

2.) Direct Labour Cost: → The labour cost consists of the following two types of cost.

i.) Cost of labour for melting the metal which consists of cost of labour for fixing the furnace, baking cores, pouring molten metal in the mould and removal of castings from the mould.

ii.) Cost of labour directly connected with the production of casting.

3.) Overhead Cost: → Overhead cost consists of cost of labour indirectly connected with production of casting. E.g. labour for grinding, shot blasting, mixing sand, repairing patterns etc. Supervision and foremen, inspectors, store-keepers etc. Cost of indirect material such as molasses, linseed oil, coal powder, sand, resin etc. is also taken into consideration in overhead cost.

iv.) Punching and Drafting: → Punching is the process of producing holes in the workpiece when it is in hot state with the help of a tool called punch. Drafting is a process of enlarging the hole with the help of a special tool called drift.

* Estimation of Forging Cost

1.) Estimation of weight: → For estimating the weight of the component, the following procedure may be adopted.

- i.) Break up the drawing of the job into suitable geometrical sections.
- ii.) Find the total volume of the material required.
- iii.) Calculate the weight of material by multiplying total volume of material by its density.

2.) Estimation of losses: → The following losses occur during forging a metal:

- i.) Tong loss
- ii.) Flash loss
- iii.) Scale loss

iv) Punching and Drafting: → Punching is the process of producing holes in the workpiece when it is in hot state with the help of a tool called punch. Drafting is a process of enlarging the hole with the help of a special tool called draft.

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* (Forging)

Forging is the process of heating the metal at sufficiently high temperature to bring it into plastic state and then applying force either manually or by machine to give desired shape.

* (Forging operations)

- i) Drawing Down: → Drawing down, also known as drawing out, is the process of increasing the length of work-piece by forging by decreasing the cross-sectional area.
- ii) Up-Setting: → This is the reverse of drawing down operation. In this operation the cross-section of the workpiece is increased at the cost of length.
- iii) Bending: → Bending is the process of holding the work-piece between two fixtures and then striking the workpiece with the help of hammer to give desired shape..

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* (Gas welding)

It is a type of fusion welding in which the heat for welding is obtained by the combustion of a fuel gas. It ~~joins~~^{joins} metals using the heat of combustion of fuel gas (i.e. acetylene, hydrogen, propane or butane) and oxygen or air mixture. The intense heat thus produced melts and fuses together the edges of the part to be welded, generally with addition of a filler material.

In case of gas welding the following two welding techniques are adopted.

- 1.) Leftward welding: In this type of welding, the filler rod is held in the left hand and the welding torch in the right hand. The welder starts welding at the right hand end of the joint and proceeds towards the left as shown in fig.

iv.) Punching and Drafting: $\rightarrow$ punching is the process of producing holes in the workpiece when it is in hot state with the help of a tool called punch. Drafting is a process of enlarging the hole with the help of a special tool called draft.

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Given, $L = 25 \text{ cm}$, $D = 2.5 \text{ cm}$, $S = 30 \text{ cm/min}$,
 $F = 0.02 \text{ cm/rev}$, Mounting time = 50 s.

Let N is the number of revolutions/min.

We know that,

$$S = \frac{\pi D N}{100}$$

$$30 = \frac{\pi \times 2.5 \times N}{100}$$

$$N = \frac{100 \times 30}{\pi \times 2.5}$$

$$N = 382 \text{ r.p.m.}$$

or,

$$\text{Machining time, } T = \frac{L}{F \times N}$$

$$= \frac{25}{0.02 \times 382}$$

$$= 6.54 \text{ min}$$

$$\text{Total machining time} = 6.54 + \frac{50}{60}$$

$$= 7.37 \text{ min}$$

Ans

* (Estimating procedure)

The various steps in estimating the cost are as follow:

- i) prepare the list of all the necessary parts or components of the product.
- ii) prepare the process sheet showing various operations in sequence.
- iii) Make a list of materials required for each part.
- iv) Make a list of tools, machinery and equipments required for production.
- v) Mention the machine time for each part.
- vi) Estimate the total material cost of product.
- vii) Calculate the total labour cost involved in manufacturing.
- viii) Calculate the prime cost by adding material cost and labour cost.
- ix) Find out the various overhead charges.
- x) Calculate the total cost by adding prime cost and overhead charges.
- xi) Add suitable profit margin to total cost for sale price.
- xii) Send this cost structure to management for necessary approval.

* Estimating: Estimating is process of calculating the probable cost of a product before the start of manufacturing. It is an art of finding the cost, which is likely to be incurred on manufacturing a product.

* (Importance of estimating)

In this era of quality awareness, rapid development and tough competition in satisfying the variant demand of the customer, it has become necessary for an organization to have advanced information about the cost of product to be manufactured.

Book

* (Aims of estimating)

The various aims of estimating are as follows:

- i.) To help the industry in taking decision of manufacturing and selling policies of the product.
- ii.) To help in tender process.
- iii.) To know about the overhead cost and to compare and check the actual overheads.
- iv.) To decide the wages of the workers with the help of time study.

* (Functions of Estimating)

The main functions of estimating are as follows:

- i) To determine material cost by considering different allowances for various operations.
- ii) To determine labour cost of tool and equipments etc.
- iii) To determine overhead charges including selling charges, packing charges and transportation charges.
- iv) To determine selling price by adding profit in total cost.
- v) To determine time required for manufacturing by conducting time study and motion study.
- vi) To determine methods and equipments in manufacturing.
- vii) To make precise records of estimates for future.
- viii) To determine most economical procedure of manufacturing.
- ix) To estimate selling price of the product.

To estimate cost of the product, the estimating department follows a set procedure. After

* (Cost Estimator and its Qualification)

The person, who prepares the Cost estimate, is called Cost estimator.

(A Cost estimator must possess the following Qualification.

- i) A Cost estimator must be able to read and understand drawings well.
- ii) He must possess good knowledge of market prices of different materials required for manufacturing.
- iii) He must possess good knowledge of use of tool, jig, fixture etc.
- iv) He must possess good knowledge of cutting speeds, feeds, depth of cut for different materials and different types of tool.
- v) He must possess good knowledge of measurement.
- vi) He must know the procedure of conducting time and motion studies.
- vii) He must be a qualified technical person.
- viii) He must possess good knowledge of different wage rates of different types of workers.

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Forging is the process of heating the metal at sufficiently high temperature to bring it into plastic state and then applying force either manually or by machine to give desired shape.

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i) Drawing Down: → Drawing down, also known as drawing out, is the process of increasing the length of work-piece by forging by decreasing the cross-sectional area.

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iii) Bending: → Bending is the process of holding the work-piece between two fixtures and then striking the workpiece with the help of hammer to give desired shape.

* (Electric Arc welding)

Electric arc welding is a type of fusion welding in which an electric arc is set up between the metal electrode and the work piece.

* (Estimation of cost of electric Arc welding)

For estimating the cost of electric arc welding, the following factors should be considered.

- 1) Material Cost →
- 2) Labour Cost :
- 3) Power Charges.
- 4) Finishing Cost : → It includes the cost of finishing the welded joint after welding. Post welding treatment such as heat treatment may also be considered in this account.
- 5) Overhead Cost.

* (Gas Cutting)

Gas Cutting is the process of cutting the metal with the help of gas flame either manually or by machine. Gas Cutting is generally carried out with the help of oxy-acetylene gas flame.

* (Estimation of gas Cutting Cost)

For estimating the gas Cutting Cost, the following factors should be considered.

- i.) Material Cost: It includes the cost of material used in gas cutting such as oxygen, acetylene etc.
- ii.) Labour Cost: It can be obtained from wage sheets.
- iii.) Finishing Cost: It includes the cost of finishing and cleaning the cut parts.
- iv.) Overhead Cost: All the costs of facilities and equipments connected with gas cutting come under the category of overheads.

- 2.) Rightward welding $\rightarrow$ In this type of welding, the filler rod is held in the left hand and the welding torch in the right hand. The welder starts welding at the left hand end of the joint and proceeds towards the right as shown in fig.

(Unit: 7)
(Estimation of other shops)

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* (Welding)

Welding is a process of joining similar or dissimilar metals by fusion with or without the application of pressure and with or without the use of filler material. The fusion of metal takes place by means of heat. The heat may be obtained from burning of gas, electric arc, electrical resistance or by chemical reaction.

* (Edge preparation of joints)

Welding without edge preparation will not be strong because the two metals do not have uniform contact throughout the depth. Hence edge preparation is must for strong welded joints. Edges of the work-piece (which are to be welded) should be free from scale, rust, rust, paint, grease or any other foreign matter etc.

Approach length AB = $\sqrt{(AR)^2 - (OS)^2}$

$$= \sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{D}{2} - d\right)^2}$$

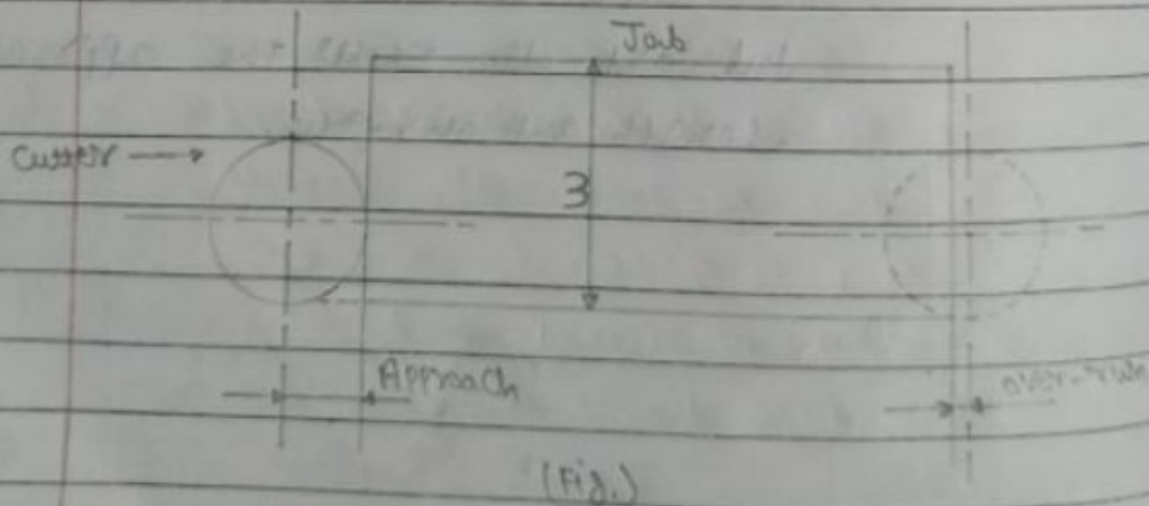
$$= \sqrt{\frac{D^2}{4} - \frac{D^2}{4} + Dd - d^2}$$

$$= \sqrt{Dd - d^2}$$

Further, over-run is generally taken as 5mm.

2.) (Facing operation)

If the diameter of cutter D is less than width of the job W , then a number of cuts are required to face the width W . Fig. shows the first and last position of the face cutter.



* (Milling operation)

Unlike Lathe, planer and Shaper which employ a single point cutting tool, Milling employs a multi-tooth rotating cutter for removal of metal. As the workpiece moves against the cutting edge, a chip of metal is removed. For estimating the time to complete a milling operation, the following factors are considered.

- i) Time taken to mill the surface. It depends upon the length of job.
- ii.) Approach length. It is the distance by which cutter has to be engaged before the full depth of cut is reached.
- iii.) Over-run or over-travel. It is the distance considered so that the cutter may clear the job.
- iv.) Total number of cuts required to complete the milling operation.
- v.) Added table travel. It is the sum of approach length and over-run.

Mainly, Cutting and Facing operation are carried out on milling machine. The time required for these operations may be obtained by the following formulae.

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$$\text{Lead for Multi-Start thread} = \frac{\text{Number of start}}{\text{Thread/cut}}$$

* (Tapping)

Tapping is the process of making internal threads with the help of a tool called tap. Taps are generally used for small works.

$$\begin{aligned} \text{Time for tapping} &= \frac{\text{Length travelled by tap}}{\text{Pitch} \times \text{r.p.m}} \\ &= \frac{L + \frac{D}{2}}{P \times N} \text{ min/cut} \end{aligned}$$

Where, L = Length of threaded portion,

D = Diameter of tap used,

P = Pitch of thread,

N = Number of revolutions/min.

$$\therefore \text{Total time for cutting thread} = \frac{3}{2} \times \frac{L + \frac{D}{2}}{P \times N} \text{ min}$$

(iv) Time for finish boring,

$$T_3 = \frac{L}{F_3 \times N_3}$$

$$T_3 = \frac{25}{0.6 \times 25}$$

$$T_3 = 1.67 \text{ min.}$$

Total time required for boring = $T_1 + T_2 + T_3$

$$= 1.74 + 5.56 + 1.67$$

$$= 8.97 \text{ min.}$$

* (Threading)

Threading is the process of removal of material to produce helix on internal or external circular surfaces for fastening purpose.

$$\text{Time for threading, } T = \frac{L + 0.7}{\text{pitch or lead} \times \text{r.p.m.}} \text{ min.}$$

Where L is the length of thread in cm and 0.7 cm has been taken as additional distance for tool travel.

Now it should be noted that

* (Boring)

Boring is the process of enlarging the hole already drilled in an object. The time required for boring may be calculated by the following formula.

$$\text{Time for boring} = \frac{\text{Length to be bored}}{\text{Feed/rev} \times \text{r.p.m.}}$$

Question Find the time required to rough bore, to second rough bore and to finish bore a cast iron cylinder whose diameter is 30cm and length of bore is 25cm. Use of following data:

- i.) Rough bore 48 r.p.m. and 0.3 cm feed.
- ii.) Second rough bore 50 r.p.m and 0.09 cm feed.
- iii.) Finish bore 25 r.p.m and 0.6 cm feed.

i.) Time for rough boring,

$$T_1 = \frac{L}{F_1 \times N_1}$$

$$T_1 = \frac{25}{0.3 \times 48}$$

$$T_1 = 1.74 \text{ min.}$$

ii.) Time for second rough boring,

$$T_2 = \frac{L}{F_2 \times N_2}$$

Given, $L = 25 \text{ cm}$, $D = 2.5 \text{ cm}$, $S = 30 \text{ cm/min}$,
 $F = 0.01 \text{ cm/rev}$, Mounting time = 50 s.

Let N is the number of revolutions/min.

We know that,

$$S = \frac{\pi D N}{100}$$

$$30 = \frac{\pi \times 2.5 \times N}{100}$$

$$N = \frac{100 \times 30}{\pi \times 2.5}$$

$$N = 382 \text{ r.p.m.}$$

or,

$$\text{Machining time, } T = \frac{L}{F \times N}$$

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ii.) Time for second rough boring,

$$T_2 = \frac{L}{F_2 \times N_2}$$

Question 1) Find the cutting speed on a piece of Carbon Steel of 6cm diameter and rotating at 240 r.p.m.

Given, $D = 6\text{cm}$

$N = 240\text{ r.p.m.}$

We know that

$$\text{Cutting Speed, } S = \frac{\pi DN}{100}$$

$$= \frac{\pi \times 6 \times 240}{100}$$

$$= 45.24\text{ m/min And}$$

Q 2.) Find the time taken to turn a ball component of 5cm diameter and 8cm long if the cutting speed is 45 m/min. and feed is 0.5 mm/rev. Assume single cut

Given,

$D = 5\text{cm}$, $L = 8\text{cm}$, $S = 45\text{ m/min.}$

$F = 0.5\text{mm/rev} = 0.05\text{cm/rev.}$

$$\text{Cutting Speed, } S = \frac{\pi DN}{100}$$

$$45 = \frac{\pi \times 5 \times N}{100}$$

* (Lathe operations)

Now we shall discuss the estimation of time on the following lathe operations.

- i.) Turning,
- ii.) Drilling,
- iii.) Boring,
- iv.) Tapping.

i.) (Turning)

It is the process of reducing the external diameter of workpiece by applying cut or a number of cuts.

Let D = Diameter of workpiece to be turned
in cm.

N = Revolutions of workpiece/min.

F = Feed/rev.

$$\text{Cutting Speed, } S = \frac{\pi DN}{100} \text{ m/min.}$$

Now,

$$\text{Feed/min} = \text{Feed/rev.} \times \text{r.p.m.}$$

$\therefore$ Time taken to turn L metre length

(Cutting Speed depends upon the following factors)

- i) Machinability of Material: Hard materials require a lower cutting speed than that of soft and ductile materials.
- ii) Material of Cutting Tool: High speed steel tool can cut at higher cutting speed than carbon steels for the same material to be cut.
- iii) Feed and Depth of Cut: If the feed and depth of cut is more, then less cutting speed is required and vice-versa.
- iv) Use of Cutting Fluids: By using good cutting fluids, cutting speed may be increased.

2.) Feed: The distance travelled by the tool along the work piece or by the workpiece to the tool in each revolution is called feed. It is generally expressed as mm per revolution.

3.) Depth of Cut: The amount by which a tool or cutter is inserted into the workpiece during one cut is called depth of cut. It is generally expressed as mm.

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* (T_u) Standard unit time Standard unit time is the sum of machining time, handling time, servicing time, organisational time and time for personal and fatigue allowance.

$$T_u = T_m + T_h + T_s + T_o + T_a$$

* (Total time (T_t))

$$\text{Total time, } T_t = T_u + \frac{T_{su} + T_{st}}{n}$$

Where n is the number of workpieces in a lot and all other terms have their usual meaning.

* (Terminology Relating to machining)

The following terms are generally used in connection with different machining operations.

1.) Cutting speed: The distance travelled by the cutting tool along the workpiece in one minute is called cutting speed. It is expressed as m/min.

$$\text{Cutting} = \frac{\pi D N}{100} \text{ m/min}$$

* (personal and Fatigue allowance (T_a))

personal allowance is the time provided to the worker to satisfy his personal needs such as drinking water, going to toilet etc. This allowance is about 5% of the total working time.

Fatigue allowance is the time provided to the worker to overcome fatigue caused during working. Fatigue is result of physical exertion, inconvenient postures, unhealthy working conditions etc. Excessive fatigue affects the performance of the worker badly. This allowance varies from 5% to 25% depending upon the work situation.

* Cycle time (T_c): This term is widely used in continuous flow production. It is the time between outputs of two consecutive units of production.

Let, T = Definite length of time in minutes.
 n = Number of units of production produced in time T .

$$\therefore \text{Cycle time, } T_c = \frac{T}{n}$$

gn job or batch order production

* Handling time (T_H): Handling time is the time required to load and unload the workpiece, to take measurements and to advance and retract the tool for certain operations.

* Tool down time (T_D): Tool down time is the time required to bring the machine tool to its original condition after removing cutting tools, fixtures etc. after machining a batch of components.

* Servicing time (T_S): Servicing time is the time required to carry out all types of servicing and maintenance of machine tool such as greasing, lubricating etc. as well as tool changing or resharpening.

* Organisational time (T_O): Organisational time is the time required for various organisational measures and delays during the machining of workpiece i.e. preparing the machine at the start of the day and cleaning the machine at the end of the day.

- * Machining cost $\rightarrow$ Machining is done on bar stocks, castings, forgings etc. in order to obtain exact shape and size of the finished part. Machining cost is calculated after calculating material cost and machining time required to machine a part.
- * Floor-to-floor time (FFT) $\rightarrow$ The floor-to-floor time (FFT) is the time elapsed from picking up a component to load on the machine for machining operation and depositing it after unloading. Therefore, this time includes time for manipulating, loading, machining and unloading the component.
- * Set up time (T_{su}) $\rightarrow$ Set up time is the time required to prepare the machine tool so that it can carry out machining operation on a batch of components.
- * Machining time (T_m) $\rightarrow$ Machining time is also known as ~~operation~~ ~~operation~~ time. Operation time is the time required to machine the workpiece actually to change its shape and size.

2.) According to time factor :→ Under this, following classification of budgets may be made.

i.) Long Term Budget :→ This budget is meant for long term. This is concerned with planning of a firm over five to ten years.

ii.) Short Term Budget :→ This budget is prepared for a period of one to two years. It is generally of a short term production plan.

iii.) Current budget :→ This budget prepared for a very short period such as one month, one quarter or one season etc.

3.) Classification According to flexibility :→ Under this, following classification of budgets may be made.

i.) Fixed Budget :→ It is a budget in which targets are fixed. Although the budget can be changed whenever it is desired, but, generally its nature is fixed.

- ii) Production Budget → It is the forecast of production based on sales and productive capacity.
- iii) Personnel Budget → It is a budget of personnel inventory and includes labour employed in productive capacity.
- iv) Research and Development Budget → It relates to the improvement in the quality of products by research for new products.
- v) Cash Budget → It is one of the important budgets. It is an estimate of cash receipt and disbursement for a future period of time.
- vi) Capital Budget → It is the forecast of outlays on fixed assets and also the sources of capital required.
- vii) Master Budget → It is a summary budget for the whole business. It is the co-ordinated and summarised budget of the entire budgetary programme.

* (Budget)

A budget is the expression of a firm's plan in financial form for a period of time into the future.

* (Main Features of Budget)

The followings are the main features of budget

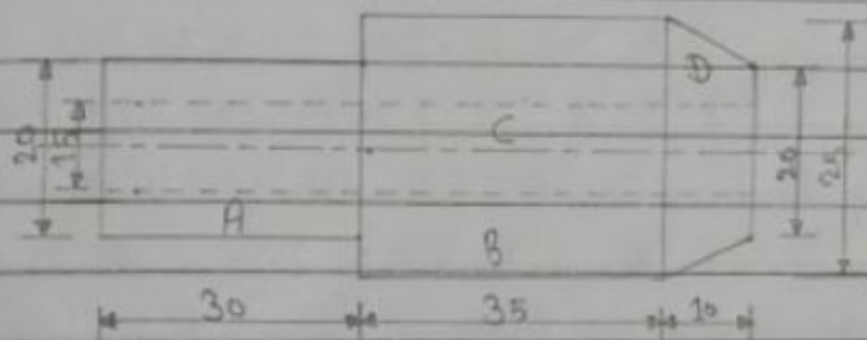
- i.) It is prepared for fixed period
- ii.) Budget makes the chain of past, present and future
- iii.) Budget is prepared for pre-determined objective
- iv.) It is expressed in monetary form.
- v.) It is used for comparative study.

* (Types of Budget)

Budget may be classified as follow.

- 1.) Functional Classification → Here budgets are associated with a particular function and are interrelated with master budget of the business. Some of them are as follow.
 - i.) Sales Budget → It is a forecast of total sales according to group of products that are expected to be sold. It reflects the expected revenue from sales and cash receipts.

Question Find out the weight of 8 mild steel Spindles shown in fig. Also find out the weight of Scrap if they are turned out from a mild steel rod of 30mm diameter. Take facing and parting off allowances as 1mm and 5mm respectively. Assume that 12mm length of rod is required for grip in the chuck. Take density of mild steel is 782 g/cm^3 .



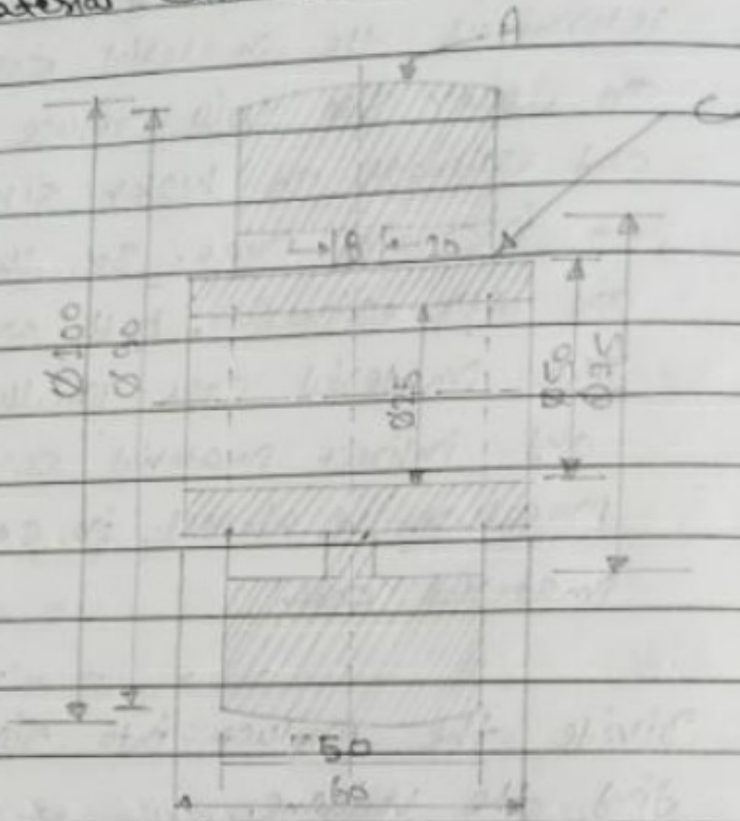
(Spindle)

$$\begin{aligned} \text{Volume of part A, } V_A &= \frac{\pi}{4} \times (20)^2 \times 30 \\ &= 9425 \text{ mm}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume of part B, } V_B &= \frac{\pi}{4} \times (25)^2 \times 35 \\ &= 17181 \text{ mm}^3 \end{aligned}$$

$$\text{Volume of part C, } V_C = \frac{\pi}{4} \times (15)^2 \times 75$$

Question Estimate the weight of cast iron pulley as shown in fig. Take density of the material as 7.2 g/cm^3 . Also find out the material cost of pulley if the material cost is RS-50/- per kg.



(Pulley)

Break up the pulley in three simple parts A, B and C.

$$\begin{aligned} \text{Volume of part A, } V_A &= \frac{\pi}{4} (100^2 - 75^2) \times 50 \\ &= 171806 \text{ mm}^3 \end{aligned}$$

$$\text{Volume of part B, } V_B = \frac{\pi}{4} (75^2 - 50^2) \times 10$$

(Unit: 5)
(Estimation of Material Cost)

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* (Estimation of Material Cost)

Estimation of Material Cost plays an important role in determining total production cost. Proper precautions must be taken in determining the material cost. The estimate on lower side will reduce the profit and estimate on higher side will lead to increased price. So the underestimation and over-estimation, both are harmful. The material cost includes both direct and indirect material costs. The following procedure is adopted in calculating material cost.

- i.) Divide the product into simple parts to find the volume.
- ii.) Neglect the corners and small fillets and take suitable approximation.
- iii.) Calculate the volume of each part.
- iv.) Find the volume of complete product by adding volumes of all the parts.
- v.) Calculate weight of material as follows:
$$\text{Weight} = \text{Volume} \times \text{Density}$$
- vi.) Finally, the material cost is calculated as follows:
$$\text{Material Cost} = \text{Cost per unit weight} \times$$

* Qualities of Cost estimator

The person, who prepares the Cost estimate is called cost estimator. A Cost estimator must possess the following qualities.

- i.) A Cost estimator must be able to read and understand drawings well.
- ii.) He must possess good knowledge of use of tools, jigs, fixtures etc.
- iii.) He must possess good knowledge of Cutting speed, feed, depth of cut for different materials and different types of tools.
- iv.) He must possess good knowledge of different wage rates of different types of workers.
- v.) He must possess good knowledge of mensuration.
- vi.) He must know the procedure of conducting time and motion studies.
- vii.) He must possess good knowledge of different types of allowances of time i.e process allowance, rest and personal allowance, special allowances.
- viii.) He must be a qualified technical person.

2.) Fatigue allowance: → Fatigue allowance is the time provided to the worker to overcome fatigue caused during working. This allowance varies from 5% to 25% depending upon the work situation.

3.) Tool changing and sharpening allowance: → When the cutting tool stops functioning properly it requires sharpening or replacement. This allowance is about 5% of the total working time.

4.) Checking allowances: → Checking allowance is the time taken by the worker to measure and check the dimension of the component which he is making. This allowance should also be taken into consideration.

5.) Other allowances: → Allowances in time should be provided for the following activities also:

- i.) Periodic cleaning and oiling of machine.
- ii.) Disposing of scrap and surplus stock.
- iii.) Filling coolant reservoirs etc.

These allowances are about 15% to 20% of the operation time.

* (Functions of Estimating)

The main functions of estimating are as follows

- i) To determine material cost by considering different allowances for various operations.
- ii) To determine labour cost of tool and equipments etc.
- iii) To determine overhead charges including selling charges, packing charges and transportation charges.
- iv) To determine selling price by adding profit in total cost.
- v) To determine time required for manufacturing by conducting time study and motion study.
- vi) To determine methods and equipments in manufacturing.
- vii) To make precise records of estimates for future.
- viii) To determine most economical procedure of manufacturing.
- ix) To estimate selling price of the product.

To estimate cost of the product, the estimating department follows a set procedure. After

a) Direct Material Cost :→ The cost associated with direct materials is called direct material cost.

b) Indirect Material Cost :→ The cost associated with indirect materials is called indirect material cost.

iv.) Overheads :

* (Miscellaneous Allowance)

A cost estimator takes into consideration certain allowances of time because of the following reasons.

- 1.) A worker cannot work continuously without rest like a machine.
- 2.) A worker needs time for his personal needs.

Such allowances called Miscellaneous allowances are as follow:

- 1.) Personal allowance :→ Personal allowance is the time provided to the worker to satisfy his personal needs such as drinking water, going to toilet.

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To estimate cost of the product, the estimating department follows a set procedure. After

* (Estimating procedure)

The various steps in estimating the cost are as follow:

- i) prepare the list of all the necessary parts or components of the product.
- ii) prepare the process sheet showing various operations in sequence.
- iii) Make a list of materials required for each part.
- iv) Make a list of tools, machinery and equipments required for production.
- v) Mention the machine time for each part.
- vi) Estimate the total material cost of product.
- vii) Calculate the total labour cost involved in manufacturing.
- viii) Calculate the prime cost by adding material cost and labour cost.
- ix) Find out the various overhead charges.
- x) Calculate the total cost by adding prime cost and overhead charges.
- xi) Add suitable profit margin to total cost for sale price.
- xii) Send this cost structure to management for necessary approval.

* Costing → Costing or Cost accounting may be defined as a System which records all the expenditure to determine the Cost of manufacture products. It may also be defined as a System of accounts which records every expenditure systematically and accurately in order to determine the Cost of a product after knowing various expense incurred on the product in various departments.

* (Purpose of Costing)

The various purposes of Costing are as follows

- i.) To determine the cost of each item.
- ii.) To achieve more economy in production.
- iii.) To determine the cost incurred in each operation.
- iv.) To keep Control on wages.
- v.) To help in deciding the selling price of the products.
- vi.) To earn more profits.
- vii.) To reduce wastage by adopting various corrective measures.
- viii.) To increase the production and increase the sales.

* (Functions of Estimating)

The main functions of estimating are as follows

- i) To determine material cost by considering different allowances for various operations.
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* (Types of estimates)

The different types of estimates are as follow:

- i.) Estimates to fix the sale price of a product.
- ii.) Estimates to set various standards for the purpose of comparison.
- iii.) Estimates to forecast the progress of production and cost of order to keep control on any variation of material costs.
- iv.) Estimates to determine whether or not to accept a contract for a new work.

* (Constituents of Job estimate)

The important constituents is estimating the cost of a component are as follow.

- 1) Design time → The time taken to design a product is called design time.
- 2) Drafting time → The estimated time taken by the draftsman to prepare such drawing is called drafting time.
- 3) Production time → Before starting

* (Comparison of estimating and Costing)

<u>S.No.</u>	<u>Estimation</u>	<u>Costing</u>
1.)	It is the calculation of cost expected to be incurred on a product. The expected cost of material, labour and overheads are taken before actual production.	1.) It is a system of accounts which record systematically and accurately every expenditure in order to determine the cost of a product. The elements of costs to be recorded are material, labour and other charges.
2.)	It requires high technical knowledge. It is done by an estimator which is basically an engineer.	2.) It requires knowledge of accounts. Hence it is done by accountants.
3.)	It is a technical work instead of clerical work.	3.) It is more of clerical nature instead of technical nature.
4.)	It is aimed to calculate the probable cost of the product before start of manufacturing.	4.) It is the determination of actual cost of the product by adding various elements of expense incurred.
5.)	It gives an expected cost of the product based on calculations.	5.) It gives actual cost of the product based on the data collected on actual expenditure.

* (Cost Estimator and its Qualification)

The person, who prepares the Cost estimate, is called Cost estimator.

(A Cost estimator must possess the following Qualification.)

- i.) A Cost estimator must be able to read and understand drawings well.
- ii.) He must possess good knowledge of market prices of different materials required for manufacturing.
- iii.) He must possess good knowledge of use of tool, jig, fixture etc.
- iv.) He must possess good knowledge of cutting speeds, feeds, depth of cut for different materials and different types of tool.
- v.) He must possess good knowledge of measurement.
- vi.) He must know the procedure of conducting time and motion studies.
- vii.) He must be a qualified technical person.
- viii.) He must possess good knowledge of different wage rates of different types of workers.

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suggesting best way of carrying out the production. planning incorporates the following phases.

- i.) Forecasting :→ Forecasting means estimation of type, quality and quantity of future work.
- ii.) Order writing :→ Order writing means giving authority to one or more person to undertake a particular job.
- iii.) Product design :→ product design means designing the product by collecting information regarding specification, bill of materials, drawing etc.
- iv.) Routing :→ Routing means finding the most economical path of doing a work and then deciding how and where the work will be carried out.
- v.) Material control :→ Material control means to determine the requirement and control of materials.
- vi.) Total Control :→ Total Control means the control of all the phases of production.

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a.) Direct labour cost :- Direct labour cost is the cost of labour employed directly in the manufacturing operations e.g. a fitter, a machinist, a welder etc.

b.) Indirect labour cost :- Indirect labour cost is the cost of labour which helps productive labour to perform their duties. e.g. store keeper, crane driver, machine setter, maintenance etc.

iii.) Material Cost :- Material cost may be of following two types.

a.) Direct material cost :- The cost associated with direct materials is called direct material cost.

b.) Indirect material cost :- The cost associated with indirect materials is called indirect material cost.

iv.) Overhead :- Overheads are the indirect expense which includes all the expense except direct labour, direct material

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- vi.) Total Control :→ Total Control means to control all the phases of production.

vii) Loading → Loading means assignment of work to a worker, machine or equipment.

viii) Scheduling → Scheduling means fixation of starting and finishing time for a job.

The time taken to complete the above phases of planning is called planning time.

The time taken to convert the raw material into finished product is called production time.

4) Design and Manufacture or procurement of Special Tools and Equipments → Sometimes, special tools and equipments such as special cutting tool, jig, fixture, die, pattern, mould, special purpose machines etc. are required for manufacturing a component of product.

5) Experimental and Research work, labour, material and overheads →

i) Experimental and Research work is carried out in every industry to find out the best and cheapest method of manufacturing a product.

* (Element of Cost)

The total Cost of a Product can be divided into three main elements which are as follow:

1) Material: Material can be further classified as follow.

i.) Direct material: Direct materials are also known as productive materials. These are the materials which are processed in the factory shops various stages to give final shape of the main product or components of the main product. e.g. Wood for furniture, mild steel for the shafts, bolts etc.

ii.) Indirect material: These are the materials which are necessary for production processes, but not directly used in the product. e.g. grease, oil, sand paper, Coolants, Cotton waste etc.

* Cost of production:- Cost of production means cost of sequence of operations which begins with supplying materials, labour and services and ends with primary packing of the product.

* (Selling price of a product)

Selling price of a product is obtained by summing the total cost of product and profit.

* (Capital investment)

Capital investment means laying out money on an activity or a project with the expectation of some benefit.

* (Requisitionment of Capital)

Capital is required in an enterprise to keep it dynamic and covers money, land, building, machines, equipments, materials etc and helps produce. It is required for the enterprise's progress and creating value.

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(Unit:-02)
(Elements of Costing)

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* (Objectives of Costing)

The various objectives of Costing are as follow:-

- i.) To determine the Cost of each item.
- ii.) To achieve more economy in production.
- iii.) To determine the cost incurred in each operation.
- iv.) To keep control on wages.
- v.) To help in deciding the selling price of the product.
- vi.) To earn more profit.
- vii.) To reduce wastage by adopting various corrective measures.
- viii.) To identify various causes of increase or decrease in profit.
- ix.) To give suggestion regarding modification.

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* Calculation of Direct Labour Cost $\rightarrow$ He should take into consideration the various allowances which are as follow:

- i) Set up time
- ii) operation time which consists of handling time and machining time,
- iii) Tear down time
- iv) Miscellaneous allowances.
 - a) Process allowance,
 - b) Rest and personal allowance,
 - c) Special allowances etc.

3) EXPENSE $\rightarrow$ All the expenses, except direct material cost and direct labour cost, which are incurred in the factory are called expenses. Expense in a factory can be classified as follow:

i.) Direct Expense $\rightarrow$ These are the expenses which are charged directly to a particular job e.g. Cost of hiring a special purpose machine, cost of special jigs and fixtures, cost of special patterns, cost of experimental works on a particular job etc.

ii.) Indirect Expense $\rightarrow$ These are the expenses

bills, insurance, depreciation, advertisement expense etc. These are further classified as follows:

- a) Factory expense,
- b) Administrative expense,
- c) Sales expenses,
- d) Distribution expenses,
- e) Research and development expense.

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* Components of Cost

The various components of cost are as follows:

- 1) Prime Cost → Prime cost is the sum of direct material cost, direct labour cost and direct expense.

$$\text{Prime Cost} = \text{Direct material cost} + \text{Direct labour cost} + \text{Direct expense.}$$

- 2) Factory Cost → Factory cost is the sum of prime cost and factory expense.

$$\text{Factory cost} = \text{prime cost} + \text{factory expense}$$

Running cost is the

- i) Calculate the volume of each component by using mensuration formulae.
- ii) Calculate the volume of product by adding volumes of all the components of the product.
- iii) Calculate the weight of the product by multiplying the volume with the density of the product.
- iv) Calculate the material cost by multiplying the total weight of the material with the cost per unit weight.

2) Labour $\rightarrow$ Labour employed in any factory can be classified as follow;

i) Direct labour $\rightarrow$ Direct labour is also known as production labour. Direct labour constitutes those workers who directly process different material manually or with the help of production machines. e.g. workers operating various production machines in machine shop, welding shop, electric winding shop etc.

ii) Indirect labour $\rightarrow$ Indirect labour constitutes

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* (overheads and their types)

Overheads are the indirect expenses which include all the expense except direct labour, direct material and direct expenses incurred on production and distribution of the product to the Customer.

(The main types of overheads are as follow)

- 1.) Production overheads: → These are the indirect expense spent by the industry from the receipt of the production order to the completion of the product i.e. all the indirect expenses starting from raw material to finished product.

(The various types of production overheads are as follow:

- i.) Building Expense: → These are the expenses relating to building of the factory like rent, repair, insurance, heating, lighting etc.

- ii.) indirect labour: → These are the expenses

Staff, executive Staff, Machine Sattels,
Shop inspectors etc.

- iii) Consumable goods like grease, oil, Cotton waste etc.
- iv) Plant maintenance and depreciation.
- v) Water, fuel and power.
- vi) Other expense on
 - Security.
 - Welfare amenities.
 - Recreational facilities.
 - Rest room, lunch room.
 - Employment Office etc.

2) Administration overheads :→ These are the expenses incurred on administrative services in the industry providing a general management to control the activities by issuing directions through clerical Staff. The various administration expense are:
Salaries of the Staff, office rent, insurance, legal costs, taxes, postal charges, telephone bills, audit fees, bank charges etc.

3) Selling overheads :→ These are the expenses required to maintain and increase the volume of sales. These include

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$$\text{Manufacturing Cost} = \text{Factory Cost} + \text{Administrative expense}$$

4.) Total Cost: Total Cost is the sum of Manufacturing Cost, Sales expense and distribution expense.

$$\text{Total Cost} = \text{Manufacturing Cost} + \text{Sales expense} + \text{Distribution expense}$$

Selling price: Selling price is the sum of total cost and profit. The customers purchase the product by paying the selling price.

$$\text{Selling price} = \text{Total Cost} \pm \text{Profit or Loss}$$

The latter of cost involving various costs is shown in fig

				Profit (+)
				Loss (-)
			Sales and distribution expense	
		Administrative expense		
	Factory expense			
Direct material cost		Factory	Manufacturing	Total
				Selling price

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Expenses on advertisement, Commission and Salaries of managers and agents, Rent of Sales rooms, offices, after Sale Service etc.

4.) Distribution overheads → These are the expense connected with transportation of the product to consumer. These include expenses on packing and storing the products with safety. e.g. loading and unloading charges, cost of transportation, warehouse charges, maintenance and running of delivery vehicles, Salaries of clerks and labourers etc.

5.) Research and Development overheads → These are the expense to be incurred on research and development facilities for continuous improvement to produce good quality products. These expense depend upon the nature of product or services and are proportional to the size of research and development department e.g. Salaries

$$\text{Percentage overheads} = \frac{\text{Total overheads}}{\text{Prime Cost}} \times 100$$

* (Percentage on Direct Labour Cost)

This method is also very simple and hence, this is also very popular. In this method, allocation of overheads is based upon wages paid to the direct labour.

This method is suitable where production is mainly carried out manually.

$$\text{Percentage overheads} = \frac{\text{Total overheads}}{\text{Direct Labour Cost}} \times 100$$

Question

A Factory has total overhead of RS. 10 lacs for the year 2018-19 while the total wages paid to the direct labour for the above period is RS. 40 lacs. Find out the percentage overheads by percentage on direct labour cost method.

$$\text{Percentage overheads} = \frac{\text{Total overheads}}{\text{Total Labour Cost}} \times 100$$

$$= \frac{10}{40} \times 100$$

$$= 25\% \text{ of Direct Labour Cost.}$$

$$\therefore \text{overhead cost} = \frac{607.50}{100} \times 20$$

$$= \text{RS. } 121.50$$

$$\therefore \text{Total Cost} = \text{Factory Cost} + \text{overhead Cost}$$

$$= 607.50 + 121.50$$

$$= \text{RS. } 729$$

profit target is 20% of the total cost.

$$\therefore \text{Selling price of 100 pieces} = \frac{729 \times 120}{100}$$

$$= \text{RS. } 874.80$$

$$\therefore \text{Selling price per piece} = \frac{874.80}{100}$$

$$= \text{RS. } 8.748 \text{ Ans}$$

Question 2) The net profit on a product is of 10% of its selling price. The total distribution expenses are 20% of total factory cost. Find the factory cost, when net selling price of the product does not exceed RS. 20. To manufacture the product, the material cost is RS. 4. The factory overhead expenses are 10% of its labour cost. If the rate of labour

* (Overhead)

Overhead are the indirect expenses which include all the expenses except direct labour, direct material and direct expenses incurred on production and distribution of the product to the customer.

* (Allocation of overhead)

Among the various methods which have been adopted to allocate overhead to production, the most common are as follow:

- 1) Percentage on Prime Cost.
- 2) Percentage on direct labour cost.
- 3) Percentage on direct material cost.
- 4) Man hour rate.
- 5) Machine hour rate.
- 6) Unit rate method.

* (Percentage on prime cost)

This is a very simple method and hence, this is very popular. This method is suitable where both labour and material play an equal part in the production process.

$$\text{Percentage overheads} = \frac{\text{Total overheads}}{\text{Prime Cost}} \times 100$$

* (percentage on direct labour cost)

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* (Percentage on Direct Material Cost)

In this method, allocation of overheads is based upon total direct material cost. This method is suitable where major part of cost is materials like minerals, foundations etc.

$$\% \text{ overhead} = \frac{\text{Total overhead}}{\text{Total direct material cost}} \times 100$$

Question

A Foundry Shop producing Water Meters has RS. 6 lacs as total overheads while the material cost is RS. 30 lacs. Find out the percentage overheads by percentage on direct material cost method.

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* (Man-Hour Rate)

This method is an improvement of direct labour cost method. In this method allocation of overheads is based upon total hours spent by the direct labour instead of wages paid to them. This method is suitable where most of the work is carried out manually and where

- 3.) Accidents → Sometimes, accident of machine occurs due to wrong operation or loose components or some other cause inside of sufficient cause. This result heavy damage. This depreciation is due to accidents.
- 4.) Negligence and deferred maintenance → Whenever a machine or equipment is supplied to a factory, certain instructions are also supplied with it for its efficient and smooth running.
- 5.) Inadequacy → Inadequacy means reduction in the efficiency of any machine or equipment or any asset. This is the depreciation due to inadequacy.
- 6.) Obsolescence → Sometimes, it occurs that after the purchase of a machine by the factory owner for his production shop, a better machine comes in the market which is economical in gives high production rate. Although the old machine is efficient, but becomes uneconomical and out of fashion due to new

* (Methods of Calculating Depreciation)

The various methods of Calculating Depreciation are as follow.

- i.) Straight line method.
- ii.) Sinking fund method
- iii.) Diminishing balance method.
- iv.) Insurance policy method
- v.) Annuity charging method.
- vi.) Revaluation method.
- vii.) Machine-hour basis method
- viii.) Sum of years digit method.

i.) Straight line method: This method is also known as fixed instalment method. This method assumes that loss of value of machine is directly proportional to its age. In this method, depreciation is calculated by deducting the scrap value from the original value and then dividing the remaining value by the number of years of useful life of machine.

Let C = initial cost of machine

S = Scrap value of machine

N = Number of years of useful life of machine

Then depreciation per year, $D = \frac{C - S}{N}$

* (Percentage on Direct Material Cost)

In this method, allocation of overheads is based upon total direct material cost. This method is suitable where major part of cost is materials like minerals, foundations etc.

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ii.) Sinking Fund Method $\rightarrow$ In this method, a depreciation fund equal to actual loss in the value of machine is estimated taking into consideration the interest on the so accumulated fund. The rate of depreciation remains constant throughout the life of the machine.

Let, C = Total Cost of Machine,

S = Scrap Value of Machine,

N = Number of years of life of machine

R = Rate of interest on depreciated fund in fraction manner.

Then, Rate of depreciation per year, $D = \frac{R(C-S)}{(1+R)^N - 1}$

iii. $\times$ Diminishing Balance Method $\rightarrow$ This method is also known as reducing balance method or percentage on book value method. This method takes into consideration that the value of machine depreciates rapidly in the early years and slowly later on. Therefore, it is better to depreciate more during early years. In this method, a certain percentage of current book value is

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5.) In financial accounting costs are recorded broadly.

6.) Financial accounting is not helpful in determining the selling price of product.

7.) Financial accounting cannot determine relative efficiency of workers, plant and machines.

5.) In cost accounting minute recording of cost is done per unit.

6.) Cost accounting is helpful in determining the selling price of the product.

7.) Cost accounting provides valuable information about the efficiency of workers, plant and machines.

* Advantages of Costing

- i.) It helps in finding the wastage of material.
- ii.) It helps in finding the actual cause of decrease in profit.
- iii.) It gives information regarding profitable and unprofitable activities.
- iv.) It provides an effective check on the wage system.
- v.) It provides data for comparing actual cost with estimated cost of the product.
- vi.) It keeps control over the selling

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S = Scrap value of the machine,

N = Number of years of life of machine,

u = Fixed percentage to calculate yearly depreciation on book value.

$$\therefore u = 1 - \left(\frac{S}{C}\right)^{\frac{1}{N}}$$

iv) Insurance Policy Method $\rightarrow$ This method covers the risk, if the machine becomes unserviceable before its estimated life.

In this method, machine is insured with some insurance company and annual premiums are paid on the insurance policy.

v) Annuity Charging Method $\rightarrow$ In this method, interest is charged on the cost of machine every year on the book value and the rate of depreciation is constant every year.

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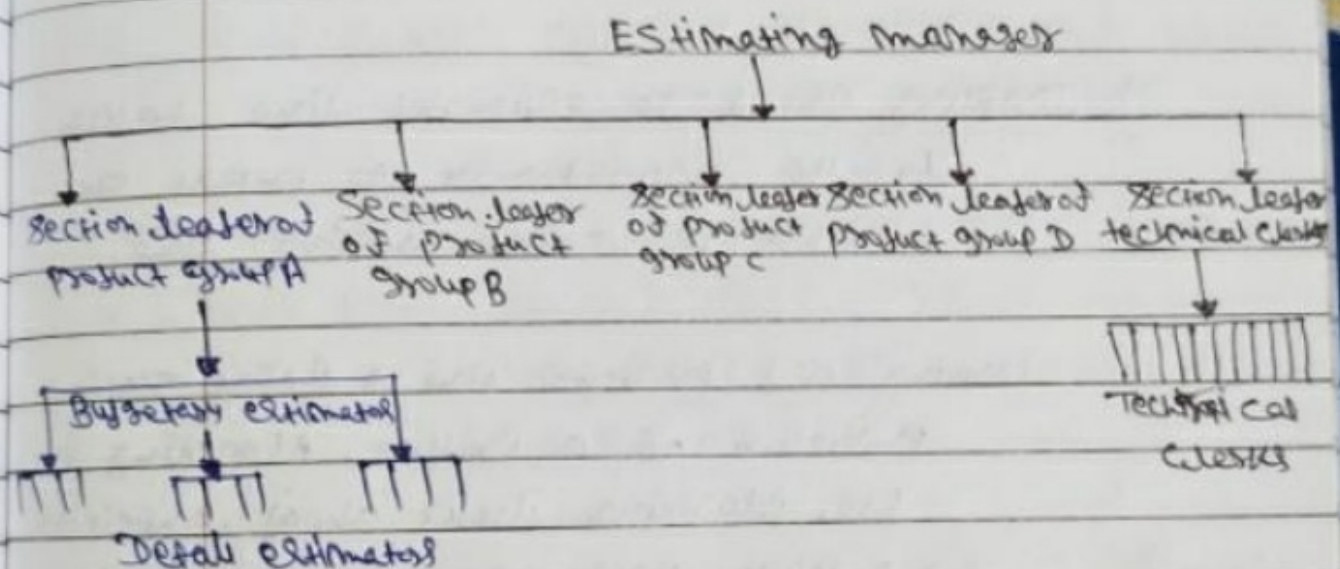
(Unit: → 4)
(Fundamentals of estimating)

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* Estimating →

* (Organisation of estimating department)

The estimating department is one of the important departments of an industry. In small industries, it functions under production manager, while in large industries, it functions under planning department.



(General structure of estimating Department)

In early stages, section leaders and technical clerks can be dispensed with. As the section grows, section leader may be chosen from budgetary

(Methods of Costing)

The important methods of Costing are as follows.

- i.) Job Costing :→ This method is also known as order costing or terminal costing. It is concerned with finding the cost of each individual job and is adopted by builders, contractors etc. Daily records of direct material, direct labour and overhead costs for each order is kept in cost sheet and total cost of the job can be found out from the cost sheet.
- ii.) Batch Costing :→ Batch Costing is just an extension of job costing. In batch costing, instead of calculating the cost of each individual component, a batch of components is taken together and is treated as one job. e.g.
- iii.) Process Costing :→ This method applies to the industries such as chemical, cement, oil refining, paint etc. where raw material goes through a number of processes before it is converted

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5.) Experimental and Research work, labour, material and overheads: →

i.) Experimental and research work is carried out in every industry to find out the best and cheapest method of manufacturing a product.

ii.) Labour Cost: Labour Cost may be of following two types.

a) Direct Labour Cost: → Direct Labour Cost is the cost of labour employed directly in the manufacturing operations e.g. a fitter, a machinist, a welder etc.

b) Indirect Labour Cost: → Indirect Labour Cost is the cost of labour which helps productive labour to perform their duties, e.g. Store Keeper, crane driver, machine setter, maintenance men etc.

iii.) Material Cost: → Material Cost may be of following two types.

* Principal Factors in Estimating

The principal factors in estimating the cost of a component are as follows

- 1) Design Time → The time taken to design a product is called design time. The standard man hour rate should be used to calculate the cost of design time.
- 2) Drafting time → The estimated time taken by the draftsman to prepare such drawings is called drafting time.
- 3) Planning and production time → Before starting production of a product, planning is done. Planning looks ahead, anticipates possible difficulties and decides in advance regarding best way of carrying out the production. Planning incorporates the following phases.
 - i) Forecasting → Forecasting means estimate of type, quality and quantity of future work.

Date / /

iii.) Product Design → Product design means deciding the product by collecting information regarding specifications, bill of

iv.) Routing → Routing means finding the most economical path of doing a work and then deciding how and where the work will be carried out.

v.) Material Control → Material control means to determine the requirement and control of materials.

vi.) Tool Control → Tool control means to determine the requirement and control of tools used.

vii.) Loading → Loading means allotment of work to a worker, machine or equipment.

viii.) Scheduling → Scheduling means fixation of starting and finishing time for a job.

4) Design and manufacture or procurement of Special Tools and equipment → Sometimes, special tools and equipments such

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