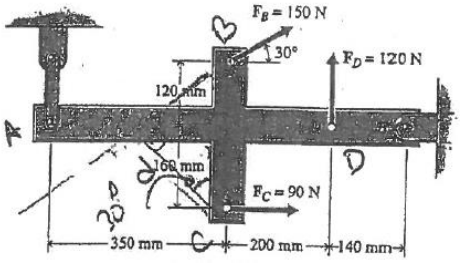
10/11/2020

ES 221 MECHANICS I (STATICS) RECITATION IV

Q1)

Three forces are applied to a bracket as shown. Determine (a) the moment of force F_C about point B, (b) the moment of force F_D about point A, (c) the moment of force F_B about point C.



Answer to Q1

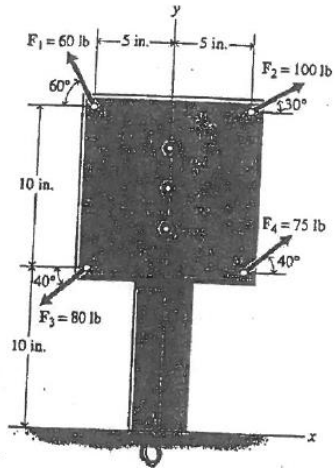
(a) $M_{C/B} = r \times F = 0.28\ m \times 90\ N = 25.2\ Nm\ \circlearrowleft$

(b) $M_{D/A} = 0.55\ m \times 120\ N = 66\ Nm\ \circlearrowleft$

(c) $M_{B/C} = 0.28\ m \times 150\ cos30^0 \approx 36.4\ Nm\ \circlearrowright$

Q2)

Four forces are applied to a square plate as shown. Determine the total moment produced by each of the forces about the origin O of the xy-coordinate system.



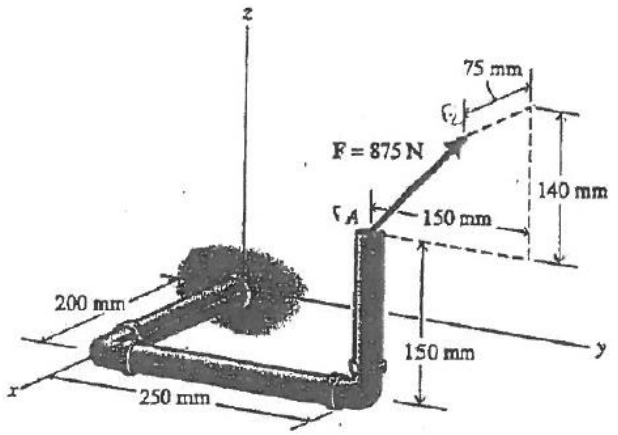
Answer to Q2

$$\circlearrowleft \sum M_O = 60\,cos60^0 \times 20 - 60\,sin60^0 \times 5 - 100\,cos30^0 \times 20 + 100\,sin30^0 \times 5 +$$
$$80\,cos40^0 \times 10 + 80\,sin40^0 \times 5 - 75\,cos40^0 \times 10 + 75\,sin40^0 \times 5 = -605.4\,lb.in$$

$$\sum M_O = 605.4\,lb.in \circlearrowright$$

Q3)

A bar is bent and loaded as shown. Determine (a) the moment of force F about point O, (b) the perpendicular distance *d* from point O to the line of action of the force.



Answer to Q3

Coordinates of Points

$A(200, 250, 150)mm$

$C(275, 400, 290)mm$

(a)

$$\vec{r}_{AC} = \{75\,\vec{\imath} + 150\,\vec{\jmath} + 140\,\vec{k}\}\,mm\,, \quad |r_{AC}| = \sqrt{75^2 + 150^2 + 140^2} = 218.5\,mm$$

$$\vec{u}_{AC} = \frac{\vec{r}_{AC}}{r_{AC}} = 0.343\,\vec{\imath} + 0.686\,\vec{\jmath} + 0.641\,\vec{k}$$

$$\vec{F}_{AC} = 875 \times \{0.343\,\vec{\imath} + 0.686\,\vec{\jmath} + 0.641\,\vec{k}\} = \{300\,\vec{\imath} + 600\,\vec{\jmath} + 561\,\vec{k}\}\,N$$

$$M_O = \begin{vmatrix} i & j & k \\ 0.2 & 0.25 & 0.15 \\ 300 & 600 & 561 \end{vmatrix} = \{50.25\,\vec{\imath} - 67.2\,\vec{\jmath} + 45\,\vec{k}\}\,Nm$$

(b)

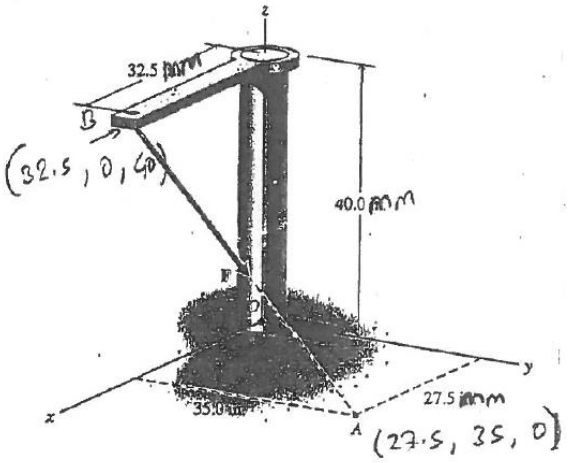
$$M = \sqrt{50.25^2 + (-67.2)^2 + 45^2} = 95.2\,Nm$$

$$95.2\,Nm = d \times 875\,N$$

$$d = 109\,mm$$

Q4)

An 800-N force is applied to a lever-shaft assembly as shown. Determine (a) the moment of force F about point O, (b) the perpendicular distance *d* from point O to the line of action of the force.



Answer to Q4

(a)

$$\vec{r}_{BA} = \{-5\,\vec{\imath} + 35\vec{\jmath} - 40\,\vec{k}\}\,mm\,, \qquad |r_{BA}| = \sqrt{(-5)^2 + 35^2 + (-40)^2} = 53.4\,mm$$

$$\vec{u}_{BA} = \frac{\vec{r}_{BA}}{r_{BA}} = -0.094\,\vec{\imath} + 0.656\,\vec{\jmath} - 0.749\,\vec{k}$$

$$\vec{F}_{BA} = 800 \times \{-0.094\,\vec{\imath} + 0.656\,\vec{\jmath} - 0.749\,\vec{k}\} = \{-75.2\,\vec{\imath} + 526.4\,\vec{\jmath} - 601.6\,\vec{k}\}\,N$$

$$M_O = \begin{vmatrix} i & j & k \\ 0.0325 & 0 & 0.04 \\ -75.2 & 526.4 & -601.6 \end{vmatrix} = \{-21.1\,\vec{i} + 16.5\,\vec{j} + 17.1\,\vec{k}\}\,Nm$$

(b)

$$M = \sqrt{(-21.1)^2 + 16.5^2 + 17.1^2} = 31.8\,Nm$$

$$31.8\,Nm = d \times 800\,N$$

$$d = 39.7\,mm$$