UNIT-5

RSK-840

Four masses m_1, m_2, m_3 and m_4 having 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively. The angle between the successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if the radius of rotation is 0.2 m

Given:

$m_1 = 200\ kg$, $m_2 = 300\ kg$, $m_3 = 240\ kg$, $m_4 = 260\ kg$

$r_1 = 0.2\ m$, $r_2 = 0.15\ m$, $r_3 = 0.25\ m$, $r_4 = 0.3\ m$

$\theta_1 = 0°$, $\theta_2 = 45°$, $\theta_3 = 45+75 = 120°$, $\theta_4 = 45+75+135$

$\theta_4 = 255°$

$r = 0.2\ m.$

Solution: Graphical method.

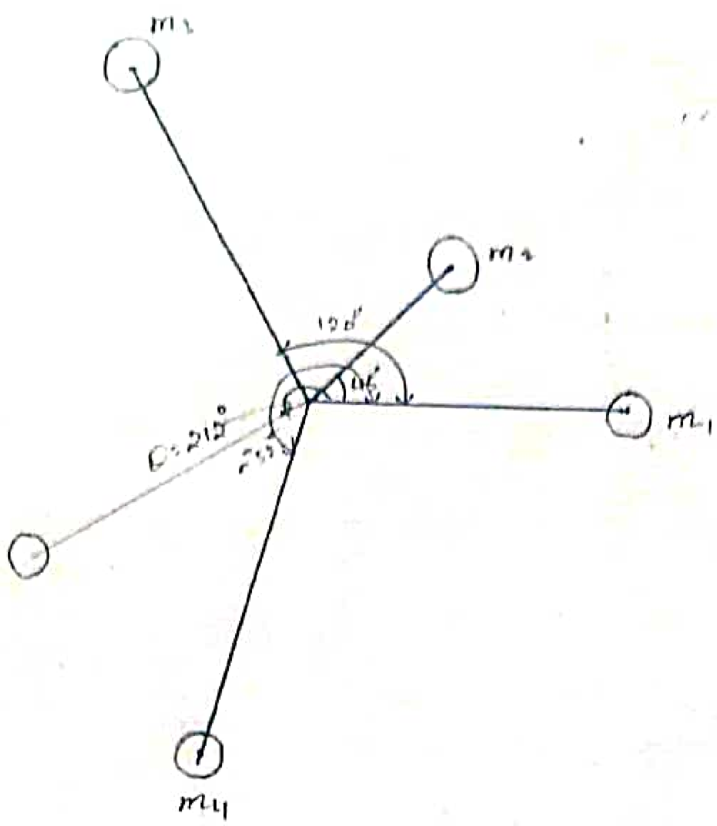
Centrifugal force of each mass is,

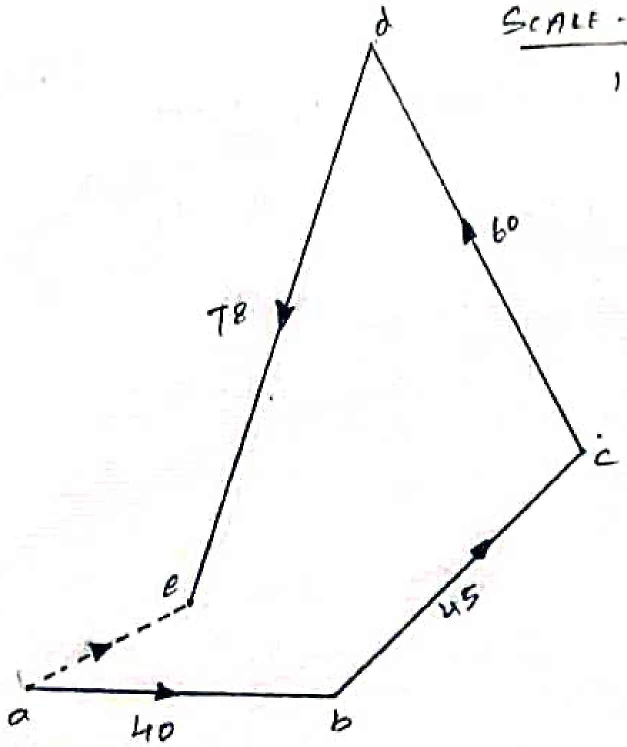
$m_1 . r_1 = 200 \times 0.2 = 40\ kg.m$

$m_2 . r_2 = 300 \times 0.15 = 45\ kg.m$

$m_3 . r_3 = 240 \times 0.25 = 60\ kg.m$

$m_4 . r_4 = 260 \times 0.3 = 78\ kg.m$





SCALE - 1:1

1 cm = 10 kg-m

FORCE POLYGON

ae = 23

m r = 23

m × 0.2 = 23

m = 115 kg

P.S.K. 881

5.10

A four crank engine has the two outer cranks set at 120° to each other and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. If the engine is to be in complete balance, find the reciprocating mass and the relative angular position for each of the inner crank. If the length of each crank is 300 mm, the length of each connecting rod is 1.2 m and the speed of rotation is 240 r.p.m. What is the maximum secondary unbalanced force?

6.36

Given: $m_1 = m_4 = 400\,kg$, $r = 300mm = 0.3m$. $l = 1.2m$.

$N = 240\ rpm$. (or) $\omega = \frac{2\pi N}{60} = \frac{2\pi \times 240}{60} = 25.14\ rad/s$.

Plane	Mass (m) kg	Radius (r) m	Centrifugal force (m.r.) kg.m	Distance from Plane. (l) m	Couple. (m.r.l) kg.m²
1.	400	0.3	120	−0.45	−54
2.(R.P)	m_2	0.3	$0.3 m_2$	0	0
3.	m_3	0.3	$0.3 m_3$	0.75	$0.225 m_3$
4.	400	0.3	120	1.35	162

Maximum Secondary unbalanced force, $= 570 \times \frac{\omega^2}{n}$

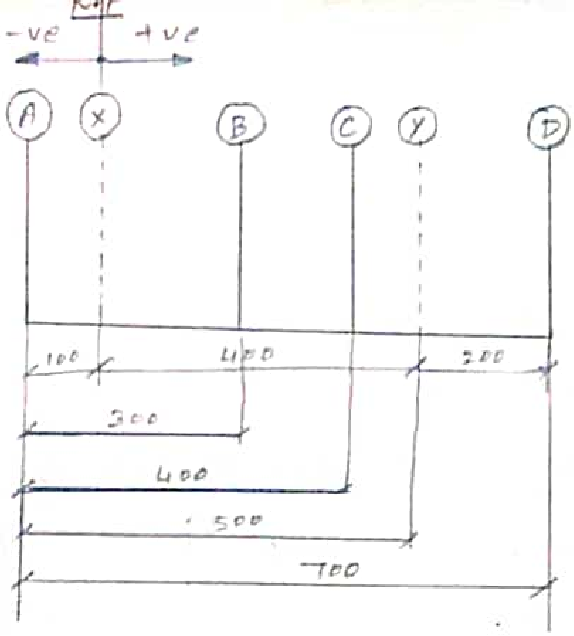
$= 570 \times \frac{(25.14)^2}{4}$

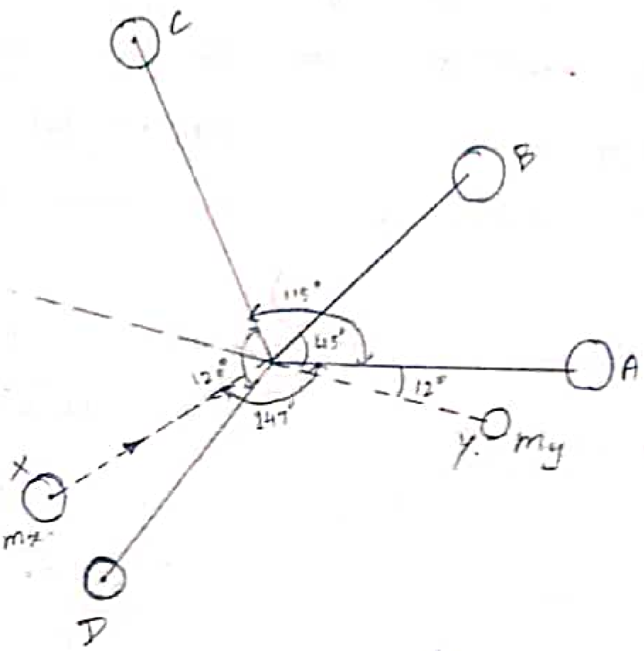
$= 90 \times 10^3\ N.$

$n = \frac{l}{r}$

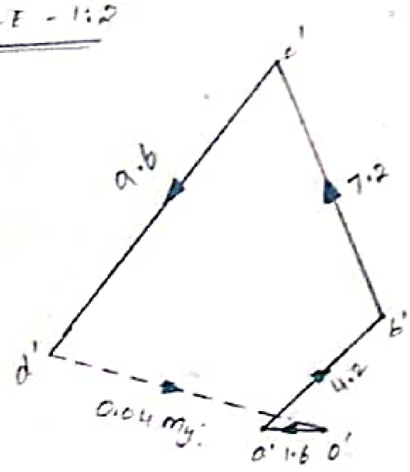
$n = \frac{1.2}{0.3}$

$n = 4$





SCALE - 1:2

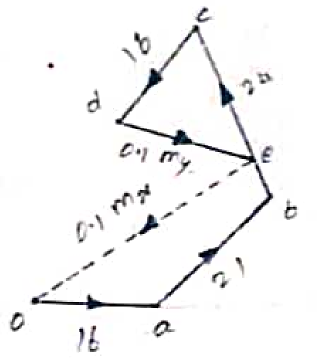


COUPLE POLYGON

$o'd' = 7.4\ kg\text{-}m^2$.

$\therefore 0.04\, m_y = 7.4$

$m_y = 185\ kg.$



FORCE POLYGON

$oe = 35\ kg\text{-}m^2$

$0.1\, m_x = 35$

$m_x = 350\ kg.$

A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively. The masses are revolving at a radii of 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured in counter clockwise are A to B 45°, B to C 70°, and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses are revolve at a radius of 100 mm, find their magnitudes and angular positions.

Given:

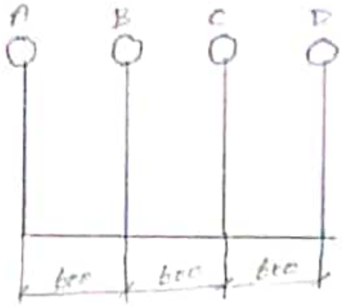
$m_A = 200$ kg, $m_B = 300$ kg, $m_C = 400$ kg, $m_D = 200$ kg

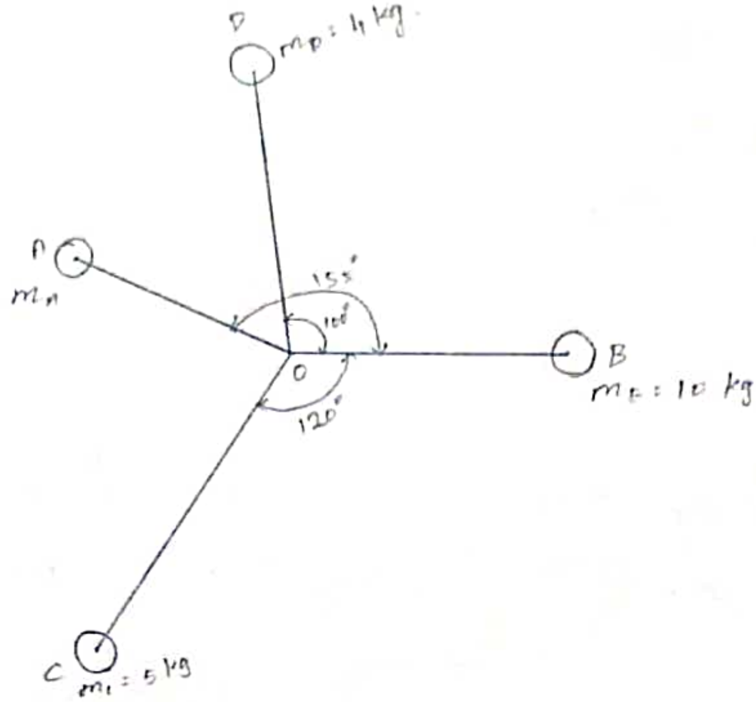
$r_A = 80$ mm, $r_B = 70$ mm, $r_C = 60$ mm, $r_D = 80$ mm

$\theta_1 = 0°$ $\theta_2 = 45°$ $\theta_3 = 45+70 = 115°$ $\theta_4 = 45+70+120° = 235°$

$r_x = r_y = 100$ mm.

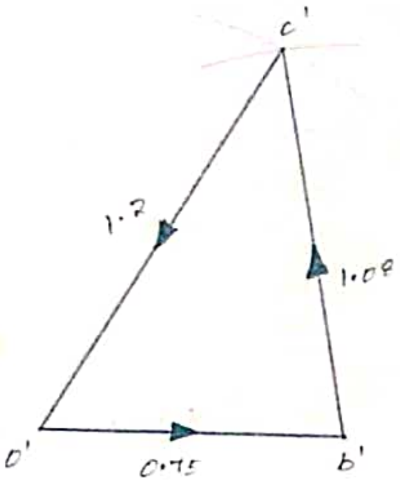
PLANE	MASS (m) kg	Radius (r) m	Centrifugal force (m.r) kg-m	Distance from Plane (l) m	Couple (m.r).l kg-m²
A	200	0.08	16	-0.1	-1.6
X (R.P)	m_x	0.1	$0.1 m_x$	0.0	0.0
B	300	0.07	21	0.2	4.2
C	400	0.06	24	0.3	7.2
Y	m_y	0.1	$0.1 m_y$	0.4	$0.04 m_y$
D	200	0.08	16	0.6	9.6





SCALE

1 cm = 0.1875 kg·m²

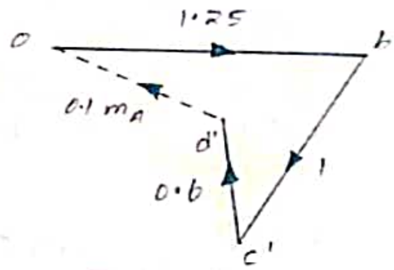


$\frac{0.75}{4} = 0.1875$

$\frac{1.2}{0.1875} = 6.4$

$\frac{1.08}{0.1875} = 5.76$

COUPLE POLYGON



SCALE

1 cm = 0.3125 kg·m

$\frac{1.25}{4} = 0.3125$

$\frac{1}{0.3125} = 3.2$

$\frac{0.6}{0.3125} = 1.92$

FORCE POLYGON

$0.1 m_A = 0.75$

i) $m_A = 7.5$ kg

ii) $\angle BOD = 100°$

iii) $\angle BOC = 240°$

iv) $\angle BOA = 155°$

R.S.K. - 847

Four masses A, B, C and D are carried by a rotating shaft at radii of 100 mm, 125 mm, and 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg and 4 kg respectively.

Find the required mass of A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

Given:

$r_A = 0.1\ m$, $r_B = 0.125\ m$, $r_C = 0.2\ m$, $r_D = 0.15\ m$

$m_A = \_\_?$ $m_B = 10\ kg$, $m_C = 5\ kg$, $m_D = 4\ kg$.

Plane	Mass (m) kg	Radius (r) m	Centrifugal force (m·r) kg-m	Distance from plane A	Couple (m·r·l) kg-m²
A - (R.P)	m_A	0.1	$0.1\ m_A$	0	0
B	10	0.125	1.25	0.6	0.75
C	5	0.2	1	1.2	1.2
D	4	0.15	0.6	1.8	1.08

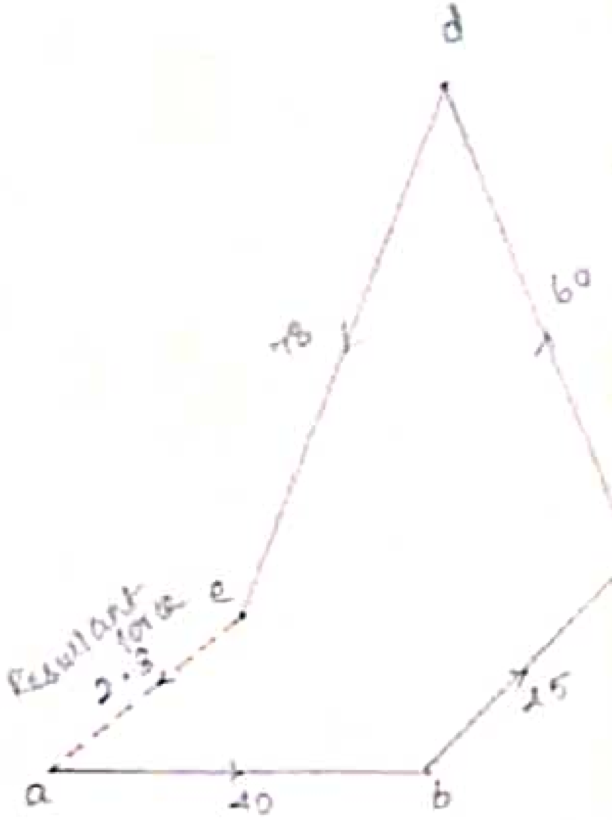
Balancing – Rotating Mass.

1, Given :-

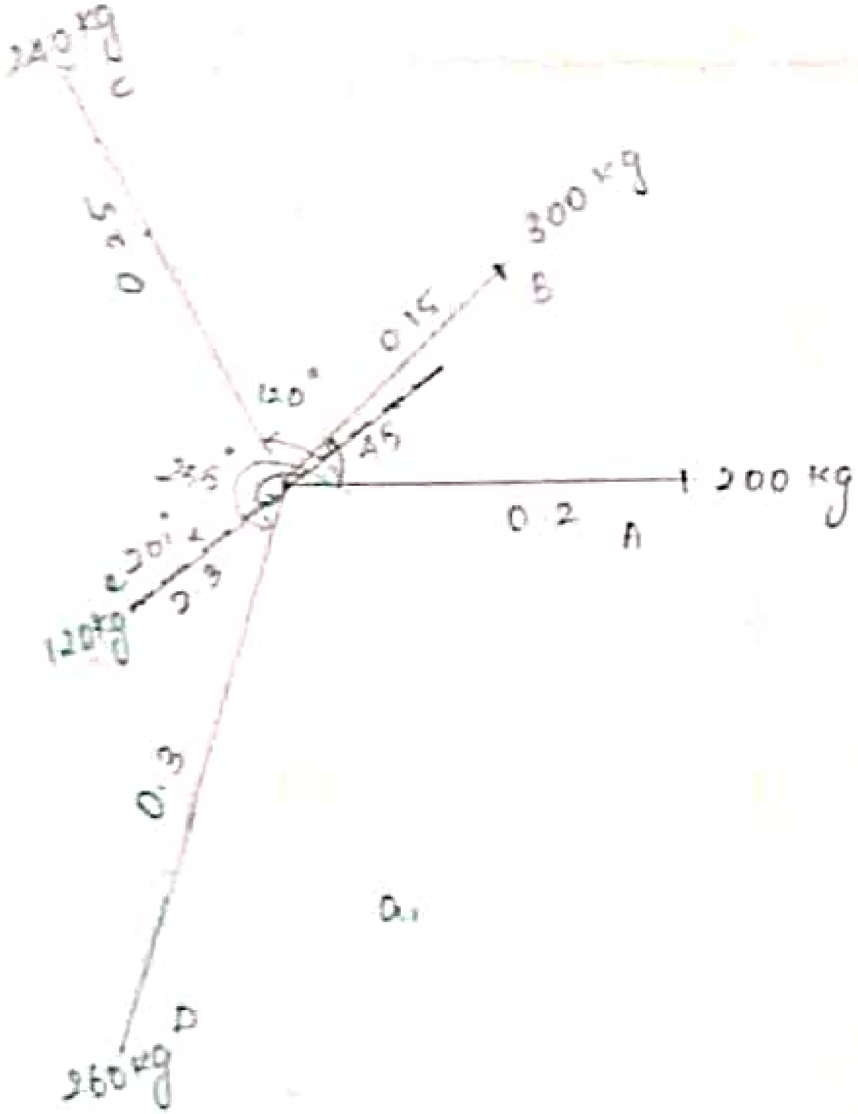
θ	Plane	Mass kg	Radius m	m×r kg m
0°	1	200	0.2	40
45°	2	300	0.15	45
120°	3	240	0.25	60
255°	4	260	0.3	78

Scale : 1:2

1 cm = 40 mm



Vector diagram



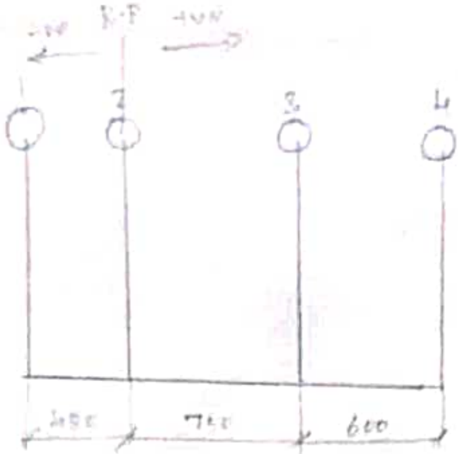
$m \times 0.2 = 23$

$m = \frac{23}{0.2}$

$= 115 \text{ kg}$

$\theta = 201°$

a.

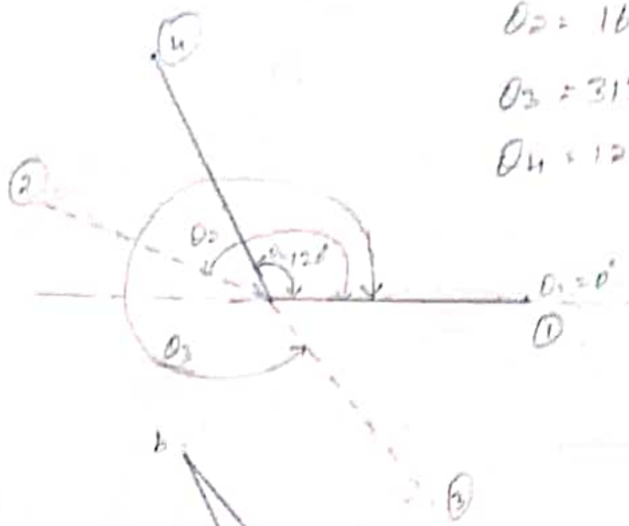


$\theta_1 = 0^\circ$

$\theta_2 = 160^\circ$

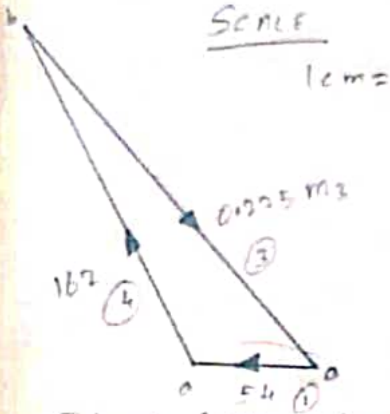
$\theta_3 = 313^\circ$

$\theta_4 = 120^\circ$



SCALE

1 cm = 32.4 kg·m²



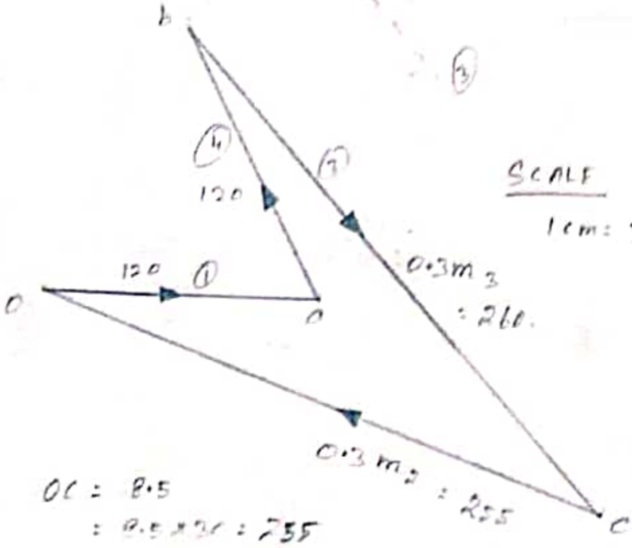
Primary Couple Polygon

$ob = 6\,cm \times 32.4$

$ob = 195\ kg \cdot m^2$

$\therefore 0.225\, m_3 = 195$

$\boxed{m_3 = 867\ kg}$



SCALE

1 cm = 30 kg·m

$oc = 8.5$

$= 8.5 \times 30 = 255$

$0.3 m_2 = 255$

$\boxed{m_2 = 850\ kg}$

Primary force Polygon

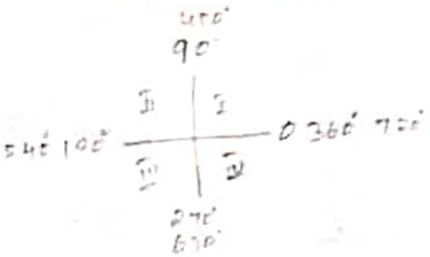
force

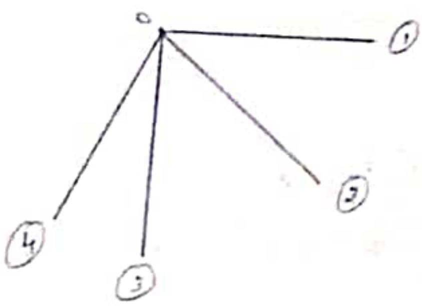
1 : 120

2 : 255

3 : 260

4 : 120

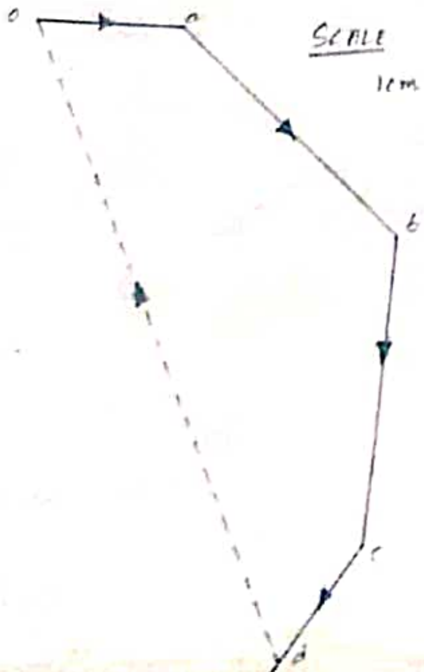




Secondary Couple Polygon

SCALE

1 cm = 60 kg·m



$Od = 9.5\,cm \times 60$

$= 570\ kg \cdot m$

Secondary force Polygon