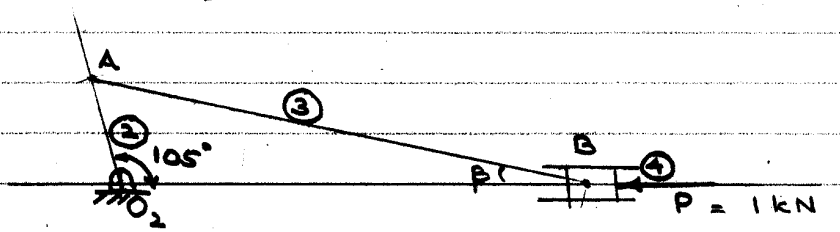
MECH 343/2 X Theory of Machines I.

Solution to Assignment # 9.

1.



$O_2A = 75$ mm 1 cm = 50 mm

$AB = 350$ mm

$\theta_2 = 105°$ $\beta = 11.946°$

(a)

For ④:

$F_{34} \cos\beta = P.$

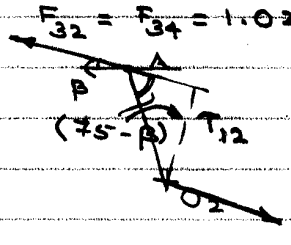
$\therefore F_{34} = 1.022$ kN

③ is a two-force member.

$F_{14} = F_{34} \sin\beta$

$= 0.2116$ kN

For ②



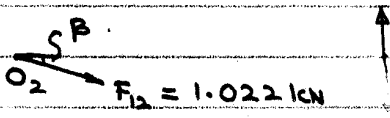
$T_{12} = 1.022 \times 0.075 \sin(75-\beta)$

$= 0.06833$ kNm

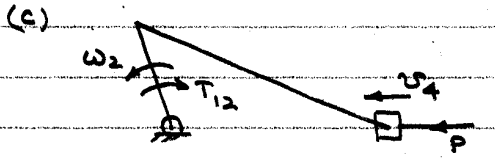
$= 68.33$ Nm.

$F_{12} = 1.022$ kN.

(b)



(c)



Forces that do work.

Σ Power $= 0$.

$(T_{12})(-\omega_2) + (P)(v_4) = 0$.

$\therefore T_{12} = \dfrac{P v_4}{\omega_2}$

$= 0.06834$ kNm

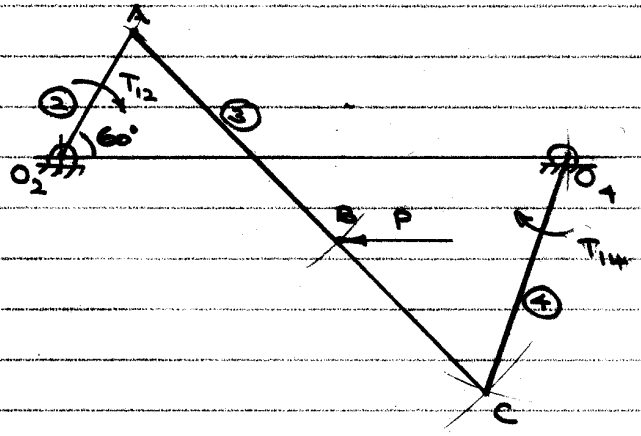
(As before).

2. $O_2O_4 = 700$ mm $AB = 400$ mm

$O_2A = 200$ mm $\theta_2 = 60°$

$AC = 700$ mm

$O_4C = 350$ mm

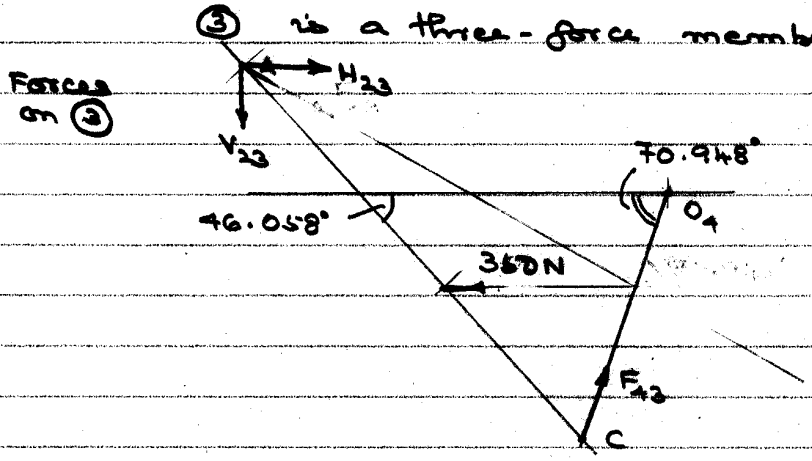


1 cm = 100 mm.

(a)(i) $P = 350$ N, $T_{14} = 0$ Nm.

Here ④ is a two-force member.

③ is a three-force members.



Note: You may solve this problem graphically.

A) $F_{43}(0.7)\sin 62.994^\circ = 350\,(0.4)\sin 46.058^\circ$

$F_{43} = 161.6$ N.

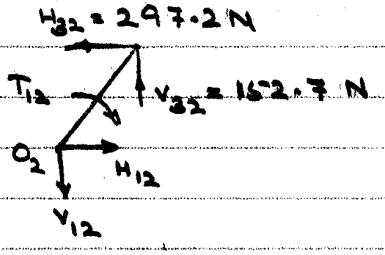
$\rightarrow \quad H_{23} = 350 - F_{43}\cos 70.948^\circ$

$= 297.2$ N.

$\uparrow \quad V_{23} = F_{43}\sin 70.948^\circ$

$= 152.7$ N.

Forces on ②



O_2)

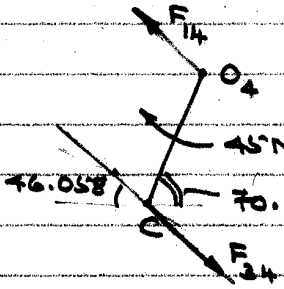
$T_{12} = H_{32}(0.2)\sin 60^\circ + V_{32}(0.2)\cos 60^\circ$

$= 66.76$ Nm.

a(ii) $P = 0 \quad T_{14} = 45$ Nm.

Here ③ is a two force member.

For ④

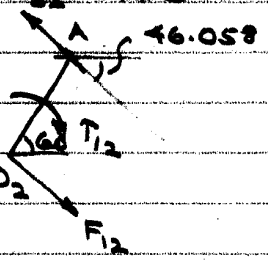


O_4)

$45 = F_{34}(0.350)\sin 62.994^\circ$

$F_{34} = 144.3$ N.

Forces on ③ $F_{32} = 144.3$



O_2) $T_{12} = F_{32}(0.200)\sin 73.942^\circ$

$= 27.73$ Nm.

a(iii) Using Superposition

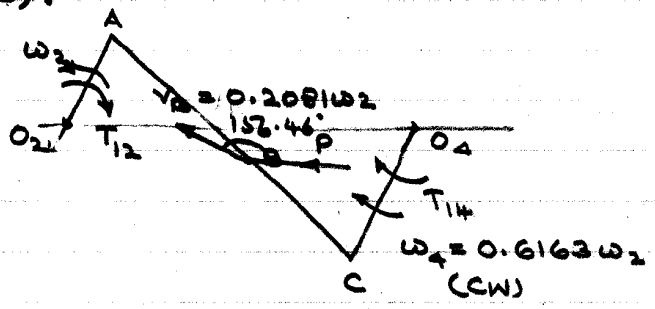
From (i) $P = 350$ N & $T_{14} = 0$ Nm $\quad T_{12} = 66.76$ Nm (CW)

From (ii) $P = 0$ N & $T_{14} = 45$ Nm $\quad T_{12} = 27.73$ Nm (CW)

$\therefore$ $P = 350$ N & $T_{14} = 45$ Nm $\Rightarrow T_{12} = 66.76 + 27.73$

$= 94.48$ Nm.

(b):



Σ Powers = 0.

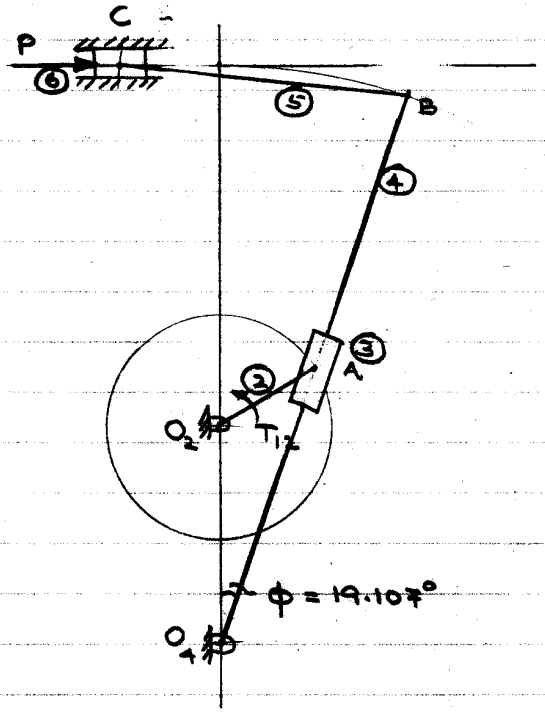
$\therefore (T_{12})(-\omega_2) + (P)(0.2081\,\omega_2 \cos 23.54^\circ) + (T_{14})(0.6163\,\omega_2) = 0$

$\therefore T_{12} = (350)(0.2081)\cos 23.54^\circ + (45)(0.6163)$

$= 94.51$ Nm.

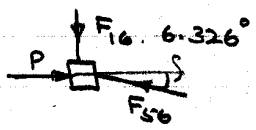
(As before).

3.



(a)

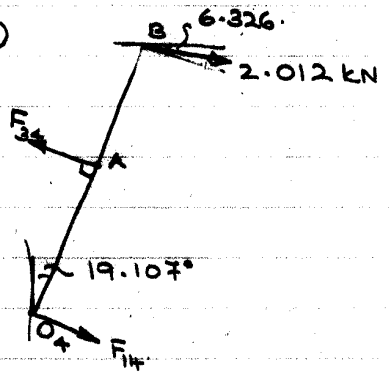
For (6)



$\rightarrow P = F_{56}\cos 6.326$

$F_{56} = \dfrac{2}{\cos 6.326} = 2.012$ kN.

For (4)

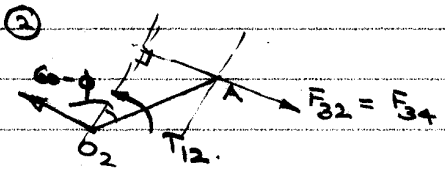


O_4) $(F_{34})(O_4A) = (2.012)(0.400)\cos 12.781^\circ$

$F_{34} = \dfrac{(2.012)(0.400)\cos 12.781}{(0.1984)}$

$= 3.956$ kN.

For (2)



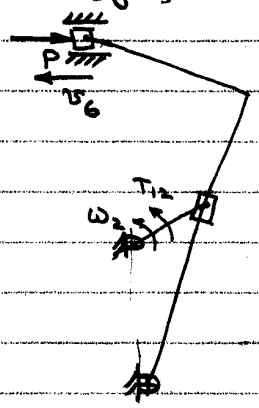
Note: (3) is a two-force member.

$\therefore T_{12} = F_{32} \cdot r_2 \cos(60-\phi)$

$= (3.956)(0.075) \cos 40.893$

$= 0.2243$ kNm

(b) Energy Method:



Σ Power $= 0$

$\therefore T_{12}\omega_2 + P(-v_6) = 0$

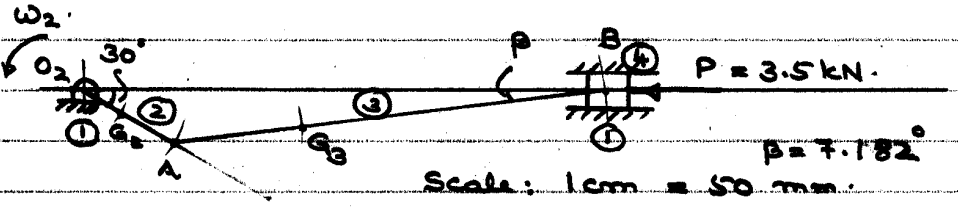
$T_{12} = P\left(\frac{v_6}{\omega_2}\right)$

$= (2)(0.1121)$

$= 0.2242$ kNm.

(As before).

4.



Scale: 1 cm = 50 mm.

Inertia Forces:

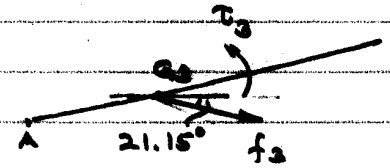
(2): 

$(\alpha_2 = 0)$

$f_2 = m_2 \cdot O_2G_2 \cdot \omega_2^2$

$= (0.45)(0.030)(100)^2$

$= 135$ N.

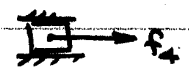
(3) 

$f_3 = m_3 a_{G3}$

$= (1.60)(727.5) = 1164$ N

$\tau_3 = I_3 \alpha_3$

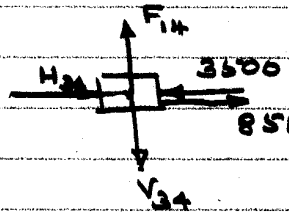
$= (0.015)(1200) = 18$ Nm.

(4)  f_4

$f_4 = m_4 a_4$

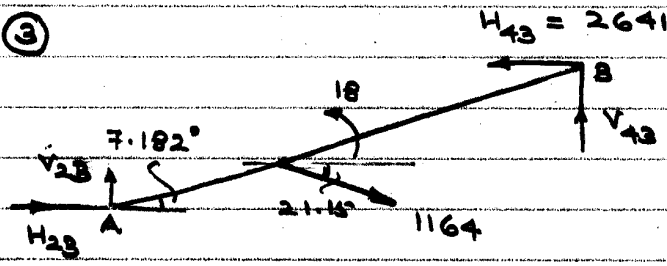
$= (1.16)(746.3) = 858.2$ N.

FORCES:

(4) 

$\rightarrow \quad H_{34} = 3500 - 858.2$

$= 2641.8$ N.

(3) 

A) $(V_{43})(0.300)\cos 7.182° + (2641.8)(0.300)\sin 7.182°$

$-(1164)(0.090)\sin 28.332 + 18 = 0$

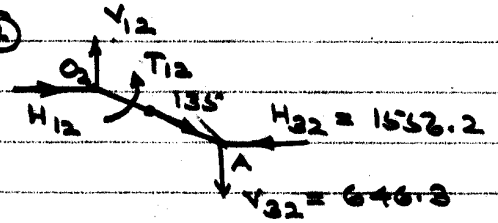
$V_{43} = -226.3$ N.

$\uparrow \quad V_{23} = 226.3 + 1164 \sin 21.15°$

$= 646.3$ N

$\rightarrow \quad H_{23} = 2641.8 - 1164 \cos 21.15°$

$= 1556.2$ N.

(2) 

O_2) $T_{12} = (1556.2)(0.075)\sin 30$

$+ (646.3)(0.075)\cos 30°$

$= 100.3$ Nm.

CCW

T_{12} & ω_2 in the same sense

$\therefore$ T_{12} is driving torque.