

MEE1014 Industrial Engineering and Management

B.Tech (Mechanical)

Sivakumar, R
SMEC, VIT Chennai

Module-2

Elements of Cost:

Determination of Material cost - Labour cost –
Expenses - Types of cost – Cost of production –
Over-head expenses– break even analysis -
Problems.(6 Hours)

Expected Outcome

CO ₂	Explain Break even analysis to determine safe production levels and costing of industrial products.
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Determination of Materials Cost, Labour Cost and Expenses

Elements of Cost

➤ Define COST

- **Cost** is the amount of expenditure incurred on
- Cost is always linked to a particular item
 - ✓ **Example:** Number of components manufactured

➤ What do you mean by ELEMENTS OF COST?

- **Elements of cost:** The elements that contribute the cost of manufacture of the product
 - ✓ The elements are



Material

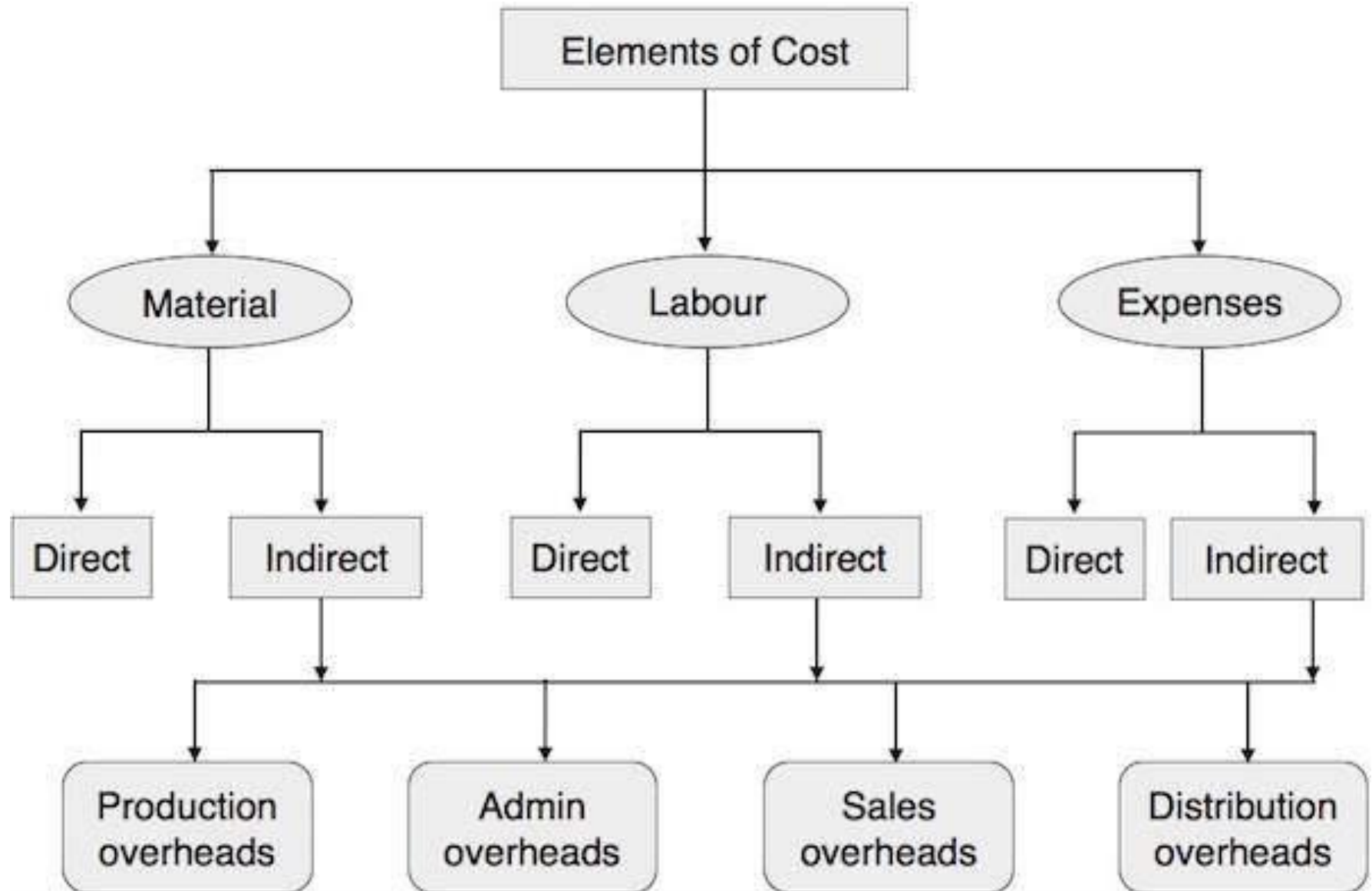


Labour



Expenses

Elements of Cost



Elements of Cost - Material

➤ **Material cost** is the cost of materials used by the organization

Direct Material Cost

- ✓ Material out of which product is manufactured
- ✓ The amount spent on direct materials is called the direct material cost
- ✓ Cost depends on the quantities produced
- ✓ Examples: Ni, Cr and Fe for making carbon steel

Indirect Material Cost

- ✓ Material necessary for production but not directly used in production
- ✓ The amount spent on indirect materials is called the indirect material cost
- ✓ Does not become part of the product
- ✓ Examples: Grease, Sand paper, oil, cotton waste

Elements of Cost - Labour

- Labour cost is the cost of remuneration (Salary, Commission, Bonus, etc.,) of the labours of an organization

Direct Labour Cost

- ✓ It is the cost of labours directly involved in the production
- ✓ Cost is calculated based on the amount of time spent by the labour on a particular job or based on the number of components produced
- ✓ Varies with the output
- ✓ Examples: Machinist, Mechanic, Welder, Painter, Carpenter

Indirect Labour Cost

- ✓ It is the cost of labours help in the production
- ✓ Remuneration paid to these labours cannot be traced to a job, process or production order
- ✓ Does not vary with the output
- ✓ Examples: Supervisor, Foreman, store keeper

Elements of Cost - Expenses

- The cost of service provided to an undertaking and the notional cost of the use of owned assets
- Expenditure other than material and Labour

Direct Expenses

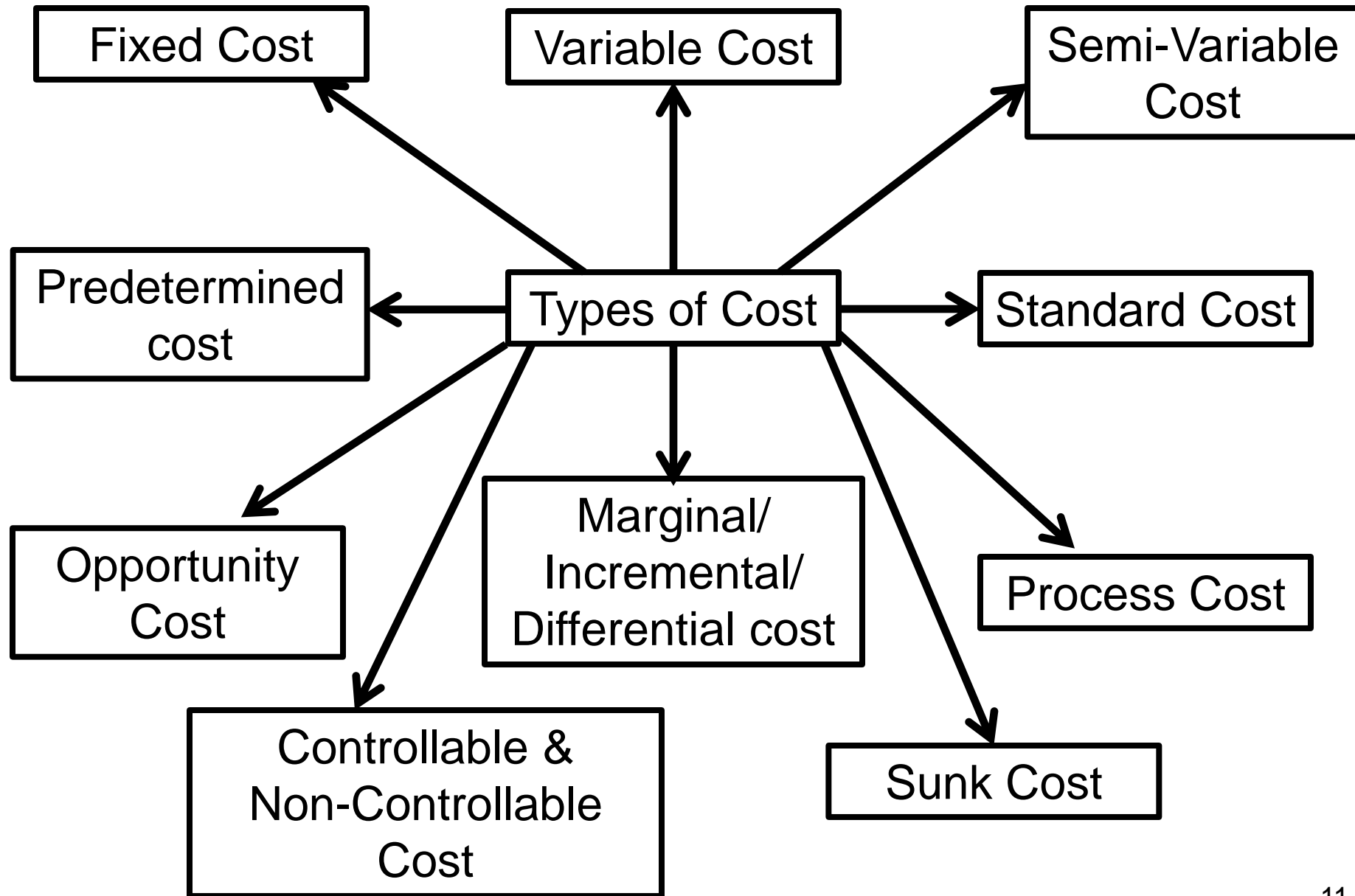
- ✓ Expenses that are specifically incurred by the organization to make a component
- ✓ Varies directly with the output
- ✓ Examples: Hire charges of special purpose tools, Royalty on products, Cost of designs for a particular component

Indirect Expenses

- ✓ Expenses that are incurred (cannot be directly identified with units of output) by the organization to make a component
- ✓ Expenses cannot be easily found out accurately
- ✓ Examples: Rent, Power, Lighting, Advertising, depreciation, Insurance, Telephone bill

Types of Cost

Types of Cost



Types of Cost

Fixed Cost:

- Does not vary for a certain given level of output or sales
- Examples: Rent, Salary, Depreciation, Administrative expenses
- High Fixed cost – Entry Barrier

Advertising



Contracted Salaries



Interest



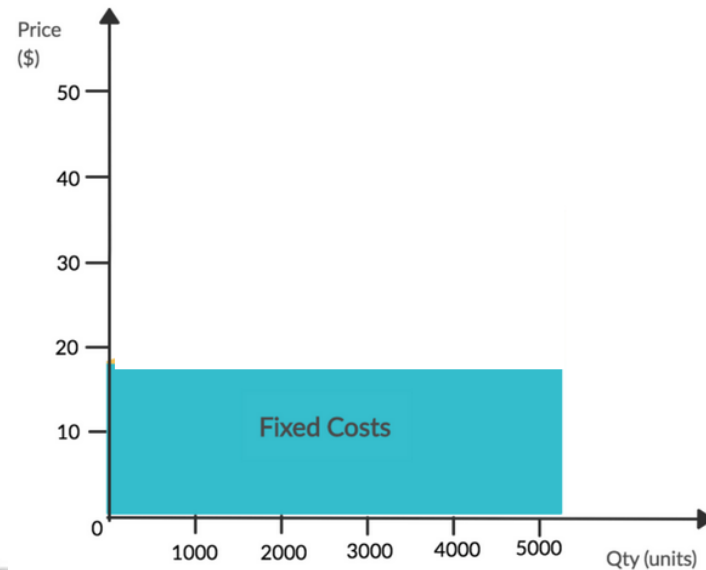
Insurance



New Building/Factory



Rent



<https://boycewire.com/fixed-cost-definition/>

Types of Cost

Variable Cost:

- Does vary directly with the volume of output
- Examples: Material, Labour



Commission Bonuses



Wage Costs

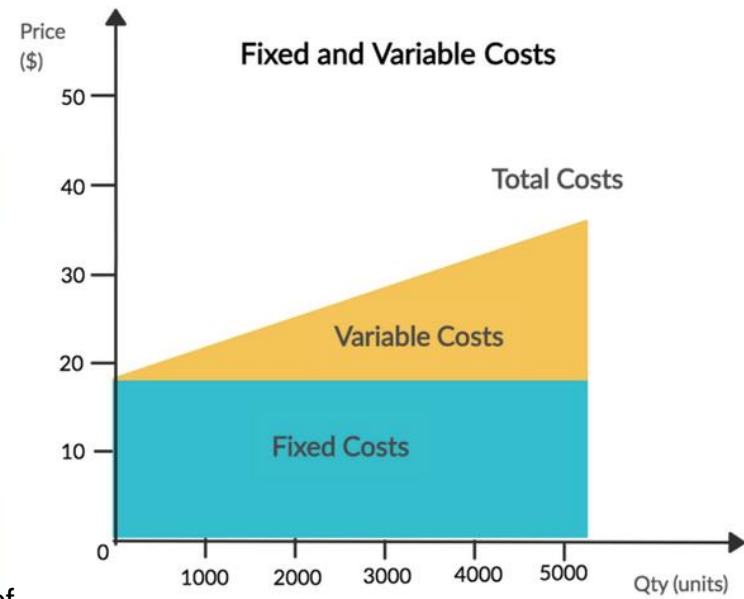


Component parts



Basic raw materials

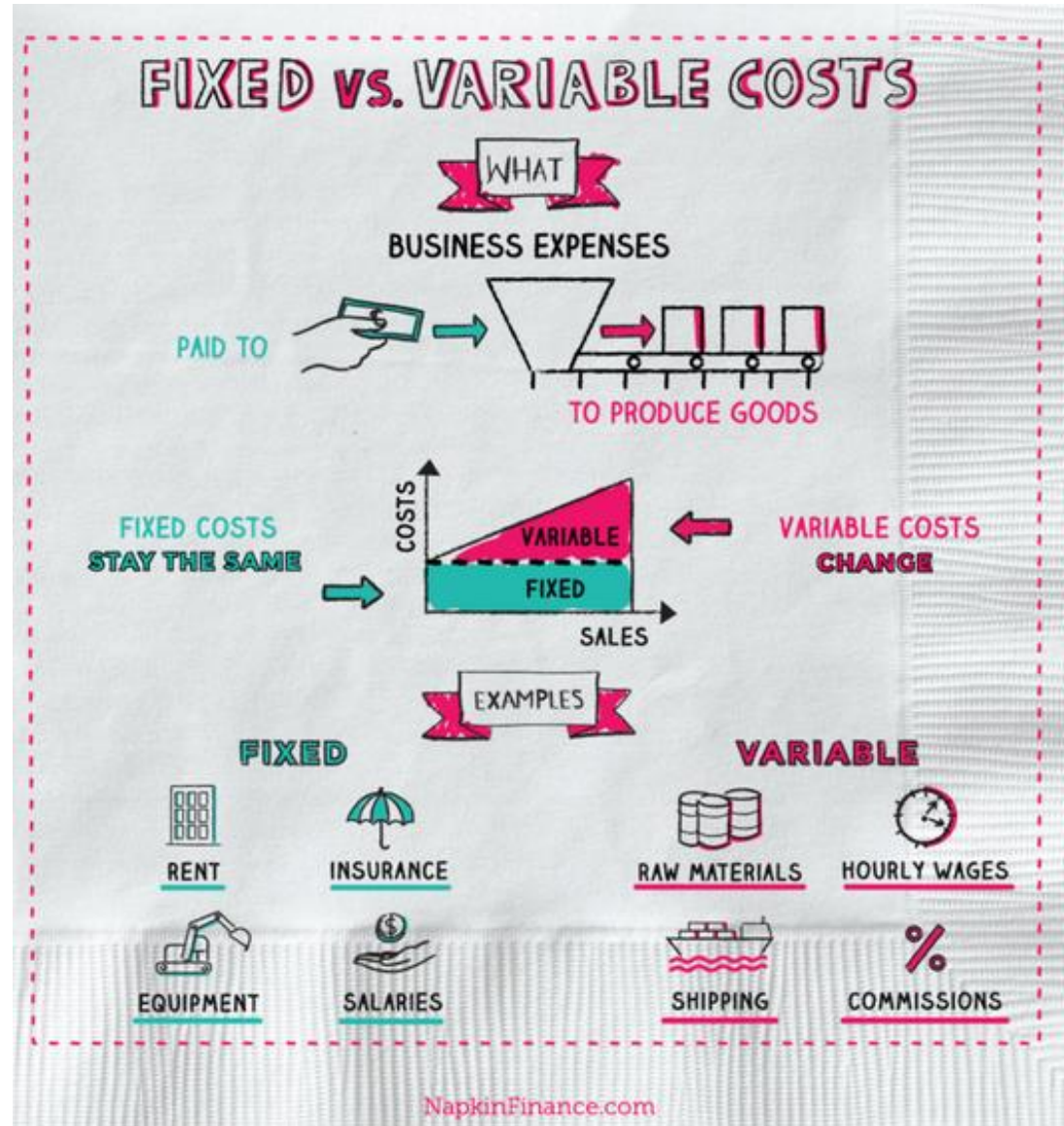
<https://www.tutor2u.net/economics/reference/short-run-costs-of-production>



<https://boycewire.com/fixed-cost-definition/>

Types of Cost

Fixed cost vs Variable Cost



Types of Cost

Semi-Variable Cost:

- Partly fixed cost and partly variable cost
- Varies irregularly with volume of output
- Examples: Indirect hourly charges of labour, Water, Electricity, Oil, Grease, Telephone, etc.,

Types of Cost

Pre-determined Cost:

- Calculated prior to start of the product by considering the factors affecting the cost
- Examples: Rent, Salary, Depreciation, Administrative expenses

Types of Cost

Standard Cost:

- Pre-determined cost
- It is a estimated cost per unit of output for material, labour and overheads based on the prediction of rates/expenses for a given future period
- Represents the best estimate by taking into consideration of eliminating inefficiencies and waste
- Systematic approach
- Represent organization's best measure of effective operation of the plant

Types of Cost

Opportunity Cost:

- Benefits lost by rejecting the best competing alternative to the one chosen
- Usually the net earnings or profits that might have been earned from the rejected alternative

Types of Cost

Marginal/Incremental/Differential Cost:

- Increase/decrease in total cost arising from producing and distributing additional/fewer unit of product
- Mostly it consists of variable cost only
- Used in determining the product selling cost
- Used in submitting bid
- Used to make a decision when replacing a new equipment/machine

Types of Cost

Process Cost:

- Aimed to evaluate wastage
- It is the cost for each of the processes which are performed to make a product
- Process cost sheet is prepared which contains the details of the total time spent and materials used on each process as well as power, light and heating cost in calculating the process cost
- Examples: Textile mill, paper mill, chemical industry

Types of Cost

Sunk Cost:

- Sunk costs are those which have already been incurred and which are unrecoverable
- In business, sunk costs are typically not included in consideration when making future decisions, as they are seen as irrelevant to current and future budgetary concerns

Types of Cost

Controllable Cost:

- Can be influenced by the action of a specified member of an undertaking
- Example: Direct materials, direct labour and certain factory overhead costs are controlled by the production manager

Uncontrollable Cost:

- Cannot be influenced by the action of a specified member of an undertaking
- Imposed by the top management
- Example: Advertising cost is allocated to different section is not under the control of section heads

Cost of Production

Cost of Production/ Production Cost

- It is the cost of the sequence of operations starting from supplying of materials, labours and services and finally ends with packing of the product

Overhead Expenses

Overhead

- Expenses other than direct expenses
- i.e. Expenses which cannot be identified with a particular unit of manufacture
- Includes cost of indirect material, indirect labour, services and other indirect expenses which cannot be conveniently charged to specific cost units
- Automation play a major role in the industries now-a-days.
- Due to automation, the cost of the plant and other auxiliaries increased a lot. Of course more than the material and labour cost.
- Overheads has a significant role now

Overhead

➤ Classification:

- ✓ Production or manufacturing overheads
- ✓ Administrative overheads
- ✓ Selling overhead
- ✓ Distribution overhead

Overhead - Production/Manufacturing

- It is the sum of all the indirect expenses incurred from the receipt of production order until its completion
- It includes
 - ✓ Building expenses - Rent, Maintenance, Repair, Insurance, lighting, depreciation, Heating, etc.,
 - ✓ Indirect labour - Supervisors, helpers, clerk, etc.,
 - ✓ Fuel, water and power
 - ✓ Plant maintenance and depreciation
 - ✓ Miscellaneous expenses - HR, Security, labour welfare & recreation, waiting rooms, rest rooms, etc.,

Overhead - Administrative

- It is the sum of all indirect expenses (management and clerical) incurred in managing the organization
- It is the cost of formulating the policy, directing the organization and controlling the functions of the organization.
- Cost includes
 - ✓ Office rent
 - ✓ Office clerks & managers salary
 - ✓ General managers, directors, auditor fee
 - ✓ Legal & banking charges
 - ✓ Insurance, taxes
 - ✓ Stationery, courier, mobile

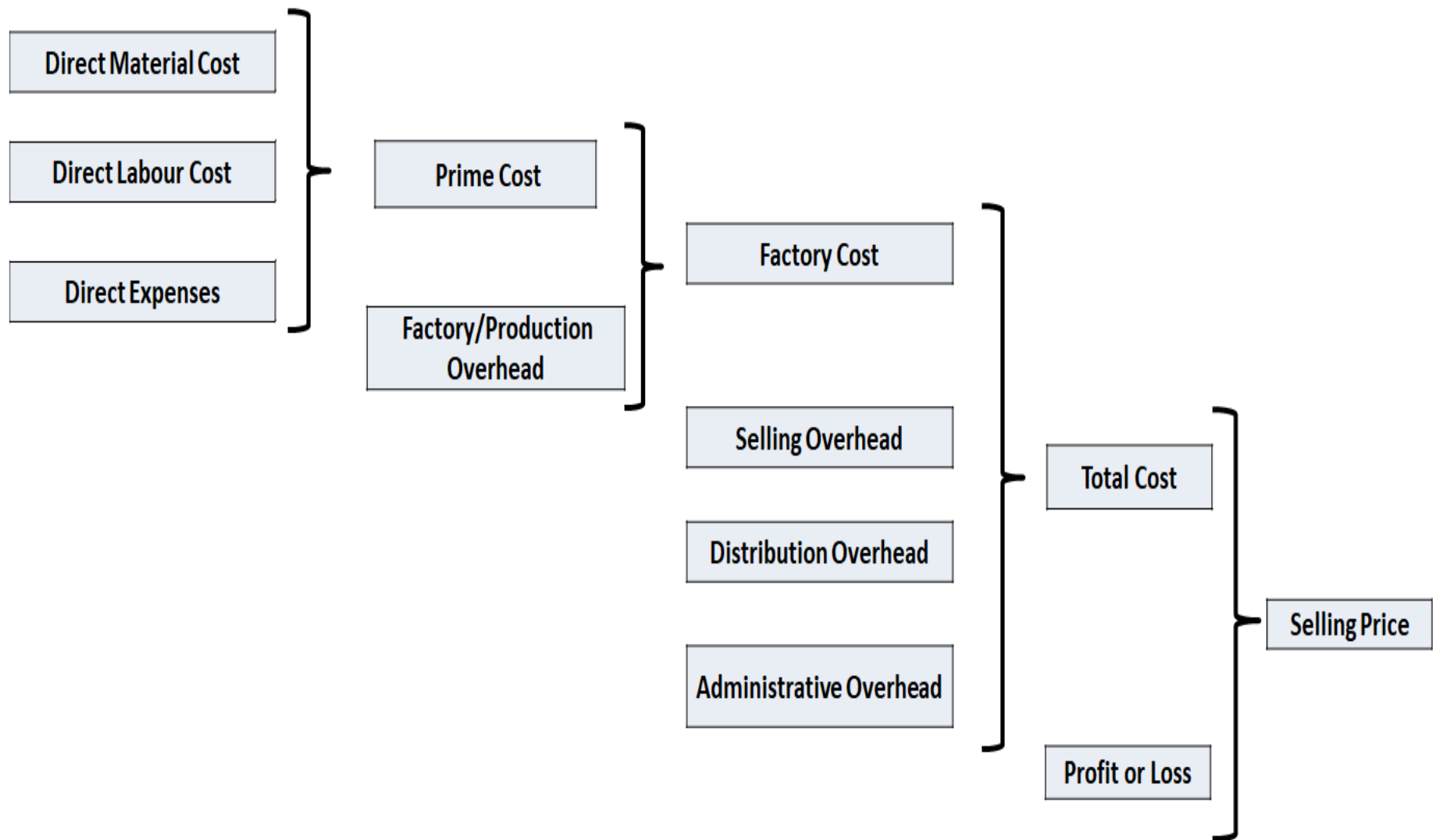
Overhead - Selling

- It is the sum of expenses (direct and indirect) incurred to sustain and increase the volume of sales
- Cost includes
 - ✓ Sales office rent and maintenance
 - ✓ Salary of Sales representatives, managers and sales office staff
 - ✓ Commission to agents
 - ✓ Advertising
 - ✓ Service after sales
 - ✓ Consumer service

Overhead - Distributive

- It is the expenses incurred in storing the products and transporting the products to consumers
- Cost includes
 - ✓ Transportation cost
 - ✓ Loading and unloading charges
 - ✓ Delivery vehicles maintenance and repair cost
 - ✓ Salaries of clerk and delivery labour

Selling Price



Production cost = Factory cost + Administrative Overhead

% Overhead Rate

Percentage on Direct Material Cost

This method is based on the theory that the overhead expense is incurred in proportion to the value of the direct materials consumed

$$\% \text{ overhead rate} = \frac{\text{Total overheads of the period}}{\text{Total direct material cost for that period}} \times 100$$

Percentage on labour cost

In this method, allocation of on-cost depends upon the wages paid to the direct labour

$$\% \text{ overhead rate} = \frac{\text{Total overheads of the period}}{\text{Total direct labour cost for that period}} \times 100$$

Percentage on Prime Cost

This method is suitable where, labour and material both play equal role

$$\% \text{ overhead rate} = \frac{\text{Total overheads of the period}}{\text{Prime cost for that period}} \times 100$$

Man-hour rate & Machine-hour rate

Man-Hour Rate

This method is very similar to the percentage on direct labour cost method.

The difference in the two methods is that in which the basis of allocation was the total direct labour cost, whereas in this basis of the total hours spent by the direct labour and not the wages paid to them

$$\text{Man hour rate} = \frac{\text{Total overheads of the period}}{\text{Total direct labour hours for that period}}$$

Machine-Hour Rate

This method is generally used where work is done mostly by machines and not by hand

$$\text{Machine hour rate} = \frac{\text{Total overheads of the period}}{\text{Total machine hours for that period}}$$

Problem-1

➤ Calculate the selling price of 10 g chocolate from the following data:

No. of Chocolate produced = 150

Labour cost (LC) = Rs. 250

Material Cost (MC) = Rs. 200

Factory Overheads (FO) = 30% of Prime Cost

Administrative and Selling Overheads (ASO) = 25 % of Factory Cost

Profit = 15% of the Total Cost

Prime cost (PC) = LC + MC = Rs 450

Factory cost (FC) = PC + FO = 450 + (30/100 * 450) = Rs. 585

Total cost (TC) = FC + ASO = 585 + (25/100 * 585) = Rs. 731.25

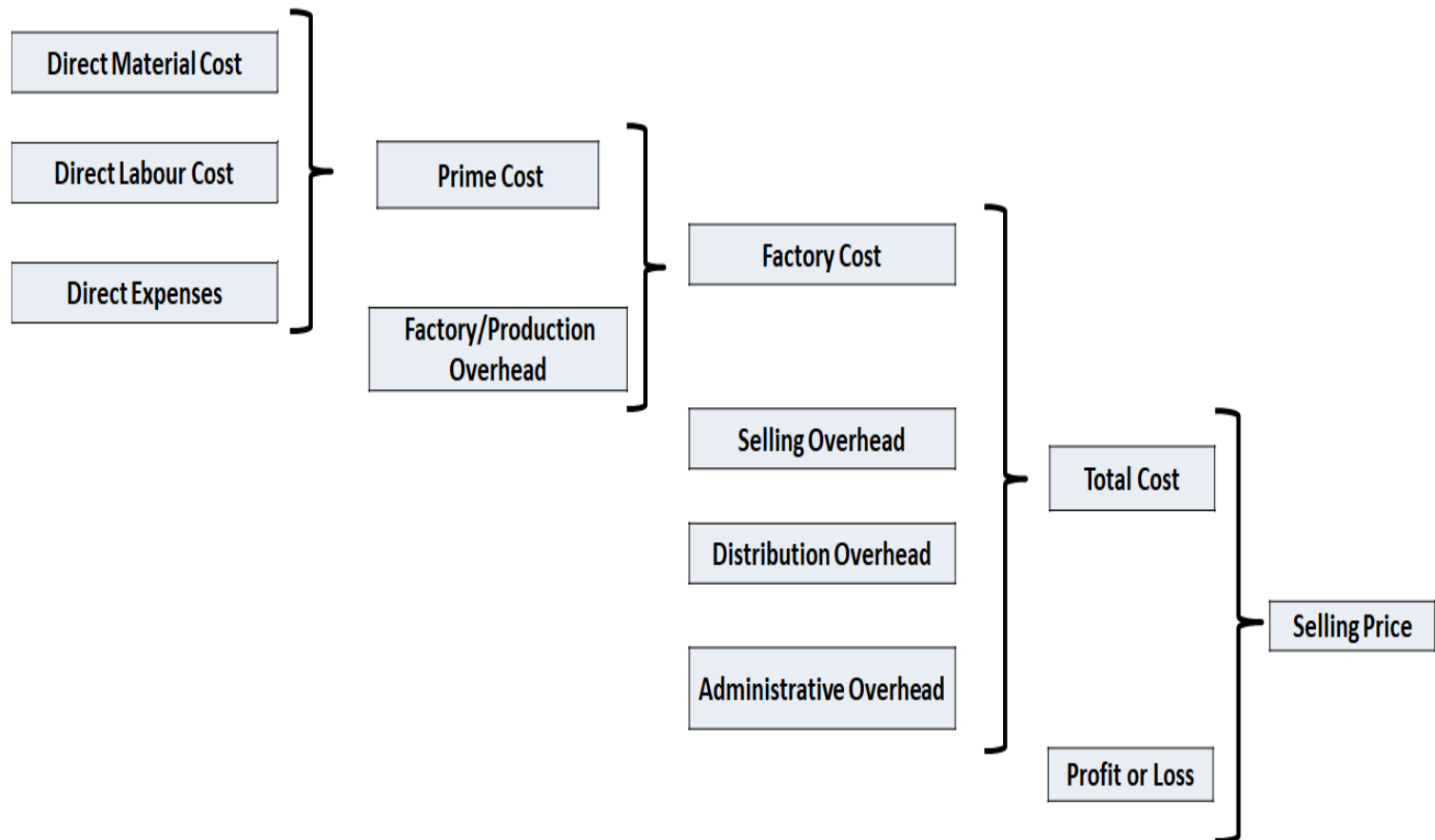
Selling price = TC + Profit = 731.25 + (15/100 * 731.25) = Rs. 840.94

Selling price of 1 chocolate = Selling price of 150 chocolates/ 150

= 840.94/150 = Rs. 5.6

Problem-2

- A mini-ink jet printer costs Rs. 7000. A discount of 20% of this price is given to the distribution. If labour cost, material cost and factory overheads are as 4:1:2 and selling expenses are 20% of the factory cost, calculate the profit of one printer. Assume factory overheads of Rs. 700.



Problem-2

- A mini-ink jet printer costs Rs. 7000. A discount of 20% of this price is given to the distribution. If labour cost, material cost and factory overheads are as 4:1:2 and selling expenses are 20% of the factory cost, calculate the profit of one printer. Assume factory overheads of Rs. 700.

Selling price of the printer = $0.8 * 7000 = \text{Rs. } 5600$

LC : MC : FO = 4 : 1 : 2

2 part of FO = Rs. 700 → 1 part of FO = $700/2 = \text{Rs. } 350$

LC = $4 * \text{FC} = 4 * 350 = \text{Rs. } 1400$

MC = Rs. 350

Prime cost (PC) = LC + MC = $\text{Rs } 1400 + 350 = \text{Rs. } 1750$

Factory cost (FC) = PC + FO = $1750 + 700 = \text{Rs. } 2450$

Total cost (TC) = FC + SO = $2450 + 0.2 * 2450 = \text{Rs. } 2940$

Selling price = TC + Profit

$5600 = 2940 + \text{profit} \rightarrow \text{Profit} = \text{Rs. } 2660/-$

Problem-3

- An organization is making a small valve by (a) Casting (b) Forging. The cost data is as follows:

	Casting	Forging
Materials cost per piece	Rs. 20	Rs. 20
Labour Rate	Rs. 10 per hour	Rs. 10 per hour
Time required to make one valve	4 Hours	40 Minutes
Overheads	30% of labour cost	125% of labour cost

Calculate and compare the total cost of each valve in two cases.

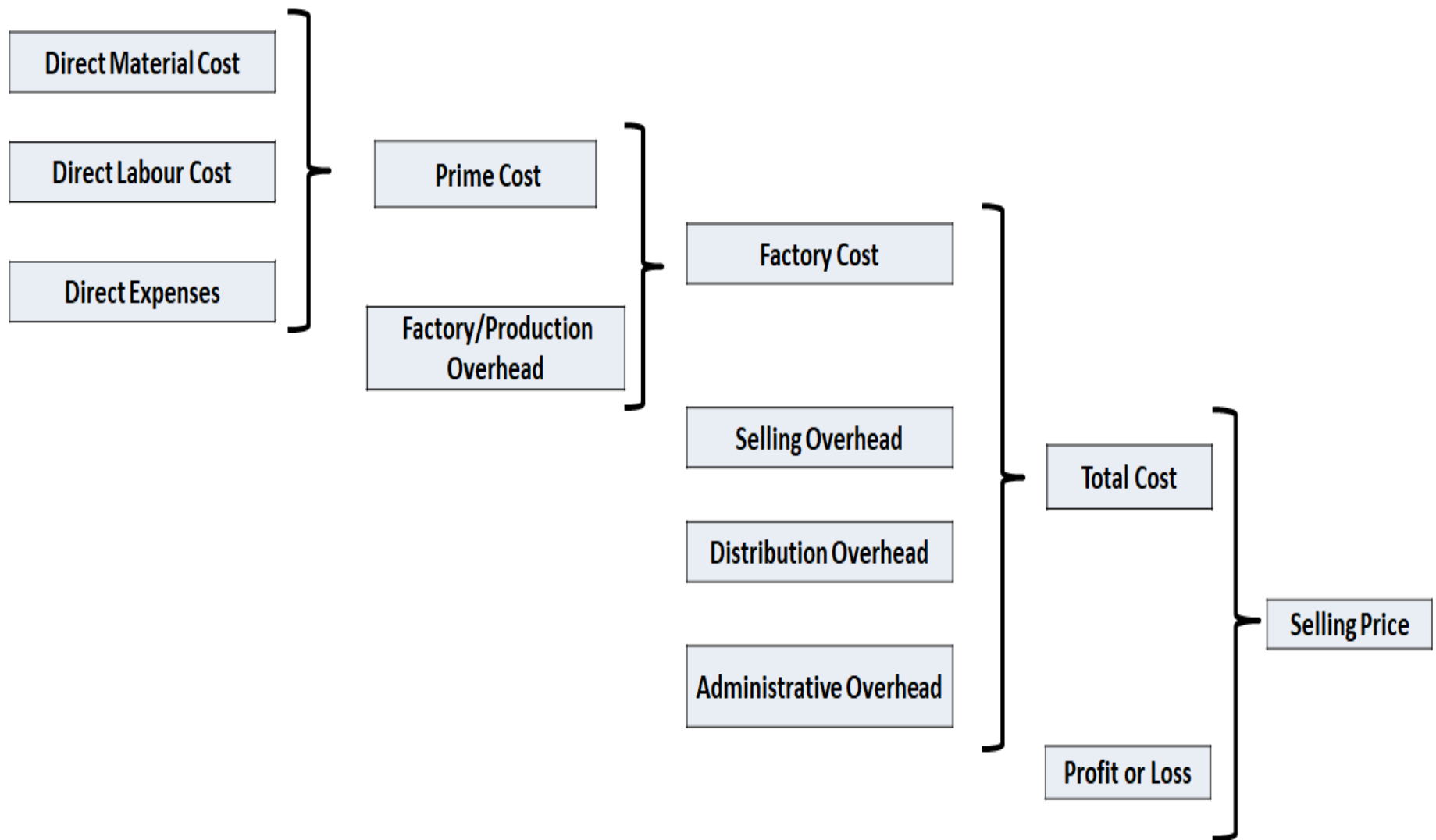
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- **Casting** is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a **casting**, which is ejected or broken out of the mold to complete the process.



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- **Forging** is a manufacturing process involving the shaping of metal using localized compressive forces. The blows are delivered with a hammer (often a power hammer) or a die.



Selling Price



Production cost = Factory cost + Administrative Overhead

Problem-3

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Casting

$$\text{Prime cost (PC)} = \text{LC} + \text{MC} = (4 * 10) + 20 = \text{Rs. 60}$$

$$\text{Factory cost (FC)} = \text{PC} + \text{FO} = 60 + 0.3 * 40 = \text{Rs. 72}$$

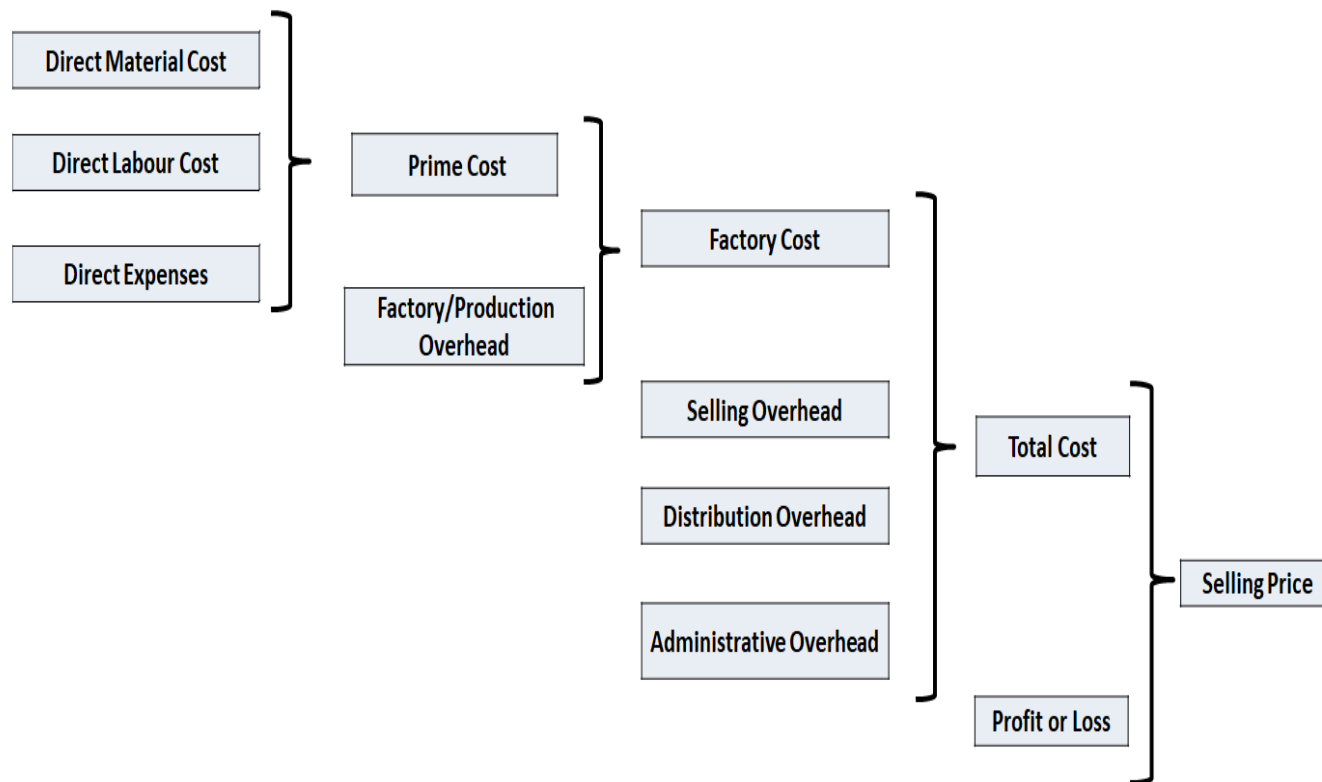
Forging

$$\text{Prime cost (PC)} = \text{LC} + \text{MC} = (40/60 * 10) + 20 = \text{Rs. 26.7}$$

$$\text{Factory cost (FC)} = \text{PC} + \text{FO} = 26.7 + 1.25 * (40/60 * 10) = \text{Rs. 35.07}$$

Problem-4

- A startup company employs 25 persons. It consumes material worth Rs, 22000, pays workers at the rate of Rs. 12 per hour and incurs total overhead of Rs. 15,000. In a particular month (26 days) workers had an overtime of 125 hours and were paid at 1.5 times their normal rate. Find the total cost and the man hour rate of overhead. Assume 8 hours work per day.



Problem-4

- A startup company employs 25 persons. It consumes material worth Rs, 22000, pays workers at the rate of Rs. 12 per hour and incurs total overhead of Rs. 15,000. In a particular month (26 days) workers had an overtime of 125 hours and were paid at 1.5 times their normal rate. Find the total cost and the man hour rate of overhead. Assume 8 hours work per day.

$$\text{Man hour rate} = \frac{\text{Total overhead}}{\text{Number of total man hours put}}$$

$$\text{Prime cost (PC)} = \text{LC} + \text{MC} = [(25 * 12 * 8 * 26) + 125 * 1.5 * 12] + 22000 = \text{Rs } 86650$$

$$\text{Factory cost (FC)} = \text{PC} + \text{FO} = 86650 + 15000 = 101650$$

$$\text{Total cost (TC)} = \text{FC} = 101650$$

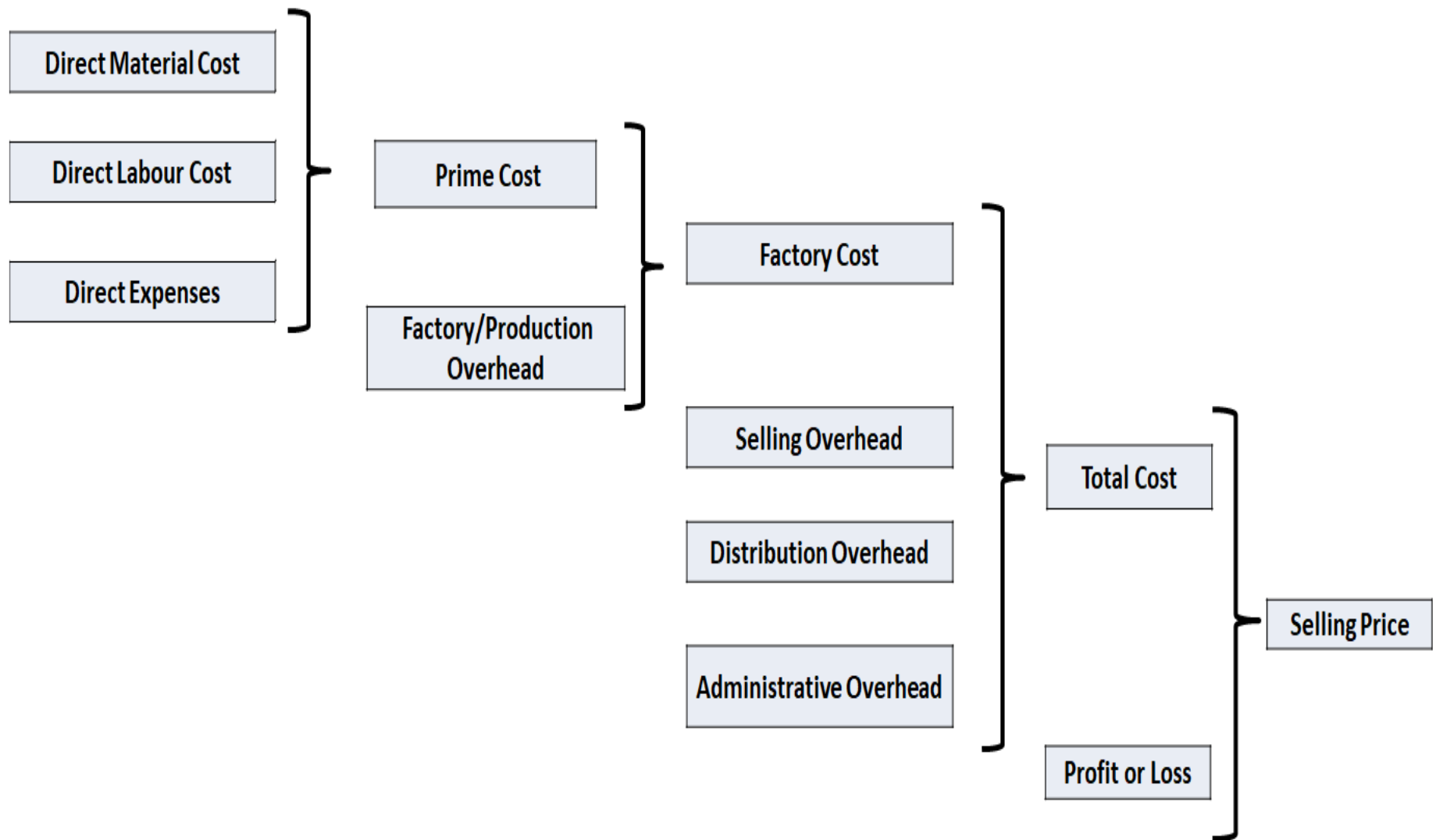
$$\text{Man hour rate} = \frac{15000}{(26 * 8 * 25) + 125} = 2.816$$

Problem-5

- Calculate the **prime cost, factory cost, production cost, total cost and selling price per item** from the data given below for the year 2019 - 2020

	Rs.
Cost of raw material in stock as on 01-04-2019	30,000
Raw material purchased	45,000
Direct labour cost	19,000
Direct Expenses	6,000
Factory/Works overhead	14,000
Administrative Expenses	11,000
Selling and distribution expenses	7,000
No. of items produced	1000
Cost of Raw material in stock as on 31-03-2020	20000
Net profit/item is 10% of total cost of the product	

Selling Price



Production cost = Factory cost + Administrative Overhead

Problem-5

Prime cost (PC) = LC + MC + Direct expenses = 19000 + (45000 + 30000 - 20000) + 6000
= Rs. 80000

Factory cost (FC) = PC + FO = 80000 + 14000 = Rs 94000

Production cost = FC + Admin overhead = 94000 + 11000 = Rs 105000

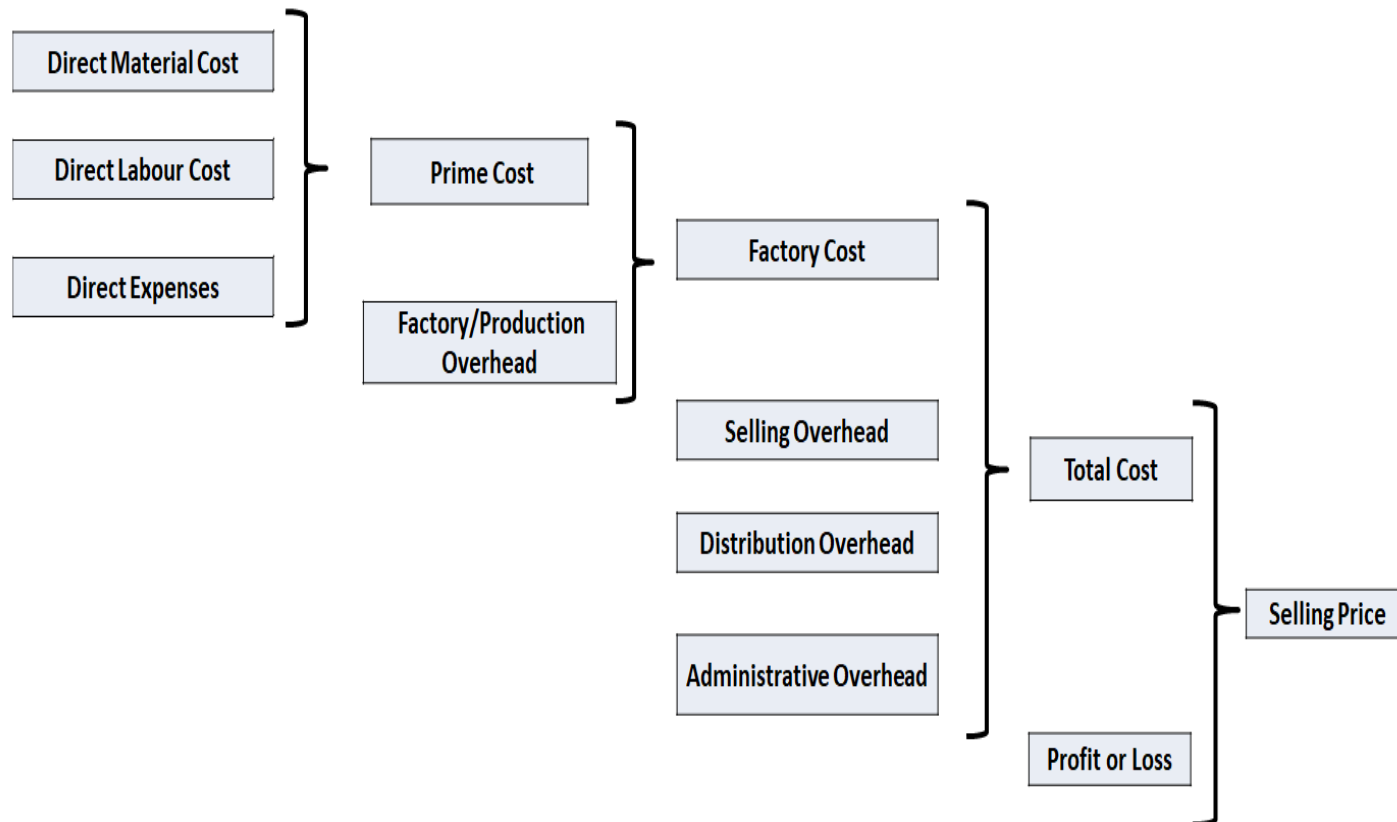
Total cost (TC) = FC + Admin + Sales + Distributive = 94000 + 11000 + 7000 = Rs. 112000

Selling price = TC + Profit = 112000 + 0.1 * 112000 = Rs 123200

Selling price/item = 123200/1000 = 123.2

Problem-6

- A health product is manufactured in batches of 200. The direct material cost is Rs. 100, direct labour cost is Rs. 150 and factory overhead charges are Rs. 130. If the selling expenses are 50% of factory cost, what should be selling price of each product so that the profit is 15% of the total cost?



Problem-6

- A health product is manufactured in batches of 200. The direct material cost is Rs. 100, direct labour cost is Rs. 150 and factory overhead charges are Rs. 130. If the selling expenses are 50% of factory cost, what should be selling price of each product so that the profit is 15% of the total cost?

Prime cost (PC) = LC + MC + Direct expenses = 100 + 150 = Rs. 250

Factory cost (FC) = PC + FO = 250 + 130 = Rs. 380

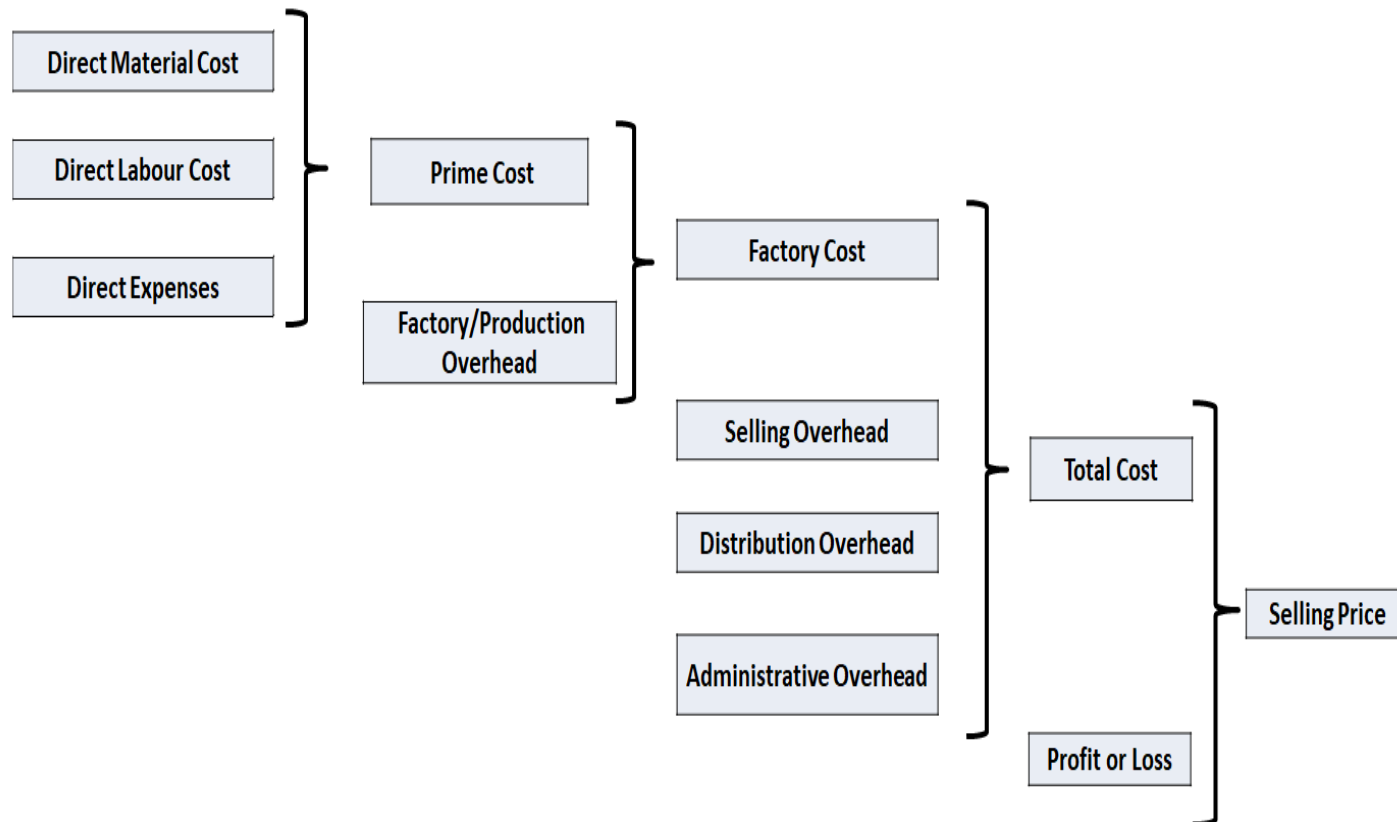
Total cost (TC) = FC + Admin + Sales + Distributive = 380 + 0.5 * 380 = Rs. 570

Selling price = TC + Profit = 570 + 0.15 * 570 = Rs. 655.5

Selling price/item = 655.5/200 = Rs. 3.28

Problem-7

- An industry manufactures 250 clutch plate per day. Each plate weights 2 kg and the material cost is Rs. 12/kg. If overhead expenses are 160% of direct labour cost and labours are paid at 80/day, calculate the cost of producing one clutch plate.



Problem-7

- An industry manufactures 250 clutch plate per day. Each plate weights 2 kg and the material cost is Rs. 12/kg. If overhead expenses are 160% of direct labour cost and labours are paid at 80/day, calculate the cost of producing one clutch plate.

Prime cost (PC) = LC + MC + Direct expenses = 80 + (250 * 2 * 12) = Rs. 6080

Factory cost (FC) = PC + FO = 6080 + 1.6 * 80 = Rs. 6208

Total cost (TC) = FC + Admin + Sales + Distributive = 6208 + 0 = Rs. 6208

Cost per clutch plate = TC/No. of plates = 6208/250 = Rs. 24.8

Problem-8

- A casting department of a factory producing cast body has Rs. 10 lakhs as total overheads while the material cost was Rs. 50 lakhs, calculate the percentage on-cost in terms of % of direct material cost.

Problem-9

- The organization overheads of a particular concern for the year 2019-2020 were Rs. 20 lakhs and the total direct wages paid to the workers during the said period were Rs. 80 lakhs, find out the percentage of on-cost by percentage on direct labour cost method.

Problem-10

- An industry has total overhead of Rs. 10 lakhs, while the prime cost is Rs. 16 lakhs. Find out the on-cost of the two products by percentage on prime cost method, if first product has Rs. 200 as direct material and Rs. 400 as direct labor cost, while second product has Rs. 200 as direct labour cost and Rs. 300 as direct material cost.

Problem-11

- An industry produces two parts X and Y. Part-X requires 30 hours and is manufactured by the workers paid at the rate of Rs. 10/hour. The second part, Part-Y also requires 30 hours but the workers producing it are paid at the rate of Rs. 8/hour. Find out the on-cost of each component if
1. It is 40% of the direct labour cost
 2. Rs. 3 per man-hour

Break Even Analysis

Break Even Analysis

- Breakeven analysis examines the short run relationship between changes in volume and changes in total sales revenue, expenses and net profit
- Also known as C-V-P analysis (Cost Volume Profit Analysis)
- C-V-P analysis is an important tool in terms of short-term planning and decision making
- It looks at the relationship between costs, revenue, output levels and profit

Break Even Analysis

Decision making on

- How many units must be sold to breakeven?
- How many units must be sold to achieve a target profit?
- Should a special order be accepted?
- How will profits be affected if we introduce a new product or service?

Break Even Analysis

Useful when

➤ **Starting a new business:**

- ✓ Helps in deciding, whether the idea of starting a new is viable
- ✓ Guide about the pricing strategy

➤ **Creating a new product:**

- ✓ Needed before launching a new product
- ✓ Specifically the product is going to add a significant expenditure

➤ **Changing the business model:**

- ✓ Needed when switching from wholesale to retail business
- ✓ Helps to find out selling price

Break Even Analysis

Key terminology:

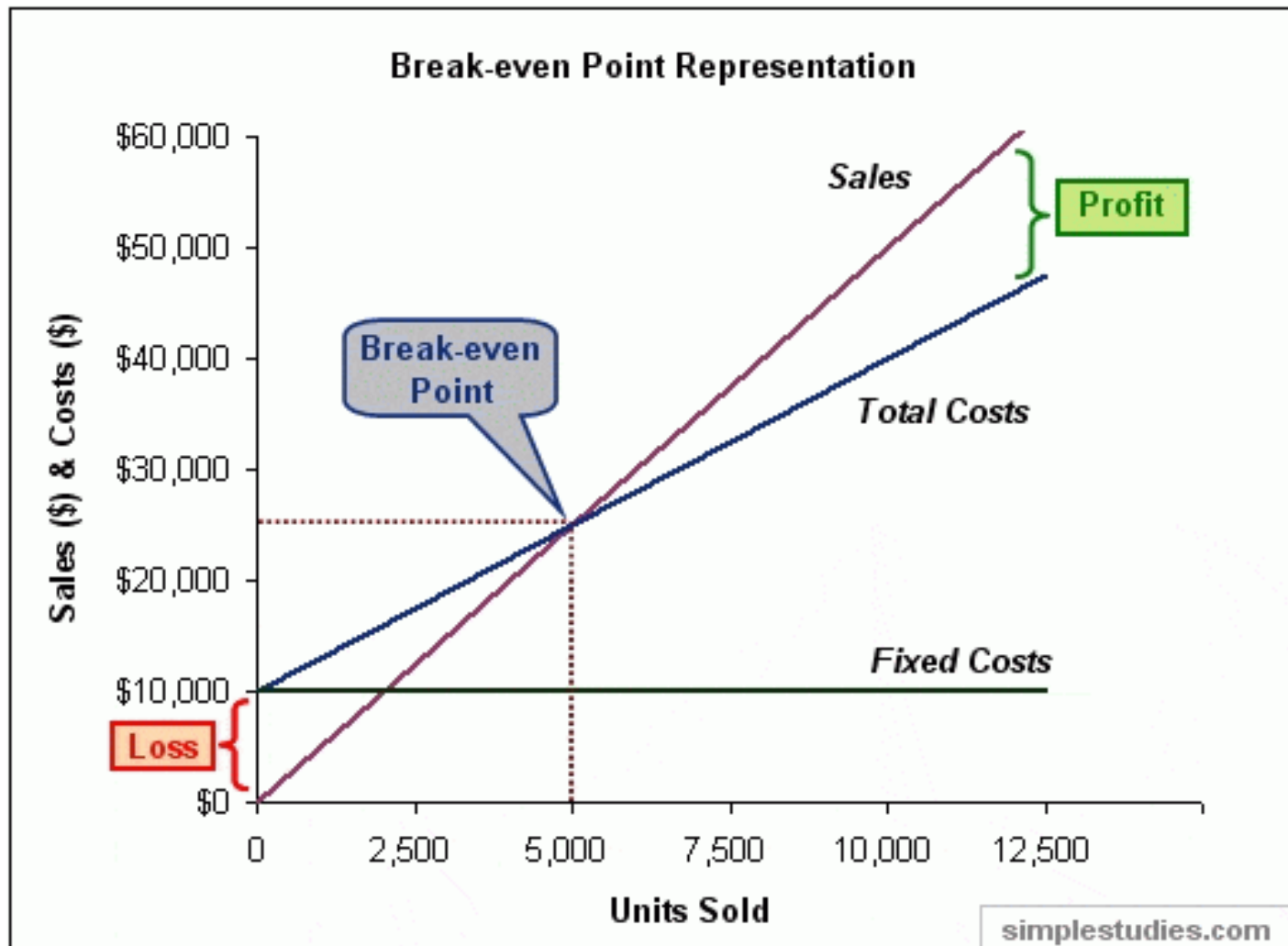
➤ Break-Even Point:

$$\text{Total revenue} = \text{Total cost}$$

- At this point, no profit or loss is incurred
- The firm merely covers its total costs
- Break-Even Point can be shown in graph form or by use of formulae

Break Even Analysis

➤ Graphical Representation



Break Even Analysis

- Calculation of Break even point

$$\text{Break even point} = \frac{\text{Fixed Cost}}{\text{Sales price per unit} - \text{Variable cost}}$$

- If Q = Quantity at Break even point

F = Fixed cost

V = Variable cost per unit produced

S = Selling price per unit

Then, $F + (Q \times V) = S \times Q$

$$Q = \frac{F}{S - V}$$

Break Even Analysis

Key Terminology

➤ Contribution per unit:

✓ **It is (Sales price - Variable cost per unit)**

✓ It measures the contribution made by each item of output to the fixed costs and profit of the organisation.

➤ Margin of safety

✓ A measure in which the budgeted volume of sales is compared with the volume of sales required to break even

➤ Marginal Cost

✓ Cost of producing one extra unit of output

Break Even Analysis

➤ Cost Involved

- ✓ Variable Cost
- ✓ Fixed Cost

➤ Variable cost

- ✓ Costs that change with changes in production levels or sales.
- ✓ **Example:** Costs of materials used in the production of the goods.

➤ Fixed cost

- ✓ Remain roughly the same regardless of sales/output levels.
- ✓ **Example:** Rent, Insurance and Wages

➤ Total costs

- ✓ **Total cost = Variable cost + Fixed cost**

Problem-12



Selling price per unit = Rs. 6

Variable cost per unit = Rs. 3

Fixed cost = Rs. 420

How many units must be sold in order to break even?

$$\text{Qty at Break even point} = \frac{\text{Fixed Cost}}{\text{Sales price per unit} - \text{Variable cost}}$$

$$\text{Quantity required} = \frac{420}{(6-3)} = 140$$

Problem-13

- A sports store sells cricket ball. How much profit/loss is made when 6000 balls are sold?

It is given that each ball is sold for Rs. 40, the variable cost is Rs. 30 per ball and the fixed cost is Rs. 30000.

$$\text{Net Profit/loss} = \text{Total contribution} - \text{Fixed Cost}$$

Here

$$\text{Total contribution} = \text{No. of balls} \times (\text{Selling price} - \text{variable cost})$$

$$\text{Net profit} = 6000 * (40 - 30) - 30000 = \text{Rs. 30000}$$

Break even analysis

- When unit cost is not given, the Profit Volume Ratio is used to find the break even point.
- Calculate the **volume** of sales needed to break even if the unit costs are not given

$$\textit{Break evenpoint} = \frac{\textit{Fixed Cost}}{\textit{Profit Volume Ratio}}$$

$$\textit{Profit Volume Ratio} = \frac{\textit{Total Contribution}}{\textit{Total Sales}}$$

Total contribution = Total Selling price – Total variable cost

Profit/loss = Total contribution – Fixed Cost

Margin of Safety is the sales over and above the breakeven analysis

Margin of Safety

- Margin of Safety is the sales over and above the breakeven analysis

$$\textit{Margin of Safety} = \frac{\textit{Profit}}{\textit{Profit Volume Ratio}}$$

Problem-14

- Calculate the Profit Volume Ratio, Profit, break even point and margin of safety for the following given data.

Sales = Rs. 60,000

Variable cost = Rs. 30,000

Fixed cost = Rs. 20,000

$$\textit{Profit Volume Ratio} = \frac{\textit{Total Contribution}}{\textit{Total Sales}}$$

$$\textit{Profit Volume Ratio} = \frac{\textit{Total Sales} - \textit{Variable Cost}}{\textit{Total Sales}}$$

$$\textit{Profit Volume Ratio} = \frac{60000 - 30000}{60000} = 0.5$$

Problem-14

- Calculate the Profit Volume Ratio, Profit, break even point and margin of safety for the following given data.

Sales = Rs. 60,000

Variable cost = Rs. 30,000

Fixed cost = Rs. 20,000

Profit = Total contribution – Fixed Cost

Profit = (Total Sales – Variable cost) – Fixed Cost

Profit = 60000 – 30000 – 20000 = Rs. 10,000

Problem-14

- Calculate the Profit Volume Ratio, Profit, break even point and margin of safety for the following given data.

Sales = Rs. 60,000

Variable cost = Rs. 30,000

Fixed cost = Rs. 20,000

$$\textit{Break evenpoint} = \frac{\textit{Fixed Cost}}{\textit{Profit Volume Ratio}}$$

$$\textit{Break evenpoint} = \frac{20000}{0.5} = \textit{Rs. 40000}$$

Problem-14

- Calculate the Profit Volume Ratio, Profit, break even point and margin of safety for the following given data.

Sales = Rs. 60,000

Variable cost = Rs. 30,000

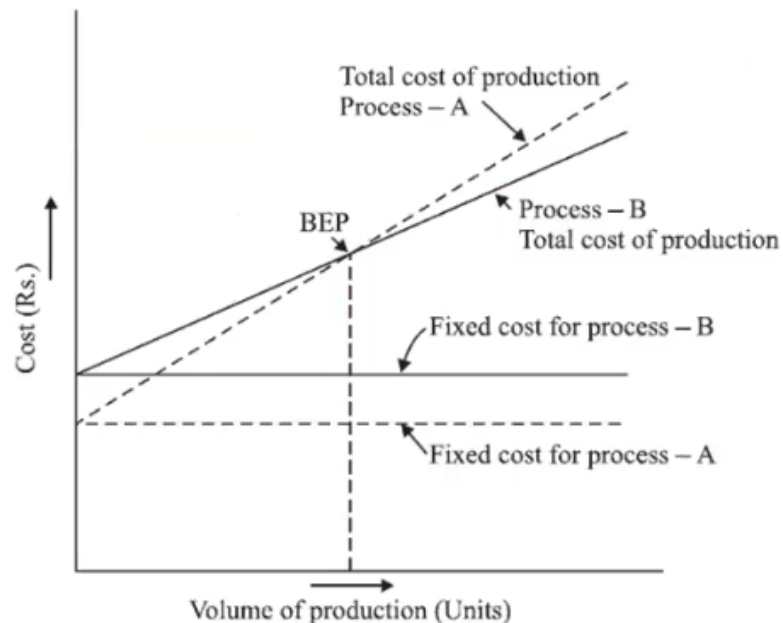
Fixed cost = Rs. 20,000

$$\textit{Margin of Safety} = \frac{\textit{Profit}}{\textit{Profit Volume Ratio}}$$

$$\textit{Margin of Safety} = \frac{10000}{0.5} = \textit{Rs. 20000}$$

Break Even Analysis

- It is also used to compare the cost of producing a product by different manufacturing processes.
- The chart tells us
 - ✓ Use Process A if the quantity to be manufactured is less than quantity at break even point
 - ✓ Use Process B if the quantity to be manufactured is more than quantity at break even point



Break Even Analysis

At the break even point,

Total cost of machine A = Total cost of machine B

Total cost = Fixed cost + variable cost

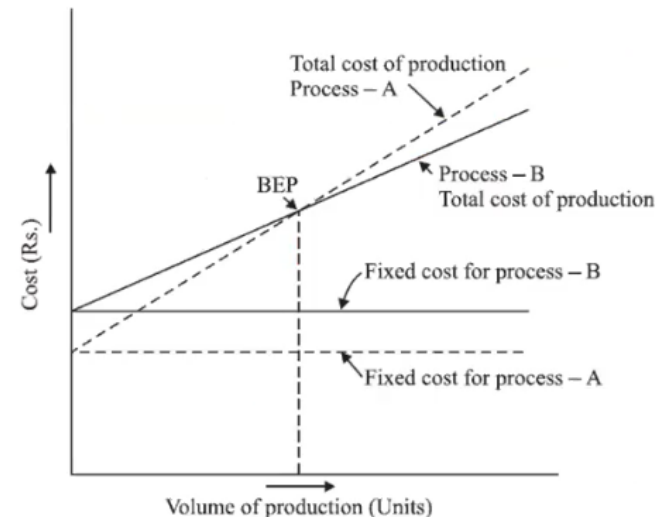
Variable cost = Unit production cost \times number of pieces

\therefore If 'Q' is the quantity of production at break-even point, then,

$$F_A + Q \times V_A = F_B + Q \times V_B$$

Where, F_A and F_B = Fixed cost of Machine A and B

V_A and V_B = Variable cost of Machine A and B



Problem - 15

- The initial cost for machine A is Rs. 20,000 and the unit production cost of the machine is Rs. 7 each. For the other machine B, the initial cost is Rs. 60,000 and the unit production cost is Rs. 2 each. Do the break even analysis

$$F_A + Q \times V_A = F_B + Q \times V_B$$

$$20000 + (Q \times 7) = 60000 + (Q \times 2)$$

$$Q = 8000$$

Problem - 16

A component can be produced with equal ease on either a capstan lathe or on a single spindle cam operated automatic lathe. Find the break-even quantity Q_E if the following information is known by using plotting break even graph

	<i>Capstan Lathe</i>	<i>Automatic Lathe</i>
(a) Tooling cost	Rs. 30.00	Rs. 30.00
(b) Cost of cams	—	Rs. 150.00
(c) Material cost/Component	Rs. 0.25	Rs. 0.25
(d) Operating labour cost	Rs. 2.50/hour	Rs. 1.00/hour
(e) Cycle time/Component	5 minutes	1 minute
(f) Setting up labour cost	Rs. 4.00/hour	Rs. 4.00/hour
(g) Setting up time	1 hour	8 hours
(h) Machine overheads (setting and operating)	300 % of (d)	1000 % of (d)

Problem - 16

Capstone Lathe

	Capstan Lathe
(a) Tooling cost	Rs. 30.00
(b) Cost of cams	—
(c) Material cost/Component	Rs. 0.25
(d) Operating labour cost	Rs. 2.50/hour
(e) Cycle time/Component	5 minutes
(f) Setting up labour cost	Rs. 4.00/hour
(g) Setting up time	1 hour
(h) Machine overheads (setting and operating)	300 % of (d)

$$\text{Overheads} = \frac{300}{100} \times 2.50 = \text{Rs. } 7.50/\text{hour}$$

$$\begin{aligned}\text{Fixed Costs} &= \text{tooling cost} + \text{setting-up cost} \\ &= 30.00 + 1(4.00 + 7.50) \\ &= 30.00 + 11.50 = \text{Rs. } 41.50 \\ &\approx \text{Rs. } 42\end{aligned}$$

$$\begin{aligned}\text{Variable costs/Component} &= \left(2.50 \times \frac{5}{60} \right) + 0.25 + \left(7.50 \times \frac{5}{60} \right) \\ &= 0.21 + 0.25 + 0.63 = \text{Rs. } 1.09\end{aligned}$$

$$\text{Variable costs/1000 components} = \text{Rs. } 1090.00$$

Problem - 16

Automatic Lathe

Automatic Lathe

(a) Tooling cost	Rs. 30.00
(b) Cost of cams	Rs. 150.00
(c) Material cost/Component	Rs. 0.25
(d) Operating labour cost	Rs. 1.00/hour
(e) Cycle time/Component	1 minute
(f) Setting up labour cost	Rs. 4.00/hour
(g) Setting up time	8 hours
(h) Machine overheads (setting and operating)	1000 % of (d)

$$\text{Overheads} = \frac{1000}{100} \times 1.00 = \text{Rs. } 10.00/\text{h}$$

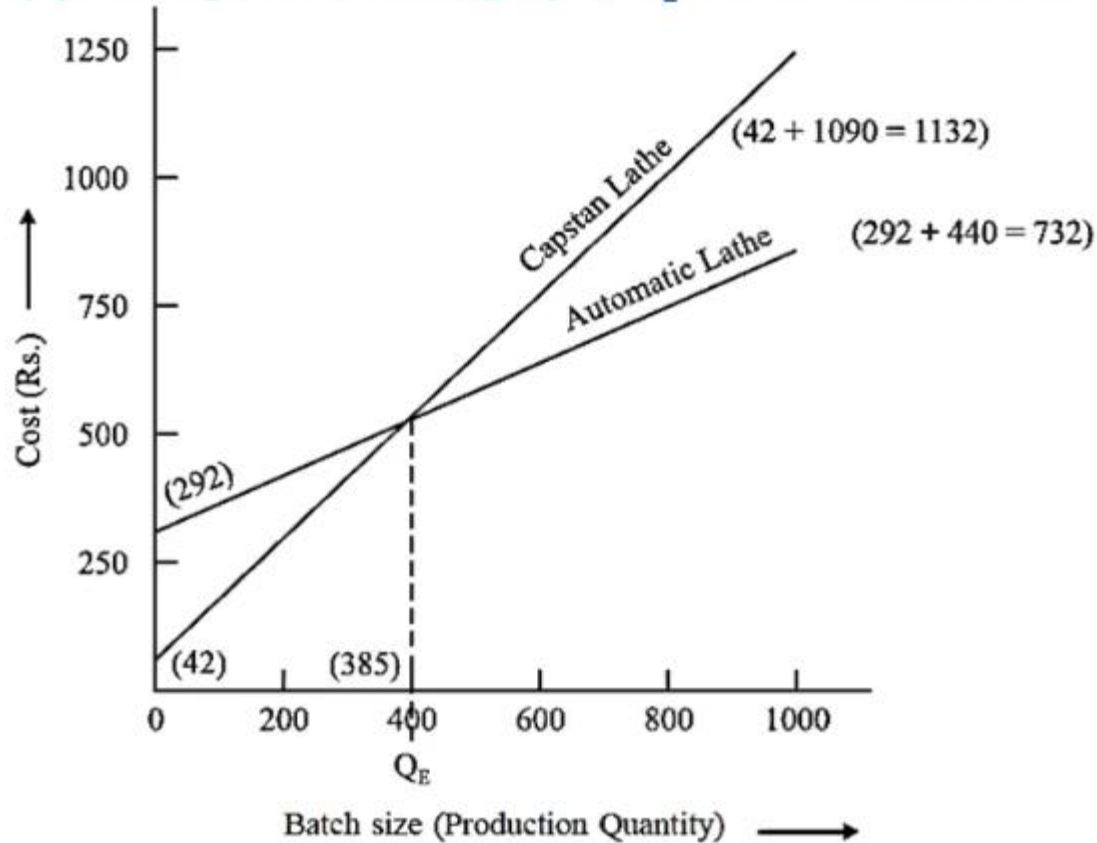
$$\begin{aligned} \text{Fixed costs} &= \text{tooling cost} + \text{cam cost} + \text{setting-up cost} \\ &= 30.00 + 150.00 + 8 (4.00 + 10.00) \\ &= 180.00 + 112.00 = \text{Rs. } 292.00 \end{aligned}$$

$$\begin{aligned} \text{Variable costs/Component} &= \left(1.00 \times \frac{1}{60} \right) + 0.25 + \left(10.00 \times \frac{1}{60} \right) \\ &= 0.02 + 0.25 + 0.17 = \text{Rs. } 0.44 \end{aligned}$$

$$\text{Variable costs/1000 components} = \text{Rs. } 440.00.$$

Problem - 16

By plotting break even graph, Q_E can be found out,



- If the batch size to be manufactured is equal to or less than 385 use the capstan lathe.
- If the batch size to be manufactured is equal to or greater than 385 use the automatic lathe.

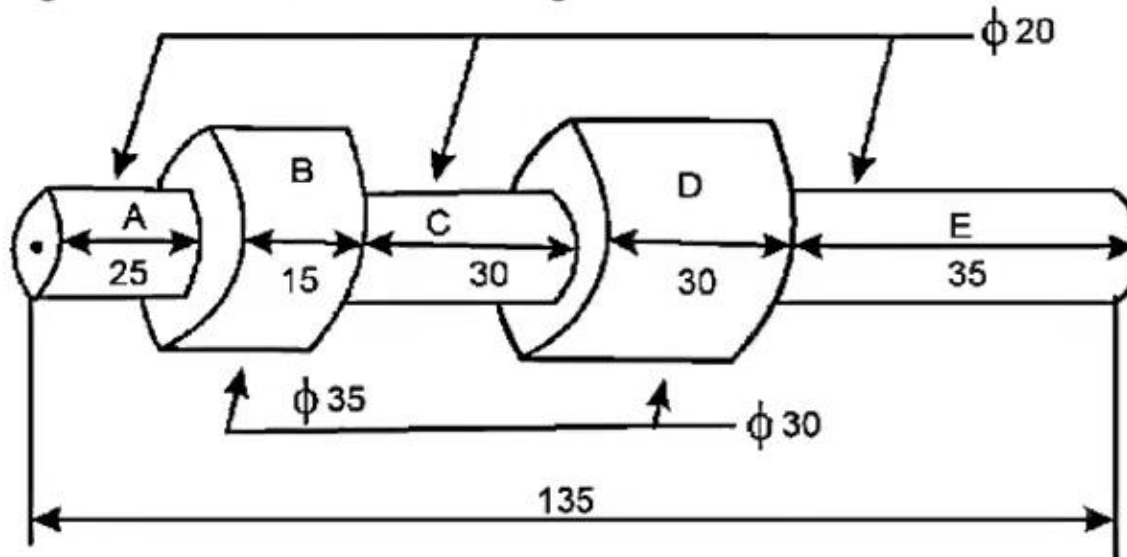
Determination of Material Cost

Procedure to calculate the material cost

- Study the drawing carefully and breakup the component into simple geometrical shapes like cubes, prisms, cylinders, etc.,
- Add the necessary machining allowances on all sides which are to be machined
- Determine the volume of each part by applying the formulae of mensuration
- Add the volumes of all the simple components to get the total volume
- Multiply the total volume of the product by the density of the material to get the weight of the material
- Find out the cost of the material by multiplying the cost per unit weight to the total weight of the material

Problem - 17

Estimate the weight of the aluminium shaft. Aluminium weighs 9 gms/cm³. Also evaluate the material cost if 1 kg Aluminium costs Rs. 8.



Lets disintegrate the given component in to geometrical parts A, B, C, D and E

Diameter of A ,B,C,D & E = 20 mm, 35 mm, 20 mm, 30 mm, 20 mm
Length of A, B, C, D & E = 25 mm, 15 mm, 30 mm, 30 mm, 35 mm

Problem - 17

$$\text{Volume of A} = \Pi/4 * D^2 l = 7853 \text{ mm}^3$$

$$\text{Volume of B} = \Pi/4 * D^2 l = 14431.69 \text{ mm}^3$$

$$\text{Volume of C} = \Pi/4 * D^2 l = 9424.77$$

$$\text{Volume of D} = \Pi/4 * D^2 l = 21205.75$$

$$\text{Volume of E} = \Pi/4 * D^2 l = 10995.57$$

$$\begin{aligned} \text{Total Volume of the given component} &= \text{Volume of [A+B+C+D+E]} \\ &= 63,911.776 \text{ mm}^3 = 63.911 \text{ cm}^3 \end{aligned}$$

$$\text{Density of the material} = \rho = 9 \text{ g/cc}$$

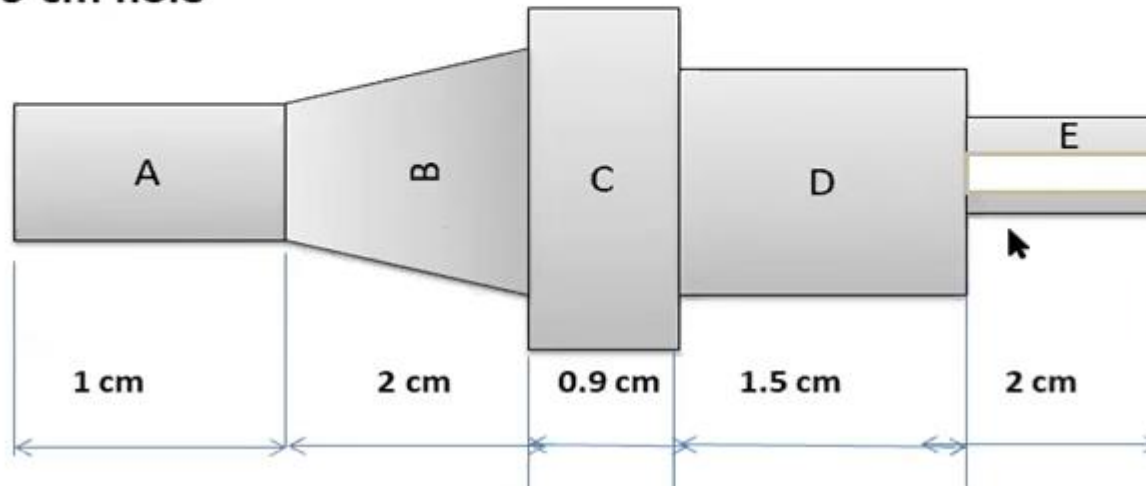
$$\text{Weight of the material} = \rho \times V = 9 \times 63.911 = 575.205 \text{ g} = 0.575 \text{ kg}$$

$$\text{Cost of 1 kg of material} = \text{Rs. 8}$$

$$\text{Cost of 0.575 kg of material} = 0.575 \times 8 = \text{Rs. 4.76}$$

Problem - 18

Estimate the volume of material required for manufacturing 100 pieces of shafts as shown in fig. The shafts are made of mild steel weighs 8g/cc and costs Rs.1 per Kg. Calculate the material cost for the shaft. The following data are Diameter of A , B, C, D and E = 1cm , 2cm, 25 cm, 1.5 cm and 1 cm with 0.75 cm hole



$$\text{Volume of A} = \frac{\pi}{4} \times D^2 \times l = 0.7857 \text{ cc}$$

$$\text{Volume of B} = \frac{\pi h}{3} (R_1^2 + R_2^2 + R_1 R_2) = 3.666 \text{ cc}$$

$$\text{Volume of C} = \frac{\pi}{4} \times D^2 \times l = 4.42 \text{ cc}$$

$$\text{Volume of D} = \frac{\pi}{4} \times D^2 \times l = 2.65 \text{ cc}$$

$$\text{Volume of E} = \frac{\pi}{4} \times (D^2 - d^2) \times l = 0.6875 \text{ cc}$$

Problem - 18

**Total Volume of the given component = Volume of [A+B+C+D+E]
= 12.21 cc**

Density of the material = $\rho = 8 \text{ g/cc}$

Weight of the material = $\rho \times V = 12.21 \times 8 = 97.68 \text{ g}$

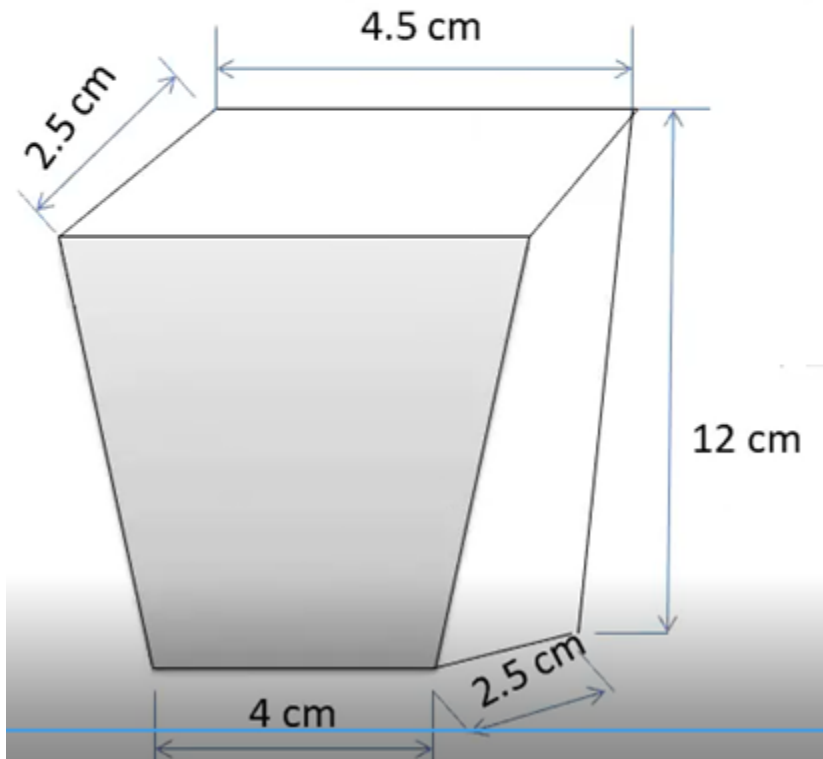
Weight of 100 shafts = $97.68 \times 100 = 9768 \text{ g} = 9.768 \text{ kg}$

Cost of 1 kg of material = Rs. 1

Cost of 9.768 kg of material = $9.768 \times 1 = \text{Rs } 9.77$

Problem - 19

An iron wedge has been made by forging out of a bar of 3 cm diameter. The dimensions of wedge is given in fig. If the density of material remains unchanged after forging, what length of bar is required for making a wedge.



Solution

The wedge is considered to be the frustum of pyramid.,

Therefore,

$$\text{Volume of pyramid} = \frac{h}{3} (a_1a_2 + \sqrt{a_1 \cdot a_2})$$

$$h = 12 \text{ cm}$$

$$a_1 = 2.5 \times 4.5 = 11.25 \text{ cm}^2$$

$$a_2 = 2.5 \times 4 = 10 \text{ cm}^2$$

$$\text{Volume of pyramid or wedge} = 127.43 \text{ cc}$$

Problem - 19

Given as weight remains unchanged,

So

Volume of bar = $\Pi/4 * D^2 l$ = Volume of wedge

$$\Pi/4 * D^2 l = 127.43$$

$$l = 18.03 \text{ cm}$$

End of Module-2