.
- (iii) Q expects that after the initial launch phase the market price will be Rs. 57 per unit. Estimated product specific fixed costs during this phase of the product's life are expected to be Rs. 15,000 per month. During this phase of the product life cycle Q wishes to achieve a target monthly profit from the product of Rs. 30,000. Demand per month is 10,000 units after initial phase

Calculate the number of units that need to be sold each month during this phase in order that Q achieves this target monthly profit.

CIMA May 2005 :Decision Making

Decision Making under Uncertainty

1. Visual check: compute the probability by adding the chances of the corresponding level . select that offer where the chance of BE is highest.

2. Expected Value Approach (E.V.) = $\sum P_i X_i$

Apply Decision Tree Model & concept of joint probability .

Problems:

1. A company has estimated the following demand level of the product.

Sales volume	Probability
10,000	0.10
12,000	0.15
14,000	0.25
16,000	0.30
18,000	0.20

It has assumed that the Sales price will be Rs. 6 per unit, Marginal cost Rs. 3.50 per unit and fixed cost Rs. 34,000. What is the probability that

(a) the company will break- even in the period ?

(b) the company will make a profit of at least Rs. 10,000

2. A Ltd. produces a range of products with an average contribution/sales ratio of 30% on current prices. Currently, fixed costs are Rs. 1,50,000 per annum and estimates are being prepared for the next budget period for which the following forecasts have been made:

Sales (current prices)	Probability
Rs. 4,00,000	0.2
Rs. 7,00,000	0.7
R. 9,00,000	0.1

Inflation rate for the next budget period	Probability
12%	0.3
6%	0.5
2%	0.2

The inflation rate is expected to affect all variable costs and 60% of the fixed costs. The company anticipates being able to raise selling prices in line with inflation without losing sales. The probabilities shown are independent.

You are required to :

- (a) prepare a table of all possible results and calculate the probability of at least breaking even ;
 (b) calculate the probability of making at least a Rs. 70,000 profit ;

3. A Company using a detailed system of standard costing finds that the cost of investigation of variances in Rs. 20,000. If after investigation an out of control situation is discovered, the cost of correction is Rs. 30,000. If no investigation is made, the present value of extra cost involved is Rs. 150,000. The probability of the process being in control is 0.18. You are required to advise.

- i) Whether investigation of the variances should be undertaken or not;
- ii) The probability at which it is desirable to institute investigation into variances.

ASSIGNMENT

Learning objective

1. how to allot jobs among workers & machines so as to reduce total time & cost
2. maximisation of revenue
3. route assignment
4. how to arrange the job of a traveling salesman

Allocation of jobs one to one basis so that the total costs or total time is minimize.

In case of un-balanced problems introduce dummy row or column so that the row & column numbers are equal i.e. the matrix is square one

Rules for Hungarian Method:

1. Select the smallest elements of each row & subtract it from all the elements of that row. Prepare a new table
2. Select the smallest elements of each column in the new table & subtract it from all the elements of that column. If '0' is present in all the columns then do not apply this rule.
3. Strike out all the zeros by drawing minimum number of straight lines along the rows or columns. So select that row or column where maximum number of zeros are there.
4. If the number of straight lines drawn = number of row or columns then optimal solution is reached.
5. In that case select a row or column with a single "0" & mark that "0" with box . Then cancel the " 0 " in corresponding column or row. You can compare it with the 1st table for the allotment purpose. Prepare the final assignment table . More than one '0' in each row & column select any one of them (Rule of thumb)
6. If the optimal solution is not reached due to shortage of lines drawn, then select the smallest element among the uncovered element. Subtract it from all the uncovered element & Add it at the crossing of lines(except in case of a " – "). Prepare a new table. Now repeat from Step- 3
7. In case of profit (or revenue) maximisation problem, i.e. subtract all the profit elements from highest profit. & Prepare a cost matrix(the opportunity costs). In case of unbalance problem, balance it before conversion into cost matrix. Give final answer in terms of profit.

Problems

1. Consider the problem of assigning five jobs to five persons, determine the optimum assignment schedule. The assignment costs are given as follows :

		Jobs				
		1	2	3	4	5
Person	A	8	4	2	6	1
	B	0	9	5	5	4
	C	3	8	9	2	6
	D	4	3	1	0	3
	E	9	5	8	9	5

2. A Business School to hold financial management courses on subjects of popular interest viz. Leasing Mutual Funds. Portfolio Management and Swaps & Options. The schedule has been drawn in such a way that one course in a week will be held & only one topic will be assigned per course so that the no. of participants who are unable to attend is kept at minimum. An analysis of the number of participants who can't attend a particular course on a specific day is as under :

Day	Leasing	Mutual Funds	Portfolio Management	Swaps and Options
Monday	50	40	60	20
Tuesday	40	30	40	30
Wednesday	60	20	30	20
Thursday	30	30	20	30
Friday	10	20	10	30

Find the optimal schedule of the courses and the total number of participants who will be missing at least one seminar.

3. The personal manager of ABC company wants to assign Mr. X, Mr. Y and Mr. Z to regional offices. But the firm also has an opening in its Chennai office and would send one of the three to that branch if it were more economical than a move to Delhi, Mumbai or Kolkata. It will cost Rs. 2,000 to relocate Mr. X to Chennai Rs. 2,600 to relocate Mr. Y there, and Rs. 3,500 to move Mr. Z. What is the optimum assignment of personnel to offices ?

Office Hires	Delhi	Mumbai	Kolkata
Mr. X	1600	2200	2400
Mr. Y	1000	3200	2600
Mr. Z	1000	2000	4600

4. A city corporation has decided to carry out road repairs on main four arteries of the city. The government has agreed to make a special grant of Rs. 50 lakhs towards the cost with a condition that the repairs must be done at the lowest cost and quickest time. If conditions warrant, then a supplementary token grant will also be considered favorably. The corporation has floated tenders and 5 contractors have sent in their bids. In order to expedite work, one road will be awarded to only one contractor.

Contractors/Road	Cost of Repairs (Rs. Lakhs)			
	R1	R2	R3	R4
C1	9	14	19	15
C2	7	17	20	19
C3	9	18	21	18
C4	10	12	18	19
C5	10	15	21	16

- Find the best way of assigning the repair work to the contractors and the costs.
 - If it is necessary to seek supplementary grants, then what should be amount sought ?
 - Which of the five contractors will be unsuccessful in his bid ?
 - If C1 unable to accept any work, find best assignment.
 - If C2 can not do R1 what will be the additional grant?
5. Five swimmers are eligible to compete in a relay team which is to consist of four swimmers swimming four different swimming styles; back stroke, breast stroke, free style and butterfly. The time taken for the five swimmers – Anand, Bhaskar, Chandru, Dorai and Easwar – to cover a distance of 100 meters in various swimming styles are given below in minutes : seconds. Anand swims the back stroke in 1 : 29, the breast stroke in 1 : 15 and has never competed in the free style or butterfly. Bhaskar is a free style specialist averaging 1 : 31 for the 100 meters but can also swim the breast stroke in 1 : 16 and butterfly in 1 : 20 Chandni swims all styles – back 1 : 10 butterfly 1 : 12 free style 1 : 05 and breast stroke 1 : 20 Dorai swims only the butterfly 1 : 11 while Easwar swims the back stroke 1 : 20, the breast stroke 1 : 16, the free style 1 : 46 and the butterfly 1 : 18. Which swimmers should be assigned to which swimming style ?

6. WELLDONE Company has taken the third floor of a multistoried building for rent with a view to locate one of their zonal offices. There are five main rooms in this floor to be assigned to five managers. Each room has its own advantages and disadvantages. Some have windows, some are closer to the washrooms or to the canteen or secretarial pool. The rooms are of all different sizes and shapes. Each of the five managers were asked to rank their room preferences amongst the rooms 301, 302, 303, 304 and 305. Their preferences were recorded in a table as indicated below :

MANAGER				
M1	M2	M3	M4	M5
302	302	303	302	301
303	304	304	305	302
305	305	301	304	304
301	303	305	303	305
	301	302		

Most of the managers did not list all the five rooms since they were not satisfied with some of these rooms and they have left off these from the list. Assuming that their preferences can be quantified by numbers, find out as to which manager should be assigned to which room so that their total preference ranking is a minimum.

7. A private firm employs typists on hourly piece rate basis for their daily work. Five typists are working in that firm and their charges and speeds are different. On the basis of some earlier understanding only one job is given to one typist and the typist is paid for full hours even when he or she works for a fraction of an hour. Find the least cost allocation for the following data :

Typist	Rate per hour (Rs.)	Number of pages Typed/hr.	Job	No. of pages
A	5	12	P	199
B	6	14	Q	175
C	3	8	R	145
D	4	10	S	298
E	4	11	T	178

8. Five professors of MBA program have given assignments to five overloaded MBA students to be completed in a day. The Students do the assignments together. The time requirement, (in hours) for each of the students for any assignment and the time each student goes to bed (must) are indicated.

	I	II	III	IV	V	Student Must go to bed at
Wily Waman	2	5	1.5	3	5	10 pm
Tricky Theresa	4	2	3	1	4	11 pm
Bhola Babloo	1	3	4	2	1.5	9 pm
Don't matter Damle	1.5	2.5	3.5	3	3	10 pm
No-good Nagarajan	5	4	3.5	2	4	12 midnight
It is now 7 p.m.						

Assuming that the students have read and followed this chapter, who would do which assignment ? Will they be able to do all the assignments ?

Airlines Route & Minimisation of Idle Time

9. XYZ airline operating 7 days a week has given the following time-table. Crews must have a minimum layover of 5 hours between flights. Obtain the pairing flights that minimizes layover time away from home. For any given pairing the crew will be based at the city that results in the smaller layover :

Chennai- Mumbai			Mumbai -Chennai		
Flight Number	Depart.	Arrive	Flight Number	Depart.	Arrive
A ₁	6 AM	8 AM	B ₁	8 AM	10 AM
A ₂	8 AM	10 AM	B ₂	9 AM	11 AM
A ₃	2 PM	4 PM	B ₃	2 PM	4 PM
A ₄	8 PM	10 PM	B ₄	7 PM	9 PM

10. Sohil Airlines, operating seven days a week, serves three cities A, B and C according to the schedule shown in the following table. The layover cost per stop is roughly proportional to the square of the layover time. How should planes be assigned the flights so as to minimize the total layover cost ?

Flight No. and Index	From	Departure	To	Arrival
A ₁ B	A	09 A.M.	B	Noon
A ₂ B	A	10 A.M.	B	01 P.M.
A ₃ B	A	03 P.M.	B	06 P.M.
A ₄ C	A	08 P.M.	C	Midnight
A ₅ C	A	10 P.M.	C	02 A.M.
B ₁ A	B	04 A.M.	A	07 A.M.
B ₂ A	B	11 A.M.	A	02 P.M.
B ₃ A	B	03 P.M.	A	06 P.M.
C ₁ A	C	07 A.M.	A	11 A.M.
C ₂ A	C	03 P.M.	A	07 P.M.

11. Amphion Airlines is a small air freight company based in Holland and operating throughout Western Europe. The company has 6 aircraft of different types, namely:

3 type 'A'
2 type 'B'
1 type 'C'

Whose operating costs and load carrying capacities are as follows:

Aircraft Type	Fixed cost (Rs. per day)	Variable cost (Rs.)		Capacity (tons)
		per mile	per ton	
A	800	0.60	30	10
B	700	0.40	35	8
C	500	1.00	25	4

For any journey variable costs are assigned on the basis of both the distance flown and the load being carried. All fixed and variable cost components are then added to obtain the relevant total cost.

On one particular day, there are 5 loads to be delivered to various destinations, the size of load and distances being:

Load	Size (tons)	Distance (miles)
1	10	200
2	2	550
3	8	320
4	5	280
5	3	450

P.T.O.

The distances given above are direct from the company's base in Holland to the location involved and in each case there is no return load so that the aircraft will fly back empty. This means that mileage costs are incurred on both the outward and return journeys can be completed within one day, and each aircraft can only fly one load in any one day. You may also assume that loads cannot be divided up and delivered in parts.

Required:

- (a) For each of the five loads, determine the cost of delivery using each of the feasible aircraft types.
- (b) Set up the cost matrix for assigning each load to each particular aircraft.

Using an appropriate procedure, decide which aircraft should be used for delivering each load so that total cost is minimized. What is the total cost of all five deliveries. (ACCA England-Adopted)

Traveling Salesman problem

12. Solve the following traveling salesman problem so as to minimise the cost per cycle :

From	To				
	A	B	C	D	E
A	--	3	6	2	3
B	3	--	5	2	3
C	6	5	--	6	4
D	2	2	6	--	6
E	3	3	4	6	--

Maximization Problems

13. Parul Corporation has four plants each of which can manufacture any one of four products. Production costs differ from one plant to another as do sales revenue. Given the revenue and cost data below, obtain which product each plant should produce to maximise profit :

Plant	Sales revenue (Rs. '000s)				Production cost (Rs. '000s)			
	Product				Product			
	1	2	3	4	1	2	3	4
A	50	68	49	62	49	60	45	61
B	60	70	51	74	55	63	45	69
C	55	67	53	60	52	62	49	58
D	68	65	64	69	65	64	58	66

Simulation

Learning Objective

To make a proper understanding of a very big project, a small or pilot project is required i.e. a portrait of a big landscape. In this we will be able to know the technique of that. This is known as simulation.

Problem involving managerial decision making are often solved by sophisticated mathematical models. However, there are many situations when the system is so complex that it is not possible to express the elements and their interrelationships as a mathematical model. In these situations the only practical solution is to simulate the system.

To develop a simulated model, its elements are analysed and expressed in terms of probability distribution function. The elements so specified are collected in a natural order of occurrence and tested for various alternatives that surface by the use of random numbers. The method using random number tables is known as Monte Carlo Techniques.

Advantages : Where making observations in a real situation may be expensive, very difficult, or a protracted exercise, and operating more than one set of real situation, all at a time, for the purpose of observing the alternative data is not feasible, the simulation technique comes handy with the aid of a computers that also generates random numbers. The time, cost and risk involved in the experimentation of a real environment, if practicable at all, are avoided and decision making becomes easier by observing the average of the results obtained by sufficient runs or replications of the set of data from theoretical population.

Disadvantages:

- Simulation is not an optimization process. It only provides a set of system's responses to different operating conditions.
- A good simulation model may be very expensive.
- Not all situations can be evaluated by using simulation.
- Simulation does not generate the solution techniques.
- It is a time consuming exercise.

Limitations

- Simulation generates a way of evaluating solutions but it does not generate the solutions techniques.
- Sometimes Simulation Models are expensive and may also take a long time to develop them.
- A simulation Model does not produce answer by itself.
- Nor all situations can be evaluated using Simulation.
- It is a trial and error approach that produces different solution in repeated runs.
- Simulation is time –consuming exercise.

Steps of Monte Carlo Method:

1. Clearly formulate the problem in order to determine the objectives and constraints.
2. Calculate respective probability.
3. Calculate cumulative probability. ($\leq$)
4. Calculate random interval : For two digit random number, upper limit of the interval = cumulative Probability $\times 100 - 1$.
5. Select a random number & check the place of that in random interval
Correlate the random numbers with the factors/items in the problem.
Summarize and examine the results in an appropriate table.
6. Evaluate the results of the simulation and select best course of action.

PROBLEMS

1. A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions, the daily production has been varying from 196 mopeds to 204 mopeds, whose probability distribution is as given below :

Production/day :	196	197	198	199	200	201	202	203	204
Probability :	1.00	0.95	0.86	0.74	0.60	0.40	0.25	0.14	0.06

The finished mopeds are transported in a specially designed three storied lorry that can accommodate only 200 mopeds.

Using the following 10 random numbers 12, 89,38,24, 53, 16, 98, 45, 04, 23, to simulate the process to find out :

- What will be the average number of mopeds waiting in the factory ?
- What will be the average number of empty space on the lorry.

2. A trader deals in a perishable commodity, the daily demand and supply of which are random variables. Records of the past 500 trading days show the following :

Supply		Demand	
Tons available	Number of days	tons demanded	Number of days
10	40	10	50
20	50	20	110
30	190	30	200
40	150	40	100
50	70	50	40

The trader buys the commodity at Rs. 200 per ton and sells at Rs. 300 per ton. If any of the commodity remains at the end of the day it has re-saleable value of Rs. 80 ton. The loss through unsatisfied demand is Rs. 90 per ton.

From this random numbers, simulate the trading : 31, 18, 63, 84, 15, 79, 07, 32, 43, 75, 81, 27.

Use the random numbers alternatively, i.e., first pair (31) to simulate supply, second pair (18) to simulate demand. Compute the profit for next 6 days.

3. A book store wishes to carry 'Ramayana' in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e. if an order is placed on March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below :

Demand (daily)	0	1	2	3	4
Probability	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of Rs. 10 per order. The store also incurs a carrying cost of Re. 0.50 per book per day. The stock out cost is Rs. 18 per unit. The inventory carrying cost is calculated on the basis of stock at the end of each day.

The manager of the book store wishes to compare two options for his inventory decision.

- Order 5 books when the inventory at the beginning of the day plus orders outstanding is less than 8 books.
- Order 14 books when the inventory at the beginning of the day plus orders outstanding is less than 8.

Currently (beginning of 1st day) the store has a stock of 8 books plus 6 books ordered two days ago and expected to arrive next day. Using Monte Carlo Simulation for 10 cycles, recommend which options the manager should choose.

The two digit random nos. are :89, 34, 78, 63, 61, 81, 93, 16, 13, 73

4. The occurrence of rain in a city on a day is dependent upon whether or not it rained on the previous day. If it rained on the previous day, the rain distribution is given by :

Event	Probability
No rain	0.50
1 cm. Rain	0.25
2 cm. Rain	0.15
3 cm. Rain	0.05
4 cm. Rain	0.03
5 cm. Rain	0.02

If it did not rain the previous day, the rain distribution is given by :

Event	Probability
No rain	0.75
1 cm. Rain	0.15
2 cm. Rain	0.06
3 cm. Rain	0.04

Simulate the city's weather for 10 days and determine by simulation the total days without rain as well as the total rainfall during the period. Use the following random numbers :
for simulation. Assume that for the first day of the simulation it had not rained the day before.

67 92 39 55 98 78 70 06 78 76

5. The output of a production line is checked by an inspector for one or more of three different types of defects, called defects A, B and C. If defect A occurs, the item is scrapped. If defect B or C occurs, the item must be reworked. The time required to rework a B defect is 15 minutes and the time required to rework a C defect is 30 minutes. The probabilities of an A, B and C defects are 0.15, 0.20 and 0.10 respectively. For ten items coming off the assembly line, determine the number of items without any defect, the number scrapped and the total minutes of rework time. Use the following random numbers:

RN for defect A	48	55	91	40	93	01	83	63	47	52
RN for defect B	47	36	57	04	79	06	10	13	57	09
RN for defect C	82	95	18	96	20	04	56	11	52	03

6. As a result of a routine analysis of cash flows, the chief Accountant of Odin Chemicals Ltd. Considers that there are only three types of cash flow which are likely to vary significantly from month to month. These are: Wages and salaries

Raw Materials purchases.
Sales revenue

Using data that have been collected over the last two years, and taking into account likely changes in the level of operations during the next few months, the flowing distributions have been estimated for the monthly cash flow in each of these three categories.

Wages and salaries (Rs. '000)	Probability	Raw materials (Rs. ' 000)	Probability
10 – 12	0.3	6 – 8	0.2
12 – 14	0.5	8 – 10	0.3
14 – 16	0.2	10 – 12	0.3
		12 – 14	0.2
Sales revenue (Rs. '000)	Probability		
30 – 34	0.1		
34 – 38	0.3		
38 – 42	0.4		
42 – 46	0.2		

All other cash flows can be regarded as fixed, and amount to a net cash outflow of Rs. 14,000 per month. Currently Odin has cash assets of Rs. 50,000. What is the expected cash balance at the end of the 6 – month period ?

Random numbers in months:	1	2	3	4	5	6
Wages and salaries	2	7	9	2	9	8
Raw materials	4	4	1	0	3	4
Sales revenue	0	6	6	8	0	2

Service Sector

7. Dr. STRONG is a dentist who schedules all her patients for 30 minutes appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and the time actually to complete the work :

Category	Time required (mts)	Probability of
Filling	45	0.40
Crown	60	0.15
Cleaning	15	0.15
Extraction	45	0.10
Checkup	15	0.20

Simulate the dentist's clinic for four hours and determine the average waiting time for the patients as well as the idleness of the doctor. Assume that all the patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 A.M. Use the following random numbers handling the above problem :

90 82 11 41 25 66 17 79

8. With a view to improving the quality of customer services, a Bank is interested in making an assessment of the waiting time of its customers coming to one of its branches located in a residential area. This branch has only one teller's counter. The arrived rate of the customers and the service rate of the teller are given below:

Time between two consecutive arrivals Probability
of customers(in minutes)

3	0.17
4	0.25
5	0.25
6	0.20
7	0.13

Service time by the teller Probability
(in minutes)

3	0.10
4	0.30
5	0.40
6	0.15
7	0.05

You are required to simulate 10 arrivals of customers in the system starting 11 AM and show the waiting time of the customers and idle time of the teller. Use the following random numbers taking the first two random numbers digits each for a trial and so on: 11, 56, 23, 72, 94, 83, 3, 02, 97, 99, 83, 10, 93, 34, 33, 53, 49, 94, 37 and 97.

9. Ramu and Raju are workers on a two station assembly line. The distribution of activity times at their station is :

Time (in min.) :	10	20	30	40	50
Time freq. For Ramu :	10	10	20	20	40
Time freq. For Raju	14	30	36	10	10

06, 55, 42, 87, 34, 17, 52, 68 for Ramu and 26, 97, 76, 02, 34, 05, 86, 56 for Raju.

Assuming Raju must wait until Ramu completes first item, before starting work. They will have to wait to process any of the other eight items.

Calculate the cost of idle time & cost of job lateness if wage rate is Rs. 40 per hour & lost contribution is Rs.120 per hr.

PERT & CPM

1. Define project. State some of its characteristics.

A project can be defined as a set of activities or jobs that are performed in a certain sequence determined logically or technologically and it has to be completed within (i) a specified time, (ii) a specified cost and (iii) meeting the performance standards .

Examples of a project from fairly diverse fields could be cited . Some of them are given below :

1. Introducing a new product in the market.
2. Construction of a new bridge over a river or construction of a 25 -- storied building.
3. Executing a large and complex order on jobbing production.
4. Sending a space craft to the mars.

All these projects are characterised by the following set of common implications, although they pertain to widely different fields.

- (i) The large-scale characteristic : These projects are generally unusually large and complex. Thousands of suppliers, workers and other categories of persons are involved and their efforts have to be co-ordinate for completion of the project.
- (ii) The non-recurring characteristic : These projects are generally of a one time nature. Neither in the past, nor in the future they are likely to be undertaken substantially in the same form.
- (iii) Uncertain and critical dates : Duration of the various activities involved in such projects are usually uncertain. Further in such type of projects, many critical dates exist by which operations must be completed in order to complete the entire project on schedule.
- (iv) Completion dead line : The fourth distinct feature of these projects is that there is dead line for the completion of the entire project. In case of any delay in the completion of the project, some penalty is levied for such delay beyond the dead line.

2. Explain the terms Resource Smoothing and Resource Leveling.

Answer : Resource smoothing : It is a technique used for smoothening peak resource requirements during different periods of a project net work. The total project duration is maintained at the minimum level. The constraint is on the project duration time. It helps to estimate the total resource requirements for various projects. In resource smoothing, time scaled diagram of various activities of a project and their floats along with their resource requirements are used the period of maximum demand for resources are identified and non critical activities during these periods are staggered by rescheduling them according to their floats for balancing the resource requirements.

Resource Leveling : It is a net work technique used for Reducing the requirement of a particular resource due to its paucity. It utilises the large floats available on non critical activities and cuts down the demand on resources. The maximum demand of a resource should not exceed the available limit at any point of time . Non critical activities are rescheduled by utilizing their floats.

3. ADVANTAGES OF CRITICAL PATH ANALYSIS

1. It allows for a comprehensive view of the entire project. Because of the sequential and concurrent relationships, time scheduling becomes very effective. Identifying the critical activities keeps the executive alert and in a state of preparedness, with alternative plans ready in case these are needed. Breaking down the project into smaller components permits better and closer control.
2. Critical path analysis offers economical and effective system of control based on the principle management by exception i.e. need for corrective action arises only exceptional situations and in most of other cases, performance is in conformity with the plans.
3. It is a dynamic tool of management which calls for constant review, a reformulation of the network, and finding the current path of relevance and optimum resources allocations.

4. **Resource smoothing**: It is a network technique used for smoothening peak resource requirement during different periods of the project network. Under this technique the total project duration is maintained at the minimum level. The resources required for completing different activities of project are smoothened by utilizing floats available on non-critical activities. These non-critical activities having floats are rescheduled or shifted so that a uniform demand on resources is achieved. The constraint is on the project duration time.

Resource Leveling: It is also a network technique used for reducing the requirement of particular resource due to its paucity. It utilizes the large floats available on non-critical activities of the project and thus cuts down the demand on the resources.

In resource leveling, the maximum demand of a resource should not exceed the available limit at any point of time. To achieve this, non-critical activities are rescheduled by utilizing their floats. It may lead to enlarging the completion time of the project. The constraint here is on the limit of the resource availability.

5. **Time Scaled Diagrams** : In the network diagrams which we have considered, it has been stressed that the length of the individual arrows has no relation to the duration of the activity which each arrow represented. It is of course possible to draw the arrows to a time scale, and this can be a very useful method of presentation for small networks.

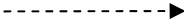
6. A FEW COMMENTS ON ASSUMPTIONS OF PERT & CPM

1. Beta distribution may not always be applicable.
2. The formulae for the expected duration and S.D. are simplifications.
3. The errors owing to the aforesaid simplification and assumption may be compounded or may cancel each other to an extent.
4. In computing the S.D. of the critical path independence of activities is implied. Limitations of resources may invalidate the independence which exists by the very definition of an activity.
5. It may not always be possible to sort out completely identifiable activities and to state where they begin and where they end.
6. Time estimates have an element of subjective-ness and, to that extent, the techniques could be weak.

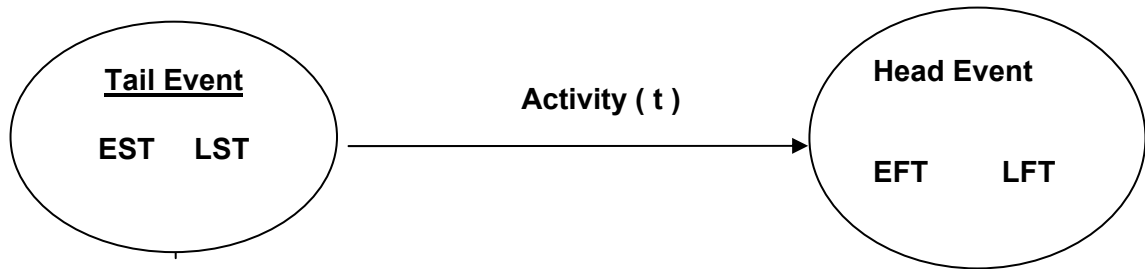
7. Distinction between PERT and CPM

PERT	CPM
1. PERT is used for non-repetitive jobs like planning the assembly of the space.	1. CPM is used for repetitive job like building a house
2. it is a probabilistic model.	2. it is a deterministic model.
3. It is event-oriented as the results of analysis are expressed in terms of events or distinct points in time indicative of progress.	3. it is activity-oriented as the result or calculations are considered in terms of activities or operations of the project.
4. It is applied mainly for planning and scheduling research programmes.	4. it is applied mainly for construction and business problems.
5. PERT incorporates statistical analysis and thereby determines the probabilities concerning the time by which each activity or entire project would be completed.	5. CPM does not incorporate statistical analysis in determining time estimates, because time is precise and known.
6. PERT serves as useful control device as it assists management in controlling a project by calling attention to such delays which might lead to delay in project completion.	6. It is difficult to use CPM as a control device for the simple reason that one must repeat the entire evaluation of the project each time the changes are introduced into the network.

Some important definition:

- Activity :** It is a particular work of a project which consumes some resources & time. It is shown as  & Represented by Capital Letter.
- Event :** it denotes the start & end of an activity & represented by a "circle". Events are no as 1, 2, 3 etc. So that in moves from lower to higher no.
- Every project starts with a single event & ends at a single event. No properly to show move from L → R.**
- Sequence :** activities are linked in a sequence known as immediate predecessor i.e. an activity which must be completed first to start another one
- Between two events there must be only one activity.**
- Dummy Activity** is required to solve the problem when two or more activities are there between two events. It is denoted as 
- Path:** a series of activities taken together to link the first & end event.
- Critical Path:** The longest path is known as critical path & represented by thick line or double lines. All activities lying in this critical path are called critical activities. Any delay in their execution will lead to a delay in the completion of the entire project.

9. Forward Pass & Backward Pass



In case of Forward pass : $EFT = EST + t$

In case of convergent event, select the highest one out of different EFT in forward pass

In case of backward pass , $LST = LFT - t$

In case divergent event, select the lowest one out of different LST in backward pass.

In the critical path all $EST = LST$ or $EFT = LFT$

10. Computation of idle time for a PERT : Slack is with reference to an event and float is with respect to an activity. In other words, slack is used with PERT and float with CPM , but they be interchangeably used in general practice. Float or slack means extra time over and above its duration which a non-critical activity can consume without delaying the project.

- A. Total float = L.S.T. – E.S.T. L.S.T. = LFT – Activity time and
E.S.T. = earliest Start Time
- B. Head or Tail event slack = Latest – Earliest of that event
- C. Free float = Total float – Head event slack.
- D. Independent float = Free float – Tail event slack
- F. Interfering Float = Latest event time of the head event – earliest event time of that.

11. Three Time Estimate for PERT. The three time estimates are as under :
An Act time can be divided into:

- A. Optimistic time, (t_o or a). This is the minimum time to perform the activity, assuming that everything goes well.
- B. Pessimistic time, (t_p or b). This is the maximum time that is required to perform the activity, under extremely bad conditions. However, such condition do not include acts of nature like earthquakes, flood, etc.
- C. Most likely time, (t_m or m). This is the most often occurring duration of the activity. Statistically, it is the modal value of duration of the activity.

$$T_e \text{ or Average time of Act} = (t_o + 4t_m + t_p) \div 6$$

$$\text{Stander Deviation of an activity} = (t_p - t_o) \div 6$$

$$\text{Variance of an activity} = \{ (t_p - t_o) \div 6 \}^2$$

$$\text{Variance of the critical path} = (\sum \text{Variances of critical path activities})$$

(As well as the project)

Estimate of Probability. As we are expecting a variability in the activity duration, the total project may not be completed exactly in time. Thus, it is necessary to calculate the probability of actually meeting the scheduled time of the project as well as activities. The probability distribution of time for completing an event can be approximated by the normal distribution due to central

limit theorem. Thus the probability of completing the project by scheduled time (t_m) is given by Prob. $(-\infty \leq Z \leq +\infty)$

The standard normal variant is given by $Z = (X - \mu) \div \delta$

Where μ = expected length of the project = duration of critical path on the basis of t_e .

$\delta = \sqrt{\text{variance of critical path}}$

In order to find out the probability of completing the project in some given time we shall consider only the expected length of the critical path and its variance. The expected time of the project can be the critical path. Since it is assumed that the two activities are independent therefore, variance of the critical path can be known by adding variances of critical activities.

Problems :

1. Draw network diagram from following activities and find critical path and all slack of activities :

Job	A	B	C	D	E	F	G	H	I	J	K
Job(days) time	13	8	10	9	11	10	8	6	7	14	18
Immediate Predecessor	--	A	B	C	B	E	D, F	E	H	G, I	J

2. A Project has the following time schedule :

Activity	Months	lab/ day	Activity	Months	lab/ day
1—2	2	4	3—7	5	8
1—3	2	5	4—6	3	4
1—4	1	8	5—8	1	5
2—5	4	7	6—9	4	6
3—6	8	6	8—9	3	8

- (a) Critical path and its duration,
 (b) All float of activity.
 (c) Show the Time Graph & Resource Smoothing.

3. Draw a network of the following activities and tabulate earliest and latest starting and finishing times of each activity and their floats.

Event Nos.	Activity symbol	Activity Description	No. of Days.
1—2	A	Study of plant Layout	2
2—3	B	Clearance of site	4
3—4	C	Earth work	10
2—4	D	Procurement of lime, sand, cement	4
4—5	E	Laying of foundations	10
2—5	F	Procurement of bricks	5
5—8	G	Construction of building	18
5—6	H	Laying of pipe lines for electric sires	12
6—8	I	Laying of electric wires.	4
5—7	J	Laying of drainage and sewage system	12
7---8	K	laying water pipes	8
8---9	L	connect water & electric to building	6
9—10	M	Finishing work is building.	12

4. The following information is known for a project. Draw the network and find critical path. Capital letters denote activities and numbers in bracket denote activity times.

This must be completed

A (30)
B (7)
B
B
C (10)
C
D (14)
E (10)
F (7)
F
F
G (21)
G
H (7)
I (12)
K (30)

Before this can start

C
D
G
K
D
G
E
F
H
I
L
I
L
J (15)
J
L (15)

5. A professional Institute is contemplating or organizing a seminar on 'New Accounting Techniques' at Delhi. The seminar will include 2 key-note speeches and 8 paper reading sessions. Compute the critical path .

Activity	Description	Time (Days)	Preceding Activities
A	Fix the dates of the seminar	2	--
B	Formulate the theme of the seminar	2	--
C	Compile a malign list	4	--
D	Get the brochure etc. printed	6	B
E	Finalize selection of the guest speakers	12	B
F	Send invitations to the two guest speakers	10	A, E
G	Mail brochure and technical paper request of all persons	3	C, D
H	Collect all submitted papers	4	G
I	Review the papers and select the papers to be presented	10	H
J	Inform authors about acceptance or rejection of papers and Time of presentation for accepted papers	7	I
K	Arrange accommodation and meals arrangements	6	C, D
L	Arrange transportation	2	C, D
M	Arrange conferences room etc.	2	C, D
N	Prepare Introductory speech	10	J
O	Assign duties to various volunteers	2	M

6. Project which is about to start comprises the following activities :

Activity	Immediately Preceding Activities	Duration in weeks	Activity	Immediately Preceding activities	Duration in weeks
A	--	4	J	H	17
B	A	13	K	H	2
C	A	5	L	J, K	3
D	C	11	M	F, L	3
E	C	3	N	B, M	3
F	D, E	4	O	I, M	2
G	--	3	P	O	3
H	A, G	5	Q	N, P	4
I	G	4			

Ignoring the holiday periods, the project must be completed by the end of week 38. If the project is delayed beyond this date it is estimated that it will cost the firm Rs. 400 a week.

Required :

- Draw a critical path network to represent the project and determine the critical path. What is the earliest time, at which the project can be completed and what penalty cost (if any) will be incurred ?
- Activity 'K' is a two week course to train new salesmen. The hotel which will be used for the course has been booked for weeks 12 & 13. In the light of your analysis should this booking be changed ?

Expected time analysis:

7. project consists for the following activities and trend time estimates :

Activity	Least time (days) (t_o)	Great time (days) (t_p)	Most likely time (days) (t_m)
1—2	3	15	6
1—3	2	14	5
1—4	6	30	12
2—5	2	8	5
2—6	5	17	11
3—6	3	15	6
4—7	3	27	9
5—7	1	7	4
6—7	2	8	5

- Draw the network
- Determine the expected task times and their variances of Act.
- Find the earliest and latest expected times to each node or event.
- Find critical path.
- What is the probability that the project will be completed by 27 days.
- What is the duration if the probability of completion is 96.5% confidence ?
- At least 23 days to complete, Find probability.
- If the average duration for activity 6.7 increases to 7 days, what will be its effect on the expected project completion time which will have 95% confidence.

8. YZ Ltd. Planning a project to introduce a new product, as listed the following activities :

Activity	Preceding activity	Expected time (week)
A	--	6
B	--	3
C	A	5
D	A	4
E	A	3
F	C	3
G	D	5
H	B, D, E	5
I	H	2
J	I, G, F	3

- (a) Draw the critical path network for the project and determine the critical path and its duration.
 (b) If the start of activity B is delayed by 3 weeks. Activity E by 2 weeks and activity G by 2 weeks, how is the total time for the project affected ?
 (c) Assume that time given in the above table are the expected times of the activities, the durations of which are normally distributed with the following standard deviation.

Activity	A	B	C	D	E	F	G	H	I	J
Standard deviation	1	0.5	1	1	0.5	0.5	1	1	0.5	1

Ignoring the delay referred to in (b) and the possible effect of uncertainty in non-critical activities, determine a 95% confidence interval for the expected time on the critical path.

- (d) The costs of the project are estimated to be Rs. 10,00,000. If it is completed within 24 weeks the expected returns should be about Rs. 10,00,000 but if the deadline of 24 weeks is not met, the product will fail to penetrate the market a net revenue of only Rs. 200,000 is expected. Determine the expected profit on this subject. For simplicity, you should ignore the delays referred to in (b) and the possible effect of uncertainty in non-critical activities.
9. Small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning (i) and ending (j) node numbers.
- (a) Draw the project network and identify all the paths through it.
 (b) Find the expected duration and variance for each activity. What is expected project length ?
 (c) Calculate the variance and standard deviation of project length. What is the probability that the project will be completed :
 i) At least 3 weeks earlier than expected ?
 ii) No more than 3 weeks later than expected ?
 (d) If the project due date is 18 weeks, what is the probability of not meeting the due date ?
 (e) What due date has about 90% chance of being met ?
 (f) Find the event or node variances in the network.
 (g) What is the probability to complete event 5 by 11 weeks?

Activity <i>i-j</i>	Estimated duration in weeks		
	optimistic	most likely	pessimistic
1-2	1	1	7
1-3	1	4	7
1-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-6	2	5	8
5-6	3	6	15

Critical Path Analysis:

10. Find the minimum duration

Activity	Normal		Crash		Immediate Predecessor
	Days	cost	days	cost	
A	8	1,200	5	1,800	none
B	6	2,900	2	3,600	A
C	10	3,800	4	5,000	none

11. Find the minimum duration and also find optimum production duration if individual cost per day is Rs. 450.

Activity	Normal		Crash		Immediate Predecessor
	Days	cost	days	cost	
A	8	1,200	4	1,800	none
B	6	2,900	3	3,700	A
C	10	3,800	2	5,400	A
D	5	2,000	1	3,200	B

12. A small project is having seven activities. The relevant data about these activities is given below

Activity	Dependence	Normal Duration (Days)	Crash duration (days)	Normal cost (Rs)	Crash cost (Rs)
A	--	7	5	500	900
B	A	4	2	400	600
C	A	5	5	500	500
D	A	6	4	800	1,000
E	B, C	7	4	700	1,000
F	C, D	5	2	800	1,400
G	E, F	6	4	800	1,600

- (i) Find out the normal duration and the minimum duration.
(ii) What is the percentage increase in cost to complete the project in 21 days ?

TRANSPORTATION

Learning Objective

1. How allocate resources at minimum cost.
2. Maximization of profit.

The rules are :-

1. Prepare a balance problem .(note 1)
2. prepare an initial allotment .(note2)
3. check the feasibility.(note 3)
4. optimality test (note :- 4)

Note-1: Problems are of 2 types :

1. Balanced problem i.e. $\sum \text{Demand} = \sum \text{Supply}$

2. Unbalanced problem, i.e. $\sum \text{Demand} \neq \sum \text{Supply}$. If it is an unbalanced problem, say demand > supply a dummy supply row is to be introduced with a production capacity equal to the difference of demand & supply and having no transportation cost in any of the cell of that column. If $\sum \text{supply} > \sum \text{demand}$, introduce a dummy column etc. etc.

Note-2: Prepare an initial solution by any of the following three methods (prefer VAM)

A. North-West Corner Rule :

- | | |
|--------|--|
| STEP-1 | Find the N-W corner empty cell. |
| STEP-2 | Check its demand and supply. |
| STEP-3 | Allocate maximum possible quantity (minimum of demand or supply or MPQ) to North-West corner empty cell. This cell is now called as Occupied cell. |
| STEP-4 | Re-calculate the demand & supply quantity of the corresponding row & column. |
| STEP-5 | If demand or supply is exhausted then put dash in the other empty cells of that row or column. This cells are known as Un-Occupied cells. |
| STEP-6 | Select next N-W cell among empty cell & repeat the process till all quantities are allotted. |

B. Least Cost Method :

- | | |
|--------|---|
| STEP-1 | Find the lowest cost empty cell. |
| STEP-2 | Allocate maximum possible quantity to the lowest cost empty cell . this is called as Occupied cell.
Incase of tie for lowest cost , select that cell where maximum quantity can be allotted .
If that is a tie also , select any one of those empty cells . |
| STEP-3 | Re-calculate the demand & supply quantity of the corresponding row & column.
If demand or supply is exhausted then put dash in the other empty cells of that row or column. This cells are known as Un-Occupied cells. |
| STEP-4 | Repeat the process till all quantities are allotted. |

C. Vogel's Approximation Method (VAM) :

1. Calculate penalty for each row and column separately, where penalty = 2nd lowest cost - lowest cost, among the empty cell
In case same lowest cost in two empty cells , penalty = 0.
2. Select highest penalty row or column
Allocate maximum possible quantity to the lowest cost empty cell in that row or column.
Re-calculate the supply & demand of the corresponding row & column.
Compute the penalty for each row and column.
Select the highest penalty etc.
3. In case of tie in penalty, select lowest cost empty cell in that row or column,
If there is a tie also, select that empty cell where highest qty. can be allotted.
If that is a tie, apply rule of thumb.

Note-3 : Check the feasibility of the above solution : no. of occupied cells $\geq m + n - 1$, where m = no. of rows, n = no. of columns

If it is not feasible , allocate a very small qty. ϵ to the lowest cost among unoccupied cell. In some cases u may require to put it in the 2nd lowest cost un-occupied cell.

In case of tie in lowest cost unoccupied cell ,check the cost evaluation or loop of the corresponding tie cell. put ϵ in such a way so that negative cost evaluation can be avoided in other tie cell.

Note-4: Test for optimal solution by either of the following 2 methods :

A. Stepping Stone Method**Rule:**

(1) Calculate cost of transferring one unit to each unoccupied cell (known as cost evaluation) with the help of the loops through the occupied cell .

(2) If all the cost evaluations are +ve or zero, then optimal solution is reached, although the zero cost evaluation cells signifies to alternative solution (only in the final table.)

(3) If the cost evaluations are -ve then select highest -ve cost.

Prepare the loop for that un-occupied cell.

Find the lowest qty. among the “-” marked cell.

Add this min. quantity to the “+” marked cell and subtract the same from the “-” marked cell.

In case of tie in “- ” cost evaluation , select that unoccupied cell where maximum qty. can be transferred.

If that is a tie also apply rule of thumb.

(4) Prepare a new table and evaluate the cost of the unoccupied cells again.

B. Modified Distribution Method. (MODI) or Algebra method

Prepare the cost equation for the occupied cells & then find the cost evaluation of the unoccupied cells. Transfer maximum possible units to the highest negative cost evaluation cell, etc. etc.

Note-5: In case of profit maximisation problem

Calculate profit for each cell where Profit = (S. P. - Production cost - transport cost) on per unit basis. Subtract the profit of each cell from the highest profit p.u. ,

The result is the cost matrix.

If it is unbalance problem, make it balance first, & then convert into cost matrix.

Now solve the problem by the previous transportation rule.

Note-6:

PROBLEMS

1. An oil corporation has got three refineries P, Q, and R and it has to send petrol to four different depots A, B, C and D. The cost of shipping 1 gallon of petrol from each refinery to each depot is given below. The requirements of the depots and the available petrol at the refineries are also given. Find the minimum cost of shipping:

Refinery	Depot				Available
	A	B	C	D	
P	10	12	15	8	130
Q	14	11	9	10	150
R	20	5	7	18	170
Required	90	100	140	120	

2. Consider a transportation problem with $m = 3$ and $n = 4$, where :

$c_{11} = 2$	$c_{12} = 3$	$c_{13} = 11$	$c_{14} = 7$
$c_{21} = 1,$	$c_{22} = 0,$	$c_{23} = 6$	$c_{24} = 1$
$c_{31} = 5$	$c_{32} = 8$	$c_{33} = 15,$	$c_{34} = 9$

Suppose $S_1 = 30$, $S_2 = 30$ and $S_3 = 20$ whereas $D_1 = 25$, $D_2 = 20$, $D_3 = 15$, and $D_4 = 20$.
Apply the transportation simplex method to find an optimal solution.

- 3.

	A	B	C	
P	2	4	7	200
Q	8	1	9	150
R	3	4	6	150
	100	150	250	500

4. A company has three factories (F) from which it transports the product to four warehouses (W). The unit cost of production at the three factories are Rs. 4, 3, 5 respectively. Given the following information on unit costs of transportation, capacities at the three factories and the requirement at the four warehouses, find the optimum allocation.

Factory	Unit cost of production Rs./unit	Transportation cost, Rs./unit.				Capacity
		W ₁	W ₂	W ₃	W ₄	
F ₁	4	5	7	3	8	300
F ₂	3	4	6	9	5	500
F ₃	5	2	6	4	5	200
Requirements		200	300	450	100	

5. The Mumbai Transport Company has trucks available at four different sites in the following number :

State A --5 trucks, Site B -- 10 trucks, Site C -- 7 trucks, Site D - 3 trucks

Customers W, X and Y require trucks as shown :

Customer W - 5 trucks, customer X -- 8 trucks, Customer Y -- 10 trucks.

Variable costs getting trucks to the customers are :

From A to W -- Rs. 7, to X -- Rs. 3, No transfer to Y

From B to W -- Rs. 4, to X -- Rs. 6, to Y -- Rs. 8

From C to W -- Rs. 5, to X -- Rs. 8, to Y -- Rs. 4

From D to W -- Rs. 8, to X -- Rs. 4, to Y -- Rs. 3

Solve the above transportation problem.

Profit maximizing decision

6. A company has four factories F₁, F₂, F₃ and F₄ manufacturing the same, product. Production and raw material costs differ from factory to factory and are given in the following table in the first two rows. The transportation costs from the factories to sales depots, S₁, S₂, S₃, are also given. The last two columns in the table give the sales price and the total requirement at each depot. The production capacity of each factory is given in the last row.

	F ₁	F ₂	F ₃	F ₄	Sales price per unit	Requirement
Production cost/unit	15	18	14	13		
Raw material cost/unit	10	9	12	9		
	<u>Transportation Cost per unit</u>					
S ₁	3	9	5	4	34	80
S ₂	1	7	4	5	32	120
S ₃	5	8	3	6	31	150
capacity	10	150	50	100		

Determine the most profitable production and distribution schedule and the corresponding profit. The surplus production should be taken to yield zero profit.

Find the amount of profit if 10 units are to be allotted to S₁F₁ cell?

Is there any alternative solution? What maximum quantity can be transferred to that cell ?

Decision making with transportation

7. The Agri-Products Company has two factories, at Tiruchi and Meerut. There are four major warehouses to which the finished products are sent : at Guwahati, Nagpur, Ahmedabad and Chandigarh. The Company plans to locate an additional factory at either Indore or at Kanpur. If the following matrix gives the details of the shipping costs, manufacturing capacities and warehouse requirements, how would you go about choosing between the two proposed locations, i.e. Indore and Kanpur. Suggest an approach.

Place	Shipping Costs Rs. per Unit				Capacity
	Guwahati	Nagpur	Ahmedabad	Chandigarh	
Tiruchi	25	9	10	20	220
Meerut	10	8	6	5	380
Indore	15	2	4	10	200
Kanpur	9	7	7	5	200
Units Required	100	150	300	250	

Theory questions

1. What is procedure to be followed in obtaining an optimal solution under Transportation Model?

Answer:

- Find initial basic feasible solution by using either North-west corner method or least cost method or Vogel's Approximation Method.
- Check the number of occupied cells for satisfying the rule $m + n - 1$.
- For each occupied cell by the current solution, solve the system of equations i.e. $u_i + v_j = C_j$.
- Compute the net evaluation for all unoccupied cells.
- Examine the sign of each $Z_j - C_j$. If all $Z_j - C_j \leq 0$, then the current solution is optimal.
- If the above is not satisfied, identify the loops and make allocation till $Z_1 - C_1 \leq 0$.

2. What are the common methods of obtaining initial feasible solution in a transportation problem.

Answer : Common method of finding initial solution in a transportation problem are :

1. Northwest corner rule
2. Least cost method or inspection method
3. Vogel's approximation method.

Linear Programming

Learning objective

1. How to solve production & sales mix problems when number limiting resources are more than one.
2. logical approach Simplex solution method i.e. application of limiting factor & Bottleneck production.
3. application of Shadow Pricing.
4. Interpretation of Simplex solution & Sensitivity Analysis

Linear programming involves the construction of a mathematical model to represent the decision problem where the activities of the problem constitute variables. The model then comprises a linear function that is to be optimized and a set of restrictions on the variables in the form of linear equations and inequalities. The model is then solved by an appropriate method or by the use of a computer package to obtain the optimal values for the activities.

List out the accounting and financing areas where Linear Programming can be used.

- i. The problem must be capable of being stated in numeric terms.
- ii. All factors involved in the problem must have linear relationship.
- iii. The problem must permit a choice or choices between alternative course of action.
- iv. There must or more restrictions on the factors involved.

Specific examples in the accounting and finance areas include :

- i. Capital investment and project appraisal particularly relating to capital rationing problems.
- ii. Maximising contribution or minimising cost decisions involving production planning, product mix and similar problems.
- iii. Transfer pricing problems and elements of corporate strategy formulation.

The industrial and management applications of linear programming.

- | | |
|--|---------------------------------|
| a. By Industrial applications of LP. | b. Product Mix |
| c. Production scheduling | d. Transportation |
| e. Trim Loss | f. Management application of LP |
| g. Portfolio selection | h. Financial Mix |
| i. Profit Planning | j. Media selection |
| k. Travelling salesman. | |
| l. Assignment problem- Allocation of machines to jobs. | |
| m. Product mix problem- Optimal product mix to maximise contribution. | |
| n. Blending problem – Optimal blending of raw materials to minimise cost of cotton blending. | |

Limitations :

- It is assumed that the objective function and the constraints are linear functions. In practice step costs might exist or resources might not be used at a constant rate throughout the entire output range.
- Constraints are unlikely to be completely fixed. Some constraints can be removed at additional costs.
- The output of the model is dependent on the accuracy of estimates used. It is difficult to segregate costs into fixed and variable.
- Divisibility of product is not realistic in practice. Fraction of product cannot be produced in certain cases.
- The graphical approach requires that only two variables (products) be considered.
- Qualitative factors are not considered.

Distinguish between a slack variable and an artificial variable in linear programming.**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. A slack variable always non negative. Example

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' start with the initial feasible solution. The variable added in the constraints as explained above is known as artificial variable. Artificial variables are always positive.

Formulation & Graphical Solution

1. 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 Rs. 3/- profit per unit and B at Rs. 8/- profit per unit. Solve for maximum profit programme by graphical & simplex method. Find Dual solution also.

2. The budgeted data relating to two products manufactured by a company 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 Rs. 14,000 and Rs. 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. Write the dual of the given problem.

3. 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 Rs. 2 for each unit of A and Rs. 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 maximise profit by graphical & simplex method. Find dual of the formulation.

4. If the shadow price of Grinding is Rs.1.4 per hr & of Turning is Re. 0.2 per hour in the above problem. Find the optimal solution. (not by simplex method or graph)
5. A company, Portland plc. Have five products in its range and is currently running the following sales/production programme.

	Product A	Product B	Product C	Product D	Product E
Sales in units	50,000	40,000	70,000	60,000	20,000
Per unit					
Sales price (Rs.)	3.50	3.00	4.50	5.00	2.00
Variable cost (Rs.)	1.50	1.26	2.00	2.34	0.88
Labour hours	2.00	1.50	3.00	2.80	1.00
Machine hours	1.00	0.80	1.50	1.20	0.40

This programme fully utilises the availability of labour and machine time.

A linear programme reveals that labour hours have a shadow price of Rs.1.00 per hour and machine hours have a shadow price of Rs.0.30 per hour.

You are required to determine the optimal production programme from the above information and compare the contribution earned with that of the existing programme.

6. A local travel agent is planning a charter trip to a major sea resort. The eight day/seven-night package includes the fare for round-trip travel, surface transportation, board and lodging and selected tour options. The charter trip is restricted to 200 persons and past experience indicates that there will not be any problem for getting 200 persons.

The problem for the travel agent is to determine the number of Deluxe, Standard, and Economy tour packages to offer for this charter. These three plans each differ according to seating and service for the flight, quality of accommodations, meal plans and tour options. The following table summarizes the estimated prices for the three packages and the corresponding expenses for the travel agent. The travel agent has hired an aircraft for the flat fee of Rs. 2,00,000 for the entire trip. Price and costs for tour packages per person

Tour Plan	Price	Hotel Costs	Meals & other Expenses (Rs.)
Deluxe	10,000	3,000	4,750
Standard	7,000	2,200	2,500
Economy	6,500	1,900	2,200

In Planning the trip, the following considerations must be taken into account :-

At least 10% of the packages must be of the deluxe type. At least 35% but not more than 70% must be of the standard type. At least 30% must be of the economy type.

The maximum number of deluxe packages available in any aircraft is restricted to 60. The hotel desires that at least 120 of the tourists should be on the deluxe and standard packages together. The travel agent wishes to determine the number of packages to offer in each type so as to maximise the total profit. Formulate the above as a linear programming problem.

Restate the above linear programming problem in terms of two decision variables, taking advantage of the fact that 200 packages will be sold.

Find the optimum solution using graphical methods for the restated linear programming problem and interpret your results.

7. Let us assume that you have inherited Rs.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 Rs.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. (May 1999)

Minimization Problem: Graphical solution

8. 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 Rs. 4/- and Rs. 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 ?

Formulation:

9. An agriculture has a farm with 125 acres. He produces Radish, Muttar and Potato. Whatever he raises is fully sold in the market. He gets Rs.5 for Radish per kg. Rs. 4 for muttar per kg. & Rs. 5 for potato per kg. The average yeild is 1,500 kg. of Radish and 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 Rs.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 Rs.40 per man day are available.

Formulate this as a LPP model to maximize the Agriculturist's total profit. (May 97 Q: 1b)

10. The owner of Fancy Goods Shop is interested to determine, how many advertisements to release in the selected their magazines A, B, and C. His main propose is to advertise in such a way that total exposure to principle buyer of his goods is maximized. Percentages of reader for each magazine are known. Exposure in the number of advertisements released multiplied by the number of principle buyers. The following data are available:

Particulars	Magazines		
	A	B	C
Readers	1.0 lakh	0.6 lakh	0.4 lakh
Principle Buyers	20%	15%	8%
Cost per Advertisement	8,000	6,000	5,000

The budget amount is at the most Rs.1 lakh for the advertisements. The owner has already decided that magazine A should have no more than 15 advertisements and that B and C each gets at least 8 advertisement. Formulate a LPP Model for this problem. (Nov 96 Q: 1b)

11. WELLTYPE Manufacturing Company produces three types of typewriters; Manual typewriters, Electronic typewriters, and Deluxe Electronic typewriters. All the three models are required to be machined first and then assembled. The time required for the various models are as follows :

Types	Machine Time	Assembly Time
	(in hours)	(in hours)
Manual Typewriter	15	4
Electronic Typewriter	12	3
Deluxe Electronic Typewriter	14	5

The total available machine time and assembly time are 3,000 hours and 1,200 hours respectively. The data regarding the selling price and variable costs for the three types are :

	Manual	Electronic	Deluxe Electronic
Selling Price (Rs.)	4,100	7,500	14,600
Labour, material & other variable costs (Rs.)	2,500	4,500	9,000

The company sells all the three types on credit basis, but will collect the amounts on the first of next month. The labour, material and other variable expenses will have to be paid in cash. This company has taken a loan of Rs. 40,000 from a co-operative bank and this company will have to repay it to the bank on 1st April, 2008. The TNC Bank from whom this company has borrowed Rs. 60,000 has expressed its approval to renew the loan.

The Balance Sheet of this Company as on 31.3.08 is as follows :

Liabilities	Rs.	Assets	Rs.
Equity Share capital	1,50,000	Land	90,000
Capital Reserve	15,000	Building	70,000
General Reserve	1,10,000	Plant & Machinery	1,00,000
Profit & Loss a/c	25,000	Furniture & Fixtures	15,000
Long term loan	1,00,000	Vehicles	30,000
Loan from TNC Bank	60,000	Inventory	5,000
Loan from Co-op. Bank	40,000	Receivables	50,000
		Cash	<u>1,40,000</u>
Total	<u>5,00,000</u>	Total	<u>5,00,000</u>

The company will have to pay a sum of Rs. 10,000 towards the salary for top management executives and other fixed overheads for the month. Interest on long term loans is to be paid every month at 24% per annum. Interest on loans from TNC and Co-operative Banks may be taken to be Rs. 1,200 for the month.

The company has promised to deliver 2 Manual typewriters and 8 Deluxe Electronic typewriters to one of its valued customers next month. Also make sure that the level of operations in this company is subject to the availability of cash next month. This company will also be able to sell all three types of typewriters in the market. The senior Manager of this company desires to know as to how many units of each typewriter must be manufactured in the factory next month so as to maximise the profits of the company.

Formulate this as a linear programming problem. The formulated problem need not be solved.

12. The most recent audited summarised Balance Sheet of Stop and Shop Financial Services is given below :

Balance Sheet as on March 31, 2008			
Liabilities	(Rs. in lakhs)	Assets (Rs. in lakhs)	
Equity Share Capital	65	Fixed Assets :	
Reserves & Surplus	110	- Assets on Lease	
		(original cost: Rs. 550 lakhs)	375
Term Loan from IFCI	80	- Other Fixed Assets	50
Public Deposits	150	Investments (on wholly owned subsidiaries)	20
Bank Borrowings	147		
Other Current Liabilities	50	Current Assets :	
		- Stock on Hire	80
		- Receivables	30
		- Other Current Assets	35
		Miscellaneous expenditure (not written off)	<u>12</u>
	<u>602</u>		<u>602</u>

The Company intends to enhance its investment in the lease portfolio by another Rs. 1,000 lakhs. For this purpose it would like to raise a mix of debt and equity in such a way that the overall cost of raising additional funds is minimized. The following constraints apply to the way the funds can be mobilized :

Total debt divided by net owned funds, cannot exceed 10. Amount borrowed from financial institutions cannot exceed 25% of the net worth. Maximum amount of bank borrowings cannot exceed three times the net owned funds. The company would like to keep the total public deposit limited to 40% of the total debt.

The post-tax costs of the different sources of finance are as follows :

Equity	:	25%	Term Loans	:	8.5%
Public Deposits	:	7%	Bank Borrowings:		10%

Note :

Total Debt = Term Loans from Financial Institutions + Public Deposits + Bank Borrowings

Net Worth = Equity Share Capital + Reserves & Surplus

Net owned Funds = Net worth-Miscellaneous Expenditures

Formulate the funding problem as a L.P.P.

Simplex Method

13. A pharmaceutical Company has 100 kg of A, 180 kg of B and 120 kg of C available per month. They can use these materials to make three basic pharmaceutical products namely 5-10-5, 5-5-10 and 20-5-10, where the numbers in each case represent the percentage by weight of A, B and C respectively in each of the products. The cost of these raw material also are given below :

Ingredient	Cost per kg (Rs.)
A	80
B	20
C	50
Inert ingredients	20

Selling prices of these products are Rs. 40.5, Rs. 43 and Rs. 45 per kg. Respectively. There is a capacity restriction of the company for the product 5-10-5 ; so as they cannot produce more than 30 kg per month. Determine how much of each of the products they should produce in order to maximize their monthly profit.

Interpretation & Shadow Price

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)

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.

Write the dual of the given problem.

15. The following details are taken from the forecasts for 20×3 of XYZ Ltd.

	Sales demand per annum,
Super de luxe model (x_1)	5,00,000
De luxe model (x_2)	7,50,000
Export model (x_3)	4,00,000

Two production facilities are required, machining and assembly, and these are common to each model.

Capacity in each facility is limited by the number of direct labour hours available.

Direct labour	Total hours available in millions	Direct labour hours per unit		
		x_1	x_2	x_3
Machining (x_4)	1.4	0.5	0.5	1.0
Assembly (x_5)	1.2	0.5	0.5	2.0

Contribution is estimated as follows.

Model	Contribution per unit.(Rs)
x_1	1,500
x_2	1,300
x_3	2,500

You are required to set up the first table of a linear programme to determine the product mix which will maximise total contribution and then to complete the first iteration only.

Interpret the following table, given that it is the final solution to the above problem.

The S variables (s_1, s_2, s_3, s_4, s_5) relate to the constraints in the same sequence as presented above

x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	in 000
1	0	0	1	0	0	0	0	500
0	0	0	0.25	0.25	1	0	-0.5	112.5
0	0	1	-0.25	-0.25	0	0	0.5	287.5
0	0	0	-0.25	-0.25	0	1	-0.5	487.5
0	1	0	0	1	0	0	0	750
0	0	0	875	675	0	0	1,250	2,443,750

Short notes

1. 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). Significant elements of CAM are computer numerical control (CNC) and robotics. CNC machines are programmable machine tools that are capable of performing a number of machining tasks, such as cutting and grinding. A computer program stores all the existing manufacturing configurations and set-up instructions for a particular machine or bank of machines, facilitating a change in 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 dramatically reduced set-up times. Furthermore, unlike human operators, who tire and are error prone, CNC machines are able to repeat the same operation continuously in an absolutely identical manner, to a completely consistent level of accuracy and machine tolerance. CNC also promotes flexibility though allowing machines to switch from output of one product to another very quickly.

Two brief examples will serve to illustrate the dramatic impact of CAM on manufacturing flexibility, and the time taken to develop a product and bring it to the market. Nissan, 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. Similar advances have been made in the resetting of machines and in the exchange of dies. These changes have reduced the changeover time in moving from one process to another. Again it is a Japanese company, Toyota, that provides one of the best examples of the advances made in this area. As the speed of production changeover increases under CAM, the possibility of producing smaller and smaller batch sizes at an economic cost also increases, so that the production schedule can be driven more and more by customer requirements rather than the constraints of the traditional manufacturing process.

2. Computer-integrated manufacturing

The ultimate extension- and logical long-term direction of AMT in the production environment is computer-integrated manufacturing (CIM), which brings together all the elements of automated manufacturing and quality control into one coherent system. The 'ideal' technological world of CIM-the fully automated production facility, controlled entirely by means of a computer network with no human interference-is not yet with us (and, indeed, with its overtones of 'ghost factories', would not necessarily be universally welcomed)

A somewhat watered-down version of CIM is already with us, however, in the form of a flexible manufacturing system (FMS) discussed below. The FMS cell is often referred to as an 'island of automation' in the context of a more traditionally organized facility.

3. Optimized production technology (OPT)

The OPT philosophy contends that the primary goal of manufacturing is to make money. Three important criteria are identified to evaluate progress towards achieving this goal. These are throughput, inventory and operating expenses. The goal is to maximize throughput while simultaneously maintaining or decreasing inventory and operating expenses.

The OPT approach determines what prevents throughput from being higher by distinguishing between bottlenecks and removing them or, if this is not possible, ensures that they are fully

utilized at all times. Non-bottleneck resources should be scheduled and operated based on constraints within the system, and should not be used to produce more than the bottlenecks can absorb. The OPT philosophy therefore advocates that non-bottleneck resources should not be utilized to 100% of their capacity, since this would merely result in an increase in inventory. Thus idle time in non-bottleneck areas is not considered detrimental to the efficiency of the organization. If it were utilized, it would result in increased inventory without a corresponding increasing in throughput for the plant.

With OPT approach, it is vitally important to schedule all non-bottleneck resources within the manufacturing system based on the constraints of the system (i.e. the bottlenecks). For example, if only 70% of the output of a non-bottleneck resource can be absorbed by the following bottleneck resources, then 30% of the utilization of the non-bottleneck is simply concerned with increasing inventory. It can therefore be argued that by operating at the 70% level, the non-bottleneck resource is achieving 100% efficiency.

4. Synchronous manufacturing

The title 'synchronous manufacturing' was coined in 1984, when leading exponents of OPT felt that the focus of the latter, as evidenced by its nomenclature, had become too narrow. The change in name allowed the newly emerging procedures and concepts of JIT and TQM to be integrated with the basic principles of OPT. It is interesting to note, however, that the guiding force behind both OPT and synchronous manufacturing is the identification and management of 'bottleneck resources' –Eli Goldratt prefers to use the term 'theory of constraints'.

Synchronous manufacturing has been defined as:

Synchronous manufacturing: 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.

Note the use of the word 'Philosophy' in the definition: This is the key to distinguishing it from its narrower, technique-based predecessor, OPT. The word 'optimized' in the latter implied that an 'optimum' position was possible, which runs counter to a belief in continuous improvement; and the words 'production' and 'technology' failed to capture the richness of the range of constraints and challenges faced by the firm in achieving its objectives- market constraints, and logistical, managerial and behavioural constraints need to be added to the physical constraints of production capacity.

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

1. Do not focus on balancing capacities, focus on synchronizing the 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 utilisation 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. process batch should be variable both along its route and over time.

Principle 5 requires a brief explanation: as we saw with OPT, it is possible to activate resource, particularly a non-bottleneck resource, beyond what is useful or productive for the system; however, that resource will only be utilized if the activation contributes positively to company performance. In other words, activating a resource without utilizing it is both wasteful and costly.

An alleged weakness of the conventional JIT philosophy is its approach of improving the process everywhere in the system. According to synchronous manufacturing principles 2 and 3, the return on improvements at a bottleneck resource is enormous. But the return on improvement made at non-bottlenecks is marginal at best, and often of non consequence at all in other words, whether across the board improvement activities have any impact on the organisational goal of making money is not known. The synchronous manufacturing philosophy, on the other hand, required managers to focus on those areas of operations that offer the greatest potential for global improvements. This process of focused improvement becomes a vital part of its own particular approach to continuous improvement throughout the entire organisation.

Another criticism of the basic JIT model is that it is unable to pre-plan the production schedule for any resource in the process except final assembly, and thus the schedule does not consider the resulting loads at the bottleneck work stations. Consequently, it may not effectively utilise the bottleneck resources and, since bottlenecks determine the throughput for the entire system, the resulting throughput may be less than optimum.

5. Business process re-engineering

Business process re-engineering involves examining business processes and making substantial changes to how the organisation currently operates. It involves the redesign of how work is done through activities.

A business process consists of a collection of activities that are linked together in a co-ordinated manner to achieve a specific objective. For example, material handling might be classed as

- a. scheduling production,
- b. storing materials,
- c. processing purchase orders,
- d. inspecting materials and
- e. paying suppliers.

The aim of business process re-engineering is to improve the key business process in an organisation by focusing on

- a. simplification,
- b. cost reduction,
- c. improved quality and
- d. enhanced customer satisfaction.

Consider the materials handling process outlined in the above paragraph. The process might be re-engineered by sending the production schedule direct to nominated suppliers and entering into contractual agreements to deliver the materials in accordance with the production schedule and also guaranteeing their quality by inspecting them prior to delivery.

The end result might be the elimination, or a permanent reduction, of the storing, purchasing and inspection activities. These activities are non-value added activities since they represent an opportunity for cost reduction without reducing the products' service potentials to customers.

A distinguishing feature of business process re-engineering is that it involves radical and dramatic changes in processes by abandoning current practices and reinventing completely new methods of performing business processes. The focus is a major changes rather than marginal improvements.

A further example of business process re-engineering is moving from a traditional functional plant layout to a just-in-time product layout and adopting a just-in-time philosophy. Adopting a just-in-time (JIT) system and philosophy, has important implications for cost management and performance reporting. It is therefore, important to understand the nature of such systems, how they differ from traditional systems.

6. Tear-Down analysis

Tear down analysis (also known as reverse engineering) involves examining a competitor's product in order to identify opportunities for product improvement and/or cost reduction. The competitor's product is dismantled to identify its functionality and design and to provide insights about the processes that are used and the cost to make the product. The aim is to benchmark provisional product designs with the designs of competitors and to incorporate any observed relative advantages of the competitor's approach to product design.

7. The need for Accurate Cost Management Systems

It is important that target costing is supported by an accurate cost system. In particular, cost drivers should be established that are the significant determinants of the costs of the activities so that cause-and-effect allocations are used. Arbitrary cost allocations should be avoided. IF arbitrary cost allocations are used the allocation base will not be a significant determinant of cost. Let us assume that an arbitrary allocation base, say direct labour hours, is used to allocate support costs to products. To reduce the projected cost towards the target cost the target costing team will be motivated to focus on reducing direct labour hours. Why? Because this will result in a smaller proportion of the support costs being assigned to the product.

However, the support costs incurred by the organisation will not be reduced because there is no cause-and-effect relationship between direct labour hours and the resulting costs.

Therefore the target costing exercise will merely result in a reduction in the costs that are allocated to the product but organisational costs will not be reduced. In contrast, if cause-and-effect allocation bases (i.e. cost drivers) are established, reductions in cost driver usage should be followed by a reduction in organisational support costs.

Therefore, it is very important that cost systems use cost drivers that are the determinants of costs so that they will motivate designers to take actions that will reduce organisational costs. Decisions taken at the design stage lead to the committed usage of cost drivers which can be difficult to change in the future.

8. Cost Leadership

By pursuing an overall cost leadership strategy, a firm can earn above-average returns in its industry despite the presence of strong competitive forces. Cost leadership attained by consistent emphasis on efficient production of a good or service, which makes the firm as a low-cost producer in the industry.

For cost leadership the commonly required skills and resources are:

1. Sustained capital investment and access to capital,
2. Process engineering skills,
3. Intense supervision of labour,
4. Products designed for ease in manufacture,
5. Low-cost distribution system.

the common organisational requirements are:-

1. Tight cost control,
2. Frequent detailed control reports,
3. Structure organisation and responsibilities,
4. Incentives based on meeting strict quantitative targets,

9. Kaizen Costing & Target Costing

Kaizen Costing is widely used by Japanese organisation as a mechanism for reducing and managing costs.

Kaizen is the Japanese terms for making improvements to a process through small incremental amounts, rather than through large innovations.

The major difference between target and Kaizen costing is

- a. Target costing is applied during the design stage whereas Kaizen costing is applied during the manufacturing stage of the product life cycle.
- b. With target costing the focus is one the product, and cost reductions are achieved primarily through product design. In contrast, Kaizen costing focuses on the production process and cost reduction are derived primarily through the increased efficiency of the production process.

Therefore the potential cost reductions are smaller with Kaizen costing because the products are already in the manufacturing stage of their life cycles and a significant proportion of the costs will have become locked-in.

The aim of Kaizen costing is to reduce the cost of components and products by a pre-specified amount. Monden and Hamada (1991) describe the application of Kaizen costing in a Japanese automobile plant. Each plant is assigned a target cost reduction ratio and this is applied to the previous year's actual costs to determine the target cost reduction.

Kaizen costing relies heavily on employee empowerment. They are assumed to have superior knowledge about how to improve processes because they are close to the manufacturing processes and customers and are likely to have greater insights into how costs can be reduced.

Thus, a major feature of Kaizen costing is that workers are given the responsibility to improve processes and reduce costs. Unlike target costing it is not accompanied by a set of techniques or procedures that are automatically applied to achieve the cost reductions.

10. **Backflush accounting**

Backflush accounting is a cost accounting system which focuses on the output of an organization and then works backwards to attributed costs to stock and cost of sales.

This system records the transaction only at the termination of the production and sales cycle. The emphasis is to measure cost at the beginning and at the end with greater emphasis on the end or outputs.

Since back flushing is usually employed in parallel with JIT, there is no work-in-progress to considered nor, does work-in-progress materially fluctuate.

Essential for Backflush accounting

1. accurate bill materials,
2. good measures of yield and
3. accurate engineering change notice when yields do change.

The philosophy of traditional cost accounting methods

Traditional cost accounting methods are based upon the principle that value is obtained by the creation of the assets known as stock. As a consequence this value must be measured and cost accumulation systems are used for this purpose. In modern JIT based production, stock does not exist and therefore such cost accumulation techniques are unnecessary. Instead costs are recognized at the point of sale rather than at the point of production.

The variants of Backflush accounting

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

- the focus is on output – costs are first associated with output (measured as either sales or completed production) and then allocated between stocks and costs of goods sold by working back.
- Conversion costs (labour and overheads) are never attached to products until they are complete (or even sold). Materials are recognized at different points according to the variant used, but only to the extent of being either stock of raw materials or part of the cost of stock of finished goods. Again, materials are not attached to WIP.

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

Variant 1: This has two trigger points (TP) :

- TP 1 - purchase of raw materials / components. A 'raw and in process (RIP)' account will be debited with the actual cost of materials purchased, and creditors credited.
- TP 2 completion of good units. The finished goods (FG) account will be debited with the standard cost of unit produced and the RIP and CC account will be credited with the standard cost.

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

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

Variant 2 : This as only trigger point – the completion of good units. The FG account is debited with the standard cost of units produced, with corresponding credits to the CC account and the creditors account.

Thus the cost records exclude :

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

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

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

It should be seen that as stock of raw materials, WIP and finished goods are decreased to minimal levels, as in a 'pure' JIT system, these variants will give the same basic results.

11. Kanban Materials Acquisition System

Kanban is a Japanese word. It is a tool for implementing JIT production. In its most common form a kanban is simply a card that contains production information. This card identifies

- a. the part number,
- b. delivery and work cell locations,
- c. part descriptions,
- d. quantity,
- e. company name and
- f. The card number within a series.

Often kanban cards are bar-coded to facilitate ease of use.

The implementation of Kanban drastically changed the buyers' activities. Under the new system the buyers

- Placed blanked orders with suppliers. Instead of suppliers receiving five to six large orders per year, smaller kanban quantities were requested often, on a daily basis.
- Made quality the primary factor. It is of no use to receive five or 500 parts if they are not usable.
- Provided the support to supply economical amounts of inventory. Buyers no longer controlled or were responsible for inventory levels and their delivery dates. Once the Kanban was formed, the buyer acted as a facilitator, providing the necessary administration to support parts movement.

Once the Kanban was in place, buyers found their relationships with the vendors had changed from adversarial and tenuous to a partnership. The vendors were thrilled with Kanban. The radical schedule and production fluctuation they had been experiencing were gone. They now had visibility of what their customer actually needed. They were able to respond immediately to demand.

12. ALLOCATION OF COMMON COSTS

Learning objective:

Common cost are presents in different cost estimations. In this chapter we will learn about the distribution technique of common cost as applied in production & service industries.

Introduction:

Every organization has to incur a number of common costs i.e. the cost which are not direct to any cost center, activity or service. Some of this common cost in relation to production, we have already treated in intermediate/PE II level. Here some advance technique regarding apportionment of common cost are discussed:

The techniques available for common cost distribution are

1. Direct method;
2. Step down method;
3. Reciprocal method;
4. Stand-alone cost allocation method;
5. Incremental cost allocation method

1. Direct method:

In this case the cost of the service or support department are distributed among the production departments only on the basis of services render to the production department.

2. Step-down Method:

The cost of service department is to be distributed among the production and other service departments. This is followed when among the service departments, one department has received less service from the other service department as compare to the service provided to others by this department.

3. Reciprocal Method:

When the service departments are providing services to each other apart from servicing the production department then this method is to be applied. For this purpose there are two techniques

- A. Repeated distribution method;
- B. Simultaneous equation method, along with the matrix method.

All this above 3 methods are discussed in detail in your previous level examination.

4. Stand alone cost allocation method:

When a common cost of operating a facility is reduced with the increase of its use. Then the common cost should be distributed in the ratio of the original cost among. This is known as Stand alone method.

Example: The products A and B uses a common process in their production line. The individual direct cost- for product A Rs. 200; and product B Rs. 150. The cost of the common process department – Uses for product A only: Rs. 2,000

Use for product B only: Rs. 1,800. However if both the products are produced then the total cost is Rs. 3,000 instead of Rs. 2,000+1,800 = 3,800.

So we can distribute this common cost Rs. 3,000 in the ratio of 2,000: 1,800 i.e. 10: 9

∴ Share of common cost for product A = $3,000 \times \frac{10}{19}$ = Rs. 1,579

∴ Share of common cost for product B = $2,000 \times \frac{9}{19}$ = Rs. 1,421

5. Incremental Cost allocation method:

In this method the individual cost users is ranked 1 which one mostly liable for incurrence of the total cost. Actually that product should be rank 1 which one is the primary user of the common cost. Any increment to that common cost by the other user should be allotted to the secondary user. From the above example product A is the primary user of the facility and product B is the secondary user. So product A should be ranked 1 and product B should be ranked 2.

∴ Share of common cost to Product A = Rs. 2,000

∴ Share of common cost to product B = Rs. 3,000 –Rs. 2,000 = Rs. 1,000

LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5808	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6514	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	3	4	5	6	6	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7083	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	3	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	1	1	2	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9547	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9634	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9982	9917	9921	9928	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

ANTILOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
.01	1023	1026	1018	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
.12	1318	1321	1324	1327	1330	1333	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
.13	1349	1352	1355	1358	1361	1364	1368	1371	1374	1377	0	1	1	1	2	2	2	2	3
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	2	3
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	2	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
.17	1479	1483	1486	1489	1492	1493	1496	1500	1503	1507	0	1	1	1	2	2	2	3	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	2	3	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	2	3	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
.35	2239	2245	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
.37	2344	2350	2355	2360	2366	2371	2376	2381	2386	2393	1	1	2	2	3	3	4	4	5
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
.39	2455	2460	2465	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	6	6
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	8
.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	8
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	8
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	8
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	8
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	8
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
.60	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4256	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
.73	5376	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	11
.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	11
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16
.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
.95	8913	8933	8954	8974	8895	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

Random Numbers Table

2181922396	2068577984	8262130892	8374856049	4837657422
1128105582	7295088579	9586111652	7055508767	5172382962
7112077556	3440672486	1882412963	0684012006	0633147925
6557477468	5435810788	9670852913	1291265730	2290031331
4199520858	3090908872	2039593181	5973470495	8076135523
3545174840	2275698645	8416549348	4676463101	5629367907
1749420382	4832630032	5670984959	5432114610	0666095693
9103161011	7413686599	1198757695	0414294470	9240121544
0764238934	7666127259	5263097712	5133648980	5111966912
3493969525	0272759769	0385998136	9999089966	1344056826
1292054466	0700014629	5169439659	8408705169	6574373193
4397426117	6488888550	4031652526	8123543276	6027534501
5826984369	4725370390	9641916289	5049082870	7463807244

AREA OF A STANDARD NORMAL DISTRIBUTION

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990