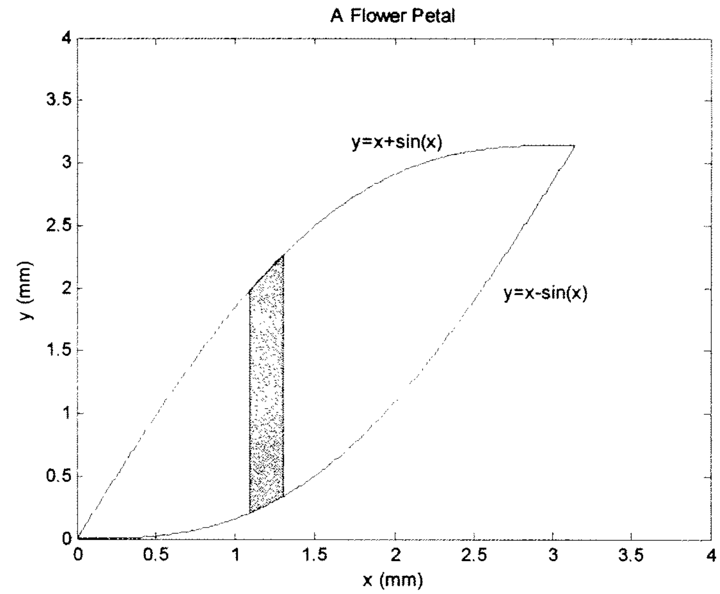
Problem 1 – Short Answer -- *27 points*

10pts (a) Consider the mathematical model of a flower petal shown in the figure below.



The equation for the y-centroid of the shape may be written (using a vertical strip) as

$$y_c = \frac{\int_A \tilde{y}\, dA}{\int_A dA} = \frac{\int_a^b \tilde{y}\ w\, dx}{\int_a^b w\, dx}$$

For the limits of integration we should choose

3

i. a=0, b=π
ii. a=0, b=$x + \sin(x)$
iii. a=0, b= $x - \sin(x)$
iv. a= $x - \sin(x)$, b= $x + \sin(x)$
v. other (specify_________________________)

For dA we should choose

3

i. $dA = (x + \sin(x))dx$
ii. $dA = (x - \sin(x))dx$
iii. $dA = (2x)dx$
iv. $dA = (2\sin(x))dx$
v. other (specify_________________________)

For the centroid of the strip we should choose

4

i. $\tilde{y} = y$
ii. $\tilde{y} = x$
iii. $\tilde{y} = x + \sin(x)$
iv. $\tilde{y} = x - \sin(x)$
v. $\tilde{y} = \sin(x)$
vi. other (specify_________________________)

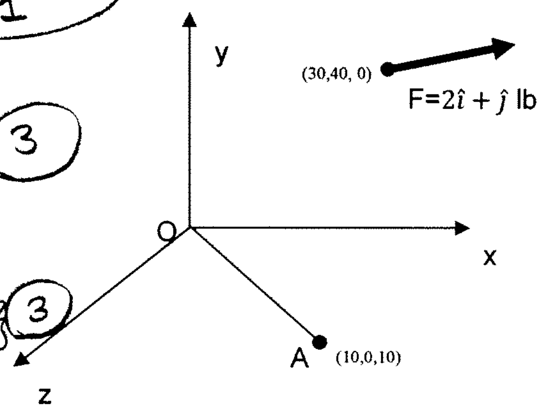
11 pts (b) Consider the diagram shown below. Find the moment about the line OA due to the force vector. All coordinates are in inches.

concept 1

$M_{OA} = \hat{e}_{OA} \cdot (\vec{r}_{OF} \times \vec{F})$

$\hat{e}_{OA} = \dfrac{10\hat{i} + 0\hat{j} + 10\hat{k}}{\sqrt{10^2 + 10^2}} = \dfrac{\sqrt{2}}{2}\hat{i} + 0\hat{j} + \dfrac{\sqrt{2}}{2}\hat{k}$ (3)

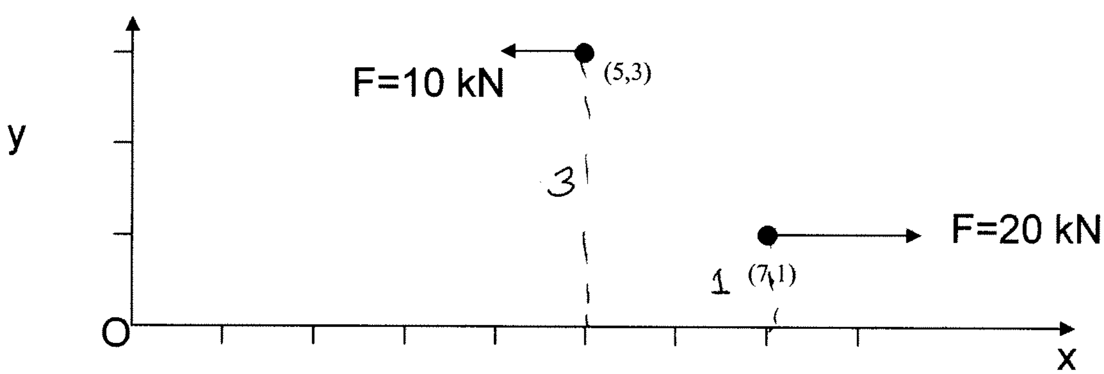
$\vec{r}_{OF} = 30\hat{i} + 40\hat{j} + 0\hat{k}$ in (3)



$M_{OA} = \begin{vmatrix} \frac{\sqrt{2}}{2} & 0 & \frac{\sqrt{2}}{2} \\ 30 & 40 & 0 \\ 2 & 1 & 0 \end{vmatrix} = \frac{\sqrt{2}}{2}(30 - 80) = -25\sqrt{2}$ in-lb

$M_{OA} = -35.4$ in-lb (4)

6 pts (c) Find the net moment due to these forces about point O (the origin). All coordinates are in meters.



$\vec{M}_o = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2$

$= +30\,kN\text{-}m\,\hat{k} - 20\,kN\text{-}m\,\hat{k}$

$= 10\,kN\text{-}m\,\hat{k}$

units 1
vector dir 1
magnitude 4