10F, Shyama Prasad Mukherjee Road
Kolkata: 700025.

For Information Purpose:

Office	:	(033) 2486- 4919 & 2419-1631
Mobile	:	98307- 16788 (Ranjan)
		98740- 42374 (Biplab)
Website	:	www.costmanagement.net.in
E-mail	:	dadaboudi@yahoo.com

Only Study (planning & questions) purposes:

Call Alok Chakraborty : 98301- 05664

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.

Content

Paper 5: Advanced Management Accounting (New Syllabus)

(One paper – Three hours – 100 marks)

Level of Knowledge : Advanced knowledge

Objective : (a)To apply various management accounting techniques to all types of organizations for planning, decision making and control purposes in practical situations.
(b)To develop ability to apply quantitative techniques to business problems

1. Cost Management

(a) Developments in the business environment; just in time; manufacturing resources planning; (MRP); automated manufacturing; synchronous manufacturing and back flush systems to reflect the importance of accurate bills of material and routings; world class manufacturing; total quality management.

(b) Activity based approaches to management and cost analysis
(c) Analysis of common costs in manufacturing and service industry
(d) Techniques for profit improvement, cost reduction, and value analysis
(e) Throughput accounting
(f) Target costing; cost ascertainment and pricing of products and services
(g) Life cycle costing (h) Shut down and divestment.

2. Cost Volume Profit Analysis

(a) Relevant cost (b) Product sales pricing and mix
(c) Limiting factors (d) Multiple scarce resource problems
(e) Decisions about alternatives such as make or buy, selection of products, etc.

3. Pricing Decisions

(a) Pricing of a finished product (b) Theory of price (c) Pricing policy
(d) Principles of product pricing (e) New product pricing (f) Pricing strategies
(g) Pricing of services (h) Pareto analysis

4. Budgets and Budgetary Control

The budget manual, Preparation and monitoring procedures, Budget variances, Flexible budgets, reparation of functional budget for operating and non-operating functions, Cash budgets, Capital expenditure budget, Master budget, Principal budget factors.

5. Standard Costing and Variance Analysis.

Types of standards and sources of standard cost information; evolution of standards, continuous - improvement; keeping standards meaningful and relevant; variance analysis; disposal of variances.
(a) Investigation and interpretation of variances and their inter relationship
(b) Behavioural considerations.

6. Transfer pricing

(a) Objectives of transfer pricing (b) Methods of transfer pricing
(c) Conflict between a division and a company (d) Multi-national transfer pricing.

7. Cost Management in Service Sector

8. Uniform Costing and Inter firm comparison

9. Profitability analysis - Product wise / segment wise / customer wise

10. Financial Decision Modeling:

(a) Linear Programming
(b) Network analysis-PERT/CPM, resource allocation & resource leveling
(c) Transporta
(f) Learning C f hypothesis

Some Important Instruction

Basic Strategy of Success in Examination

1. Maintain separate copies (Rule sheet) for class note & home work.
2. All pages should be numbered.

3. 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.

4. 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 students score 72, 73 by answering 80 or 85 out of 100 marks paper.

5. Generally maximum theory to answer is 34 marks or min 16 marks. So , plan ur exam according to ur strength in theory & problem.

As we write only 80 or 85 marks in 3 hours, automatically we get the following advantage:

a. Available time to answer per question will increase
b. Reduces no. of mistakes, which a student normally does to attempt of 100 marks within the same time.
c. Increase quality of answer.
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.

Pre-conditions of quality answers are:

1) Proper heading for each statement & working note.
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 for 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 color in ur answer.

8) Do not underline the key or catch word of each sentence. Mention proper question no. in each answer.

9) A good hand writing is a must for a "quality answer".

10) Use pencil in exam. to prepare graph & chart

Remember:

1 Take part in class discussion .
2 Switch off your Mobile.
3 **Try all Home work**.**
4 Registered in our website: www.costmanagement.net.in
5 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.

**Try all Home work, How?

Step 1: First read the Class note to check the theory
Step 2: Carefully Read the problem at least twice.

Step 3: Now read 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 4: Analysis according to technique which you fell most appropriate.
Step 5: Give Final answer. It will take at least 40 minutes

Tips for the final revision phase:

As the exam looks 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.

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. So check 1 problem per topic.
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.

.

Basic Concept

1. Define Cost & Management Accountancy

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

ICAI Management Accountancy 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. Proforma of a Cost Sheet as in CAS– 1 & 4 for detail refer www. costmanagement.net.in

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

(1) Consistency of related information elements: Operating personnel are alert for information that is in 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.

(5) A database should be maintained with costs appropriately coded and classified so that relevant cost information can be extracted to help managers make better decisions. Future costs rather than past costs are required for decision making.

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

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.

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

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

i. They arise from periodic (usually yearly) decisions regarding the regarding the maximum outlay to be incurred.

ii. They are not tied to a clear cause & affect relationship between inputs & outputs.

Examples of discretionary costs includes : advertising, public relations, executive training, teaching, research, health care and management consulting services.
The note worthy 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 est development functi jor reports to mana

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

Committed fixed costs, are those fixed costs that arise from the possession of

(i) a plant, building and equipment (e.g. depreciation, rent, taxes, 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. Cost control and Cost Reduction :

Cost Control is the guidance and regulation by executive action of the costs of operating an undertaking according to the functional budgets. It includes planning, communication, motivation, reporting and decision making.

Cost reduction may be defined as the achievement of real and permanent reduction in the unit cost of the products manufactured.

The following distinction may be made between them--

(i) Cost Control implies setting up for norms or targets through budgets, standards forecasts etc. and efforts made to achieve them. Cost reduction donates systematic efforts to improve the targets set by better designs, improved planning and organization.

(ii) In Cost Control, Standards or Budgets once set up are accepted and not changed whereas in the case of cost reduction the very standards/budgets are changed and efforts are made to improve upon them.

(iii) Cost control is a basically preventive function where by the result/goal is achieved by keeping to a standard. Cost reduction is a corrective action and continuous efforts are made to correct or adjust the present standards or budgets.

(iv) Cost reduction has dynamic approach with a much wider application. It covers product design, factory layout, production control etc. whereas Cost Control is not so dynamic having limited scope of staying within the predetermined standards and budgets.

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**

1. Definition 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.

2. 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.

(V) Budgeting lays emphasis on the necessity for advance decision on future course of action.

3. 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.

(d) 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.

(e) Budgets facilitate **centralized control** with delegated authority & responsibility. Grouped according to the responsibilities of different executive levels, they facilitate decentralization of work.

(f) 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.

4. Working of a Budgetary Control System:

The responsibility for successfully introducing and implementing a Budgetary Control System rests with the Budget Committee acting through the Budget officer. The Budget Committee would be co and guide the delibe

1. To assist in the preparation of the various budgets by coordinating the work of the accounts department which is normally responsible to compile the budgets- with relevant functional departments like sales, production, plant maintenance etc.

2. To forward the budget to the individuals who are responsible to adhere to them, and to guide them in overcoming any practical difficulties in its working;

3. To prepare the periodical budget reports for circulation to the individuals concerned:

4. To follow-up action to be taken on the budget reports;

5. To prepare an overall budget working report for discussion at the Budget Committee meetings and to ensure follow-up on the lines of action suggested by the Committee.

6. To prepare periodical reports for the Board meeting. Comparing the budgeted Profit & Loss Account and the Balance Sheet with the actual results attained.

It is necessary that every budget should be thoroughly discussed with the functional head before it is finalized.

It is the duty of the Budget Officer to see that the periodical budget reports are supplied to the recipients at a frequent intervals as far as possible. The efficiency of the Budget officer, and through him of the Budget Committee, will be judged more by the smooth working of the system and the agreement between the actual figures and the budgeted figures.

5. 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.

6. Limitations of Budgetary Control System:

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.

7. Zero base budget- definition & other questions .

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 simple 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–opera

8. 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

9. Rolling Budgets.

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.

10. Performance Budgeting (PB)

Performance Budgeting provide a meaningful relationship between estimated inputs and expected outputs as an integral part of the budgeting system. '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 correlating the physical and financial aspect of the individual items comprising the budget.

Traditional budgeting vs. Performance budgeting

1. The traditional budgeting (TB) gives more emphasis on the financial aspect than the physical aspects or performance. PB aims at establishing a relationship between the inputs and the outputs.

2. Traditional budgets are generally prepared with the main basis towards the objects or items of expenditure i.e. it highlights the items of expenditure, namely, salaries, stores and materials, rates rents and taxes and so on. In the PB latter the emphasis is more on the functions of the organisation, the programmes to discharge these function and the activities which will be involved in undertaking these programmes.

Steps in PB:: According to the Administrative Reforms Commission (ARC) the following steps are the basic ones in PB :

(a) establishing a meaningful functional programme and activity classification of government operations ;
(b) bring the system of accounting and financial management in accord with this classification

(c) evolving suitable norms, yardsticks, work units of performance and units costs, wherever possible under each programme and activity for their reporting and evaluation.

The Report of the ARC use the following terms in an integrated sequence :

Fun

The team 'function' is used in the sense of 'objective'. For achieving objectives 'programmes' will have to be evolved. In respect of time horizon, it is essentially a replacement of traditional annual fiscal budgeting by a more output-oriented, but still an annual, exercise.

For an enterprise that wants to adopt PB, it is thus imperative that :

(a) the objectives of the enterprise are spelt out in concrete terms.
(b) the objectives are then translated into specific functions, programmes, activities and tasks for different levels of management within the realities of fiscal; constraints ;
(c) realistic and acceptable norms, yardsticks or standards and performance indicators should be evolved and expressed in quantifiable physical units.
(d) a style of management based upon decentralised responsibility structure should be adopted, and
(e) an accounting and reporting system should be developed to facilities monitoring, analysis and review of actual performance in relation to budgets.

11. Performance Reporting at various levels of management:

Report: A major part of the management account's job consists of preparing reports to provide information for purposes of control and planning:

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

Significance	: Are the facts in the reports reliable? Does it either called for action or demonstrate the effect of action? It is material enough.
Timeliness	: How late can the information be and still be of use? What is the earliest moment at which it could be used if it were available? How frequently is it required.
Accuracy	: How small should be an inaccuracy which does not alter the significance of he information?
Appropriateness	: Is the recipient the right person to take any action that is needed? Is there any other information which is required to support the information to anyone else jointly interested?
Discrimination	: Will anything be lost by omitting the item? Will any of the items gain from the omission ? Is the responsibility for suppressing the item acceptable?
Presentation	: Is the report clear and unbiased? Is the form of it is suitable to the subject? Is the form of it suitable to the recipient?

12. 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. PTO

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.

13. 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.
- I… …shed goods, r…

PTO

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 generated sales revenue. To achieve this, maximum amount of throughput is required with the financial definition. **Sales revenue - 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.

14. The Balanced Scorecard

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 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.

3. Innovation & learning: 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, p rs(s) direct.

Problems : Functional Budgets: Single product

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

Quarter	:	I	II	III	IV
Sales Units	:	30,000	37,500	41,250	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) aw 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. Each unit of the product requires 3 lbs of material P and 1½ lbs of material Q for manufacture as well as a processing time of 7 hours in the Machine shop and 2½ 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:

	Machine Shop	Assembly shop
In 2007	11,00,000	3,45,000
In 2008	10.30.000	3,20,000
In 2009	10,80,000	3,40,000
Absorption rate on LHR(Rs)	4	3.2
No. of Employees	600	180

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

	Finished Goods	Material P	Material Q
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 :

(a) The number of units of the product proposed to be sold.
(b)
(c) comments.

Functional Budgets: Multi products

3. A company manufactures two Products A and B by making use of two type of materials, viz., X and Y . Product A requires 10 units of X and 3 units of Y. Product B requires 5 units of X and 2 units of Y. The price of X is Rs. 2 per unit and that of Y is Rs. 3 per unit. Standard hours allowed per product are 4 and 3, restively. Budgeted wages rate is Rs. 8 per hour. Overtime premium is 50% and is payable, if a worker works for more than 40 hours a week. There are 150 workers.

The sales Manager has estimated the sales of Product A to be 5,000 units & Product B 10,000 units. The target productivity ratio (or efficiency ratio) for the productive hours worked by the direct worker in actually manufacturing the product is 80%, in addition, the non-productive downtime is budgeted at 20% of the productive hours worked. There are twelve 5-day weeks in the budget period and it is anticipated that sales & production will occur evenly through the whole period.

It is anticipated that stock at the beginning of the period will be :

Product A 800 units; Product B 1,680 units. The targeted closing stock expressed in termed of anticipated activity during the budget period are Product A 12 days sales & product B 18 day's sales. The opening and closing stock of raw material of X and Y will be maintained according to requirement of stock position for Product A & B.

You are required to prepare the following for the next period :

i) Material usage and Material budget in terms of quantities and values.
ii) Production budget.
iii) Wages budget for the direct workers.

4. 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	Requirement of components on per unit basis.			
	Rs. p.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:

Sub-assembly	Skilled Hours	Un-Skilled Hours
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 2009 are as under:

Sub-assemblies		Components	
P	600	Frames	2000
Q	1400	Part X	800

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 2010:

(i) Sales in quantities and value
(ii) Production in quantities

(iii) Material usage & purchase
(iv) Manpower budget for both categories of labour including wages payable.

Selling Expenditure Budget

5. Pharma Ltd. sells Ayurvedic medical 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

a. Prepare a Quarterly Budget of selling expenses for the year.

b. 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:
(i0 Expected cash collections during February (ii) Expected cash balance, February 1
(iii) 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 :

(Rs. in lacks)

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sales	34	40	40	50	50	60	65
Purchase	24	16	17	20	32	25	28
Wages and Salaries	12	14	14	18	24	20	22
Miscellaneous	5	6	6	6	7	7	7
Interest Received	2	--	--	2	--	--	2
Sales of Shares	--	--	20	--	--	--	--

(iii) 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.

(iv) 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.

(v) 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)

(vi) 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 Per unit	Product B 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
i) Total sales potential is limited;
ii) Raw Material is in short supply;
iii) 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 8,400, find PBF
(d) If only one product is to sale in question (c), 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.

a. You are required to find the optimum product mix.

b. 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 gi re required to analy

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. SM makes two products, Z1 and Z2. its machines can only work on one product at a time. The two products are worked on in two departments by differing grades of labour. The labour requirements for the two products are as follows:

	Minutes per unit of product Z1	Z2
Department 1	12	16
Department 2	20	15

There is currently a shortage of labour and the maximum times available each day in Departments 1 and 2 are 480 minutes 840 minutes , respectively. The current selling prices and costs for the two products are shown below:

	Z1 Rs. per unit	Z2 Rs. per unit
Selling price	50.00	65.00
Direct materials	10.00	15.00
Directs labour	10.40	6.20
Variable overheads	6.40	9.20
Fixed overheads	12.80	18.40
Profit per unit	10.40	16.20

SM needs to know the optimum output levels. All output is sold.

(i) Calculate the maximum number of each product that could be produced each day, and identify the limiting factor /bottleneck.

(ii) ach day, and

13. 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.

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 & B. The bottleneck hours required per product unit for product A & B are 0.02 & 0.015 respectively.

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

Flopro plc has decided to determine the profit maximizing mix of products A and B based on the throughput Accounting principle.Calculate the mix (units) of products A and B which will maximize net profit and the value of that net profit.

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**

14. 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.

Fixed & Flexible Budget & Performance Analysis

15. From the figures given below you are required to prepare the production cost budget for the period from January to June, 2009.

	Budget	Actual
Production (units)	20,000	18,000
	Rs.	Rs.
Material cost	2,000 MT 40,00,000	1900 MT 39,90,000
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 2009, 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 2009 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 2008 actual.
You are required to prepare the production cost budget for the period January-June, 2009.

16. V Ltd. manufactures a single product. The selling price of the product is Rs. 150 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	1,79,000	1,73,000

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, 6,000 and 6,500 unit levels and de

(ii) Ca ...000 units.

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

	Budgets Quarters I – III		Rs.('000)
Period Covered	Q – I	Q – II	Q – III
Activity :			
Sales (Units)	9	17	15
Production (Units)	10	20	15
Costs (Rs.'000)			
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.

18. Nabharat Commerce College, Bombay has six sections of B. Com, & two sections of M. Com with 40 & 30 students per section respectively. The college plans one day pleasure trip around the city for the students once in an academic session during winter break to visit park, Zoo, planetarium & aquarium.

A Transporter used to provide the required number of buses at a fiat rate of Rs. 700 per bus for the aforesaid purpose. In addition, a special permit fee of Rs. 50 per bus is required to be deposited with city municipal corporation. Each bus is 52 seater. Two seats are reserved for teachers who accompany in each bus. Each teacher is paid daily allowance of Rs. 100 for the day. No other costs in respect of teachers are relevant to the trip.

The approved caters of the college supply breakfast, lunch and afternoon tea respectively a Rs. 7, Rs. 30 and Rs. 3 per student.

No entrance fee is charged at the park. Entrance fees come to Rs. 5 per student both for the zoo and the aquarium. As regards planetarium the authorities charge block entrance for as under for group of students of educational institutions depending upon the number of students in a group.

Number of Students in a Group	Block Entrance Fee Rs.
Up to 100	200
101-200	300
201 & above	450

Cost of prizes to be awarded to the winners in different games being arranged in the park depend upon the strength of students in a trip. Cost of prizes to be distributed are :

Number of Students in a Trip	Cost of Prizes
Up to 50	900
51-125.1	1,050
126-150.1	1,200
151-200.1	1,300
201-250.1	1,400
251 & above	1,500

To meet the above costs the college collects Rs. 65 from each student who wish to joint the trip. The college releases study of Rs. 10 per student in the trip towards it.

You are required to :

(a) Prepare a tabulated statement showing total costs at the levels of 60, 120, 180, 240 and 300 students indicating each item of cost.

(b) Compute average cost per student at each of the above levels.

(c) Calculate the number of students to break even for the trip as the college suffered loss during the previous year despite 72% of the students having joined the trip.

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 Traditional Pricing technique for establish product :**
   S.P.= prime cost (actual) + overhead recovered + mark up

2. **Conversion cost method : S.P.= total cost + mark up on conversion cost**

3. **Standard Cost Method.**
   S.P.= Standard Cost + mark up

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. **Relevant cost technique**
   Minimum sale price = variable cost + discretionary cost + opportunity cost.

7. **Learning Curve Method or Experience curve method .**
   S.P.= Static cost + Reducible cost + Mark up

8. **Return on investment method: (ROCE or ROI)**
   S.P.= total cost + mark up on capital employed .

9. **Activity Base Costing .**
   S.P.= Prime cost + overhead on cost driver + mark up

10. **Life Cycle Costing :**
    S.P. = total cost on estimated life + mark up

11. **Target Costing:**

12. 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.

13. Pareto analysis:

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.

14. 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.

15. 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

PTO

(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 usual be traced to 20% of the various underlying causes.

16. Limitation: Potential cost, product & customer of low rank is neglected.

17. Skimming Pricing Policy.

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 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 know 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.

18. Penetration Pricing policy

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.

19. Competitive pricing

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.

Problems : 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 Ibs. @ Rs. 2.30 per Ib.
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.
Materiel 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 :

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

(a) 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.

(b) 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.

(c) 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 percen

PTO

Production Dept.	Capacity utilized
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 :

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

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

(b) 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.

Absorption Costing

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

Rules & procedure for determining overhead recovery rate:

1. **COLLECTION**
2. **CLASSIFICATION :**
3. **COST ALLOCATION :**
4. **COST APPORTIONMENT :**
5. **RE-APPORTIONMENT OR SECONDARY DISTRIBUTION. (Ref q-6)**
6. **COMPUTATION OF RECOVARY RATES ON SUITABLE BASIS**
7. **OVERHEAD ABSORPTION or RECOVARY or CHARGED or ADDED or APPLIED BY PREPARING A JOB COST SHEET**

Problem:

1. Following data are given to you from which you are required to calculate the machine hour rate & composite machine hour rate of two production departments A and B. There are two service departments X and Y as well as an establishment department E (i.e. Administrative office). The data given are the annual expenses budgeted for the year .

Expenditure	Total amount Rs.	Remarks
Establishment expenses	13,60,000	Distribute on the basis considered best by you.
Indirect labour	16,00,000	Allocate Rs. 3,00,000 to each of the service deprt. & the balance to production deprts on the basis of your choice, according of cost accounting principles.
Fuel consumption	12,00,000	Only department B consumes fuel.
Rent	10,00,000	Both for factory and office
factory general expenses	21,95,000	Allocate as per floor space but not for office.

The following table is also supplied to you :

		Prod. department		Service department		Estb. Dept.
	Total	A	B	X	Y	E
Floor space(sq. ft.)	1,00,000	40,000	30,000	15,000	10,000	5,000
Direct labour hours	4,20,000	2,00,000	1,50,000	50,000	20,000	-
Machine hours	2,00,000	10,00,000	8,00,000	5,20,000	-	-
Direct Wages (Rs.)	109.91,000	50.00,000	30,00,000	15,20,500	14.70,500	-
Personnel employed	3,500	1,200	1,200	600	300	200
Value of Plant and Tools stock at purchased value (Rs.)	32.5 lakhs	15.0 lakh	10.0 lakh	7.5 lakh	-	-
Amortisation of tools as a percentage of line method						-

PTO

Service department Y renders service to A, B, and X departments. Service department X renders service to production departments only. Expenses apportioned to service department Y are to be distributed to service department X and production departments on the basis of direct labour hours. Expenses of service department X are to be distributed to production departments on the basis of machine hours.

Also calculate the job cost & sale price at 20% mark up on the basis of two recovery rates as computed above if the material cost is Rs. 15,000 & hours requirement

	LHR	MHR
Department A	800	1,120
Department B	500	1,500

2. 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. The factory adds 25% mark up for its sale price.

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	18,200	760	1,280
Assembly	23,600	420	430
Finishing	14,300	740	510 .

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

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

Other data are:

Direct material	Rs. 100 per unit
Direct Labour	Rs. 100 per unit at normal efficiency
Variable Overhead	Rs. 50 per unit
Fixed Overhead at budgeted capacity	Rs. 1,00,000
Variable selling overhead	Rs. 26,000
Budgeted fixed selling overhead	Rs. 30,000
Actual fixed selling overhead	Rs. 25,000
Selling price	Rs. 400 per unit

There was no opening stock.

(i) Present the profitability statement under absorption costing system.

(ii) Assuming actual labour was 25% below normal efficiency and that 100 units of production [illegible] loss.

(iii) [illegible]

Standard Costing

1. CIMA's terminology defines Standard Costing as follows:

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. In presence of Standard Costing, a budget is multiplication of Standard costing. The resulting variances may be analysed to show their causes.

2. What is a Standard Cost?

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 separa overhead.

3. 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.

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 different responsible managers:

Variance analysis are 2 types

1. **Cost variances**
   - **a. Variable cost Variance;** **b. Fixed cost variance**
2. **Revenue variances**
   - **a. on sales** **b. on margin**

Rules for variable costs variances

$T_1 \Rightarrow$ **COST VARIANCE** $= SC \times \frac{AO}{SQ} - AC$

$T_2 \Rightarrow$

Problems:

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

Direct materials	1.5 tons	@ Rs.400 per ton.
Direct Labour	3.0 hours	@ Rs. 60 per hour.
Factory overhead	3.0 hours	@ Rs. 20 per hour.

Normal capacity is 2,10,000 direct Labour hours per mensum (i.e. monthly). The factory overhead recovery rate is arrived at on the basis of a fixed overhead of Rs.10,50,000 p.m.

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.65 per hour Factory overhead for the month amounted to Rs.35,00,000 of which Rs.11,25,000 was fixed.

Actual & standard sale price is Rs.1,100 per unit. Compute all variances & show the profit reconciliation statement..

What is Standard Hors? If idle time is 2,000 hours , what will be the change in the above calculations?

2. The following information is available from the records of Standcost Ltd. for October 2010 :-

			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
Fixed Overhead Incurred	:		11,000
Actual selling cost	:		12,800

Units produced 900 units. These were sold at Rs. 65 per unit
Actual idle time was 180 hours.

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	Re.1 per hour
Fixed overheads	Rs. 4.00 per labour hour.
Fixed Overhead Budgeted	Rs.:10,000
Budgeted selling cost	Rs. 15 p.u.

Compute Cost Variances for October 20010.& show the ledger accounts following Partial / Single / Integral plan. Identify one or more departments who are held responsible for each variance.

3. U Ltd. commenced business on Jan.1, 2009, 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 2009. 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. 2010 it was found that the actual total operating time for 2009 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 2009 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 2009 were Rs. 61,800 & selling cost Rs. 21,500. Sales price is Rs 45 p.u Set out the variance to compute the profit under single plan.

Journal Entries with Standard Costing: 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 favorable:

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:**

WIP ……Dr.		(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)		

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.

7. **Variable Production Overhead incurred & show the expenditure variance in GLA:**

Podn. Overhead Control A/c …..Dr. (Std. rate× actual Hrs)
Expenditure Variance…..Dr. (Difference in rate× actual hrs)
To GLA Actual cost

8. **Fixed production Overhead incurred & show the expenditure variance in GLA:**

Prodn. Overhead control A/c ……Dr. (BFO)
Expenditure variance ……Dr. (BFO –AFO)
To GLA (Actual Cost)

9. **Show the other production overhead variances in overhead control A/c**

10. **Transfer Production overhead to WIP:**

WIP ……..…… Dr. (Std. cost for actual output)
To Prodn. Overhead controls A/c

11. **Administration overhead transferred:**

a) **Of Production nature:**

WIP……Dr. Std cost for actual output
To Administration overhead

b) **Of Marketing nature:**

Selling Overhead Control A/c or COS a/c ……..Dr. **“**
To Administration overhead

c) Transfer cost variances from Admin ohd. con a/c to variance control a/c

12. **Transfer units produced to finished goods:**

FG control A/c (Actual output× Std. cost/unit)…….Dr. Std. cost for Actual Output
To WIP

13. **Transfer goods sold to COS A/c at Standard Cost:**

COS A/c… ……Dr. Standard Cost for AO Sold
To Finished goods Control A/c

14. **Transfer selling & distribution overhead to COS at Standard cost:**

COS A/c…….. Dr. Standard Cost for AO Sold
To Selling and control A/c

15. **Show the selling cost variance in selling and overhead control A/c**

Sales cost variance a/c . Dr.
To Sales ohd con a/c

16. **Transfer COS to P/L A/c:**

Costing P/L…… Dr. Standard Cost

17. **Actual Sales:**
    GLA A/c…….Dr.
    To Costing P/L

18 **The difference is known as margin.**

19. **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

20. **The net amt. of variance control A/c is transferred to costing P/L for adjustment against the margin. If adverse:**

    Costing P/L ……Dr.
    To Variance Control A/c

21. **Calculate NP in Costing P/L and transfer it to GLA:**

    Costing P/L A/c……..Dr. Net profit transfer
    To GLA

Under Partial Plan

1. Material Purchased:
   MC/SLC A/c……Dr. Actual Cost
   To GLA

2. Direct Material issued for production:
   Process/ Product/WIP A/c……..Dr. "
   To SLC

3. Indirect material issued:
   Production overhead control A/c……Dr. "
   To SLC

4. Paid Wages:
   Wages Control A/c…….Dr. "
   To GLA

5. Transfer- Direct & Indirect wages:
   WIP A/c……..…Dr. Direct wages
   Production/Administration/Selling overhead A/c…Dr indirect wages
   To Wages Control A/c

6. Overhead incurred (other than material & labour):
   Production/Administration/Selling overhead……..Dr "

7. Production overhead transferred:
WIP……..Dr. “
To Production overhead control A/c

8. Administration overhead transferred:

a) Of Production nature:
WIP……Dr. “
To Administration overhead

b) Of Marketing nature:
Selling Overhead Control A/c or COS a/c ……..Dr. “
To Administration overhead

9. Show the variances in WIP A/c:
a) For adverse variance:
…….Variance A/c…….Dr.
To WIP

b) For favourable variances:
WIP…….Dr.
To……..Variance A/c

Rest of the Journals are same as before.

Integral Account

1. **Material purchase:**
SLC ……..Dr. (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:**
WIP ……Dr. (Std. rate ×actual Qty. consumed)
To SLC

4. **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:**
WIP …….Dr. (Std. rate × actual Hrs.)

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.:
WIP ……Dr. (Std. cost for AO)
To Overhead Control A/c

11. Finished goods will be transferred at std. cost:
Finished Goods control A/c ……..Dr. (Std. cost for actual output)
To WIP

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 2010 :

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. On 1st April, 2009, 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)	7.50
Total Cost		32.50

The following data was obtained from ZED Company's records for April, 2009 :

	Debit Rs.	Credit Rs.
Sales	--	1,25,000
Sundry Creditors (For purchase of D. materials in April 09)	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 2009 was 4,000 units of the gadget, and the actual sales for the month was 2,500 units.

Required:
(i) Standard direct labour hours allowed for the actual output achieved.
(ii) Actual direct labour hours worked.

(iii) Actual direct labour rate.
(iv) Standard quantity of direct materials allowed (in kgs.)

(v) Actual quantity of direct materials used (in kgs.)
(vi) Actual quantity of direct materials purchased (in kgs.)
(vii) Ac

7. 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

			Rs.
		Purchase of raw materials	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).

8. The following uncompleted accounts appear in the ledger of MDX plc for March 2009. 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 hr.

Equivalent Production : Always apply FIFO for computation of variance

9. 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		24

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 Cost Control Accounts & Trial Balance. (May 1991)

10. 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)	120

During July, 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 standard 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 wip 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:

a. Computation of standard cost of production of the shirts per dozen & total for each lot.

b. Find the variation in quantity of material used & labour hrs worked for each lot & in total.

c. Calculate the material price variance; labour rate variance; variable overheads efficiency variance and fixed overheads volume & Expenditure variance.

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

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

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

	80%	90%	100%	110%
Production (units)	6,000	6,750	7,500	8,250
Variable overheads (Rs.)	18,000	20,250	22,500	24,750
Fixed overheads (Rs.)	11,250	11,250	11,250	11,250
	29,250	31,000	33,750	36,500

Actual data for the month of January :

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.

nverted.

Deter

12. 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 2009 performance, budgeted overhead is Rs. 98,000 for the standard labour hours allowed. The following additional information pertains to the month of March 2009:

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:

a) for each cost element, equivalent units of performance & the actual cost per equivalent unit.

b) actual cost of returns in process on March 31.

c) The total labour, labour rate and labour efficiency variances as well as total overhead volume and overhead budget variance.

13. 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
Units completed & transferred during the month	16,000	20,000

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:

Rules :

i) MCV = Standard Material Cost for actual production–actual material cost.

ii) MPV = (Standard Rate–Actual Rate) Actual quantity consumed.

iii) MUV = (Standard Consumption of actual output–Actual consumption) Standard Rate.

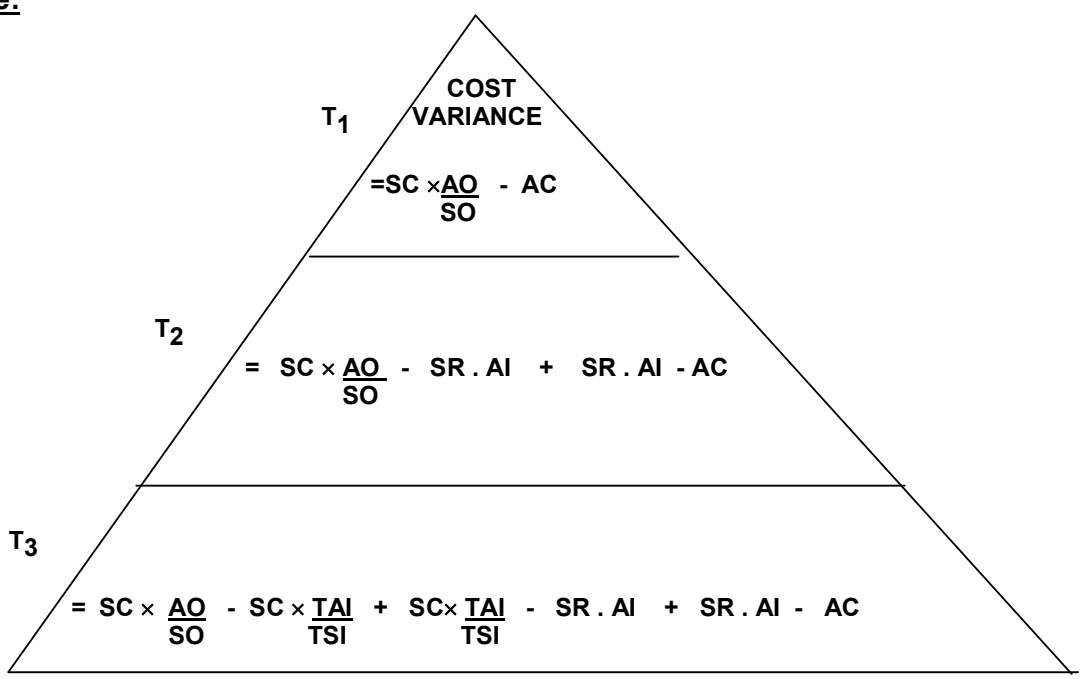
iv) MMV = (Total Actual Input in standard mix ratio–Actual Input) Standard Rate.

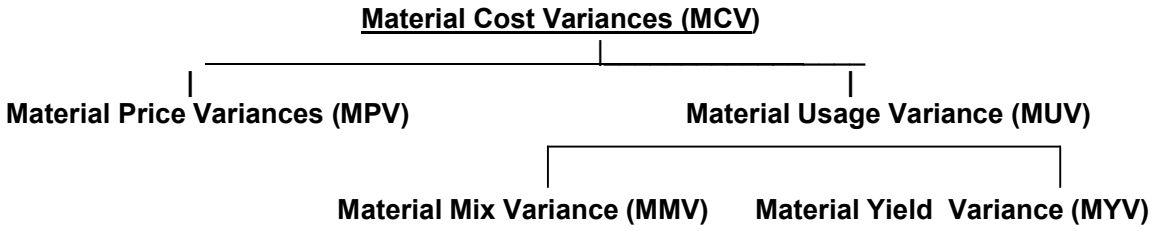
v) MYV = (Actual Output–Standard Output for Actual Input) Standard rate of Yield.

Check :

1. MPV + MUV = MCV & 2. MMV + MYV = MUV

Prove:





Remember : (for cost variances)

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.
4. Production = Output = Yield

Qu

14. 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 variances & show SLC A/c.

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

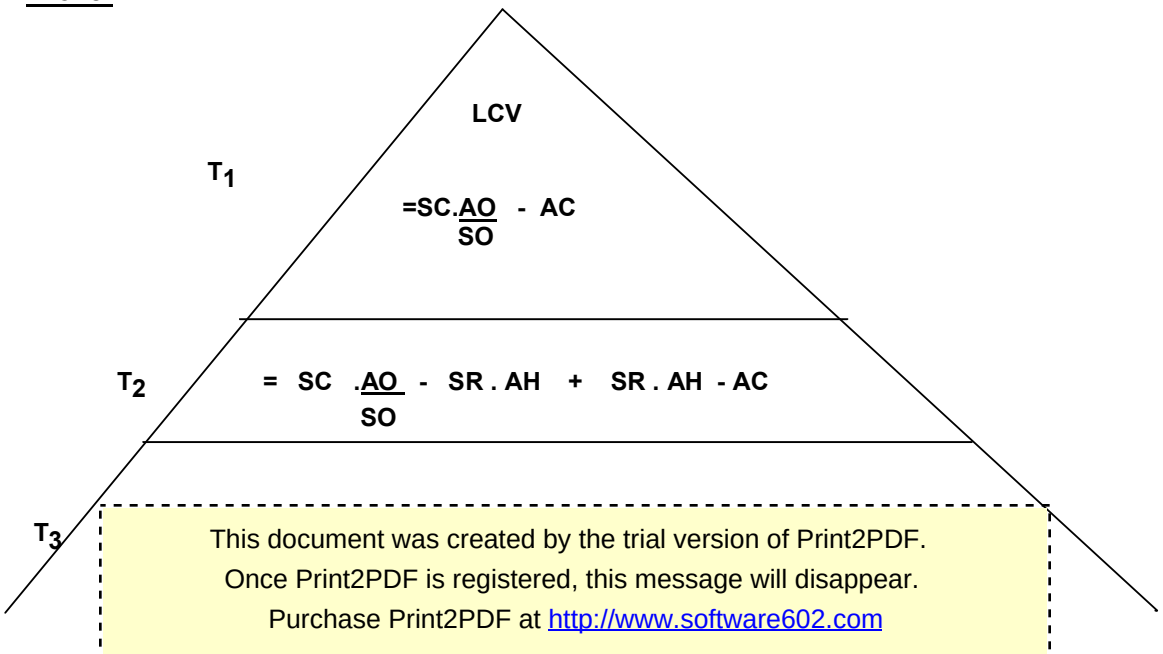
Particulars	A	B
Standard Price/kg	Rs. 12	Rs. 15
Actual Price/kg	Rs. 15	Rs. 20
Standard Input (kgs)	50	?
Actual Input (Kgs)	?	70
Material Price Variance	?	?
Material Uses Variance	?	Rs. 300 Adverse
Material Cost Variance	?	?

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

Labour Variances: Rules :

i) LCV = Standard Labour Cost for actual production – Actual Labour Cost
ii) RPV = (Standard Rate – Actual Rate) Actual Hours worked.
iii) ITV = Actual Idle Time x Standard Rate. (Note : This is always an adverse variance.)
iv) LEV = (Standard Time for actual production – RAT) Standard Rate.
v) LMV = (Total Rate in standard time ratio – RAT) Standard Rate.
vi) LYV = (Actual production – Standard production during RAT) Standard Rate of Yield i.e. Std. cost/Std. production

Prove:



Labour Cost Variance

Rate of Pay Variance (RPV)	**Idle Time Variance(ITV)**	**Labour Efficiency Variance(LEV)**
		Lab. Mix Variance(LMV) / **Lab. Gang Variance(LGV)**
		Lab. Yield Variance (LYV) / **Lab Output Variance (LOV)**

Note:

1. **In presence of idle time actual hour = Revised actual time + Idle Time.**
2. **If output is not given, apply the definitions of Standard hours i.e. one labour hour = one unit.**
3. **Show the check. i) RPV + ITV + LEV = LCV & ii) LGV + LOV = LEV.**

16. 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.

17. A standard costing system is adopted in a Machine Shop which is fabricating components for Refrigerators. The following is the composition of the standard machine hour rate:–

Direct Labour	@ Rs. 2 per hour	Rs. 2.00	
Overheads	@ Rs. 4 per hour	Rs. 4.00	6.00

All machines are identical in the shop. The above rates have been worked out on the basis of 2,60,000 machine hours per annum consisting of 52 weeks. In a particular week the following components were produced:–

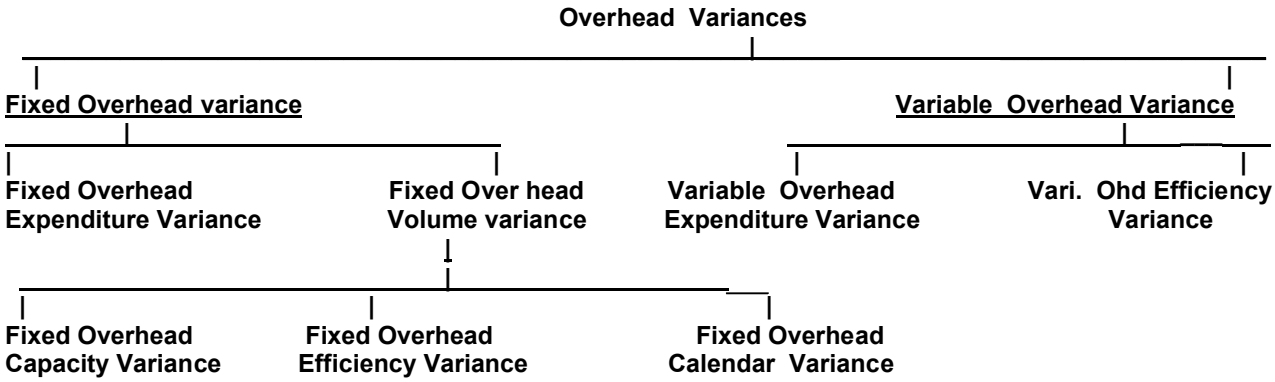
Bottom Trays	500 Nos. X 1
Side Panels	600 Nos. X 4
Door Panels	800 Nos. X 2

The standard time allowed for the above items are 1, 4 & 2 hours per unit respectively. During the week, actual labour and overhead costs incurred are:

Direct labour Rs. 11,000 @ Rs. 2 per hour
Overheads Rs. 23,000

You are required to work out the various labour & overhead cost variances for the week.

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



Fixed Overhead :

Rules for Fixed Overhead :

a) **Fixed Overhead Cost Variance** = **Standard Fixed Overhead for actual production – actual fixed overhead.**

b) **Fixed Overhead Expn. Variance** = **Standard Fixed Overhead – Actual Fixed Overhead.**

c) **Fixed Overhead Volume Variance** = **(Actual Output – Standard Output) Standard rate/output.**

d) **Fixed Overhead Capacity Variance** = **{Actual hrs worked – Installed Capacity} Standard rate/hour.**

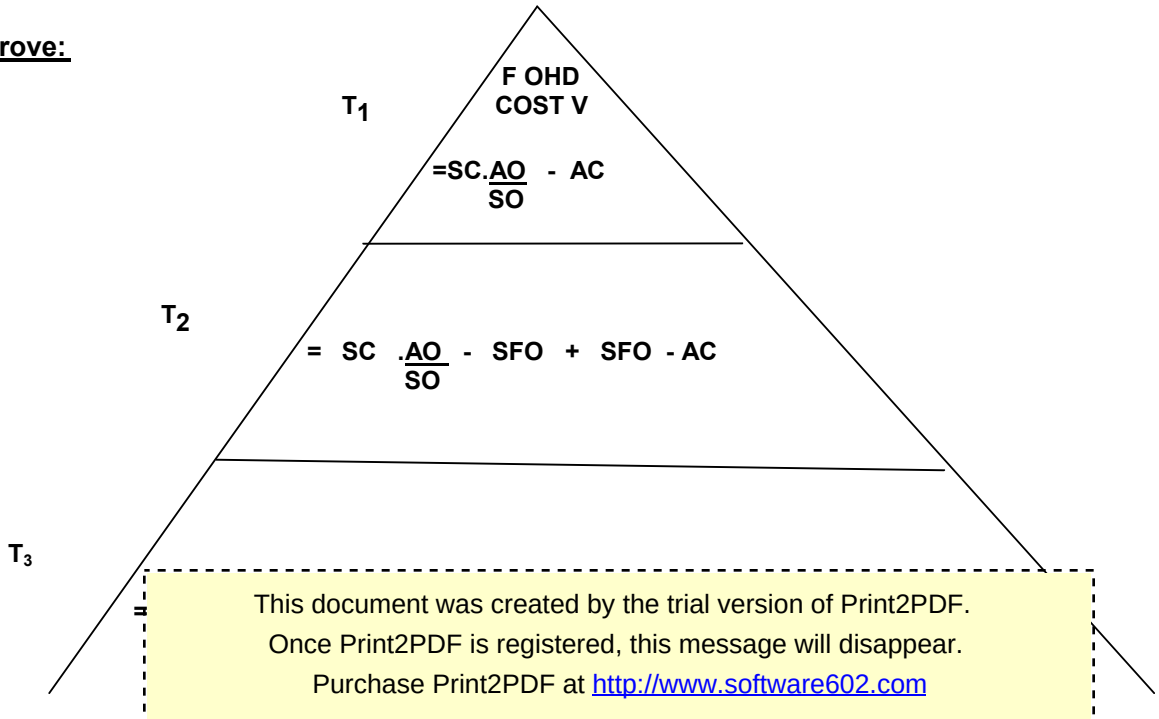
e) **Fixed Overhead Efficiency Variance** = **(Actual Number of days – Budgeted Number of days) Std rate/day.**

Installed Capacity = Actual no. of days × Std. hours per day.

Checks : **(1) a = b + c** **(2) c = d + e + f**

Note: Calculate Overhead Recovery Rates on the Basis of Budgeted Hours, Units & Days.

Prove:



VARIABLE OVERHEAD : **Rules for Variable Overhead**

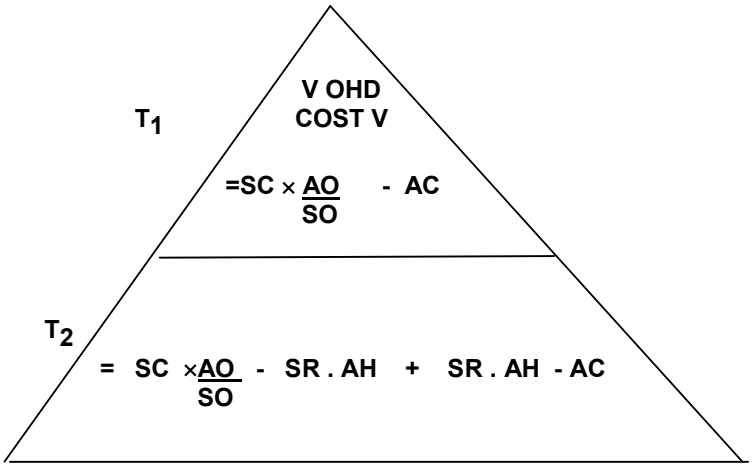
a) **Variable Cost Variance** = **(Std. Variable Overhead for actual production – Actual Variable Overhead).**

b) **Variable OHD Expen Variance** = **(Std. Variable Overhead for actual hr. worked – Actual Variable Overhead).**

c) **Variable OHD Efficiency Variance** = **(Std. time for actual production – Actual time taken) Std. rate/hour/min/day.**

Check : a = b + c

Prove:



18. The following information has been extracted from the books of Goru Enterprises which is using standard costing system:

Actual output	=	9,000 units
Direct wages paid	=	1,10,000 hours at Rs. 22 per hours of which 5,000 hours, being idle time, where not recorded in production
Standard hours	=	10 hours per unit
Labour efficiency variance OH	=	Rs. 3,75,000 (A)
Standard Variable OH	=	Rs. 150 per unit
Actual variable OH	=	Rs. 16,00,000

You are required to calculate:
(i) Idle time variance (ii) Total variable overhead variance
(iii) Variable overhead expenditure variance (iv) Variable overhead efficiency variance.

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

		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	

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 :

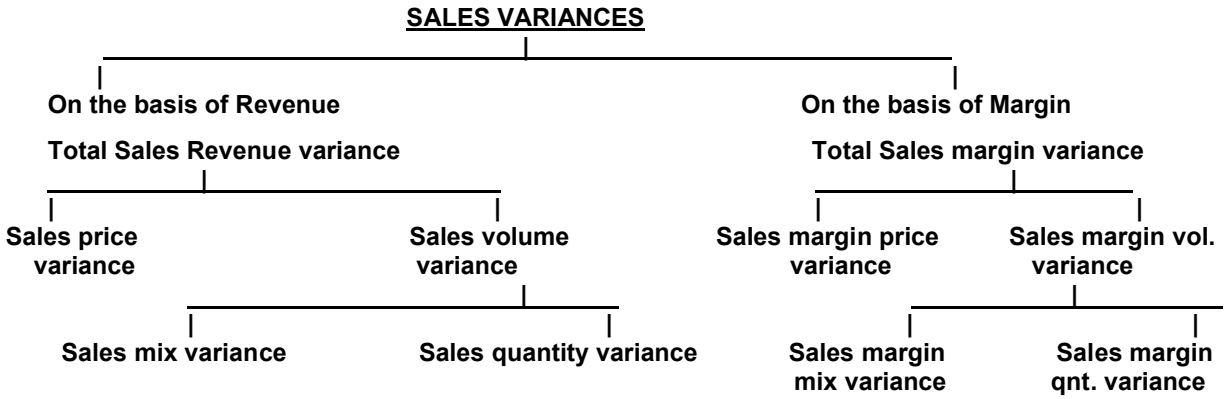
(i) Budgeted Machine Hours (ii) Actual Machine Hours
(iii) Applied Manufacturing Overhead (iv) Expenditure variance.

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.	Output
Standard usage :Product A	1 kg.	1 kg	1,130 units
Product B	0.5 kg	1.kg.	2,550 units



On the basis of value:

Rules :

1. **Sales Value Variance = Actual Sales – Budgeted Sales.**
2. **Sales Price Variance = (Actual Price – Standard Price) × Actual unit sold.**
3. **Sales Volume Variance = (Actual Units – Budgeted Units) × Std. Price.**
4. **Sales Mix Variance = (Actual Units – Total Actual units in Std. Ratio) × Std. Price.**
5. **Sales Quantity Variance = (Total Actual units in Std. Ratio – Budgeted units) × Std. Price.**

Chec

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

Rules :

1. **Sales Margin/Profit/Variance = Actual Profit – Budgeted Profit.**
2. **Sales margin Price Variance = Actual units (Actual Profit – Budgeted Profit)**
3. **Sales Margin volume variance = (Actual quantity– Budgeted quantity) standard margin**
4. **Sales Margin mix variance = (Actual quantity – total quantity standard ratio) standard margin**
5. **Sales margin quantity variance = (Total quantity in std. ratio – budgeted quantity) × Std. Margin.**

Check : 4 + 5 = 3 & 3 + 2 = 1

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, when the problem ask to calculate the Sales variance. Similarly, when all the variances are given, the sales variance represents sale margin variances**
3. **Market Share & Size variance are the improper 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.
4. **SPMV = SPV.**

22. 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 2009

	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 2009

	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 2009 from the internal management estimate of a 20% market share and an industry sales forecast by computer manufacturers assoc ndustry sales of 68,

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

FOR THE QUARTER JANUARY-MARCH 2009

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)

(U) = Unfavourable; (F) = Favourable

You are required to :
(a) Compute the Sales Quota given to each salesman and their actual contribution made.
(b) Rank the Salesmen according to performance, explaining the basis.
(c) Comment on the use of commission as an incentive.

24. The sales performance of SATYA Ltd. a dealer in Toy-products for 2007-08 was as follows :

Product	TV sets	Washing m/cs	Computers	Total
Units	40,000	1,00,000	1,80,000	3,20,000
	Rs.	Rs.	Rs.	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 2008-09 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. :

(i) sales margin quantity variance is Rs.33,333.33 (F);
(ii) Average standard margin per unit Rs.1.6667;
(iii) Budgeted sales (in unit) of washing machines were achieved;
(iv) TV sets were sold at the standard selling price;
(v) 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;
(vi) 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.

25. 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 extant 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 :

(i) T s penetration

P.T.O.

(ii) The sales mix will be changed from 50% of each size unit to 60% of the larger & 40% of the smaller with a contribution of Rs.11 & Rs. 9 p. u. respectively. The selling price would be so raised than an additional contribution of Rs. 0.50 p. u. is available uniformly on all units;

(iii) 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;

(iv) Curtailing 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.

Reconciliation:

26. The trading results of ZED Ltd. for 2007-08 and 2008-09 are as follows :

	Rs.	Rs.
Material	1,60,000	2,05,200
Wages	96,000	1,32,000
Variable Overheads	40,000	46,000
Fixed Overheads	50,000	54,800
Total costs	3,46,000	4,38,000
Profit	54,000	90,000
Sales	4,00,000	5,28,000

Selling price was enhanced by 10 % in 2008-09. Material prices and wages rates too have increased by 8 % and 12 % respectively. Prepare profit reconciliation statement & also prepare performance statement showing the changes in each element separately.

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		4,32,000
Total Costs		15,84,000
Sales		18,00,000
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 a

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

Items	2008	2009
	Rs. in lakhs	Rs. in lakhs
Sales	600	770
Direct Materials	300	324
Direct Wages	120	137
Variable Overhead	60	69
Fixed Overhead	80	150
Profit	40	90
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.

Variances on Marginal & Absorption Costing

29. 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	120	145.2
Contribution	80	63.8
Fixed Costs	70	68.0
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.

30. 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

You are required to calculate :

(i) the standard contribution per unit ;

(ii)

(iii)

31. The following figures are available. Find out the missing figures, given appropriate formula:

			Rs.
Budgeted profit			15,000
Less:	Adverse variances:		
	Contribution price variance	10,600	
	Direct materials variance	1,000	
	Fixed overhead variance	600	(12,200)
Add:	Favourable variances:		
	Contribution quantity variance	1,800	
	Direct wages variance	600	
	Variable overhead variance	1,800	4,200
	Actual profit		7,000

There is no inventory. Production units = Sales units for both actual and budget.

Other information:

Standard selling price	Rs. 18/ unit
Standard variable cost	Rs. 15/ unit
Standard contribution	Rs. 3/ unit
Actual selling price	Rs. 17/ unit
Budgeted sales	10,000 units

Standard material cost p. u. = Re. 1 (which is 5 kg. @ 20 paisa/kg.)
Material usage variance = 400 (Adv.)
Actual labour hours @ actual rate = Rs. 63,000

Actual labour hours @ Standard rate = Rs. 61,950
Variable overhead standard rate = Rs. 2
Standard hours of production = 4 per unit

Variable overhead at Standard rate = Rs. 84,800
Variable overhead expenditure variance = 1,800 (F)
Budgeted fixed overhead = Rs. 15,000

Find out the following:

1. Actual sales units
2. Actual sales Rs.
3. Actual quantity of raw materials used
4. Labour efficiency variance
5. Actual variable overhead in Rs.
6. Variable overhead efficiency variance
7. Actual fixed overheads
8. operating profit variance.

Standard in Service Sector

32. 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. P.T.O.

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

(i) Calculate standard cost of Primary Health Check-up and Advanced Health Check-up.

(ii) Prepare an operating cost statement for the month for the specialist unit showing standard cost and actual cost with variances.

Planning & Operating Variances

33. 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)	48	
		(148)
Standard contribution (per unit)		52

	Rs.'000	Rs. '000
Actual results for the first year were:		
Sales (1,000 units)		316
Production costs (1,000 units):		
Raw materials (10,800 kg)	194.4	
Labour (5,800 hours)	69.6	
		(264)
Actual contribution (1,000 units)		52

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 contri[illegible] fully efficient. Despit[illegible] calculate the traditi[illegible]

34. C preserves produces Jams, Marmalade and Preservers. All the products are produced in a similar fashion; the fruits are cooked at low temperature in a vacuum process and then blended with glucose syrup with added citric acid and pectin to help setting.

Margins are tight and the firm operates, a system of standard costing for each batch of Jam.

The standard cost data for a batch of raspberry jam are:

Fruits extract	400 kgs. @ Rs. 16 per kg.
Glucose syrup	700 kgs. @ Rs. 10 per kg.
Pectin	99 kgs. @ Rs. 33 per kg.
Citric acid	1 kg @ Rs.200 per kg.
Labour	18 hrs. @ Rs. 32 per hour
Standard processing loss 3%	

The climate proved disastrous for the raspberry crop. As a consequence, normal prices in the trade were Rs. 19 per kg for fruits extract although good buying could achieve some savings. The impact of exchange rates for imported sugar plus the minimum price fixed for sugarcane, caused the price of syrup to increase by 20%. The retail results for the batch were –

Fruit extract	428 kgs @ Rs. 18 per kg.
Glucose syrup	742 kgs @ Rs. 12 per kg.
Pectin	125 kgs @ Rs. 34 per kg.
Citric acid	1 kgs @ Rs195 per kg.
Labour	20 hrs @ Rs. 30 per hour.
Actual output	1,164 kgs. of raspberry jam.

You are required to:

(i) Calculate the ingredients planning variances that are deemed uncontrollable.
(ii) Calculate the ingredients operating variances that are deemed controllable.
(iii) Calculate the mixture and yield variances.
(iv) Calculate the total variances for the batch.

35. D Ltd. Manufactures and sells musical instruments, & uses a standard cost system. The budget for production and sale of one particular drum for April was 600 units at a selling price of Rs. 72 each. When the sales director reviewed the results for April in the light of the market conditions that had been experienced during the month, she believed that D Ltd. Should have sold 600 units of this drum at a price of Rs. 82 each. The actual sales achieved 600 units at Rs. 86 p. u.

(a) Selling price planning variance
(b) Selling price operating variance

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 of fixed items, Budgeted Input for Actual Output = the Budget input.

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

36. 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.) (Row 6÷Row 5)	20	22
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:

1. Describe briefly the elements you would include in Westwood's balanced scorecard.

2. Calculate the growth, price-recovery, and productivity components that explain the change in operating income from 2007 to 2008.

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.

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. CVP analysis and purposes:

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 interalia on selling price. By and large cost also depends on volume of production.

hus, 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 known the amount of overhead costs that could be charged to productions costs at v

3. The assumptions of cost-volume-profit analysis :

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

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.

5. Main limitations of break-even chart.

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.

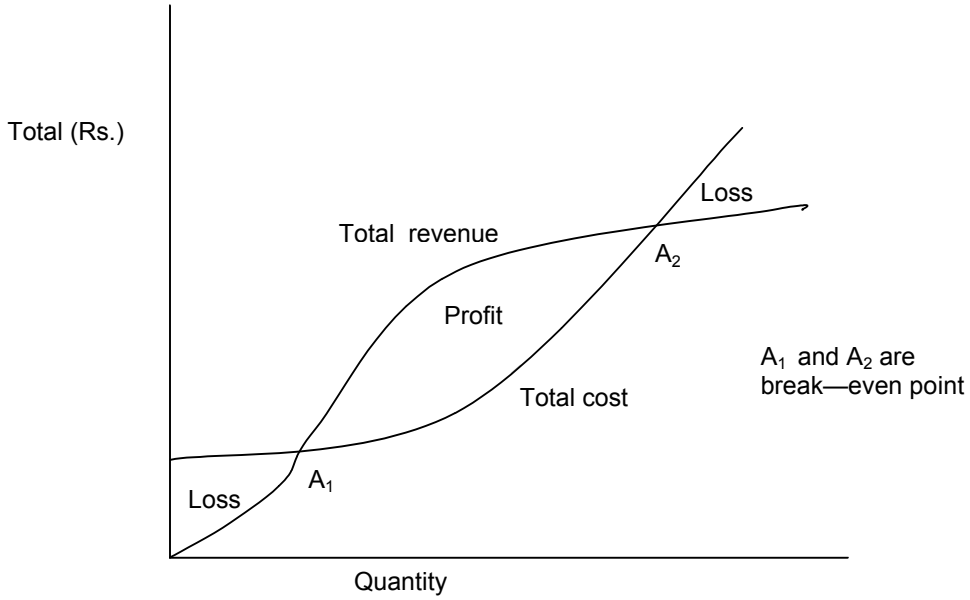
6. Curvilinear CVP analysis.

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 :

--- After the saturation point of existing demand the sales value may show a downward trend.

--- 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 and can also benefit from division of labour. 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. Thus the law of increasing costs may operate and the variable cost per unit may increase after reaching a particular level of output.

In such cases, the contribution will not increase in linear proportion on the phenomenon of diminishing marginal productivity, the total cost line will not be straight, as assumed but will be of curvilinear shape. This situation will give rise to two break even points. The optimum profit profits is earned at the point where the distance between sales and total cost is the greatest.



7. 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**.

8. Angle of Incidence :

It is the angle of intersection between the sales & 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 & 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 & 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.

9. Circumstances when sale price is less than the marginal cost of the product.

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.

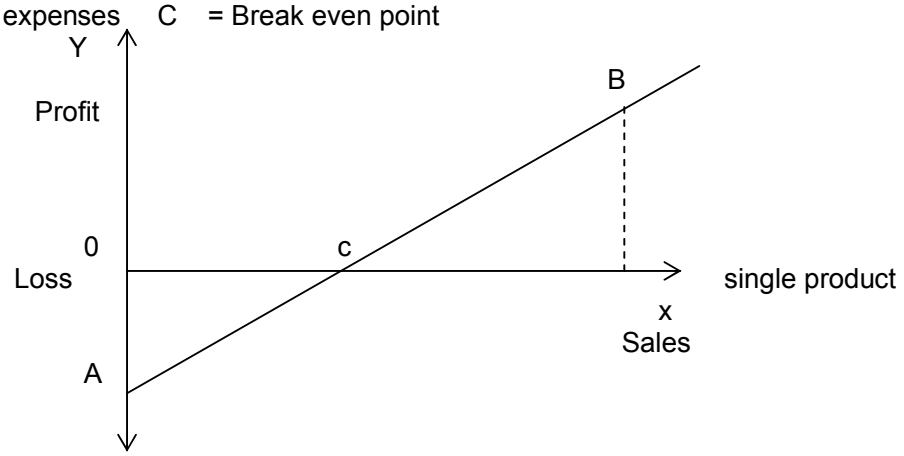
10. Distinguish between absorption costing and marginal costing.

	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 in 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.

11. Profit graph

Profit graph is a special type of break–even chart which shows the profit or less 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 OA. The loss demises 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.

Formulae for Calculations

1. **Sales - Variable Cost = Contribution = Fixed Cost + Profit (marginal cost equation)**

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 or slab fix cost, BEP = (fix cost + no. of slab x step cost per slab) ÷ contribution per unit.**
   d. **Composite BEP i.e. more than one product with common fixed costs**

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

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

      where composite P/V ratio = ∑ [Sales Mix × P\V Ratio]

   e. **Perishable product :BEP = Opening stock + (remaining fix cost ÷ contribution p.u.)**
   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 Σdiscounted Cash in flow = Σdiscounted 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 **Cash BEP = Cash fixed cost ÷ contribution p.u. So do not consider the sunk cost.**
   k. **BEP for decision making purpose : (Total relevant fix & Opportunity cost) ÷ contribution p.u.**

Simple Problems :

1. **Om Ganesh** Ltd. which makes only one product, sells 10,000 units of its product making a profit of Rs. 80,000. Variable cost per unit of the product is Rs. 30 and the fixed cost is Rs. 2,30,000.

   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 sales of 20,000 units.

2. A manufacturing company has an installed capacity of 1,20,000 units per annum. The cost structure of the product manufactured is as under :

		Rs.
(i)	Variable cost per unit ---	
	Materials	8
	Labour (Subject to a minimum of Rs. 56,000 p. m.)	8
	Variable Overheads	3

(ii) Fixed overheads Rs.1,68,750 per annum.

(iii) Semi –variable overheads Rs. 48,000 per annum at 60% capacity, which increase by Rs. 6,000 per annum for increase of every 10% of the capacity utilisation or any part thereof, for the year as a whole. The capacity utilisation for the next year is estimated at 60% for two months, 75% for six months and 80% for the remaining part of the year.

If the company is planning to have a profit of 25% on the selling price, calculate the selling price per unit. Also calculate the BEP.

3. 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.

a. 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

b. 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 ?

c. what should be the revised sale price to have a margin of safety of 30% of last year sale volume if other conditions are remain same?

4. 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

(a) 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.

(b) Quantum of advertisement expenditure permissible to increase sales by Rs.1.2 lakhs, without affecting existing profits quantum.

5. A single product company furnishes the following data :

	Year 1.	Year 2
Sales	Rs.24,00,000	?
PV ratio	33 ⅓%	30%
Margin of safety	25%	40%

While there was no change in the volume of sales & variable cost in year 2, the selling price & fixed costs are reduced. Calculate the sales, fixed costs and profit for year 2.

6. Titan Engineering is operating at 70% capacity and presents the following information:

Break-even point	Rs. 200 corers
P/V Ratio	40%
Margin of safety	Rs. 50 corers

Management has decided to increase production to 95% capacity level with the following modifications. The selling price will be reduced by 8 %. The variable cost will be reduced by 5% on sales. The fixed cost will increase by Rs. 20 corers , including depreciation on additions , but excluding interest on additional capital. Additional capital of Rs. 50 corers will be needed for capital expenditure and working capital . The management will be needed to earn Rs.10 corers over and above the present profit and also meet 20 per cent interest on the additional capital.

What will be the revised : Break-even point , P/V Ratio , Margin of safety .

7. The comparative profit statement of two quarters of a firm is as under :

	Quarter I	Quarter II
Units sold	2,500	3,750
	Rs.	Rs.
Direct materials	87,500	?
Direct wages	62,500	?
Fixed and variable Factory overheads	75,000	96,000
Sales	2,75,000	?
Profit	50,000	65,250

In the second quarter, the direct material price has increased by 20%. These was a saving of Rs.4,000 in fixed overheads in the second quarter. The other costs and selling price remained the same. Determine the quantity that should have been sold in the second quarter to maintain the same amount of profit per unit as in the first quarter.

8. Supreme Ltd., which manufactures the component EXCEL has achieved A turnover of Rs. 6,00,000 for the calendar year 2008. The Manager of the Company has informed that the company has worked at a profit volume ratio of 25% and margin of safety of 20%. But he feels due to severe competition, the selling price is to be reduced to maintain the same volume of sales for the year 2009. He does not expect any change in variable costs. He expects that due to cost reduction programme, the profit volume ratio and margin of safety will be 20% and 30% respectively and considerable saving in Fixed cost for 2009.

Even if the company prefers to shut down its operations for 2009, it expects to incur a minimum fixed cost of Rs. 60,000. You are expected to:

(i) Present the comparative statement for the year 2008 & 2009 showing under Marginal costing.
(ii) What will be minimum sales required, if it decides not to shut down its unit in 2009?

9. A Ltd. Makes and sells as single product. The company's trading results for the year 2007 are:

	Rs. '000	3,000
Sales		
Direct materials	900	
Direct Labour	600	
Overheads	900	2,400
Profit		600

For the year 2008, the following are expected:

(i) Reduction in the selling price by 10%
(ii) Increase in the quantity sold by 50%.

(iii) Inflation of direct material cost by 8%
(iv) Price inflation in variable ohd by 6%
(v) R

P.T.O.

It is also know that:

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

The are required to:
(i) Prepare a statement showing the estimated trading results for 2008.
(ii) Calculate the Break-even point for 2007 and 2008.
(iii) Comment on the BEP and profits of the years 2007 and 2008.

BEP in case of Merger

10. 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 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.

BEP on Step costs

11. Calcutta Mahanagar, a local 'authority' whose area includes a holiday resort situated on the east cost, 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 :

	Rs. per guest
Food	25
Electricity for hearing 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.

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

			Rs.
Sales			1,20,000
Direct materials	30,000		
Direct Labour	36,000		
Variable overheads	15,000		
Subtotal Variable cost		81,000	
Fixed cost		16,800	
Total cost			97,800
Profit			22,200

After the first 500 units of production, the company has to pay a premium of Rs. 6 per unit towards overtime labour. The premium so paid has been included in the direct labour cost of Rs. 36,000 given above. You are required to compute the Break-even point.

13. Kalyan University conducts a special course on "Computer Application" for a month during summer. For this purpose, it invites applications from graduates. An entrance test is given to the candidates and based on the same, a final selection of a hundred candidates is made. The Entrance Test consists of four objective type examinations and is spread over four days, one examination per day. Each candidate is charged a fee of Rs. 500 for taking up the entrance test. The following data was gathered for the past two years.

Statement of Net Revenue from the Entrance Test For the Course of "Computer Application"

	2008	2009
Gross Revenue (Fees Collected)	Rs. 10,00,000	Rs. 15,00,000
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	60,000	60,000
Total Cost	8,40,000	11,60,000
Net Revenue	1,60,000	3,40,000

You are required to compute:
(a) The budgeted net revenue if 4,000 candidates take up the entrance test in 2010.
(b) The break-even number of candidates.
(c) The number of candidates to be enrolled if the net income desired is Rs. 2,00,000

Multi Product Problems:

14. 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:
(a) Which factory is more profitable? (b) Cash BEP for each factory individually.
(c) BEP for company as a whole assuming the product mix can be altered as desired.
(d) Co mand remain co

15. The budgeted results of A Ltd. as under:

Product	Sales Values (Rs.)	P / V ratio (%)
X	2,50,000	50
Y	4,00,000	40
Z	6,00,000	30

Fixed overheads for the period Rs. 5,02,200. The management is worried about the results. You are required to prepare a statement showing the amount of loss, if any, being incurred at present and recommend a change in the sale value of each product as well as in the total sales value maintaining the same sales – mix, which will eliminate the said loss.

16. Anuradha Enterprises manufactures and sells black phenyl worth Rs. 20,000, white phenyl worth Rs. 25,000, scented phenyl worth Rs. 10,000 and naphthalene balls worth Rs. 5,000 every month. The firm's total fixed costs per month are Rs. 14,700. the variable costs are : on black phenyl 60%, on white phenyl 68%, on scented phenyl 80% and on naphthalene balls 40%.

The proprietor, Ms. Anuradha Shah, being basically a science graduate, wonders at what combined sales volume does she really start earning profit. Please help her in arriving at such a sales volume.

17. 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 p.u. 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 company break even ? Give separately for both X and Y the break even sales in Rs. & units.

BEP for Decision making purpose

18. 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 p. 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 :

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

19. 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 if the demand is 80,000 units per week.

20. 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.

Required:

(a) Calculate, for each production method the net increase in company profits which will result from the introduction of the new magazine, at each of the following levels of activity: 5,00,000 / 4,00,000 / 6,00,000 copies per month

(b) Calculate for each production method, the amount by which sales volume of the new magazine could decline from the anticipated 5,00,000 copies per month before the co. makes no additional profit from the introduction of the new publication.

BEP on DCF Technique

21. 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

22. A Company produces formulations having a shelf life of one year. The company has an opening stock of 15,000 boxes on 1/1/2009 and expects to produce 75,000 boxes as was in the just ended year of 2008. 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 2009.

Fixed costs are estimated at Rs.16,80,000 . New price for 2009 is Rs.70/- per box while the sale price in 2008 was Rs. 60. Variable cost of the opening stock is Rs. 20 per box.
Find actual & potential BEP.

Reconciliation of profit : Marginal Vs. Absorption Costing:

23. 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 2008-09. 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 2008-09 are us 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 reveled an excess spending of variable factory overheads to the extent of Rs. 80,000 [illegible] e no variance in resp[illegible]

24. 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 2009 ;

	Quarter ended	
	30/9/09	31/12/09
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, 2009 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	200
	3,000

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	
	30/9/09	31/12/09
Selling overheads	24,00,000	22,00,000
Distribution overheads	20,50,000	21,00,000
Administration overheads	16,00,000	17,00,000

The production overhead expenditure variance is Rs 20,000 (F) in Q-1 & nil in Q-2.
You are required to reconcile the profits under Marginal & Absorption costing system, for the two quarters separately.

Decision Making:

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 scare resource problem**
4. **make or buy**
5. **Selection of products, etc etc.**

These are four techniques of Decision makings:

1. **Relevant cost or minimum price = Variable cost + Opp. Cost+ Discretionary fixed cost.**
2. **Limiting Factor**
3. **Incremental revenue Vs Differential cost**
4. **Indifferent Cost 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 but not absorbed overhead.

2. Major areas of short-term decisions in which differential cost analysis is useful.

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. incremental costs , Sunk cost & incremental revenue.

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 worlds, 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.

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 togeth[illegible]ue to change either

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

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

The direct materials were all imported. Due to foreign exchange restrictions, henceforth, the company can import only 3,00,000 units of raw materials. The company can produce in all 1,00,000 units maximum (all products). However, they can market only 20,000 units of product A & C each.

There is a local substitute material which is available at a price of Rs.3.75 per unit. Besides, the company has to spend Rs.50,000 on intermediaries and consumables, if local substitute material is used in the production process. There is also a third party who was willing to take a part of the plant on lease up to 50,000 units capacity of Product B and willing to pay lease charges of Rs.2,75,000.

You are required to advise the management :

(i) What should be the quantum of production/sales mix of products with existing import restrictions?

(ii) Whether the company can optimise production of 1,00,000 units with local substitute materials ?

(iii) Whether the company can enhance profits by leasing out a part of the plant to the third

3. 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 Sale 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 .

4. 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

P.T.O.

(a) You are required to present a statement to show:
(i) the profit for the current year;
(ii) 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.

(c) If maximum production of any product is 960 tons, find the most profitable product mix in question (b).

5. A company manufactures three products from an intermediate produced in its own plant . The downstream units at full capacity operations require 1,00,000 kg. 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 & minimum stock of 3,500 kgs. has to be maintained in any case in the Downstream division. 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 .

6. The operating results of B.M. Ltd. For the year 2008 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 2009 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 2009 sales value.

Requi showing the profita

7. Bloom Ltd. Makes 3 products, A, B & C. The following information is available:

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

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

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

You are required to:

(i) Advise the company about the best product mix during peak-season for maximum profit.
(ii) What will be the maximum profit for the off-season?

Make or Buy i.e. outsourcing:

8. 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. Find best mix

You are required to calculate (these are 3 different problems given in the examination)

a) find the best product mix.

b) If Purchase price: A Rs.114, B Rs.122, C Rs.45 ,hours available 160 hrs, find the best product mix if time per unit is same as before.

9. XYZ Ltd. is currently manufacturing 5,000 units of the product 'XY 100' annually, making full use of its machine capacity. The selling price & total cost p. u. associated with 'XY 100' are as follows

	Rs. p.u.	Rs. p.u.
Selling price	900	
Direct materials	200	
Variable machine costs @ Rs.100	150	
Manufacturing overhead costs	180	
Marketing and administrative costs	200	730
Operating income per unit of 'XY 100'		170

XYZ Limited can sell additional 3,000 units of 'XY 100' , if it can outsource those additional units. ABC Limited, a suppliers of quality products, has agreed to supply upto 6,000 units of 'XY 100' per year at a price of Rs. 650 per unit delivered at XYZ's factory.

XYZ Limited can use its facility to produce an alternative product 'XY 200' . It can sell up to 12,000 units of 'XY 200' annually. Estimated selling price and total costs per unit to manufacture and sell 12,000 units of 'XY 200' are as follows :

	Rs. p.u	Rs. p.u.
Selling price	600	
Costs per unit :		
Direct materials	200	
Variable machine costs @ Rs 100	50	
Manufacturing overhead costs	60	
Marketing and administrative costs	110	420
Operating income per unit of 'XY 200'		180

Other information pertaining to the operating of XYZ Limited is as follows :

(a) XYZ Limited use machine hours as the basis for assigning fixed manufacturing overhead. The fixed manufacturing overhead for the current year is Rs. 3,00,000. These costs will not be affected by the product-mix decision.

(b) Variable marketing and administrative costs per unit for various products are as follows :

Manufactured	'XY 100'	Rs. 80
Purchased	'XY 100'	Rs. 40
Manufactured	'XY 200'	Rs. 60

Fixed marketing and administrative costs for the current year is Rs. 6,00,000. These costs will not be affected by the product-mix decision.
Calculated the quantity of each product that XYZ Limited should manufacture and / or purchase to maximize operating income. Show your calculations.

10. A company produces four products A, B, C and D which are in great demand,
The cost particulars as Rs p.u. are as under.

	A	B	C	D
Direct Materials	57	63	36	54
Direct Labour:				
Machine Dept. (Rs. 9 per hour)	36	27	54	18
Assembly Dept. (Rs. 6 per hour)	18	24	24	12
Variable Overheads	16	12	24	8

Fixed overheads at different operating levels are :

Production hours	Total fixed costs
Up to 1,00,000 hours	Rs. 15,00,000
1,00,001-2,00,000 hours	Rs. 20,00,000

P.T.O.

The sales department has booked orders for the supply of the following quantities for the year :

	A	B	C	D
Units	45,000	40,500	22,500	27,000
Selling Price (Rs.)	151	149	165	110

The existing production capacity of machine department is 3,15,000 hours per annum. This capacity is far below the requirement of market demand. Although the Company is planning to increase the machine department's capacity in about a couple of years time, the company does not at present want to lose the customers. Hence the company is contemplating to sub-contract part of its work for which the following offer has been received :

	A	B	C	D
Sub-contract Price (Rs.)	136	120	147	103

Required :

i) Prepare a table to show what products and in what quantities are to be produced and / or sub-contracted to maximize the company's profits.

ii) Present a statement showing the profits resulting from your decision in (I) above.

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

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

The factory overheads are applied on the basis of direct labour hours. To utilize the idle capacity and to improve the profitability of the company, the following proposals were put up before the Board of Directors for consideration :

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

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

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

	in Rs.
Direct materials	30,000
Direct labour	52,500
Variable overheads	25,500
Fixed overheads	33,000
Total	1,41,000

The component 'EH' however can be purchased from the market at Rs. 7.90 per unit.

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

(
(cost data of

P.T.O.

	Rs.
Direct materials	42,000
Direct labour	31,500
Factory variable overheads	13,500
Other variable overheads	25,500
Total	1,12,500

Required :

i) prepare a statement showing profitability of the company envisaged in the budget.

ii) Evaluate the export order and state whether it is acceptable or not.

iii) Make an appraisal of proposal to manufacture component 'EH' and state whether the component 'EH' should be manufactured in the factory or purchased form the market. Assume that no alternative use of spare capacity is available.

Evaluate the alternative use of the spare capacity and state whether to manufacture or buy the component 'EH' and if your decision is to buy the component 'EH', which of the two alternatives for the use of spare capacity will you prefer?

Problem on Bottleneck:

12. 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.

13. A company manufactures two products EXE and WYE, which pass through two of its departments exclusively used for them. A market research study conducted by the company reveals that the company can sale either 38,500 units of EXE or 31,500 units of WYE in a year. The manufacturing cost and selling price details are as under:

	EXE	WYE
Selling price per unit	375	540
Costs:		
Department 1: Direct materials	58	100

Depar

Overheads:	Department 1	Department 2
Variable overhead rate per DLH	Rs. 2.40	Rs. 3.60
Fixed overheads	Rs.5, 00,000	Rs.10, 00,000
Budgeted direct labour hours	1,75,000	2,80,000

Since the quantity which can be sold exceeded the production capacity, the company has been considering the use of sub-contracting production facilities. Accordingly, when tenders were floated, two contractors responded as under:

Contractor DS offers to produce up to a maximum of 17,500 units of EXE or 14,000 units of WYE in a year for the type of work done by department 1 of the company. The price charged by DS is Rs.138 per unit of EXE and Rs.212 per unit of WYE. These prices included the cost of direct materials used in department 1 of the company.

Contractor DW can produce up to a maximum of 11,200 units of EXE and 7,000 units of WYE in a year for the type of work done by department 2 of the company. The price charged by DW is Rs.150 per unit of EXE and Rs. 192 per unit of WYE. These prices included the cost of direct materials used in department 2 of the company.

Required:

(1) If the company does not wish to use the sub-contracting facility, which of the two product and in what quantity should be produced and sold by the company by using its own manufacturing capacity to earn maximum profit? Calculate the resultant maximum profit.

(2) If the company wishes to produce either 38,500 units of EXE or 31,500 units of WYE by using sub-contracting facility, state which of the two products should be produced to maximise the profits. Calculate the resultant maximum profit.

14. 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 Q at Rs.12 per unit.

Required :

(i) Calculate the quantity of each product to be manufactured and / or to be sub-contracted in at most way of fulfilling the market demand

(ii) ove.

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

15. The following are cost data for three alternative ways of processing the clerical work for cases brought before the management :

	A Manual (Rs.)	B Semi- Automatic (Rs.)	C Fully-automatic (Rs.)
Monthly fixed costs :			
Occupancy	15,000	15,000	15,000
Maintenance contract	0	5,000	10,000
Equipment lease	0	25,000	1,00,000
	15,000	45,000	1,25,000
Unit variable costs (per report) :			
Supplies	40	80	20
Labour	5 hr. X 40	1 hr. X 60	0.25 hr. X 80
	or 200	or 60	or 20
	240	140	40

Required :

(i) Calculate cost indifference points. Interpret your results.

(ii) If the present load is 600 cases and it is expected to go up to 850 cases in near future, which method is most appropriate on cost considerations ?

16. 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 ?

17. 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.

18. 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 3,50,000 tubes per month and ultimately to 4,50,000 tubes per month.

P.T.O.

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

19. 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%. What is the minimum price for an additional offer of 3,750 units?

20. 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 mfg. 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.

21. 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)	5,000	10,000
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 2007–08 amounted to Rs. 2,25,000.

During 2008-09 the company expects that the direct material costs will rise by 5%, the labour hourly rate will rise by 25 paisa 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 :

(a) Utilise the balance capacity to produce 'AB' and to sell this increased production at the existing selling price of Rs. 80.

(b) 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 & distribution expenses of Rs. 50,000 will have to be spent to sell this additional output.

(c) Introduce new product 'EF' to utilize the balance capacity. One unit of 'EF' can be manufactured in 7 labour hours. Direct material will cost Rs. 40 p.u.. Its selling price p.u. 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 :

(i) Present a statement of Profit for 2007– 08 .

(ii) Using incremental revenue and differential cost approach, find out which proposal is more profitable for 2008-09.

(iii) Present a statement of profit for 2008-09 based on above recommendation.

22. 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

23. 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.

24. X Ltd. Having an installed capacity of one lakh units of a product is currently operating at 70% utilization. At current level of input prices, the FOB costs per unit, taking credit for applicable export incentive workout as follows:

Capacity utilization	70%	80%	90%	100%
FOB cost per unit (Rs.)	97	92	87	82

The company has received three Foreign offers as under:

Source A : 5,000 units @ Rs. 55 per unit FOB
Source B : 10,000 units @ Rs. 52 per unit FOB
Source C : 10,000 units @ Rs. 51 per unit FOB

Advice the company whether it should accept any or all the export orders.

Differential costing with limiting factor

25. 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 [illegible] capacity is distri[illegible]

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

Required :
(a) What would be the profit maximizing 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 maximizing sales price and quantity for each product ?

Process Costing

27. A Company is able to obtain 2,00,000 kgs. of A and 4,00,000 kgs. of B from the input of 6,30,000 kgs of a raw-material 'F'. Normal loss 5% of output with no residual value. 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:	(6,30,000 x 2)	12,60,000
Variable processing costs		6,30,000
Fixed processing costs		2,80,000
Total		21,70,000

The company has three proposals for consideration :-

a) Product A can be further processed by mixing it with other purchased materials into a new product P . The entire 2,15,000 kg quantity of the resultant product 'P' can be sold at Rs. 15 per kg. The further processing costs amount to Rs. 16,80,000.

b) 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 6,30,000 kgs.

Required :-
i) Find the original profit on sale of A and B.
i) 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) [illegible] to pay for the

Export Incentive

28. 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.

29. 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 of C Ltd from Z Ltd.

(e) C will furnish to Z detailed quarterly returns. Other information available :

(i) FOB price agreed £510. Exchange rate to be adopted £1 = Rs. 48.00
[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 Rs. of the locally procured goods represent cost of the standard items.

(viii) Cost of assembly & 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 target

30. 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	500
Total Costs		42,000
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.

Introduction of own sale force

31. 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

P.T.O.

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	3.50
	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 :

(i) 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.

(ii) 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.

(iii) 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.

Complimentary & Substitute Products

32. 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)				
	A	B	C	D	Total
Sales	400	500	200	100	1200
Direct Materials	64	70	32	7	173
Direct Wages	88	105	60	18	271
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 produ… fixed selling exper… P.T.O.

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.

If product 'C' is discontinued, the fixed factory and selling & administration overheads will be reduced by Rs.22 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. 17 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.

Change in production plan

33. 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.

Decision Making On D.C.F.

34. 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. Joint cost of Process: Rs. 300 per MT. Production of Cp is 40,000 MT p.a.

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 & liberalization more and more units for manufacturing Cp & 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 p. 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.170 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.60 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 or not.

Best Weekly Programme

35. RK Pvt. Ltd. has spare capacity in two of its manufacturing departments – Department 4 and Department 5. A five day week of 40 hours is worked, but there is only enough internal work for 3 days per week so that 2 days per week (16 hours) could be available in each department. R Ltd. has sold this time to another manufacturer, but there is some concern about the profitability of this work.

The accountant has prepared a table giving the hourly operating cost in each department. The summarised figures are as follows:

	Department 4	Department 5
	Rs.	Rs.
Power	40	60
Labour costs	40	20
Overhead costs	40	40
	120	120

The labour is paid on a time basis and there is no charge in the weekly wage bill whether or not the plant is working at full capacity. The overhead figures are based on firm's current overhead absorption rates (fixed and variable) when the departments are operating at 90% of full capacity (assume a 50 week year), the budgeted fixed overhead attributed to department 4 is Rs. 36,000 p.a. and that for Dept. 5 Rs. 50,400 p.a.

As a short term measure the company has been selling processing time to another manufacturer @ Rs. 70 per hour in either departments. The customer is willing to continue this arrangement and to purchase any spare time available, but R Ltd. is considering the introduction of a new produ .T.O.

Each unit of the new product would require 45 minutes in Deptt. 4 and 20 minutes in Deptt. 5. The variable cost of the required input material is Rs. 10 per unit.

The market study indicated as follows:

(i) With a selling price of Rs. 100, the demand would be 1,000 units p.a.
(ii) With a selling price of Rs. 110, the demand would be 1,000 units p.a.
(iii) With a selling price of Rs. 120, the demand would be 500 units p.a.

You are required to calculate the best weekly programme for the spare time in the two manufacturing departments, to determine the best price to charge for the new product and to quantity the weekly gain that this programme and price should yield.

Training of Worker

36. An engineering company is engaged in producing four products through operations at welding and pressing departments. Products W_1 & W_2 are produced by welders in the welding department whereas products P_1 & P_2 are produced by press-operators in the pressing department. Due to specific skill requirements, the welders and press-operators can only work in their own department. The following relevant data are available in respect of the products:

	Products			
	W_1	W_2	P_1	P_2
Hours required per unit	4	4	5	2
Selling price per unit (Rs.)	48	50	77	69
Direct material cost per unit (Rs.)	18	22	32	44
Direct labour hourly rate (Rs.)	4	4	4	4
Variable overhead rate per unit (Rs.)	2	2	3	3

The company incurs Rs. 50,000 per annum towards fixed costs. The maximum available hours are 20,000 and 16,000 for welding and pressing departments respectively. The demands keep on fluctuating but the minimum demands which are to be met as per management's decision are 2,000 units of W_1, 2,500 units of W_2, 1,800 units of P_1 and 2,200 units of P_2.

The production manager suggests that the welders and press-operators can be trained to perform both welding and pressing jobs so that excess demand of any of the products can be met. This decision is going to increase the burden of fixed costs by Rs. 5,000 per annum.

Prepare the profitability statement for optimum product-mix and recommend with reasons and appropriate workings whether it is advisable to train the welders and press – operators as suggested by the production manager.

Best material programme

37. X Ltd. has two factories, are at Lucknow and another at Pure producing 7,200 tonnes and 10,800 tonnes of a product against the maximum production capacity of 9,000 and 11,880 tonnes respectively at Lucknow and Pune. 10% of the raw material introduced is lost in the production process. The maximum quantity of raw material, available locally are 6,000 and 13,000 tonnes at Rs. 720 and Rs. 729 per tonne at Lucknow and Pune respectively. For the additional needs supplier of Bhopal is ready to supply raw material at our factory site at Rs. 792 per tonne.

Other variable costs of the production process are Rs. 22.32 lacs and Rs. 32.94 lacs and fixed costs are Rs. 18 lacs & Rs. 24.84 lacs respectively for Lucknow & Pune factory. The output is sold at a selling price of Rs. 1,450 and Rs. 1,460 per tonne by Lucknow and Pune factory respectively .

You are required to compute the cost per tonne and net profit earned in respect of each factory. Can you ny change in present

Shut down & Divestment

1. **Shut down point = {(Total fixed cost – Shut down costs) ÷ Contribution per unit}**

Decision Making in Relation to Shut Down Vs. Continue

In case of decision rendering closure or shut down we consider the following points:

1. **Current profit situation has to be maintained, So by analyzing the proposal of shut down or outsourcing if the current income is reduced then shut down will not be allowed unless the product or factory has reached at the end of its life cycle.**

2. **In case of outsourcing proposal we can also apply the differential cost concept i.e. saving in cost must be greater than or equal to out-sourcing fees payment. Here saving in cost i.e. cash inflow is computed from the concept of relevant cost i.e. by closing down we are saving variable cost of production, and discretionary fixed cost or shut down cost. This cash inflow further may be classified into two parts:**

    1. **Saving in variable cost per time period i.e. CIF per annum.**
    2. **One time cash inflow following shut down i.e. sale of machine, sale of current stock of material etc.**

∴Total CIF or saving following shut down = one time CIF + CIF p.a. × life span of the proposal of outsourcing.

If this total is greater than total outsourcing fees then shutdown will take place other production will be continue.

38. A paint manufacturing company manufactures 2,00,000 p.a. medium-sized tins of "Spray Lac paints" when working at normal capacity. It incurs the following costs of manufacturing per unit.:

	Rs.
Direct materials	7.80
Direct labour	2.10
Variable overhead	2.50
Fixed overhead	4.00
Product cost (Per unit)	16.40

Each units (tin) of the product is sold for Rs. 21 with variable selling and administrative expenses of 60 paise per tin.

During the next quarter only 10,000 units can be produced and sold. Management plans to shut down the plant estimating that the fixed manufacturing cost can be reduced to Rs. 74,000 for ther quarter.

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

You are required:

(a) To express your opinion, along with the calculations, as to whether the plant should be shut down during the quarter, and

(b) To calculate the shut down point for quarter in units of products (i.e. in terms of number of tin

39. Alfa Engineering Works Ltd. had the following annual budget for the year ending on 30th June

	60%	80%
Production capacity costs (Rs. In lakhs)		
Direct materials	9.60	12.80
Direct Labour	7.20	9.60
Factory expenses	7.56	8.04
Administrative expenses	3.72	3.88
Selling & distribution expenses	4.08	4.32
Total cost	32.16	38.64
Profit	4.86	10.72
Sales	37.02	49.36

Owing to adverse trading conditions, the company has been operating during July/September at 40% capacity, realizing budgeted selling prices.

Owning to acute competition, it has become inevitable to reduce prices by 35% even to maintain the sales at the existing level. The directors are considering whether or not their factory should be closed down until the trade recession has passed.

A market research consultant ha advised that in about a year's time there is every indication that sales will increase to 75% of normal capacity and that the revenues to be produced for the full year at that volume could be expected to Rs. 40 lakhs

If the directors decide to close down the factory for a year it is estimated that:

(a) The present fixed costs would be reduced to Rs. 6 lakhs p.a.

(b) Closing down costs (redundancy payments, etc.) would amount to Rs. 2 lakhs.

(c) Necessary maintenance of plant would cost Rs. 50 p.a.; and

(d) On re-opening the factory, the cost of overhauling the plant, training and engagement of new personal would amount to Rs. 80,000.

Prepare a report for the directors, making your recommendations.

40. Universe Ltd. manufacture 20,000 units of 'X' in a year at its normal production capacity. The unit cost as to variable costs and fixed costs at this level are Rs. 13 and Rs. 4 respectively.

Due to trade depression, it is expected that only 2,000 units of 'X' can be sold during the next year. The management plans to shut-down the plant. The fixed costs for the next year then is expected to be reduced to Rs. 33,000. Additional costs of plant shut-down are expected at Rs. 12,000. should the plant be shut-down? What is the shut-down point?

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**

1. 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 m
5. A and more d

2. Some important activities & cost driver :

Activity (items)	Cost Driver
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

3. 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. So it does not help in cost reduction.

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.

5. ABC does not help in short term decision making problems.

4. 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.

5. 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

6. 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. 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 million	
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	200	Number of orders
Total overheads	880	

Notes:

1. 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).
2. 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.
3. packing costs are Rs. 32 for a large package, and Rs. 25 for a small package.
4. 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

Calculate the charge for selling and distribution overheads for order A and order B using:

(i) The current system and

(ii)

(iii)

2. 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 2009 , KL's manufacturing overhead costs were :

	Rs.('000)
Equipment operation expenses	125
Equipment maintenance expenses	25
Wages paid to technicians	85
Wages paid to store men	35
Wages paid to dispatch staff	40
	310

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 a component r for which direct labour hours worked 25. Direct materials cost Rs.1,200. Component consignment received 42. Production runs 16. Quality inspections 10. Goods orders dispatched 22. Quantity produced 560.

In April 2009 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 s selling prices with c uction cost of the un 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 2009. KL's cost of capital is 3 % per quarter. The annual value @3% in 8 quarters = 7.0197

Requirements

(a) Calculate the unit cost of components r. using KL's existing cost accounting system (single-factory, labour-hour).

(b) Calculate the unit cost of components r. using this ABC system.

(c) 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.

3. S & P Products plc purchases a range of foods quality gift and household products from around the world. If then sells these products through "mail order" or retails outlets. The company receives "mail order" by post. Telephone and internet. Retails 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 2001s 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 corning 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.	Number each year for each outlet 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
		Rs.	Rs.	Rs.
Processing "mail order"	Orders	5	6	3
Dealing with "mail order" Queries	Orders	4	4	1
Packing and deliveries for "mail packe	Packages	Number of packages per order 2	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	300,000
	4,350,000

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.

4. 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:

- T
- 1

P.T.O.

- 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

5. 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.
0.20 kg. of ingredient N	@ Rs. 2.50 per kg.
1.15 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)	Rs. 8,000
		Rs. 12,000

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.

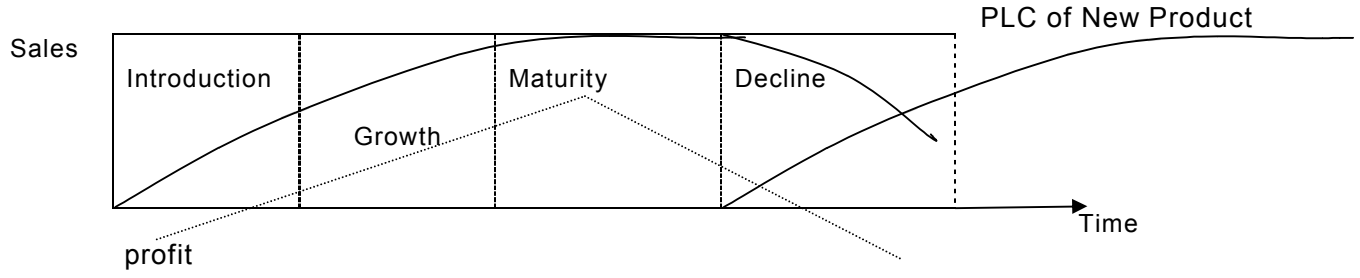
So, cost p.u. = total cost during life cycle ÷ total no. of units

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 be 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.

1. Phases of Product 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

2. 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.

3. 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.

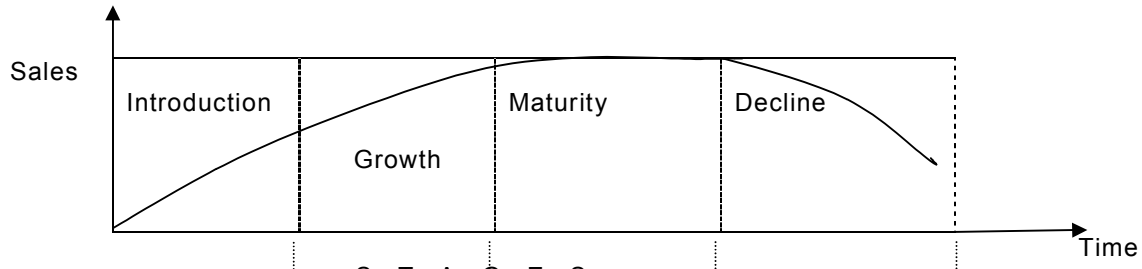
(viii) Selling: Stimulating and creating demand for the product when the product is available for sale.

(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.

he plant used

4. 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)

5. 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.

6. Costs included in different stages of PLC

1. Development phase: R & D cost/Design cost.
2. Introduction phase: Promotional Cost/Capacity costs.

3. Growth phase/Maturity: Manufacturing Cost/Distribution Costs/Product support cost.
4. Decline /Replacement phase: Plants reused/sold/related costs i.e. project clean up cost.

7. 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.

Application of DCF & Probability

1. 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.

2. 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 uncertainly 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.

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

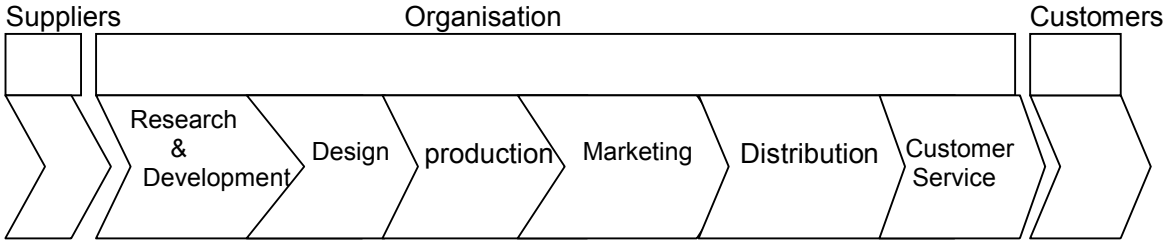
(i) Identifying improved product designs that reduce the product's cost without sacrificing its utility and/or

(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 if 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

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 of 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.

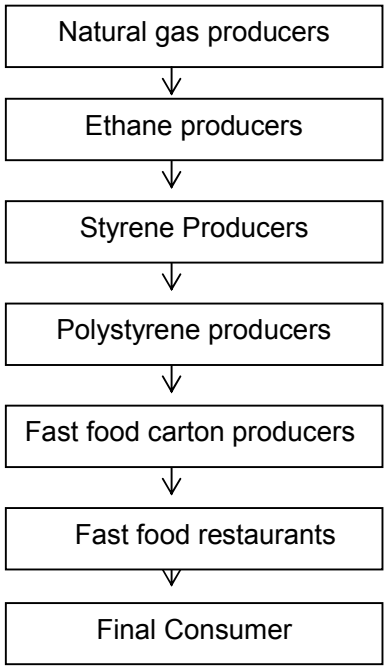
Guidelines

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-creating 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 o t attributes of e

3. Vertical linkage Analysis

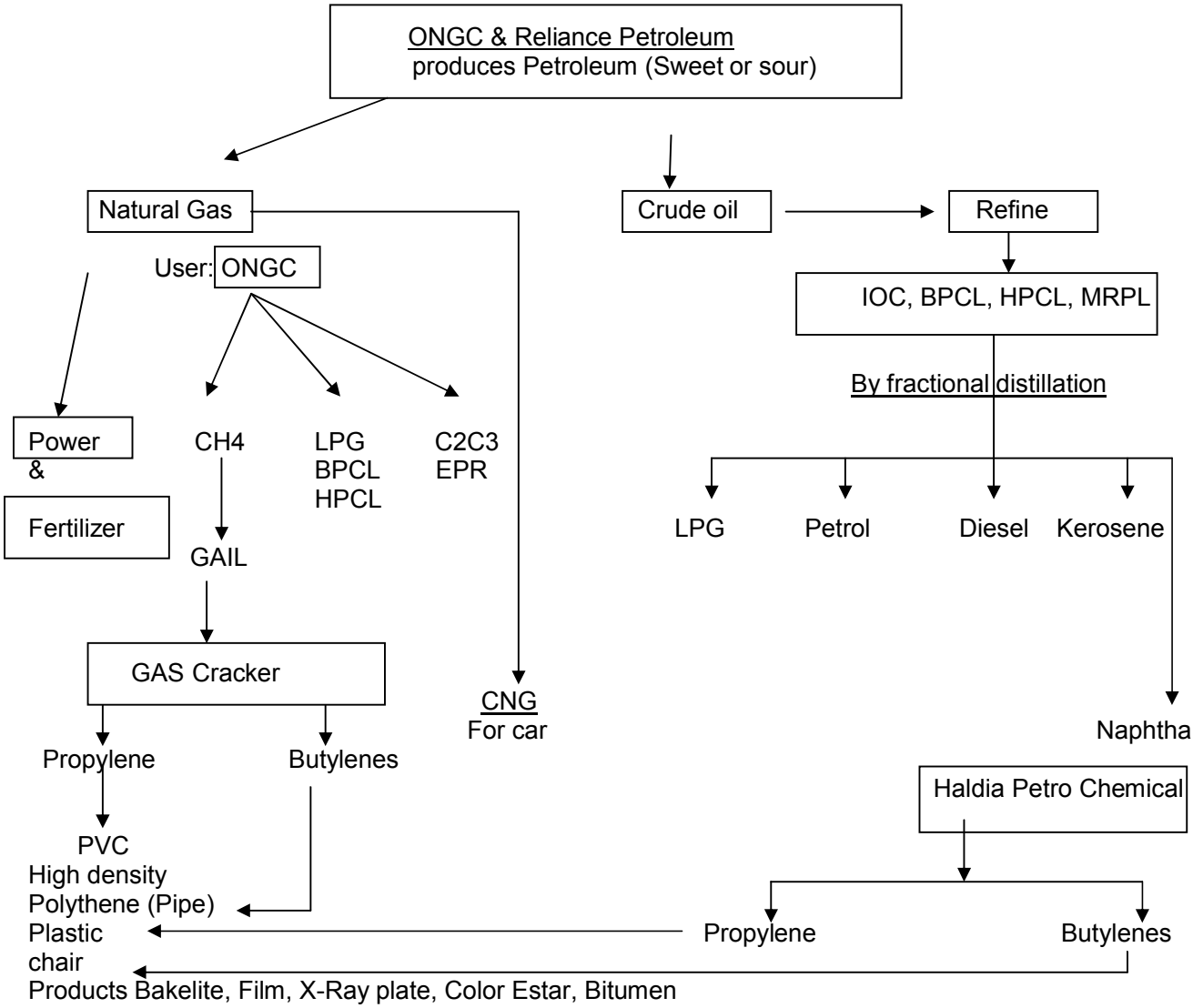
Linkages among value creating processes do not end with the activities within a firm. The greatest competitive advantage may come out of linkages between a firm's value creating activities and those of its suppliers, channels or users.

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 because 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 or JIT.
4. Efficient order processing can reduce customers ordering costs.

- 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 em[illegible].

Target Costing

Learning Objective

1. **how to find target cost for a new product**
2. **how to apply the concept for existing product**

An important from of market-based pricing is target pricing. A target price is the estimated price for a product (or service) that potential customers will be willing to pay. This estimated is based on an understanding of customers' perceived value for a though close contract and interaction with customers, is often in the best position to identify customers' need and their perceived value for a product. To gain further insight, companies also conduct market research studies about product features that customers want and the price they are willing to pay them.

The target price, calculated using customer and competitor inputs, form the basis for calculating target costs. The target cost per unit is the price minus target operating income per unit. The target operating income per unit is the operating income that a company wants to earn per unit of a product (or service) sold. The target cost per unit is the estimated long-run cost per unit of a product (or service) that enables the company to achieve its target operating income per unit when selling at the target price.

Target costing originated in Japan in the 1960s, where it is know as Genka Kikaku. It is such a costing system where the management considers it as a profit planning system.

Implementation

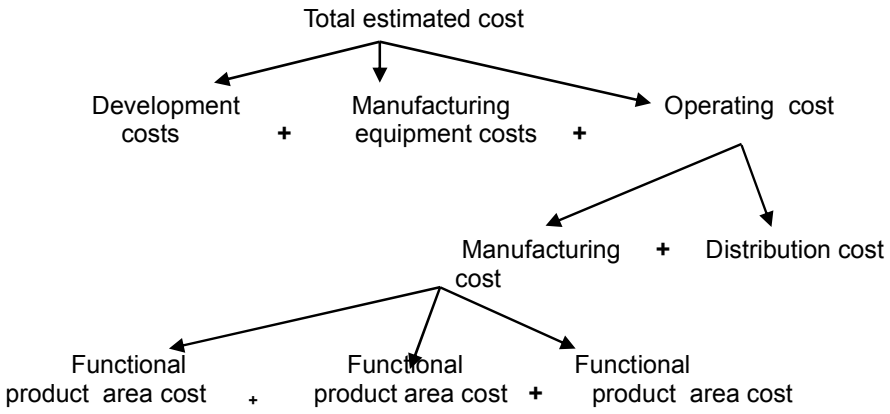
There are four main steps in developing target prices and target costs. The steps are illustrated by using an Provalue example.

Step 1 : Develop an idea for a product that satisfies Needs of potential customers

Step 2 : Select a Target Sale Price for the product through proper market survey.

Step 3 : Derive Target Cost p.u. = Target Price p.u. - Target profit p.u

Step 4 : Perform Value Engineering to achieve total estimated cost as below:



Step 5 : if the total estimated cost as computed on basis of life cycle ≤ total target cost , then the project will start.

1. 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 operated 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 draftsman 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 (AL).

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.)
   - Reduce the Variety in product development .

2. 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	70	60
Direct manufacturing cost per unit (Total)	525	495
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

Calcu wing break-up of

3. 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 p. u. 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 in 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.

1. 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.

2. 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)

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

JIT as a tool to improve organisation's profitability.

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

i) Immediate detection of defective goods being manufactured so that early correction is ensured with least scrapping.
ii) Eliminates/ reduces WIP between machines within working cell.
iii) OH costs in the form of rentals for inventory, insurance, maintenance costs etc. are reduced.
iv) Higher product quality ensured by the JIT approach leads to higher premium in the selling price.
v) Detection of problem areas due to better production/scrap reporting/labour tracing and inventory accuracy lead to reduction in costs by improvement.

3. Back-flushing in a JIT system

A unique production system such as JIT often leads its own unique costing system. Organizing manufacturing in cells, reducing defect and manufacturing lead time, and ensuring timely delivery of materials enables purchasing, production, and sales to occur in quick succession with minimal inventories. The absence of inventories makes choice about cost-flow assumptions (such as weighted-average or first-in, first-out) or inventory costing methods (such as absorption or variab w directly into cost ods that are imme

Definition

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. What is essential, however, is an accurate bill materials goods measures of yield generally effective production control and accurate engineering change notice when yields do change.

The principle of a just-in-time system is that production is pulled by customer demand and this in turn pulls the purchasing procedures. Thus, theoretically there are zero stocks of raw materials. Work-in-progress and finished goods. For such a situation to exist there needs to be an excellent system of production planning ad communication with materials suppliers.

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 tan 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) & then allocated between stocks & costs of goods sold by working back.
- Conversion costs (labour and overheads) are never attached to products until they are complete (or even sold)–thus the traditional WIP account doesn't exist. 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 & overheads) are incurred they will be recorded in a conversion cost (CC) account.

Variant 1: This has tow 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 [illegible] count and the creditor

Traditional Model of Material Management

1. **Minimum level of inventory = Re-order level - (Average rate of consumption × lead time)**

2. **Maximum level of inventory = Re-order level + Re-order quantity – (Minimum consumption × Minimum re-order period)**

3. **Re-order level = Maximum re-order period × Maximum Usage**
   OR
   Minimum level or safety stock level + (Average or normal rate of consumption × Average time to obtain fresh supplies).

4. **Average inventory level = Minimum + ½ Re- order quantity**
   (or)
   (Maximum level + Minimum level) ÷ 2

5. **EOQ** $= \sqrt{\frac{2 \times \text{Annul consumption (A)} \times \text{ordering cost per order } (C_o)}{\text{Carrying cost per unit per annum } (C_h)}}$

6. **Total ordering cost = No. of order × C_o**

   Annual carrying or storing or holding cost = Quantity per order ÷ 2 × C_h

   Total ordering & carrying cost (Known as Relevant Storing cost)

   = $\sqrt{2 \times \text{Annul consumption} \times C_o \times C_h}$

7. **Buffer stock = ROL - Consumption during the lead time.**
   If the result is negative then it is known as Stock Out Quantity

   ∴Stock out quantity = Consumption during the lead time - ROL

   ∴Expected Stock out quantity = ∑ (Present Stock out quantity - increase in ROL) ×Probability

   Stock out cost = Expected Stock out quantity × C_S (Stock-out cost p.u.)

   Storing cost = Increase in stock × C_h .

8. **The best stock policy : Select the min of annual carrying/storing/holding + total ordering cost + stock out cost. (objective minimization of total cost)**

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. Interest on working capital is 14% p.a.

   Each gallon requires ¼ sq.ft of storage space. If warehouse space is not used it can be rented out to [illegible] 00 sq. ft. The store [illegible] ventory 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 :

(i) the reorder level that should be set by the materials manager ;
(ii) the anticipated reduction in the value of the average stock ;
(iii) the anticipated reduction in total inventory cost in the first and subsequent years.

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:
a) Prepare a budget of production and requirements of components for the next year.
b) Find the economic order quantity.

c) Based on the economic order quantity calculated in (b) above, calculate the savings arising from switching over to the new ordering system both in terms of cost and reduction in working capital.

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 buffer 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.

Materials Requirement Planning (MRP) system

Materials requirements planning (MRP) is a "pull-through" system that manufactures finished goods for inventory on the basis of demand forecasts.

1. 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.

2. 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.

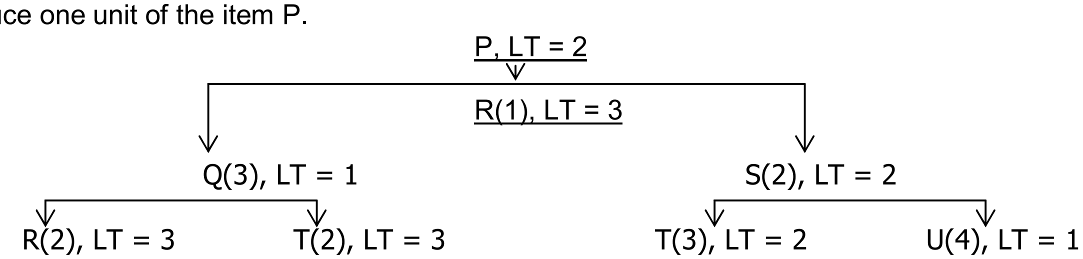
(v) **Master parts file** : It contains information about the production time of sub-assemblies and components produced internally and lead time for externally procured items.

3. 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.

Problems

1. 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 [illegible] the following items [illegible]

ENTERPRISE RESOURCE PLANNING (ERP)

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.

1. 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.

2. Components of ERP :

To enable the easy handling of the system, ERP has been divided the following core subsystems,

1. sales and marketing,
2. master scheduling,
3. materials requirements planning,
4. capacity requirement planning,
5. bill of materials,
6. purchasing,
7. shop floor control,
8. accounts payable/receivable ,
9. logistic,
10. assets management and
11. financial accounting.

3. 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 Inf… (Robots) for en… sses.

4. 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.

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.
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.

5. 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.

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,

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 :

nified, simple
benefits and

Costing of Service Sector

1. 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.

2. 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

3. 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

= total Costs incurred in period ÷ Number of units of service supplied in the period

4, 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.

5. 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 consid

6. 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.

7. Customer Costing

It 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

a. how fast the package is to be delivered,
b. the destination, weight, size of package and
c. whether the package is to be collected from customers' location or will be dropped at the office of the courier firm.

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.

Problem on goods transport:

1. A company presently brings coal to its factory from a nearby yard and the rate paid for transportation of coal from the yard located 6 km away to factory is Rs. 50 per tonne. The total coal to be handled in a month is 24,000 tonne.

The Company is considering proposal to buy its own truck and has the option of buying either a 10 tonne capacity or a 8 tonne capacity track.

The following information are available :

	10 tonne Truck	8 tonne Truck
Purchase price	Rs. 10,00,000	8,50,000
Life (Year)	5	5
Scrap value at the end of 5th year	Nil	Nil
Km per litre of diesel	3	3
Repair/Maint. P per Truck	60,000	48,000
Other Fixed Expns. P.a.	60,000	36,000
Lubricants & Sundries per 100 km	Rs. 20	20

Each track will daily male 5 trips (to and from) on an average for 24 days in a month.
Cost of Diesel Rs. 15 per litre.

Salary of Drivers Rs. 3,000 per month – Two Drivers will be required for a Truck.
Other staff expenses Rs. 1,08,000 p.a.

Present a comparative Cost Sheet on the basis of above data showing transport cost per tonne of ope

Problem on passenger transport:

2. AZ Transport Group p.l.c comprises three divisions – AZ Buses; AZ Taxis; and Maintenance. AZ Buses operates a fleet of eight vehicles on four different routes in Ceetown,. Each vehicle has a capacity of 30 passengers. There are two vehicles assigned to each route, and each vehicle completes five return journeys per day, for six days each week, for 52 weeks per year.

AZ Buses is considering its plans for the year ending 31st December 2009. Data in respect of each route is as follows :

	Route W	Route X	Route Y	Route Z
Return travel distance (km)	42	36	44	38
Average number of passengers :				
Adults	15	10	25	20
Children	10	8	5	10
Return journey fares (in Rs.):				
Adults	3.00	6.00	4.50	2.20
Children	1.50	3.00	2.25	1.10

The following cost estimates have been made (in Rs.):

Fuel and repairs per kilometer	0.1875
Drivers' wages per vehicle per work-day	120
Vehicle fixed cost p.m.	2,000
General fixed cost p.a.	300,000

Requirements:

(a) Prepare a statement showing the planned income of each route and the total contribution and profit of the AZ Buses division for the year ending 31st December 2009.

(b) In route W only adult fare will increase to Rs.3.75 per return journey, this will reduce the number of adult passengers using this route by 20%,(assuming that the ratio of adult to child passengers remains the same). Recommend whether or not AZ Buses should amend the adult fare on route W.

Problem on hotel pricing:

3. 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	Number of guests '	Average stay (nights) Private guest booking
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

P.T.O.

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.

4. Elegant Hotel has a capacity of 100 single rooms and 20 double rooms. It has a sports centre with a swimming pool, which is also used by persons other than residents of the hotel. The hotel has a shopping arcade at the basement and a specialty restaurant at the roof top.

The following information is available :

(i) Average occupancy :75% for 365 days of the year.

(ii) Current cost are :

	Variable cost	Fixed cost	Rs./per day
Single Room	400	200	
Double room	500	250	

(iii) Average sales per day of restaurant Rs. 1,00,000 contribution is at 30%. Fixed cost Rs. 10,00,000

(iv) The sports centre/swimming pool is likely to be used by 50 non-residents daily; average contribution per dry per non-residential is estimated at Rs. 50 fixed cost is Rs. 5,00,000 p.a.

(v) Average contribution per month from the shopping arcade is Rs. 50,000 fixed cost is Rs. 6,00,000 per annum.

You are required to find out :

(a) Rent chargeable for single & double room per day so that there is a margin of safety of 20% on hire of room & that the rent for a double room shall be kept at 12% of a single room.

(b) Evaluate the profitability of restaurant, sports centre and shopping arcade separately.

Problem on power pricing:

5. 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)		
	Water, Compressed air etc.	13.5	15.0
	C.O./B.F. Gas	121.5	
(iv)	Apportionment of total inter services		
	Electricity	21.6	
	Steam		90.00
(v)	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. a

Problem on hospital pricing:

6. A hospital operates a 40 bed capacity special health care development. The said department levies a charged of Rs. 425 per bed day from the patient using its services. The data relating to fees collected and costs for the year 2008 are as under :

	Rs.
Fees collected during the year	34,95,625
Variable costs based on patient days	13,57,125
Department fixed costs	6,22,500

Apportioned costs of the hospital administration charges10,00,000. Besides the above, nursing staff were employed as per the following scale at Rs, 48,000 per annum per nurse.

Annual Patient days	No. of Nurses required
Less than 5000	3
5000 – 7000	4
7000 – 9000	6
Above 9000	8

The projections for the year 2009 are as under; --

-- The costs other than apportioned overheads will go up by 10%.
-- The apportioned overheads will increase by Rs. 2,50,000 per annum.
-- The salary of the nursing staff will increase to Rs. 54,000 per annum per nurse.

The occupancy of the bed capacity is not likely to increase in 2009 and consequently the management is actively considering a proposal to close down the department. In that event, the departmental fixed costs can be avoided.

Required :
(i) Present statement to show the profitability of the department for the years 2008 and 2009.
(ii) Calculate the :
-- break-even bed capacity for the year 2009
-- increase in fee per bed day required to justify continuance of the department.

Problem on home loan processing of a bank:

7. The loan department of a Canara Bank performs several functions in addition to home loan application processing task. It is estimated that 25% of the overhead costs of loan department are applicable to the processing of home-loan application. The following information is given concerning the processing of a loan application:

Direct professional labour:	Rs.
Loan processor monthly salary: (4 employees @ Rs. 20,000 each)	80,000
Loan department overhead costs (monthly)	
Chief loan officer's salary	5,000
Telephone expenses	750
Depreciation building	2,800
Legal advice	2,400
Advertising	400
Miscellaneous	650
Total overhead costs	12,000

You are required to compute the cost of processing home loan application on the assumption that one h

Pricing problem of an hotel having multiple profit centre:

8. The management of New Hotel has prepared the budget, which shows the following room occupancy :

	Average %
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	20 %
Total	100%

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:

	Accommodation		Restaurant		Bar	
	%	%	%	%	%	%
Revenue		100		100		100
Wages	20		30		15	
Cost of Sales	--		40		50	
Direct costs	10	30	10	80	5	70
		70		20		30

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.

9. 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.(00)
	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	960	2	3,200	5	13,500	7 ½
Total	39,360	82	64,000	100	1,28,700	71 ½
Profit	8,640	18	---	-	51,300	28 ½

Additional information:

(a) 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.

(b) Insurances and Taxes and depreciation are for the entire of twelve months.

(c) 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.

(d) Electricity charges include fixed charges of Rs. 64,000, Rs. 1,92,000 and Rs. 9,90,000 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. 6,90,000 is for the season and Rs. 3,00,000 for the entire period of twelve months.

Mr. Philips is interested in increasing his net income. The following two options are under his considerations:

(a) 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.

(b) 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 excepted 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 60% 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 & off-season period respectively but 5% discount on the original rates will have to be offered during of-season period.

Which[illegible] him any other alterna[illegible] profit? (use increm[illegible]

Problem on airways pricing:

10. Modern Airways owns a single jet aircraft and operates between EXETOWN and WYETOWN. Flights leave EXETOWN on Mondays and Thursdays and depart from WYETOWN as Wednesdays and Saturdays. Modern Airways cannot afford any more fights between EXETOWN and WYETOWN. Only tourist class seats are available on its flights. As analyst has collected the following information :

Seating capacity per plane	360
Average passengers per flight	200
Flights per week	4
Flights per year	208
Average one-way fare	Rs. 5,000
Variable fuel costs	Rs. 1,40,000 per flight
Food service to passengers (not charged to passengers)	Rs. 200 per passenger

Commission paid to travel agents paid by Modern Airways on each ticket booked on Modern Airways. (Assume that all Modern Airways tickets are booked by travel agents): 8% of fare

Fixed annual lease costs allocated to each flight	Rs. 5,30,000 per flight
Fixed ground services (maintenance, check-in, Baggage handling) costs allocated to each flight	Rs. 70,000 per flight
Fixed salaries of flight crew allocated to each flight	Rs. 40,000 per flight

For the sake of simplicity, assume that fuel costs are unaffected by the actual number of passengers on a flight.

Required :

(a) What is the operating income that Modern Airways makes on each one way flight between EXETOWN and WYETOWN?

(b) The market research department of Modern Airways indicates that lowering the average one way fare to Rs. 4,8000 will increase the average number of passengers per flight to 212. Should Modern Airways lower its fare?

(c) Zed Tours and Travels, a tour operator, approaches Modern Airways to charter its jet aircraft twice each month, first to take Zed's international tourists from EXETOWN to WYETOWN and then bring the tourists back from WYETOWN to EXETOWN. If Modern Airways accepts the after, it will be able to offer only 184 (208 minus 24) of its own flights each year. The terms of the charter are :

(i) For each one-way flight Zed will pay Modern Rs. 7,50,000 to charter the plane and to use its flight crew and ground service staff.
(ii) Zed will pay for fuel costs.
(iii) Zed will pay for all food costs.

On purely financial considerations, should Modern Airways accept the offer from Zed Tours and Travels? What other considerations should Modern Airways consider in deciding whether or not to charter its plane to Zed Tours and Travels?

Problem on repair service:

11. Motor craft has just completed repair work on Car No. DL 6CB 2051 of Mr. X. The parts used to repair to vehicle cost Rs. 500. The company's 40% mark up rate on parts covers parts- related overhead costs. Labour involved 9 hours of time from a Motor Craft service engineer whose wages 0%. You are require % mark up.

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.

1. Definition of Quality: (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.

2. How does 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.

3. 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 99.999998% 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:

1. Improved customer satisfaction
2. Reduction cycle time
3. Increased productivity
4. Reduction in total defect
5. 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.

4. 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

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..

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.

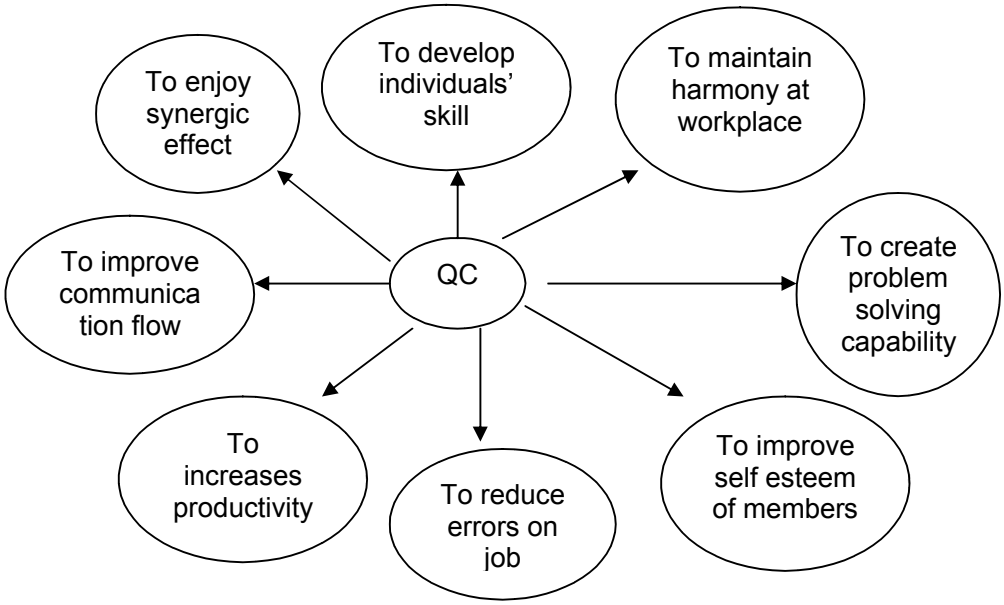
Co-operation: The application of Total Employee Involvement (TEI) principles is paramount. The on-the-job experience of all employees must be fully utilised & their involvement & co-operation sought in the development of improvement strategies and associated performance measures.

Customer focus: The needs of the customer are the major driving thrust; not just the external customer 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.

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 proce[illegible] deficiencies corre[illegible]

5. 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.

6. Cost of quality

Usually cost of quality 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.
iv)

Cost of internal failure :

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.

7. Critical success factors of TQM :

-- The focus should be on 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.

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 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 [illegible]? Show your calcula

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:

a. The optimum amount of maintenance to be undertaken each week:
b. Compute the additional net revenue that will be resulting from the optimal level, compared with the present level.

3. Torty 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 Torty 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. Torty'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

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

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

Required:
(i) Advise whether inspection at the point of receipt is justified?
(ii) Which of the two suppliers should be asked to supply?

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

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

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

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

	Current	Expected
On –time delivery	85%	95%
Variable costs per carton lost or damaged	Rs.50	Rs.50
Fixed costs per carton lost	Rs.30	Rs.30
Number of cartons lost or damaged	3,000	1,000

The company expects that each per cent point increases in on-time performance will Result in revenue increase of Rs.18,000 per annum. Contribution margin of 45% is required. Should Asha Road Carriers acquire and install the new system?

7. 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

P.T.O.

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:

			Rs('000)
	Option-1	Option-2	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	70	180	225
Total	148	285	385

You are required
(a) to recommend which of the three options the company should adopt.
(b) comment critically in respect of non-financial feature.

8. 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	4. Reduction of 40% of the existing cost.

P.T.O.

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.

9. A company has a normal manufacturing capacity of 1,50,000 units of a product per annum. The actual costs based on this output achieved during the last year were as under :

	Rs.
Direct materials	36
Direct labour	20
Variable overheads	20
Fixed overheads	20

The budget for the next year envisages the following increases :

Direct materials	33⅓%
Direct labour	10%
Variable overheads	5%

P

P.T.O.

In view of the substantial increase in material costs, the company explored the possibilities of using a substitute material. The company has been able to identify a cheaper source of direct materials which will cost Rs. 40 per unit of output. The tests reveal that the use of cheaper direct material as above will make the following impact on the costs :

- the direct labour cost will increase by Re. 1 per unit of output.
- it will lead to 5% rejection in output.
- it will result in a final quality testing programme evaluating an additional fixed cost of Rs. 4,00,000.

The selling prices are estimated as under for different levels of sales volume for the next year :

Selling price per unit (Rs)	:	128	136	144	152	160	168	176
Demand (1,000 units)	:	190	170	150	140	125	110	95

Required :

(i) Advise whether the company should use the regular direct materials or cheaper direct materials to maximise its profitability by producing the normal volume of output.

(ii) Considering the range of selling prices estimated at different volumes of output, determine the selling price which will maximise the profit if : (A) regular direct materials are used and (B) cheaper materials are used.

(iii) Calculate for the price selected by you in (ii) above, the amount of fixed cost at which the company will be indifferent in choice of direct materials.

10. A business employees 20 swing machinists, but he is aware that ten are the better workers than others. He is considering to conduct a training programme for his ten less efficient mechanists to increase their efficiency to be equal to that achieved by “better” workers. Relevant data are as follows:

- There is one sewing machine for each machinist.
- All the machinists are engaged on similar work and are paid Rs. 2.20 each good garment produced on piecework system.

- To rectify each rejected garment costs Rs. 4, this work is done by subcontractor.
- Garment machining department operates 2,000 hours a year.

- Average output of per machinist (on the basis of all 20 machinists) is 12 good garments with one rejected per worker per hour. However 10 less efficient machinists averages only 10 good garments with 1.5 rejected per worker per hour.

- Depreciation of each sewing machine is Rs. 10,000 per year and the variable cost of power, cleaning and preventive maintenance is Rs. 5 per hour per machine.
- Fixed production overhead other than depreciation is Rs. 20 per machine hour.
- Selling price per garment is Rs. 18.

- Direct Material cost per garment is Rs. 12.
- Training will not reduce productive hours.
- There is no problem in selling increased output.

You are required:

(a) To prepare a statement of comparative costs for the “better” worker and the “less efficient” workers excluding material cost.

(b) To [illegible] on a training co[illegible]rkers.

11. 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.
(iii) 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) 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) (exclu			86,700
Fixed			1,85,000

Decision Making : Relevant Costing

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.

A. 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.

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 t ating a major c

B. 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. **Objective Present profit has to be maintained**
2. **All these cost reports are for top management to bargain with the customer**
3. **The resources should be limiting in nature.**

Example 2 :

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 .

You are required to :
(a) State with reasons the costs which are non-relevant to the decision of alternative choices
(b) what is the opportunity cost of mat , if it is required for a new offer?

Example 3 :

(a) A company has some obsolete material in stock (purchased at Rs.5) 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. Present purchase price Rs.6 per ton. Opportunity cost or Shadow price 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

4. 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.

5. 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	42,000	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.

a) Would it be prudent for the company to accept the order at this price?
b) What is the price beyond which it would be profitable accept this order ?
c) 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 deicide?
d) What maximum order quantity can be accepted at this export price ?

6. 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 2009 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.

7. 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 estima units.
You a erage cost of capita

C. Relevant Material Cost for the offer: Important Definitions :

1. **Replacement price,**
2. **Market price,**
3. **Quick Sale price.**
4. **idle stock**
5. **Regular use**

8. For an offer, find the relevant cost of material from the following data:

Material Cost	Required Total units for offer	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

(i) 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.

(ii) 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).

(iii) 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.

9. Your company regularly uses material X and currently has in stock 200 kg. for which it paid Rs.500 two weeks ago. It 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.

10. 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	20.00	18.00
Direct materials (Rs.2.00 / kg.)	6.00	5.00
Direct labour	4.00	3.00
Variable overhead unit	2.00	1.50
	12.00	9.50
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 material ? Find the net evaluation of Quone.

D. Relevant Labour Cost

What is the nature of labour force?

PERMANENT	VARIABLE OR TIME RATE OR CASUAL LABOUR
Relevant cost: Nil	**Relevant cost = amount of wages payable**

DEFINITIONS : MONTHLY RATED, MAN MONTS & MAN-HOURS

11. 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 p. a. 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.

E. Relevant Overhead :

1. **Variable overhead : always relevant**
2. **Fixed overhead : Discretionary fixed costs are always relevant**
   Committed fixed costs are always Non-relevant
3. **If only overhead recovery rates are given, consider it Non-relevant, as it is a past of overhead ABS. e.g. Rs. per LHR, Rs./MHR, or % of Direct wages.**

F. 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 vale 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. 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

Find t in the above proble

G. 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.

H. 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 controller 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.

I. 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. The minimum price from a profit centre is its sale price = variable cost + discretionary fixed cost + opportunity cost

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.

J. 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 dividend 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.

K. 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 marking 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 form 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. 2,70,800 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.1,14,500 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. 3,300.

(b) 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 at a cost of Rs. 15,000.

(c) 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.

(d) 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 .

(e) General overheads of Rs. 23,000 would be added to the cost of the additional work.

(f) 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. Present rate of interest is 4% p.a. The project requires 4 months to complete.

(g) 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) Co[illegible]

(c) Lis[illegible] the decision in[illegible]

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.(00)
Direct materials :			
Steel	$10m^2$ @ Rs 500 per m^2	(1)	50
Brass fittings		(2)	20
Direct labour :			
Skilled	25 hours @ Rs 800 per hour	(3)	200
Semi-skilled	10 hours @ Rs 500 per hour	(4)	50
Overhead	35 hours @ Rs.1000 per hour	(5)	350
Estimating		(6)	100
			770
Administration overhead @ 20% of production cost		(7)	154
			924
Profit @ 25% of total cost		(8)	231
Selling price			1,155 .

Notes :

1. The steel is regularly used, and has a current stock value of Rs 500 per sq. metre. There are currently $100m^2$ in stock. The steel is readily available at a price of Rs 550 per sq. meter.

2. The brass fittings would have to be bought specifically for this job.

3. The skilled labour is currently employed by your company and paid at a rate of Rs 800 per hour. If this job were undertaken it would be necessary either to work 25 hours overtime which would require a premium 50% or reduce production of another product which earns a contribution of Rs 1300 per hour.

4. Semi-skilled labour is presently under-untilised, and at present 15 hours per week are recorded as idle time.

5. 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.

6. 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.

7. It is company policy to add 20% on to the production cost as an allowance against administration costs associated with the job accepted.
8. 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

4. Polymix manufactures chemical compounds and has been offered the opportunity to produce 4,000 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.3 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 litters 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	Wax	Mixer	Polymer
Book value per kg/ litter 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. 2.4 /- 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 accepted the machine meant for Durables & Co. if certain alterations are done to suit Steady Enterprises' needs and the price is attractive. Costs incurred on the machine are :.

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

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..

(b) Price quoted to Durables & Co., was Rs. 18,00,000

(c) To cater to Steady Enterprises' needs, the alteration cost will be :

	Department M	Department A
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

(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 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.

Requi[illegible]elevant costs only, f[illegible]

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	5,350	16,050
Fixed selling and administrative		5,405

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	4,200

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:

Direct material	Rs.	2,850
Direct labour		3,300

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	Selling and administrative:
Variable	50% of direct-labour cost	xxx
Fixed	25% of direct-labour cost	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

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

		Rs. in lacs
Land (3 Grounds at Rs.20 lacs each)		60
Drawings and Design		7
Registration		10
Materials :	Cement and Sand	6
	Bricks and Tiles	4
	Steel	10
	Others (including interior decoration)	10
Labour	- Skilled	12
	- Unskilled	8
	- Supervisor's Salary	5
Overheads	General	12
	Depreciation	6
Total cost		150

The Accountant also provides the following information :

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

Drawing and Design : These have already been prepared and 50% of the cost has been paid.

Materials :

(i) Cement and sand are already in stock and are in regular use. If used for this contract, they have to be replaced at a cost of 8 lacs.

(ii) Bricks and tiles represent purchases made several months before for a different contract. They could be sold readily for a net Rs.5 lacs after meeting all further expenses.

(iii) Others : Materials worth Rs.2 lacs relating to interior decoration are in stock for which no alternative use is expected in the near future. However they can be sold for rs.1 lac.

Labour :

(i) Skilled workers will be transferred to this project from another project. The Project Manager claimed that if the men were returned to him, he could have earned the company an additional Rs.2 lacs in terms of profits.

(ii) The supervisor undertakes various tasks in the sites and his pay and continuity of employment will not be affected by the new contract. If the contract is taken, he will devote half of his time.

Overheads :

(.i) The equipment that would be used on the contract was bought one year before for Rs.30 lacs and is expected to last for five years. It can also be used on other contracts and the current replacement price will be Rs.32 lacs and in a year's time it will be Rs.25 lacs.

(ii) The general overheads includes both specific and absorbed overheads. If the contract is not undertaken, Rs.4 lacs of the same can be avoided.

Ranka Builders has also on hand another project, which would not be executed if the contract from Excel Ltd. were to be accepted. The estimated profit on that project is Rs.10 lacs.In the light o r the contract from E

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

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

After searches, a new customer for the equipment has been found. He is interest to take the equipment, if certain modification are carried out. The new customer wanted the equipment in its original condition, but without its control device and with certain other modifications.

The costs of these additions and modifications are estimated as under :

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

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

The following additional information is available :

(1) The direct materials required for the modification are in stock and if not used for modification of this order, they will be used another job in place of materials that will now cost Rs. 2,250.

(2) Department A is working normally and hence any engagement of labour will have to be paid at the direct wages rate of Rs. 120 per man day.

(3) Department B is extremely busy. Its direct wages rate is Rs. 100 per man and it is currently yielding a contribution of Rs. 3.20 per rupees of direct wages.

(4) Supervisory overtime payable for the modification is Rs. 1,050.

(5) The cost of the control device that the new customer does not require is Rs. 13,500. If it is taken out, it can be used in another job in place of a different mechanism. The latter mechanism has otherwise to be brought for Rs. 10,500.The dismantling and removal of the control mechanism will take one man day in department A.

(6) If the convention is not carried out, some of the materials in the original equipment can be used in another contract in place of materials that would have cost Rs. 12,000. It would have taken 2 man days of works in department A to make suitable for this purpose. The remaining will realise Rs. 11,400 as scrap. The drawings, which are included as part of the job can be sold for Rs. 1,500.

You are required to calculate the minimum price, which the company can afford to quoted for the new customer as stated above.

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

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

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

(.i) Material X is an obsolete material. It can only be used on another product, the material for which is available at Rs.1,35,000 (Material X requires some adaptation to be used and costs Rs.27,000).

(ii) Material Y is ordered for some other product which is no longer required. It now has a residual value of Rs.2,10,000.

(iii) Skilled labour can work on other contracts which are presently operated by semi-skilled labour at a cost of Rs.5,70,000.

(iv) Non-skilled labour are specifically employed for this contract.

(v) Supervisory staff will remain whether or not the contract is accepted. Only two of them can replace other positions where the salary is Rs.35,000.

(vi) Overheads are charged at 200% of skilled labour. Only Rs.1,25,000 would be avoidable, if the contract is not accepted.

Relevant costing with Shut-Down & Outsourcing: definite or indianite period

10. 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:

Unit	Sales price	Unit variable selling costs	Unit contribution Rs.
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 demanded for 10,000 units a month. Should the firm continue to make the produ o switch from makin

11. 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.	Rs.
Direct Materials (including "Protecto")		1,40,000
Direct Labour		1,00,000
Overheads :		
Department Manager	16,000	
Depreciation of machine	30,000	
Maintenance of machine	7,200	
Rent (portion of warehouse)	9,000	
Other Miscellaneous costs	31,500	93,700
		3,33,700
Administration Overhead (20% of direct costs)		48,000
		3,81,700

Pack Knack Associates have approached the R&Rl Ltd. offering to make all the crates required on a 4 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 knack 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 PK Ltd:-
(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 Knack 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) [illegible] ced by 20%

Adv

Problems on Responsibility Accounting

12. 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 & 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	1,500
Total	1,66,200

Following additional information is available.

1. 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.

2. 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.

3. 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.

4. 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 :

	Fabrication	Welding
	In Rs.	
Variable cost machine hour	7	19
Departmental Fixed Costs	6	20
Profit	7	4
Transfer Price	20	43

5. 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.

13 Companies GP, GR, GS and GT are members of a group. GP wishes to buy an electronic control system for it's 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. 35,000 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 it's 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.

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.

Main objective

Maximize the group profit. Hence all the profit centers will have to adopt such a transfer price which must not reduce the group profit.

1. 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.

2. 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 maid in the market price to provide benefit of these expenses to the profit centre, receiving the goods.

3. 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.

4. 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 he 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.

5. 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 MNC s 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 officiate so that its credit rating may be enhanced.

6. 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. profit for the gr

7. 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.

Problems : 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. 200	Market price per Barrel of Crude oil
Fixed costs per Barrel of Crude oil	=	Rs. 600	to Third Parties = Rs. 1200
Absorption Costs per Barrel of Crude oil	=	Rs. 800	

TRANSPORTATION DIVISION OF BHARAT PETROLEUM

Variable Costs per Barrel of Crude oil	=	Rs. 10
Fixed Costs per Barrel of Crude oil	=	Rs. 30
Absorption Costs per Barrel of Crude oil	=	Rs. 40

REFINING DIVISION OF BHARAT PETROLEUM

Variable Costs per Barrel of Gasoline	=	Rs. 80	Market Price per Barrel of
Fixed cost per Barrel of Gasoline	=	Rs. 60	Crude Oil Delivered to Haldia
Absorption Costs per Barrel of Gasoline	=	Rs.140	Refinery by 3rd Parties= Rs 1800

External Sale Market price per Barrel of Gasoline Sold to Third Parties = Rs. 5400.

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 Iran 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. 1800 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

Meths.

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
Cost of goods sold:			
Opening Stocks			
Manufacturing Costs:			
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	10,000	
Cost of goods available for sale		1,35,000	
Deduct Closing Stock at cost			
	Division 1	--	
	Division 2	10,000	1,25,000
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		14,000	37,000
Net profit before tax			18,000

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 broken down as follows:

Division 1	Rs. 40,000
Division 2	Rs. 1,40,000
	Rs. 1,80,000

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:

(a) Prepare division profit statement that might be used to evaluate the performance of the two division managers.

(b) Explain the transfer pricing policy you have used in preparing the statement and the state whether it is suitable for decision making purposes.

3. 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 custom 2008.
Which

Variable costs :	Rs.
Skilled labour	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). Budgeted Skilled labour hour is 6,000. 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.

Calculating the total transfer value & profit of each division, 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.

On Limiting Factor

4. 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.

a. What will be the minimum transfer price, if the total labour hours available in Division RF are : (i). 3800 hours ? (ii). 5600 hours ?

b. If 330 unit of Y are to be transferred what should be he minimum transfer price if only 3,800 labour hours are available?

On Differential Cost Approach:

5. 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 tr

On Group Conflict

6. X Ltd. has two divisions, A and B, which manufacture product A and B respectively. A and B profit centers with the respective Divisional Managers being given full responsibility and credit for their performance. The following figures are presented:

Division	A Rs. Per unit	B Rs. Per unit	
Direct Material Cost	20	24*	*(other than A)
Material A, if transferred from Division A	--	144	
Material A, if purchased From outside	--	160	
Direct Labour	25	14	
Variable production overhead	20	2	
Variable selling overhead	13	26	
Selling price in outside market	160	300	
Selling price to B	144	--	
Selling price to S Ltd.	--	250	

Other information:
To make one unit of B, one unit of component A is needed. If transferred from A, B presently takes product A at Rs. 144 per unit, with A not incurring variable selling overheads on units transferred to B.

Product A is available in the outside market at Rs. 160 per unit from competitors.

B can sell its product B in the external market at Rs. 300 per unit, whereas, if it supplied to X Ltd.'s subsidiary, S Ltd., it supplies at Rs. 250 per unit, and need not incur variable selling overhead on units transferred to S Ltd. S Ltd. requires 6,000 units and stipulates a condition that either all 6,000 units be taken from B or non at all.

	A (units)	B (units)	
Manufacturing capacity	20,000	28,000	
Demand in external market	18,000	26,000	
S. Ltd.'s demand	--	6,000	or zero

Assume that Divisions A and B will have to operate during the year.
What is the best strategy for:

(i) Department A?
(ii) Department B, given that A will use its best strategy?
(iii) For X Ltd. as a whole?

7. 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 tones to outside market and 1200 tonnes to the Processing unit.

The transfer price for the year 2009 was agreed at Rs. 400 per tonne. This price has been fixed in line with the external wholesale trade price on 1st January 2009. 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 2009. This price however was not made applicable to the sales made [illegible] n of the price as ap[illegible] turned down by the

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 :

	Basic unit (Rs.)	Processing unit (Rs.)
Raw Materials/tonne	70	Transfer price
Variable Costs/tonne	140	170
Fixed costs/month	(Rs) 3,00,000	1,20,000

Prepare statements showing the estimated profitability for June 2007 for each unit and the company as a whole on the following bases

a) 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.

b) 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.

c) At 100% capacity utilisation of the Basic unit at the market price and transfer price to the Processing unit of Rs. 360 per tonne.

d) Comment on the effect of the Company's transfer pricing policy on the profitability of the Processing unit. What should be the transfer price?

On Opportunity Cost

8. 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?

On ROCE basis:

9. 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) In case it is agreed that the transfer to the other Division be made at a price of Rs.2.30 p.u.

(a) at what price should the transferor sell the remaining units so as to maintain the desired return of 30% ? , or

(b) how many more units should it produce assuming that this will not change in the fixed cost, the asset cost or the selling price, so as to maintain the desired return of 30% ?

10. 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

(i) 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.

(ii) Yo

11 AB Ltd. manufactures foam, carpets and upholstery in its three divisions. Its operating statement for 1995-96 showing the performance of these divisions drawn for the use of managements is reproduced below :

	Manufacturing Divisions			
(Rupees in '000)	Foam	Carpets	Upholstery	Total
Sales revenue (a)	1,600	1,200	1,200	4,000
Manufacturing Costs:				
Variable	1,200	700	680	2,580
Fixed (Traceable)	-	100	20	120
Total cost (b)	1,200	800	700	2,700
Gross profit (a-b)	400	400	500	1,300
Expenses :				
Administration	134	116	172	422
Selling	202	210	232	644
	336	326	404	1,066
Net Income	64	74	96	234
Division's Ranking	3rd	2nd	1st	

(A) Sales include foam transferred to the Upholstery division at its manufacturing cost Rs. 2,00,000.

(B) Common expenses of Rs. 1,30,000 and Rs. 1,00,000 on account of administration and selling respectively stand apportioned to these divisions at 10% of Gross Profit in case of administration and 2.5% of Sales in case of selling expenses. Rest of Rs. 8,36,000 of the expenses are traceable to respective divisions.

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

You are required to :

(a) Draw the revised operating statement using contribution approach and pricing the internal transfer at market price.

(b) Compute relevant ratios to show comparative profitability of these divisions and rank them in the light of your answer at (a) above. Further, offer your comments on the contention of the manager of foam division.

(c) State why the contribution approach and pricing of internal transfers at market price are more appropriate in realistic assessment of the performance of various divisions.

Profit & cost center

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

Sales per day (Units)	5000	10,000	15,000	20,000	25,000	30,000
Average price p. u. of P (Rs.)	393.75	298.50	247.50	208.50	180.00	150.75

The manufacturing cost (excluding the cost of the component from Division X) of P in Division Y is Rs. 14,06,250 on first 5,000 units and Rs. 56.25 per unit in excess of 5,000 units. P.T.O.

Division X incurs a total cost of Rs. 5,62,500 per day for an output up to 5,000 components and the total costs will increase by Rs. 3,37,500 per day for every additional 5,000 components manufactured. The manager of Division X has set the transfer price for the component at Rs. 90 per unit to optimize the performance of his Division.

Required :

(i) Prepare a divisional profitability statement at each level of output, for divisions X and Y separately ;

(ii) Find out the profitability of the company as a whole at the output level where :

(a) Division X's net profit is maximum :
(b) Division Y's net profit is maximum.

(i) Find out at what level of output, the company will earn maximum profit, if the company is not organized on profit centre basis.

13. Ripod Ltd. has three divisions-X, Y and Z, which make products X, Y and Z respectively. For division Y, the only direct material is product X and for Z, the only direct material is product Y. Division X purchases all its raw material from outside.

Direct selling overhead, representing commission to external sales agents are avoided on all internal transfers. Division Y additionally incurs Rs. 10 per unit and Rs. 8 per unit on units delivered to external customers and Z respectively. Y also incurs Rs. 6 per unit picked up from X, whereas external suppliers supply to Y's factory at the stated price of Rs. 85 per unit.

Additional information is given below:

	Figures Rs./ unit			
	X	Y	Z	
Direct Materials (external supplier rate)	40	85	135	
Direct Labour	30	50	45	
Sales agent's commission	15	15	10	
Selling price in external market	110	170	240	
Production capacity	20,000	30,000	40,000	units
External demand	14,000	26,000	42,000	units

You are required to discuss the range of negotiation for Managers X, Y and Z for the number of units and the transfer price for internal transfers.

Learning Curve

Leaning 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 decrease 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-linerities must be considered when estimating and predicting units 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.

1. 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.

2. 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 grate opportunities for cost reduction to be achieved by improving learning.
viii. LC[illegible]ns

3. 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 in interrupted, the curve may be deflected or assume a new slopes
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.

4. 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 slop 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 grater 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

   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. **T**
4. **st 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 competed; 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	Re. 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, it the customer places a repeat orders 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. 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 @ Rs.350 per metre
	Q ..	4 kgs. @ Rs.140 per kg.
Conversion cost per unit in	Department : 1	14 hours .. at Rs. 75 per hour
	Department : 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: It 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

5. M Ltd. manufactures a special product purely carried out by manual labour. It has a capacity of 20,000 units. It estimates the following cost structure:

Direct Material	30 Rs./unit
Direct Labour	20 Rs. /unit
Variable overhead	10 Rs./unit

Fixed overheads at maximum capacity is Rs. 1,50,000.

It is estimated that at the current level of efficiency, each unit requires one hour for the first 5,000 units. Subsequently it is possible to achieve 80% learning rate. The market can absorb the first 5,000 units at Rs. 100 per unit. What should be the minimum selling price acceptable for an order of 15,000 units for a prospective client?

6. 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)	6
	56

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.

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 (skilled0	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 30th 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	7,500
	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 ad[illegible]y with which mater[illegible]rning curve.

P.T.O.

The actual production for the first three months was as follows :

Month	1	2	3
Batches produced	5	11	16

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, 2008. 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 2007, 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.

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

Maxim re completed with n 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
	60

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.

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.

P.T.O.

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, whereas the average unit variable manufacturing cost of all four batches would be Rs. 52.85. 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.

Assignment

Learning objective

1. **How to allot jobs among workers & machines so as to reduce total time & cost**
2. **Maximization 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 then 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).**
   Incase 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.

	Cost of Repairs (Rs. Lakhs)			
Contractors/Road	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

(i) Find the best way of assigning the repair work to the contractors and the costs.
(ii) If it is necessary to seek supplementary grants, then what should be amount sought ?
(iii) Which of the five contractors will be unsuccessful in his bid ?
(iv) If C1 unable to accept any work , find best assignment.

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 Easwa : 46 and the butter

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 does 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. The Captain of a cricket team has to allot five middle batting positions to five batsmen. The average runs scored by each batsmen at these positions are as follows:

	Batting positions				
Batsman	I	II	III	IV	V
P	40	40	35	25	50
Q	42	30	16	25	27
R	50	48	40	60	50
S	20	19	20	18	25
T	58	60	59	55	53

(i) Find the assignment of batsmen to positions, which would give the maximum number of runs.

(ii) If another batsman 'U' with the following average runs in batting positions as given below :

Batting position :	I	II	III	IV	V
Average runs :	45	52	38	50	49

Is added to the team, should he be included to play in the team? If so, who will be replaced by him?

9. 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. Find the best assignment

	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.

Airlines Route & Minimisation of Idle Time

10. 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

12. Amphion Airlines is a small air freight company based in Mumbai and operating throughout Western India. The company has 6 aircraft of different types, namely 3 of type 'A', 2 of type 'B' , 1 of type 'C', Whose operating costs and load carrying capacities are as follows:

Aircraft	Fixed cost	Variable cost (Rs.)		Capacity
Type	(Rs. per day)	per mile	per ton	(tons)
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	1	2	3	4	5
Size (tons)	10	2	8	5	3
Distance (miles)	200	550	320	280	450

The distances given above are direct from the company's base in Mumbai 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. Decide which aircraft should be used for delivering each load so that total cost is minimized.

Traveling Salesman problem

13. Solve the following traveling salesman problem so as to minimise the cost per cycle :

	To				
From	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

14. A firm produces four products. There are four operators who are capable of producing any of these four products. The processing time varies from operator to operator. The firm records 8 hours a day and allows 30 minutes for lunch. The processing time in minutes and the profit for each of the products are given below:---

Operators	Products			
	A	B	C	D
1	15	9	10	6
2	10	6	9	6
3	25	15	15	9
4	15	9	10	10
Profit (Rs.) per unit	8	6	5	4

Find the optimal assignment of products to operators.

15. A manufacturing company has four zones A, B, C, D and four sales engineers P, Q, R, S respectively for assignment. Since the zones are not equally rich in sales potential, therefore it is estimated that a particular engineer operating in a particular zone will bring the following sales:

Zone A : 4,20,000
Zone B : 3,36,000
Zone C : 2,94,000
Zone D : 4,62,000

The engineers are having different sales ability. Working under the same conditions, their yearly sales are proportional to 14, 9, 11 and 8 respectively. The criteria of maximum expected total sales is to be met by assigning the best engineer to the richest zone, the next best to the second richest zone and so on.

Find the optimum assignment and the maximum sales.

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 generates the solutions techniques.
- Sometimes Simulation Models are expensive & may also takes 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 trail 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. Do not change the order of the events.**
3. **Calculate cumulative probability. (<)**
4. **Calculate random interval : For two digit random number, upper limit of the interval = cumulative Probability x 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 :

(i) What will be the average number of mopeds waiting in the factory ?

(ii) 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.5 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.

A. Order 5 books when the inventory at the beginning of the day plus orders outstanding is less than 8 books.

B. 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 tw

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	No rain	1 cm. Rain	2 cm. Rain	3 cm. Rain	4 cm. Rain	5 cm. Rain
Probability	0.50	0.25	0.15	0.05	0.03	0.04

If it did not rain the previous day, the rain distribution is given by :

Event	No. Rain	1 cm. Rain	2 cm. Rain	3 cm. Rain
Probability	0.75	0.15	0.06	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 & Salaries (Rs. '000)	Probability	Raw material (Rs. ' 000)	Probability	Sales revenue (Rs. '000)	Probability
10 – 12	0.3	6 – 8	0.2	30 – 34	0.1
12 – 14	0.5	8 – 10	0.3	34 – 38	0.3
14 – 16	0.2	10 – 12	0.3	38 – 42	0.4
		12 – 14	0.2	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
Check up	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 of customers(in minutes)	Probability
3	0.17
4	0.25
5	0.25
6	0.20
7	0.13

Service time by the teller (in minutes)	Probability
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, 03, 02, 97, 99, 83, 10, 93, 34, 33, 53, 49, 94, 37 and 97.

Network analysis: P.E.R.T,C.P.M & Resource Allocation

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. A project is a new work for which organisation has no preliminary experience .

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 characterized 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.

Resource smoothing : It is a technique used for smoothening peak resource requirements during different periods of a project net work. The total product 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 scarcity. 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.

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. 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.

5. 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 owning to the aforesaid simplification and assumption may be compounded or may cancel each other to an extent.

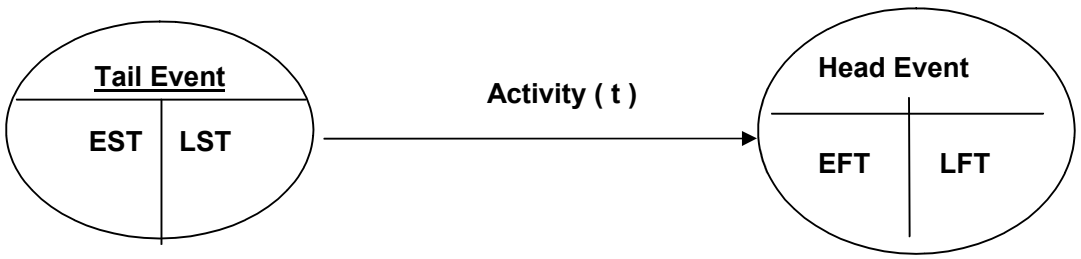
4. In computing the S.D. of the critical path independence of activities is implied. Limitations of resources may invalidate the independence which exists by the very definition of an activity.
5. It may not always be possible to sort out completely identifiable activities and to state where they begin and where they end.
6. Time estimates have an element of subjective-ness and, to that extent, the techniques could be weak.

6. 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 mana… calling attenti… delay in proje…	6. It is difficult to use CPM as a control device for …eat the entire …the changes

Some important definition:

1. **Activity : It is a particular work of a project which consumes some resources & time. It is shown as ⟶ & Represented by Capital Letter.**
2. **Event : it denotes the start & end of an activity & represented by a "circle". Events are no as 1, 2, 3 etc. So that it moves from lower to higher no.**
3. **Every project starts with a single event & ends at a single event.**
4. **Sequence : activities are linked in a sequence known as immediate predecessor i.e. an activity which must be completed first to start another one**
5. **Between two events there must be only one activity.**
6. **Dummy Activity is required to solve the problem when two or more activities are there between two events. It is denoted as ----------▶**
7. **Path: a series of activities taken together to link the first & end event.**
8. **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. Sometimes there may be more than one critical paths as they have same highest time duration. In that case, select that one with highest variance.**
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 or Average time of Act **= $(t_o + 4t_m + t_p) \div 6$**

Stander Deviation of an activity **= $(t_p - t_o) \div 6$**

Variance of an activity **= $\{(t_p - t_o) \div 6\}^2$**

Variance of the critical path (As well as the project) **= ($\sum$ Variances of critical path 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) Sh[illegible]

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)
Before this can start	C	D	G	K	D	G	E	F

This must be completed	F (7)	F	F	G (21)	G	H (7)	I (12)	K (30)
Before this can start	H	I	L	I	L	J(15)	J	L (15)

5. The following information is available:

Activity		No. of days	No. of men required per day
A	1-2	4	2
B	1-3	2	3
C	1-4	8	5
D	2-6	6	3
E	3-5	4	2
F	5-6	1	3
G	4-6	1	8

i) Draw the network and find the critical path.

ii) What is the peak requirement of Manpower? On which day(s) will this occur?

iii) If the maximum labour available on any day is only 10, when can the project be completed?

6. 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 subject 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 & technical paper request of all persons	3	C, D
H	Collect all submitted papers	4	G
I	Review papers and select the papers to present	10	H
J	Inform authors about acceptance 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

7. A 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. 4 lakhs a week.

Required :

(a) 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 ?

(b) 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

8. The NRB Company is planning to design, develop and market a new racing cycle. The project is composed of the following activities:

Activity	Description	Predecessors	Time(weeks)
A	Design frame `	none	4
B	Design wheels	none	3
C	Design gears	none	3
D	Design handlebars	C	2
E	Test steering	A,B,D	1
F	Test gears	A,B,D	2
G	Performance test	E, F	3
H	Manufacturing layout	A,B,D	3
I	Manufacture demonstrators	H	5
J	Prepare advertising	G	2
K	Prepare users' manuals	G	4
L	Distribute to dealers	I,J.K	2

Construct the network, determine the critical path and the duration of the above Project.
NRB Company's management would like to get the new bicycle to their dealers in 15 weeks. Would it help if they:

(i) Work overtime to get the frame designed in only 3 weeks?
(ii) Assign more designers to design the gears? If so, from what activity should the designers be taken from?

Expected time analysis:

9. 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 ex uld ignore the de ities.

10. A project consists of 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

(a) What is the probability that the project will be completed by 27 days.
(b) What is the duration if the probability of completion is 96.5% confidence ?
(c) 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 interval.

11. A construction company is preparing a PERT network for laying the foundation of a new art museum. Given the following set of activities, their predecessor requirements and three time estimates of completion time :

		Time Estimates (Weeks)		
Activity	Predecessors	Optimistic	Pessimistic	Most Likely
A	none	2	4	3
B	non	8	8	8
C	A	7	11	9
D	B	6	6	6
E	C	9	11	10
F	C	10	18	14
G	C,D	11	11	11
H	F,G	6	14	10
I	E	4	6	5
J	I	3	5	4
K	H	1	1	1

The contract specifies a Rs. 5,000 per week penalty for each week the completion of the project extends beyond 37 weeks. What is the probability that this company will have to pay a maximum penalty of Rs. 15,000?

12. 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) 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 ?

(b) Find the event or node variances in the network. What is the probability to complete event 5 by 11 weeks?

Activity	Estimated duration in weeks		
I – j	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			
5 – 6			

Critical Path Analysis:

13. Find the minimum & optimum project duration. Indirect cost is Rs. 300 per day

Activity	Normal		Crash		Immediate
	Days	cost	days	cost	Predecessor
A	8	1,200	5	1,800	none
B	6	2,900	2	3,600	A
C	10	3,800	4	5,000	none

14. Find the minimum and optimum project duration if indirect cost per day is Rs. 450.

Activity	Normal		Crash		Immediate
	Days	cost	days	cost	Predecessor
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

15. 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 ?

16 A small project consists of jobs as given in the table below. Each job is listed with its normal time and a minimum or crash time (in days). The cost (in Rs. per day) of each job is also given:

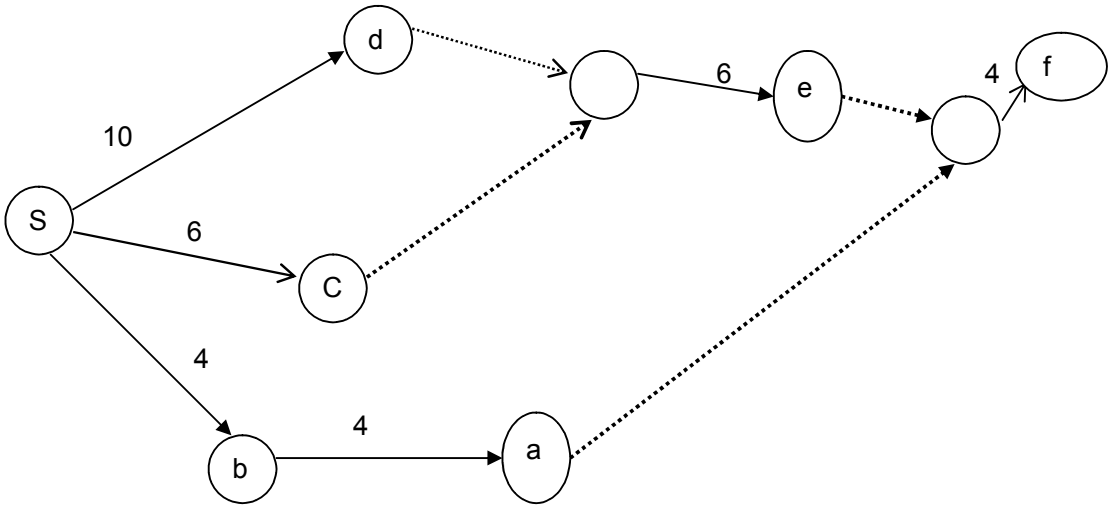
Job (i-j)	Normal duration (in days)	Minimum (crash) Duration (in days)	Cost of Crashing (Rs. per day)
1-2	9	6	20
1-3	8	5	25
1-4	15	10	30
2-4	5	3	10
3-4	10	6	15
4-5	2	1	40

(i) What is the normal project length and the minimum project length?

(ii) Determine the minimum crashing cost of schedules ranging from normal length down to, and including the minimum length schedule. That is, if L = Length of the schedule, find the costs of schedules which are L, L-1, L-2, and so on.

(iii) Overhead costs total Rs. 60 per day. What is the optimum length schedule in terms of both c lution.

17. ABC Ltd. is in the process of undertaking a contract. An article Clark has produced the following wrong diagram of the project :



The activities are mentioned as a, b, c, d, e, f The starting event is S. The numbers given along the activity are the normal expected completion time in days. Dotted lines are representing Dummy activities. Each separate activity costs Rs.200 per day and there is further charge of Rs.500 for everyday the project is in progress.

You are required to

(i) Draw the Network diagram & compute the EST & EFT for each activity.

(ii) Indicate the critical path and the total cost.

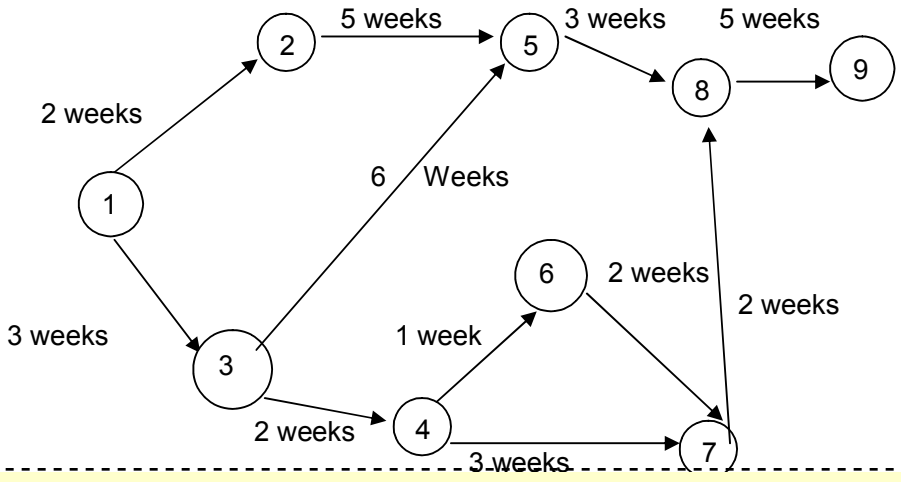
(iii) Calculate the optimum plan for the project if the time of activities (b), (c) and (d) can be progressively reduced to one day at an extra cost as under :

Activity	b	c	d
Extra cost per day saved(Rs.)	125	150	300

18. A network is given below:

(i) Name the paths and given their total duration

(ii) Given three different ways of reducing the project above duration by four days



19. A company had planned its operations as follows:

Activity	Duration (days)
1-2	7
2-4	8
1-3	8
3-4	6
1-4	6
2-5	16
4-7	19
3-6	24
5-7	9
6-8	7
7-8	8

(i) Draw the network and find the critical paths.

(ii) After 15 days of working, the following progress is noted:

(a) Activities 1-2, 1-3 and 1-4 completed as per original schedule.
(b) Activity 2-4 is in progress and will be completed in 4 more days.
(c) Activity 3-6 is in progress and will need 17 more days to complete.

(d) The staff at activity 3-6 are specialised. They are directed to complete 3-6 and undertake an activity 6-7, which will require 7 days. This rearrangement arose due to a modification in a specification.

(e) Activity 6-8 will be completed in 4 days instead of the originally planned 7 days.
(f) There is no change in the other activities.

Update the network diagram after 15 days of start of work based on the assumption given above. Indicate the revised critical paths along with their duration.

Transportation

Learning Objective

1. **How allocate resources at minimum cost.**
2. **Maximization of profit.**
3. **Decision making tools for management.**

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. ∑Demand = ∑Supply**

2. **Unbalanced problem, i.e. ∑Demand # ∑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 ∑supply > ∑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 :

1. **Find the lowest cost empty cell.**
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 .
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.

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 : Feasibility test : To check whether the above the above allotment is ready for final allotment or not.

If the allotment is feasible then no. of occupied cells = m + n - 1, where m = no. of rows, n = no. of columns

If it is not feasible, allocate a very small qty. $\in$ to the lowest cost among unoccupied cell. In some cases u may require to put it in the 2^{nd} 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 $\in$ in such a way so that negative cost evaluation can be avoided in other tie cell.

Note-4: Optimal Test : To check whether the present total cost is minimum or not. For this purpose we have to check differential cost of putting one unit to an un-occupied cell from the present allotment of occupied cells. The Demand & Supply are constant.
2 methods are available for solution :

A. Stepping Stone Method

Rules:

(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.

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 rules & report it in profit format.

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. A manufacturer of jeans is interested in developing an advertising campaign that will reach four different age groups. Advertising campaigns can be conducted through TV, Radio and Magazines. The following table gives the estimated cost in paise per exposure for each age group according to the medium employed. In addition, Maximum exposure levels possible in each of the media, namely TV, Radio and Magazines are 40, 30 and 20 millions respectively. Also the minimum desired exposures within each age group, namely 13-18,19-25,26-35,36 and older, are 30, 25,15 and 10 millions. The objective is to minimize the cost of attaining the minimum exposure level in each age group.

Media	Age Groups			
	13-18	19-25	26-35	36 and older
TV	12	7	10	10
Radio	10	9	12	10
Magazines	14	12	9	12

(i) Formulate the above as a transportation problem, and find the optimal solution.
(ii) Solve this problem if the policy is to provide at least 4 million exposures through TV in the 13-18 age group and at least 8 million exposures through TV in the age group 19-25.

3.

	A	B	C	
P	2	4	7	200
Q	8	1	9	150
R	3	4	6	150

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. W_1	W_2	W_3	W_4	Capacity
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 : Site 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.

6. The initial allocation of a transportation problem, along with the unit cost of transportation from each origin to destination is given below. You are required to arrive at the minimum transportation cost by the Vogel's Approximation method and check for optimality.

(Hint: Candidates may consider $U_1 = 0$ at Row 1 for initial cell evaluation)

					Requirement
11	2 [8]	8	6 [6]	2 [4]	18
9 [10]	9	12	9	6	10
7	6	3 [8]	7	7	8
9 [2]	3	5	6 [2]	11	4
Availability					
12	8	8	8	4	40

7. The following table shows all the necessary information on the available supply to each warehouse, the requirement of each market and the unit transportation cost from each warehouse to each market:

		Market				
		I	II	III	IV	Supply
Warehouse	A	5	2	4	3	22
	B	4	8	1	6	15
	C	4	6	7	5	8
		7	12	17	9	

Requirement

The shipping clerk has worked out the following schedule from his experience:

12 units from A to II
1 unit from A to III
9 units from A to IV
15 units from B to III
7 units from C to I and
1 Unit from C to III.

You are required to answer the following:

(i) Check and see if the clerk has the optimal schedule;

(ii) Find the optimal schedule and minimum total shipping cost; and

(iii) If the clerk is approached by a carrier of route C to II, Who offers to reduce his rate in the hope of getting some business, by how much should the rate be reduced before the clerk should consider giving him an order ?

Profit maximizing decision

8. XYZ &Co. has provided the following data seeking your advice on optimum investment strategy:

Investment Made at the Beginning of year	Net Return Data (in Paise) of Selected Investments				Amount Available
	P	Q	R	S	(Lacs)
1	95	80	70	60	70
2	75	65	60	50	40
3	70	45	50	40	90
4	60	40	40	30	30
Maximum Investment (Lacs)	40	50	60	60	------

The following additional information are also provided:

-- P, Q, R and S represent the selected investments.
-- The company has decided to have four years investment plan.
-- The policy of the company is that amount invested in any year will remain so until the end of the fourth year.
-- The values (paise) in the table represent net return on investment of one Rupee till the end of the planning horizon (for example, a Rupee invested in investment P at the beginning of ye paise).

Using

9. A company wishes to determine an investment strategy for each of the next four years. Five investment types have been selected, investment capital has been allocated for each of the coming four years, and maximum investment levels have been established for each investment type. An assumption is that amounts invested in any year will remain invested until the end of the planning horizon of four years. The following table summaries the data for this problem. The values in the body of the table represent net return on investment of one rupee up to the end of the planning horizon. For example, a rupee invested in investment type B at the beginning of year 1 will grow to Rs. 1.90 by the end of the fourth year, yielding a net return of Rs. 0.90.

Investment made at the beginning of year	Investment type					Rs. Available (in '000)
	A	B	C	D	E	
		Net	Return	Data		
1	0.80	0.90	0.60	0.75	1.00	500
2	0.55	0.65	0.40	0.60	0.50	600
3	0.30	0.25	0.30	0.50	0.20	750
4	0.15	0.12	0.25	0.35	0.10	800
Maximum Rupee investment (in '000)	750	600	500	800	1,000	

The objective is this problem is to determine the amount to be invested at the beginning of each year in an investment type so as to maximize the net rupee return for the four-year period. Solve the above transportation problem and get an optimal solution. Also calculate the net return on investment for the planning horizon for four-year period.

10. ABC Enterprises is having three plants manufacturing dry cell, located at different locations. Production cost differs from plant to plant. There are five sales offices of the company located in different regions of the country. The sales prices can differ from region to region. The shipping cost from each plant to each sales office and other data are given by following table:

Production Data Table		
Production cost per unit	Max. Capacity in No. of units	Plant No.
20	150	1
22	200	2
18	125	3

Shipping Cost and Demand & Sales Price Table:
Shipping Costs

	Sales office 1	Sales office 2	Sales office 3	Sales office 4	Sales office 5
Plant 1	1	1	5	9	4
Plant 2	9	7	8	3	6
					7

P.T.O.

Demand & Sales Prices

	Sales office 1	Sales office 2	Sales office 3	Sales office 4	Sales office 5
Demand	80	100	75	45	125
Sales price	30	32	31	34	29

Find the production and distribution schedule most profitable to the company.

11. A company produces a small component for all industrial products and distributes it to five wholesalers at a fixed price of Rs. 2.50 per unit. Sales forecasts indicate that monthly deliveries will be 3,000, 3,000, 10,000, 5,000 and 4,000 units to wholesalers 1,2,3,4 and 5 respectively. The monthly production capabilities are 5,000, 10,000, 12,500 at plants 1,2 and 3 respectively. The direct costs of production of each unit are Rs. 1.00, Rs. 0.90 and Rs. 0.80 at plants 1,2 and 3 respectively. The transportation costs of shipping a unit from a plant to a wholesaler are given below:

		Wholesaler				
		1	2	3	4	5
Plant	1	0.05	0.07	0.10	0.15	0.15
	2	0.08	0.06	0.09	0.12	0.14
	3	0.10	0.09	0.08	0.10	0.15

Find how many components each plant supplies to each wholesaler in order to maximize profit.

Decision making with transportation

12. 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.

	Shipping Costs Rs. per Unit				
Place	Guwahati	Nagpur	Ahmedabad	Chandigarh	Capacity
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

- 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.

is optimal.
$-C_1$ is ≤ 0.

Linear Programming

1. Definition:

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.

2. Pre condition for applying LPP:

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.

3. industrial & Management applications

. 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.

4. 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.

5. Distinguish between Slack & Artificial Variable:

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.

Problems : Graphical Solution & Shadow Price;

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 of the formulation

2. The budgeted data relating to two products manufactured by a Co. for a month are as under :

	Product A	Product B
Selling price	300	200
Variable manufacturing cost	160	60
Sales commission	60	40

Each unit of product incurs costs in the company's two departments P and Q. the total capacity available for the month under review is budgeted to be 1,400 hours in department P and 2,000 hours in department Q. The capacity costs amount to 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 graphical & simplex method. .

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 marker 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
Labou					00
Machi					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. The costs and selling prices per unit of two products manufacturing by a company are as under:

Product	A (Rs.)	B (Rs.)
Selling price	500	450
Variable costs:		
Direct Materials @ Rs. 25 per kg.	100	100
Direct Materials @ Rs. 20 per kg.	80	40
Painting @ Rs. 30 per hour	30	60
Variable overheads	190	175
Fixed costs @ Rs. 17.50/D.L. Hr.	70	35
Total costs	470	410
Profit	30	40

In any month the maximum availability of inputs is limited to the following:

Direct Materials	480 kg.
Direct Labour hours	400 hours
Painting hours	200 hours

Required:

i) Formulate a linear programme to determine the production plan which maximizes the profits by using graphical approach.

ii) State the optimal product mix and the monthly profit derived from your solution in (i) above.

iii) If the company can sell the paints time at Rs. 40 per hour as a separate service, show what modification will be required in the formulation of the linear programming problem. You are required to re-formulate the problem but not to solve.

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 Graphical Method so as to maximize return on investment.

8. 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 [illegible] for the entire trip. P[illegible]

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 you results.

Minimization Problem: Graphical solution

9. 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, I 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:

10. An agriculture has a farm with125 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 each100 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 rasie 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.

11. 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:

	Magazines		
Particulars	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 decide[illegible] and C each gets a[illegible]

12. 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 (in hours)	Assembly Time (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	1,40,000
Total	5,00,000	Total	5,00,000

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.

13. Transport ltd. provides tourist vehicles of 3 types- 20 seater van, 8-seater big cars and 5 seater small cars. These seating capacities are excluding the drivers. The company has 4 vehicles of the 20 seater van type, 10 vehicles of the eight seater big car types and 20 vehicles of the 5 seater small car types. These vehicles have to be used to transport employees of their client compa in the same housi e other is the Branc morning and

office to residence in the evening. Each day, 180 officials need to be transported in Route I (from residence to head office and back) and 40 officials need to be transported in Route II (from residence to Branch Office and back). The cost per round trip for each type of vehicle along each route is given below.

You are required to formulate the information as a linear programming problem, with the objective of minimizing the total cost of hiring vehicles for the client company, subject to the constraints mentioned above. (only formulation is required. Solution is not needed).

Figures- Rs./round trip	20 seater vans	8 seater big cars	5 seater small cars
Route I:			
Residence: Head office and Back	600	400	300
Route II:			
Residence-Branch Office and Back	500	300	200

Simplex Method

14. 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:	A	B	C	Inert Ingredients
Cost per kg. (Rs.)	80	20	50	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.

15. Noah's Boats makes three different kins of boats. All can be made profitably in this company, but the company's monthly production is constrained by the limited amount of labour, wood and screws available each month. The director will choose the combination of boats that maximizes his revenue in view of the information given in the following table:

Input	Row Boat	Canoe	Kayak	Monthly Availability
Labour (Hours)	12	7	9	1,260 hours
Wood (Board feet)	22	18	16	19,008 board feet
Screws (Kg.)	2	4	3	396 Kg.
Selling price (in Rupees)	4,000	2,000	5,000	

(a) Formulate the above as a linear programming problem.
(b) Solve it by the simplex method.

From the optimal table of the solved linear programming problem answer the following questions:

(c) How many boats of each type will be produced and what will be the resulting revenue?
(d) Which, if any, of the resources are not fully utilized? If so, how much of spare capacity is left?
(e)
(f)

16. Three grades of coal A, B and C contains phosphorus and ash as impurities. In a particular industrial process, fuel up to 100 ton (maximum) is required which could contain ash not more than 3% and phosphorus not more than 0.03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grade. The percentage of impurities and the profits of each grades are as follows:

Coal	Phosphorus (%)	Ash (%)	Profit in Rs. (Per ton)
A	0.02	3.0	12.00
B	0.04	2.0	15.00
C	0.03	5.0	14.00

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

Interpretation & Shadow Price

17. 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)

			3	4	1	0	0	0
Programme	Profit	Quantity						
			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
S3	0	10	0	0	8/6	8/6	-10/6	1
		(Cj - Zj)	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.

18. The following details are taken from the forecasts for 20×8 of XYZ Ltd. Sales demand p.a.:

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.

		x_1	x_2	x_3
Machining (x_4)	14,00,000	0.5	0.5	1.0
Assembly (x_5)	12,00,000	0.5	0.5	2.0
Contribution is estimated as follows.(Rs p.u.)		1,500	1,300	2,500

You are required to set up the first table & Interpret the following final table 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 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	187.5

A problem & solution on slack &Artificial Variable

19. Maximize $Z = x_1 + 2x_2 + 3x_3$
Subject to $x_1 - x_2 + x_3 > 4$
$x_1 + x_2 + 2x_3 < 8$
$x_1 - x_3 > 2$
$x_1, x_2, x_3 > 0$

Introducing slack variable s_2 for eq-2 , surplus s_1 & s_3 a nd artificial variables A_1, A_2 , for eq 1& 3 , the problem is reformulated as

Maximize, $Z=x_1+2x_2+3x_3+0s1+0s2+0s3 - MA1- MA2$

Subject to, $x_1-x_2+x_3-s_1+A_1 = 4$
$x_1+x_2+2x_3+s_2 = 8$
$x_1-x_3-s_3+A_2 = 2$
$x_1, x_2, x_3, s_1, s_2, A_1, A_2 \geq 0$

Let us solve this problem using big-M simplex method.

Common for All tables	Profit	Prog	Qty.	1 x_1	2 x_2	3 x_3	0 s_1	0 s_2	0 s_3	-M A_1	-M A_2	Mini Ratio
	-M	A_1	4	1	-1	1	-1	0	0	1	0	4
Table 1	0	s_2	8	1	1	2	0	1	0	0	0	8
	-M	A_2	2	1	0	-1	0	0	-1	0	1	2 →
Net evaluation				1+2M	2-M	3	-M	0	-M	0	0	0
	-M	A_1	2	0	-1	2	-1	0	1	1		1 →
Table 2	0	s_2	6	0	1	3	0	1	1	0		2
	1	x_1	2	1	0	-1	0	0	-1	0		-ve
Net evaluation				0	2 –M	2 +2M	-M	0	1 +M	0		
	3	x3	1	0	-1/2	1	-1/2	0	½			-ve
Table 3	0	s2	3	0	5/2	0	3/2	1	-1/2			6/5
	1	x1	3	1	-1/2	0	-1/2	0	-1/2			-ve
Net evaluation				0	4	0	2	0	-1			
	3	x3	8/5	0	0	1	-1/5	1/5	2/5			
Table 4	2	x2	6/5	0	1	0	3/5	2/5	-1/5			
	1	x1	18/5	1	0	0	-1/5	1/5	-3/5			
Net evaluation				0	0	0	-2/5	-8/5	-1/5			

Since all NC elements of the last table are<0, this table will provide the optimal solution.
The optimal solution is given by
$X_1 = 18/5$, $x_2 = 6/5$, $x_3 = 8/5$ and $Z = 18/5 + 2x6/5+3x8/5 = 18/5 + 12/5 + 24/5 = 54/5 = 10.8$

New Topics

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. Theses 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 simple 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 behavioral 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. P.T.O.

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. 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 form 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.

11. ALLOCATION OF COMMON COSTS

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× 10÷19 = Rs. 1,579
∴ Share of common cost for product B = 2,000× 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

12. Uniform Costing & Inter Firm Comparison : check additional material

13. Test of hypothesis : check additional material

14. Time series analysis : check additional material

LOGARITHM TABLE

	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	7318	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	7350	7355	73	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	7619	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

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
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

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.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	.1028	.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	.3375	.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	.4722	.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	.4841	.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