Total volume of stepped cone pulley

$= V_A + V_B + V_C - V_D = 3927 + 2036 + 904.7 - 678.6.$

$= 6189.1 \text{ cm}^3$ or cc.

Unit of component = density × volume

$= 7.209 \frac{\text{gms}}{\text{cc}} \times 6189.1\text{cc}$

$\boxed{\text{Unit} = 44617.2 \text{ gms.}}$

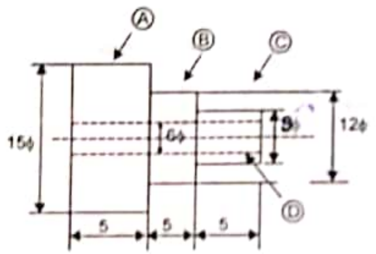
$= \frac{44617.2}{1000} \text{ kg.}$

$= \mathbf{44.617 \text{ kg.}}$

Cost of pulley = 44.617 kg × 20 Rs./kg.

$\boxed{\text{Cost} = \text{Rs. } 892.34}$

• **Problem 2.** *A CI conepulley is shown in fig. Taking density of CI as 7.0208 gm/cc. Calculate unit of component. Also what is cost of material if cost per kg is Rs. 15.*



Solution. Volume of part A $= \frac{\pi}{4} d^2 l$

$= \frac{\pi}{4} \times 15^2 \times 5$

$= 883.57 \text{ mm}^3.$

$\boxed{V_A = 0.8836 \text{ cm}^3}$

Volume of part B $= \frac{\pi}{4} d^2 l$

$= \frac{\pi}{4} \times 12^2 \times 5$

$\boxed{V_B = 0.565 \text{ cm}^2.}$

Volume of part C $= \frac{\pi}{4} d^2 l$

$= \frac{\pi}{4} \times 9^2 \times 5$

$= 318 \text{ mm}^3.$

$\boxed{V_C = 0.318 \text{ cm}^3.}$

Volume of part D $= \frac{\pi}{4} d^2 l$

$= \frac{\pi}{4} \times 6^2 \times 15$

$= 424 \text{ mm}^3.$

$\boxed{V_D = 0.424 \text{ cm}^3.}$

Total volume of stepped conepulley

$= V_A + V_B + V_C - V_D$

$= 0.8836 + 0.565 + 0.318 - 0.424$

$\boxed{V = +1.3426 \text{ cm}^3.}$

Unit of component = density × volume

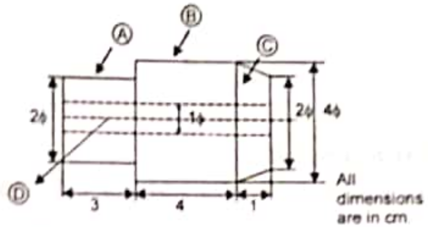
= 7.209 gm/cc × 1.3426 cc.

Unit = 9.688 gm.

Unit = 0.0096 kg.

Cost of pulley = 0.0096 kg × 15 Rs/kg

= Re. 0.145



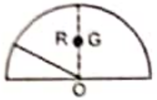
Problem 3. *The spindle has dimensions as shown in the figure above. The spindle is turned from MS rod of 45 mm dia facing and parting off allowances are 1mm and 5mm respectively. Assuming 15 mm length of rod is required for grip in the churk. Calculate the unit of 10 MS spindle taking density of MS = 7.8 gms/cc. Also calculate unt of the scrap.*

Solution. Volume of part A $= \frac{\pi}{4} d^2 l$

$= \frac{\pi}{4} \times 2^2 \times 3$

$V_A = 9.425 \text{ cm}^3.$

Volume of part B $= \frac{\pi}{4} d^2 l$

7. **Semi Circle**		$OG = \frac{4}{3\pi}R$ $= 0.424\,R$ R = radius of circular area

8.7 DIFFERENTIATE BETWEEN ESTIMATING AND COSTING

Estimating	Costing
1. It is the process of determining the probable cost of an article.	1. It is a process of determining the actual lost of an article.
2. It is done before the product is manufactured.	2. It is done after the product is manufactured.
3. Based on assumption.	3. Based on facts.
4. The estimator should be engineer, well qualified.	4. Anybody having accounting knowledge.
5. It requires a lot of experience.	5. It does n't require much experience as that of estimating.
6. It may be overestimation or underestimation as estimation may go wrong as it is based on some assumptions.	6. The cost will never go wrong as it is based on facts.
7. Profits or losses may be forecasted	7. Profits or losses are actually felt.

8.8 ESTIMATION OF MATERIAL COST

Generalized procedure to calculate cost of the material

Step 1 : Observe the component drawing, break up the drawing into simple parts as per your convenience so as to calculate areas and volumes easily.

Give the notations for each of the part x, y, z and so on.

Step 2 : Using formulae calculate areas and volumes of each part.

Step 3 : Add the volumes of all the parts.

Total volume $= x + y + z$ and so on.

Step 4 : Multiply component vol × density

$\therefore$ weight = density × volume.

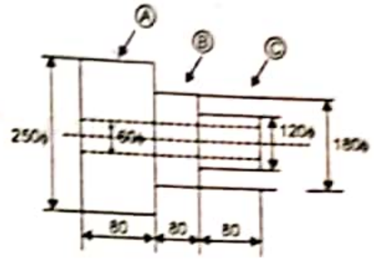
Problem 1. *A CI stepped cone pulley is shown in the following figure.*

Material cost = 20/kg

Calculate the cut and material cost.

Density of CI = 7.009 gms/cc

All dimensions are in mm.



Solution.

Volume of part A $= \frac{\pi}{4}d^2 l$

$= \frac{\pi}{4} \times 250^2 \times 80$

$V_A = 3.927 \times 10^6$ mm³

$= \mathbf{3.927\ cm^3.}$

Volume of part B $= \frac{\pi}{4}d^2 l$

$= \frac{\pi}{4} \times 180^2 \times 80$

$= 2.036 \times 10^6$ mm³

$V_B = \mathbf{2036\ cm^3.}$

Volume of part C $= \frac{\pi}{4}d^2 l$

$= \frac{\pi}{4} \times 120^2 \times 80 = 9.0478 \times 10^5$ mm³

$= \frac{9.0478 \times 10^5}{1000}$ cc.

$V_C = \mathbf{904.7\ cm^3.}$

Volume of cone D $= \frac{\pi}{4}d^2 l$

$= \frac{\pi}{4} \times 60^2 \times 240 = 6.786 \times 10^5$ mm³

$V_D = \mathbf{678.6\ cm^3}$

$$= \frac{\pi}{4} \times 4^2 \times 4$$

$$V_B = 50.26 \text{ cm}^3.$$

$$\text{Volume of part D} = \frac{\pi}{4} d^2 l$$

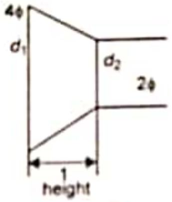
$$= \frac{\pi}{4} \times 1^2 \times 8$$

$$V_D = 6.283 \text{cm}^3.$$

Part C is like a frustrum of cone

$$V_C = \left[\frac{\pi}{4}d_1^2 + \frac{\pi}{4}d_2^2 + \sqrt{\frac{\pi}{4}d_1^2 \times \frac{\pi}{4}d_2^2}\right]^{\frac{h}{3}}$$

$$= \left[\frac{\pi}{4}4^2 + \frac{\pi}{4}2^2 + \sqrt{\frac{\pi}{4}4^2 \times \frac{\pi}{4}2^2}\right]^{\frac{1}{3}}$$



$$V_C = 7.33 \text{ cm}^3.$$

Total Volume of Finished Spindle.

$$V_A + V_B + V_C - V_D = 9.425 + 50.26 + 7.33 - 6.283$$

$$= \mathbf{60.732 \text{ cc.}}$$

Weight of 1 spindle = volume × density

= 60.732 cc × 7.8 gm/cc.

= 473.71 gms.

Unit of 10 spindles = 473.71 × 10

= **4737 gms.**

$$= \frac{4737}{1000} \text{kg.}$$

Unit of 10 spindles = **4.74 kg.**

Calculation of Total material reqd. including scrap.

Length of 1 spindle = 80 mm

Total length for 10 spindles = 80 × 10

= **800 mm.**

Allowance reqd. for facing = 1 mm.

Reqd. for 2 sides.

Total allowance facing = 10 × 2 = 20 mm.

parting off allowance = **5 mm**

for 10 spindles = 5 × 10 = 50 mm.

Length reqd. for holding the job = 15 mm.

Total length of MS rod = 800 + 20 + 50 + 15

= 885 mm.

Diameter of MS rod = 4.5 cm.

$$\text{Volume of rod reqd.} = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times (4.5)^2 \times 8.85$$

= **1407.5**

Unit of rod = volume × density

= 1407.5 × 7.8

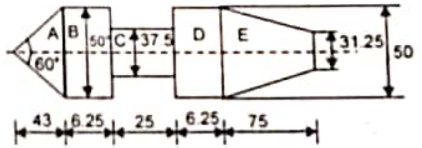
= 10978.7 gms.

Unit of scrap = 10978.7 – 4734. g

= 6241.7 g

= **6.2417 kg.**

Problem 4. *The lathe centre has dimensions shown in 1. The material density = 7.78 g/cc. The material costs Rs. 30/kg. Estimates the unit and cost of material.*



Solution.

$$V_A = \frac{1}{3} \times \pi r^2 \times h \qquad a = 1/2 \times \text{base} \times \text{height}$$

$$= \frac{1}{3} \times \pi \times (25)^2 \times 43 \qquad = 1/2 \times 50$$

$$= 28.14 \text{ cm}^3.$$

$$V_B = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 50^2 \times 6.25$$

$$= 12271.8 \text{ mm}^3.$$
$$= \mathbf{12.27 \text{ cm}^3.}$$

$$V_C = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 37.5^2 \times 25 = \mathbf{27.611 \text{ cm}^3.}$$

$$V_D = \frac{\pi}{4} d^2 l$$

$$= \mathbf{12.27 cm^3.}$$

$$a_1 = \pi R_1^2$$
$$a_2 = \pi R_2^2$$
$$= \pi \times (15.625)^2 = 766.99 \text{ mA}^2$$
$$a_2 = \pi \times (25)^2$$
$$a_2 = 1963.4 \text{ mm}^2$$

$$V_E = \frac{h}{3}\left[a_1 + a_2 + \sqrt{a_1 a_2}\right]$$

$$= \frac{75}{3}\left[766.99 + 1363.4 + \sqrt{766.99 \times 1963.4}\right]$$

$$V_E = 98938.6 \text{ mm}^3$$

$$V_E = \frac{98938.6}{1000} \text{cm}^3.$$

$$\boxed{V_E = 98.94 \text{ cm}^3.}$$

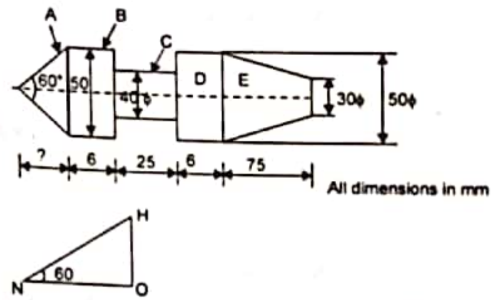
$$\text{Total volume of component} = V_A + V_B + V_C + V_D + V_E$$
$$= 28.14 + 12.27 + 27.61 + 12.27 + 88.84$$

$$\boxed{V = 179.23 \text{ cm}^3.}$$

$$\text{Unit of material} = V \times \text{density}$$
$$= 179.23 \times 7.78$$
$$= 1334.3 \text{ gm.}$$
$$= 1.334 \text{ kg.}$$

$$\text{Cost of material} = 1.394 \text{ kg} \times 30$$
$$= \text{Rs. } 41.83$$

Problem 5. *The following figure shows the dimensions of lathe centre. Calculate weight and cost of material. If material has density of 7.8 gms/cc. and cost of material is 25/kg.*



Solution.

$$\tan 60 = \frac{OM}{ON}$$

$$ON = \frac{OM}{\tan 60}$$

$$ON = \frac{25}{\tan 60} = 14.43 \text{ cm.}$$

$$V_A = \frac{1}{3}\pi r^2 h$$

$$= \frac{1}{3} \times \pi \times (25)^2 \times ON$$

$$= \frac{1}{3} \times \pi \times (25)^2 \times 14.43 = 9444.4$$

$$\boxed{V_A = 9.44 \text{ cm}^3.}$$

$$V_B = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 50^2 \times 6 = 11780.97$$

$$\boxed{V_B = 11.780 \text{ cm}^3.}$$

$$V_C = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 40^2 \times 25$$

$$\boxed{V_C = 31.416 \text{ cm}^3.}$$

$$V_D = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 50^2 \times 6$$

Scanned by CamScanner

V_D = 11.78 cc.

$V_E = \frac{h}{3}\left[a_1 + a_2 + \sqrt{a_1 a_2}\right]$

$= \frac{15}{3}\left[1963.5 + 706.86 + \sqrt{1963.48 \times 706.86}\right]$

$a_1 = \pi \times 25^2 = 1963.49 \text{ mm}^3.$

$a_2 = \pi \times 15^2 = 706.86 \text{ mm}^3.$

$V_E = 96.208 \text{ cm}^3.$

Total volume $= V_A + V_B + V_C + V_D + V_E$

$= 9.44 + 11.78 + 31.41 + 11.78 + 96.21$

$\boxed{V = 160.62 \text{ cm}^3.}$

Unit of material = density × volume

= 4.8 gm/cc × 160.62 cc.

= 1252.8 gm

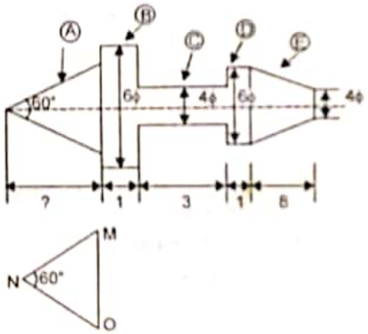
= **1.253 kg.**

Cost of Material = Unit × Cost/kg

= 1.253 kg × 25 kg.

= Rs. 31.32

Problem 6. *Calculate unit of lathe centre if material density is 8 g/cc. Calculate the cost of material if its rate Rs. 20/kg.*



Solution. $V_A = \frac{1}{3}\pi r^2 h$

$= \frac{1}{3}\pi \times 3^2 \times 7 = \frac{1}{3} \times \pi \times 3^2 \times 5.19 \text{ cm}$

$\boxed{V_A = 48.97 \text{ cm}^3.}$

$V_B = \frac{\pi}{4}d^2 l$

$= \frac{\pi \times 6^2}{4} \times 1$

$\boxed{V_B = 28.27 \text{ cm}^3.}$

$V_C = \frac{\pi}{4}d^2 l = \frac{\pi}{4} \times 4^2 \times 3$

$V_C = 37.69 \text{ cm}^3.$

$V_D = \frac{\pi}{4}d^2 l = \frac{\pi}{4} \times 6^2 \times 1$

$\boxed{V_D = 28.27 \text{ cm}^3.}$

$a_1 = \pi R_1^2$

$= \pi \times 3^2$

$= 28.27 \text{ cm}^3$

$a_2 = \pi R_2^2$

$= \pi \times 2^2$

$= 12.5 \text{ cm}^3$

$V_E = \frac{h}{3}\left[a_1 a_2 + \sqrt{a_1 a_2}\right]$

$V_E = \frac{8}{3}\left[28.27 + 12.57 + \sqrt{28.27 \times 12.57}\right]$

$\boxed{V_E = 159.17 \text{ cm}^3}$

Total volume

$V = V_A + V_B + V_C + V_D + V_E$

$= 48.97 + 28.27 + 37.69 + 28.27 + 159.17$

$\boxed{= 302.2}$

Unit of material = density × volume

= 4.8 g/cc × 302.2 cc.

Unit = **2357.16 gm**

$\boxed{\text{Unit} = 2.357 \text{ kg.}}$

Cost = cut × cost/kg.

= 2.357 kg × 20/kg.

$\boxed{\text{Cost} = \text{Rs. } 47.14}$

Problem 7. *As crank shaft is similar in dimensions on both sides of xy. ∴ volume on one side can he calculated and total volume will be twice of that of one side.*

Solution. Volume of A $= \frac{\pi}{4}d^2 l = \frac{\pi}{4} \times 27^2 \times 27$ = **15.46 cc.**

Volume of B $= \frac{\pi}{4}d^2 l$

$$= \frac{\pi}{4} \times 24^2 \times 30 = \mathbf{13.57\ cc}$$

$$\text{Volume of C} = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 60^2 \times 22.5 = \mathbf{63.62\ cc.}$$

$$\text{Volume D} = \frac{\pi}{4} d^2 l$$

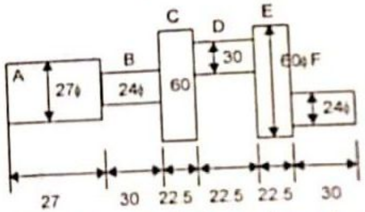
$$= \frac{\pi}{4} \times 30^2 \times 22.5 = \mathbf{15.90\ cc.}$$

$$\text{Volume E} = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 60^2 \times 22.5 = \mathbf{63.62\ cc.}$$

$$\text{Volume of F} = \frac{\pi}{4} d^2 l$$

$$= \frac{\pi}{4} \times 24^2 \times 30 = \mathbf{13.57\ cc.}$$



Calculate the unit of the forged crank shaft as shown in figure. It is made up of MS which has density of 0.008 kg/cm³. ⇒ 8kg / cc.

$$\text{Total volume of 1/2 crank shaft} = VA + VB + VC + VD + VE + VF$$

$$= 15.46 + 13.57 + 63.62 + 15.9 + 63.62 + 13.57$$

$$\text{Total Volume} = 183.74 \times 2$$

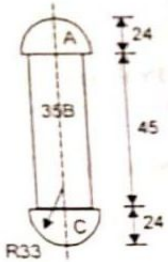
$$\boxed{V = 371.48\ \text{cc.}}$$

$$\therefore \quad \text{Unit of crank shaft} = \text{volume} \times \text{density}$$

$$= 371.48\text{cc} \times 0.008\ \text{kg/cc.}$$

$$\boxed{\text{Unit} = 2.971\ \text{kg.}}$$

Problem 8. *The following figure shows the rivet with dimensions. Calculate the unit if one rivet of density is 8 gms/cc. If the rivets are manufactured from 6.5 kg of material, calculate the no. of rivets that can be manufactured. Assume that there is no. usage of material.*



Solution. The given rivet is divided into 3 parts.

Volume of part A V_A is a segment of sphere.

$$\therefore \quad V_A = \frac{\pi}{6} h^2 (3D - 2h)$$

$$= \frac{\pi}{6} 24^2 (3 \times 66 - 2 \times 24)$$

$$V_A = \mathbf{45.238\ cm^3.}$$

$$V_B = \frac{\pi}{4} d^2 l = \frac{\pi}{4} \times 35^2 \times 45$$

$$V_B = \mathbf{43.29\ cm^3.}$$

$$V_C = V_A = \mathbf{45.238\ cm^3.}$$

$$\text{Total volume} = 43.29 \times 45.238 \times 2$$

$$= 133.77\ \text{cc.}$$

$$\text{Unit of 1 rivet} = \text{Volume} \times \text{density}$$

$$= 133.77 \times 8\ \text{gm/cc.}$$

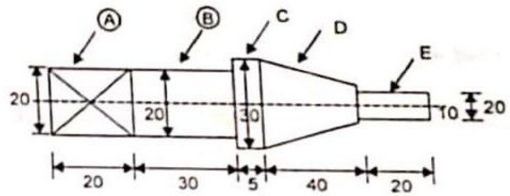
$$= 1070.16\ \text{gm} = \mathbf{1.07\ kg.}$$

$$\text{Availability of material} = \mathbf{6.5\ kgs.}$$

$$\text{No. of rivets manf.} = \frac{6.5}{1.07} \approx 6.07$$

$$\approx \mathbf{6\ rivets.}$$

Problem 9. *As unit cost of M.S. casting shown in figure. Assume density is 7.85 gm/cc and cost of material Rs. 11/kg.*



Solution.

$$V_A = \text{square}$$

$$V_A = l^3.$$

$$V_A = 20^3$$

$$= 8000\ \text{mm}^3.$$

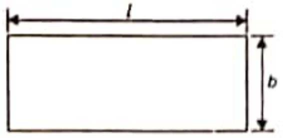
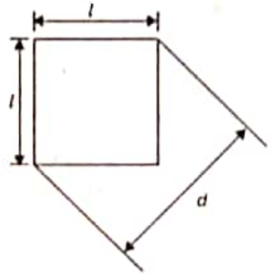
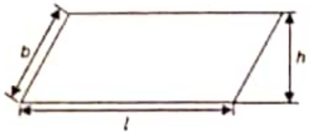
$$\boxed{V_A = 8\ \text{cc}}$$

$$V_B = \frac{\pi}{4} d^2 l = \frac{\pi}{4} \times 20^2 \times 30$$

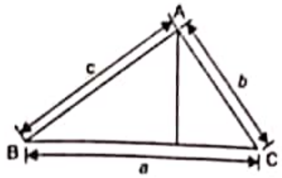
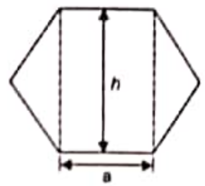
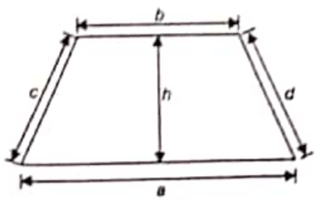
$$\boxed{V_B = 9.425\ \text{cc.}}$$

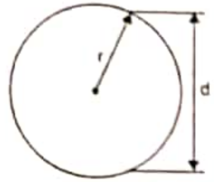
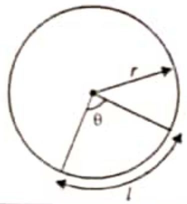
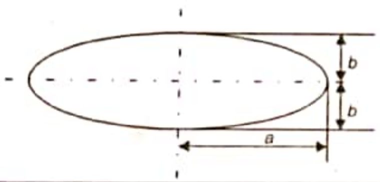
Office cost (cost of goods sold) = FC + AOH
= (administration OH)
Total cost = Office cost + SDOH + R and D expenses
= (selling and distribution OH)
Selling price = Total cost $\pm$ profit.

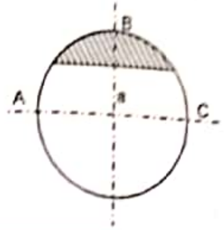
MENSURATION

Plane figures	*Perimeter*	*Area*
1. **Rectangle**  l = length of rectangle b = breadth of rectangle	$P = 2(l + b)$	$A = l \times b$
2. **Square**  l = length of each side of square d = length of diagonal	$P = 4l$	$a = l^2$
3. **Parallelogram**  l = length of 1 side of parallelogram	$P = 2(l + b)$	$a = l \times h$

(Contd......)

b = length of another side of parallelgram. h = height of parallelogram		
4. **Triangle**  abc = length of sides h = ht. of A from base BC	$P = a + b + c$ if $\left(s = \frac{a+b+c}{2}\right)$	$a = 1/2\, a \times h$ $= 1/2 \times \text{base} \perp^*$ area $= \sqrt{s(s-a)(s-b)(s-c)}$
5. **Hexagon**  a = length of each side h = height	$P = 6a$ height $h = \sqrt{3a}$	area $= \frac{3\sqrt{3}}{2}a^2$
6. **Any regular polyon** n sides of length a units.	$P = na$	area = ½ × perimeter × inner radius.
7. **Trapezium** $a\ b\ c\ d$ = length of 4 sides.  h = parallel dist between parallel sides.	$P = a + b + c + d$	area $= \left(\frac{a+b}{2}\right) \times h$

8. **Circle**  r = radius of circle d = dia of circle	$P = \pi d$ $P = 2\pi r$	$a = \pi / 4d^2$ $a = \pi r^2$
9. **Sector** r = radius of circle $\theta = L^{le}$ in radious l = length of arc $l = r\theta$. 		area = $\dfrac{\text{angle of sectar}}{2\pi}$ × area of circle $a = \dfrac{\theta}{2\pi} \times \pi r^2$ $a = \dfrac{lr}{2}$
10. **Fillet** r = radius of fillet 		$a = r^2 \dfrac{-\pi}{4} r^2$ $= r^2\left[1 - \dfrac{\pi}{4}\right]$ $a = 0.215r^2$ $\boxed{a = \dfrac{r^2}{4}}$ approx.
11. **Ellipse** a = semi-major axis b = semi-minor axis 	$P = \pi(a + b)$	$a = \pi ab$

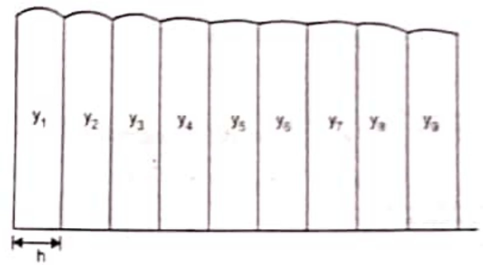
12. **Segment of circle** 		area $= \dfrac{2}{3} hL$ $\boxed{a = \dfrac{4}{3} h \sqrt{\dfrac{l^2}{4} + \dfrac{2}{5} h^2}}$ h = BD l = AC

AREAS OF IRREGULAR FIGURES

1. By Bumprant's Rule

Let h = distance between each ordinate

then area $= h/3[(y_1 + y_a) + 2(y_3 + y_5 + y_7) + 4(y_2 + y_4 + y_6 + y_8)]$



2. By Trapezoidal Rule

If $y_1, y_2 \ldots y_6$ are lengths of ordinates and h = distance between each ordinate.

then $a = h\left[\dfrac{1}{2}(y_1 + y_6) + y_2 + y_3 + y_4 + y_5\right]$

3. Method of Counting Squares

Area of figure = No. of squares × area of 1 square.

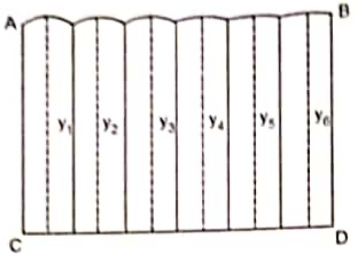
4. Area of Trapezium

= Distance between successive ordinates × sum of half of first and last ordinates together with all remaining ordinates.

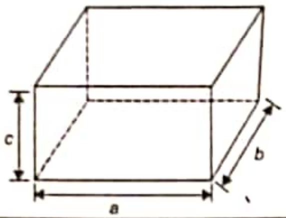
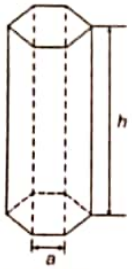
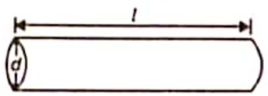
5. Mid-ordinate Method

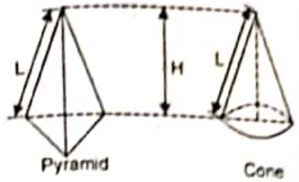
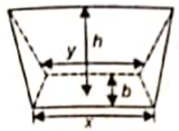
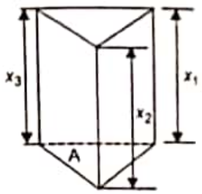
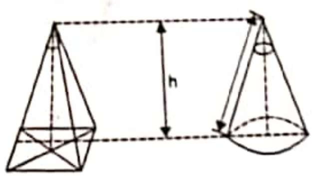
$$\text{Area} = \frac{(y_1 + y_2 + y_3 + y_4 + y_5 + y_6) \times CD}{6}$$

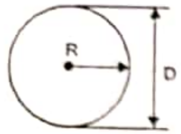
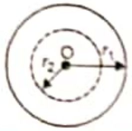
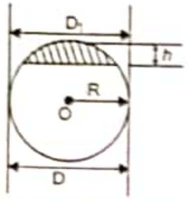
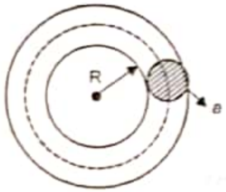
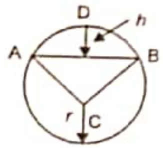
Average length of line × length of base line.



VOLUME AND SURFACE AREA OF SOLIDS

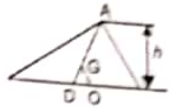
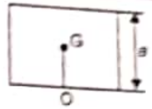
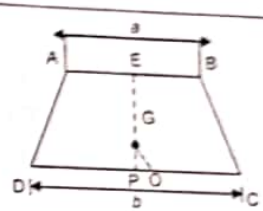
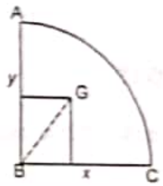
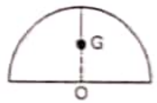
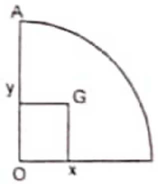
Plane figure	Volume	Surface area
1. **Rectangular solid** Let a, b, c be length, breadth and height of solid. 	$\boxed{V = abc}$ (length of diagonal $= \sqrt{a^2 + b^2 + c^2}$)	$\boxed{s = 2(ab + bc + ca)}$
2. **Prism** Let h = height of prism a = breadth of 1 side. 	V = area of base × height	s = No. of surface × ah + area of ends.
3. **Cylinder** Let d = dia of cylinder l = length of cylinder 	$\boxed{V = \frac{\pi}{4} d^2 l}$	$\boxed{s = \pi\, d\, l + \frac{\pi}{2} d^2}$

4. **Pyramids and cones** 	V = area of base $\times \frac{\text{perpendicular } ht \text{ H}}{3}$	s = area of base + perimeter of base × 1/2 length b of slant side
5. **Wledge** 	V = h/3 × area of base $V = h/3 \times \left(\frac{x + y}{2}\right) b$	
6. **Triangular prism** 	V = area of c.s. × mean length of edges $= A \times \left(\frac{x_1 + x_2 + x_3}{3}\right)$ where A = area of c.s. of triangle	
7. **Frustrum of pyramid and cone** a_1 and a_2 are areas of 2 ends. but for frustrum of cone $a_1 = \pi R_1^2$ $a_2 = \pi R_2^2$ 	$V = h/3 \times (a_1 + a_2 + \sqrt{a_1 a_2})$ Cone $V = \frac{\pi h}{3}(R_1^2 + R_2^2 + R_1 R_2)$	

8. **Sphere** 	$V = \frac{\pi}{6}D^3$ $= \frac{4}{3}\pi r^3$	$s = \pi D^2$ $= 4\pi r^2$
9. **Hollow sphere** 	$V = \frac{4}{3}\pi(r_1^3 - r_2^3)$	
10. **Segment of sphere** 	$V = \frac{\pi h^3}{3}(3R - h)$ $= \frac{\pi}{6}h^2(3D - 2h)$ or $V = \frac{\pi}{6}h\left[\frac{3}{4}(D_1^2 + h^2)\right]$	
11. **Circular ring** $a = \pi r^2$,  r = radius of circular cross section; R = mean radius of ring	V = area of c.s. × mean length $= 2\pi R \times \pi r^2$ $= 2\pi^2 Rr^2$	
12. **Spherical sectar** 	$V = ABCD = \frac{2}{3}\pi rh$	

	$V = \frac{\pi}{6}h\left[\frac{3}{4}(a_1^2 + a_2^2) + h^2\right]$	

POSITION OF CENTROID

1. **Triangle**		$OG = \frac{1}{3}h$ $GD = \frac{1}{2}AD$ where AD = median
2. **Square**		$OG = \frac{a}{2}$ $= \frac{1}{2}$ side of square
3. **Trapezoid**		$OG = \frac{h}{8} \times \frac{(2a + b)}{(a + b)}$
4. **Quardrant of circular arc**		$xG = Gy$ $= 0.637$ R. and BG = 0.9 R where r = radius of circular arc.
5. **Semi circular arc**		OG = 0.637 R. where R = rad. of circular arc.
6. **Quadrant of Circle**		XG = YG $= 0.424$ R. where R = rad Oa

8

ESTIMATION

8.1 DEFINITION

The process of compiling the statement of the quantity of materials involved, the amount of time involved in the production and the procedures to be followed in putting an order through together with the cost of the articles made or to be made where experience supplies no complete figures.

8.2 OBJECTIVES OF ESTIMATION

1. To help the owner of a factory to decide about the manufacturing and selling price.
2. To help in filling up the tenders so as to estimate the profit.
3. To decide the amount of overheads.
4. To determine the usage rate of the workers.
5. To take a decision whether to manufacture or to buy a particular product from the markets.

8.3 THE FUNCTIONS OF ESTIMATING DEPARTMENT

1. To determine the material cost taking into consideration different allowances given for different manufacturing operations.
2. To find the cost of the parts to be purchased from outside the venders.
3. To determine cost of equipment, tools, machinery, jigs and fixtures etc. (direct expenses).
4. To determine the labour cost considering the labour time with the help of the wage rate, labour cost in values the direct and indirect labour cost based on "WORK-STUDY".
5. To calculate the overhead charges associated with the product.

   The different overhead charges are administrative, office, selling and distribution.
6. To calculate the selling price of the product including the products.
7. To find the most economical procedure of making the product.
8. To conduct time study.
9. To keep control over selling expenses with the help of sales manager.

8.4 QUALITIES OF A GOOD ESTIMATIOR

1. An estimator should be able to read and understand the drawing and also the blue prints which are the part of the many process. Allowances of different material used?
2. He must have a good knowledge about the different machine, the various process output times etc., which are connected to the manufacturing of a product.
3. He should have a sound knowledge about proper tools, jigs and fixtures etc.
4. He should be a qualified technical person.
5. He should possess the knowledge about the wage rate of worker.
6. He should have the knowledge of work study.
7. He should possess a good knowledge of material.
8. He should also know the cost accounting procedures.

8.5 CONSTITUENTS OF ESTIMATION

1. Design time and cost
2. Drafting time and cost
3. Motion and time study
4. Planning and production central time
5. Procurement, design or manufacturing of special tools, jigs and fixture etc.
6. Experimental work
7. Material cost
8. Labour cost
8. Overheads.

1. Design cost

Considerable time is consumed in designing a particular product. In estimating, the usages and other expenditures required to be paid in designing a product are to be considered, for this reason, cost can be estimated on basis of similar products already designed in past or on basis of good judgement of designing. In this the remuneration paid to design office staff and other expenditure incurred during designing a product in a particular period are also added.

2. Drafting cost

After design work is over, the estimated time consumed by draftsman in drawings of individual components is called "drafting time". For calculating drafting cost, remuneration of draftsman is taken as basis.

3. Time and motion studies planning and production control cost

Sufficient time is consumed for such activities therefore estimated time and costs incurred on it are decided by past experience or judgement.

4. Cost of design and arrangement of special time

The estimator must take into account the cost of special items such as patterns, care boxes, flasks, dies, jigs and fixtures and tools etc., whenever they are used.

5. Cost of experimental work

The best and cheapest method of production is determined with the help of researches and experiments. They are performed on old and present methods and sometimes inventions are required to be done. The cost incurred on such estimates is given due considerations.

6. Materials cost

The material cost is found with the help of samples on drawings which show only finished dimensions, while estimation takes into account additional figs. to be provided including policy turning, stamping, moulding, wastage or spoilage in cutting and finishing etc, Therefore estimation must have practical knowledge of various allowances.

An estimation first prepares rough drawing with all allowances and calculates volume and cut is obtained by multiplying density. The material cost is obtained by knowing market rates of material., the scrap value is deducted from material cost.

7. Labour cost

To estimate labour cost, an estimation must have a large experience and through knowledge of all operations carried out during production and he should take advice of production department while deciding about exact time of each operations different allowances like personal, fatigue, tool changing and funding and checking measurement allowance should also be taken into consideration.

8. Time allowance

The classification of time allowances are as under:

1. Set up time
2. Operation time (*a*) handling time (*b*) machine time
3. Tear down time
4. Miscellaneous allowances

1. **Set up time :** It is the time required for setting and fixing the job and different tools on the m/c and time required to study drawings, blue prints, to set m/c, to inspect job, setting of gauge etc.
2. **Opeation time :** It is the time taken by m/c's for actual o/p's on the job, also known as 'cutting or floor' time', which includes.

   (*a*) **Handling time :** It means time required in physical movements while performing m/c'ing o/p's.

   (*b*) **m/c'ing time :** The time taken by m/c's from start when tool touches job to the end when tool leaves the job.
3. **Tear down time :** It is the time counted from when last element of operation has been completed.

4. **Miscellaneous allowances :** an estimator should consider different allowances for time because it can't be expected that a worker can work for all the 8 hrs. without rest. Therefore, allowances as given which generally consume 10 to 15% of the total time taken. These allowances are :

(a) Personal allowances

(b) Fatigue allowances

(c) Tool changing and grinding allowances

(d) Measurement checking allowances

(e) Other allowances

(a) **Personal allowances :** is time consumed to other his personal needs such as going to lavatour, to take water, to smoke etc. Reduction in efficiency due to falls in this category. This takes 5% of total working time.

(b) **Fatigue allowance :** A worker cannot work for full time with same speed and sometimes he feels some tiredness, due to excessive work, poor lighting, machine noice etc., leading to fatigue and allowance for fatigue is nearly 5% of total time.

(c) **Tool changing and grinding allowance :** is time required to remove tool from its holder and to fix another tool and sharpen the tool. To sharpen the tool, worker has to remove the tool, rear up to the grinder to grind tool, come back to m/c and set the tool again on the m/c and the allowance is nearly 5-10% of total time.

(d) **Measurement and checking allowance :** is time taken for measuring and checking different dimensions of the product and this takes 2 to 3% of total time.

(e) **Other allowances :** is time consumed in as like periodic cleaning, oiling, getting stocks, delivering jobs, disposing of scraps and surplus stocks etc., and this takes 15-20% of the operation time.

9. Overheads

These include the expenditure which cannot be definitely charged to a particular product during production. These include expenses such as:

(a) **Indirect material cost :** In this, the cost of greases, coolants, oils, cotton waste, contingencies, light, water, etc. are considered.

(b) **Indirect labour cost :** In this, the pay of supervisors, draftsmen, designers, research workers, helpers, chowkidars and persons working for material handling etc., are included.

(c) **Administrative overheads :** These include salaries of high officials, salaries of persons working in general office, telephone, telex to insurance premium etc.

(d) **Selling overheads :** These include salaries of salesmen, commission to salesmen and advertising expenditure etc.

(e) **Repairs and maintenance expenses**

(f) **Insurance premium on building and plants.**

(g) **Depreciation of building, furniture and equipment.**

The sum of all these expenses is found out which will be total estimated cost of product.

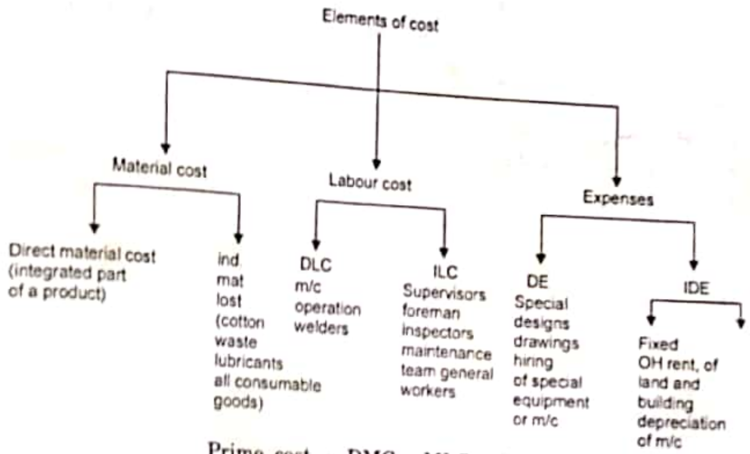
8.6 COSTING

It is the determination of an actual cost of an article after adding different expenses incurred in various departments. It is a system which systematically records all the expenses and determines the cost of manufacturing product.

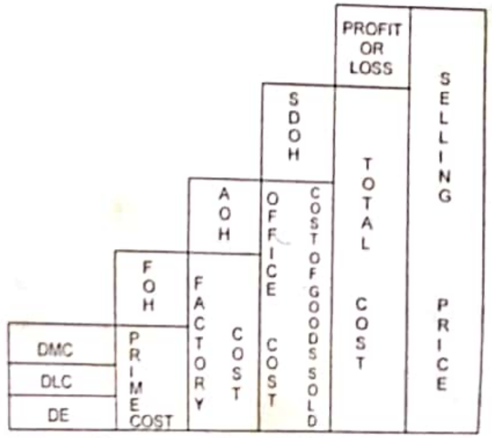
The basic difference between estimation and costing is while estimation estimates the expenses because the actual production of a product cost whereas costing is done after manufacturing the actual product.

The technique and process of ascertaining the lost is known as costing. Every bit of expenditure has to be considered while calculating the actual cost of production.

The elements of cost are as follows :



Prime cost = DMC + MLC + DE



Factory cost (production cost) = P.C. + FOH (IMC + ILC + IE) or production OH