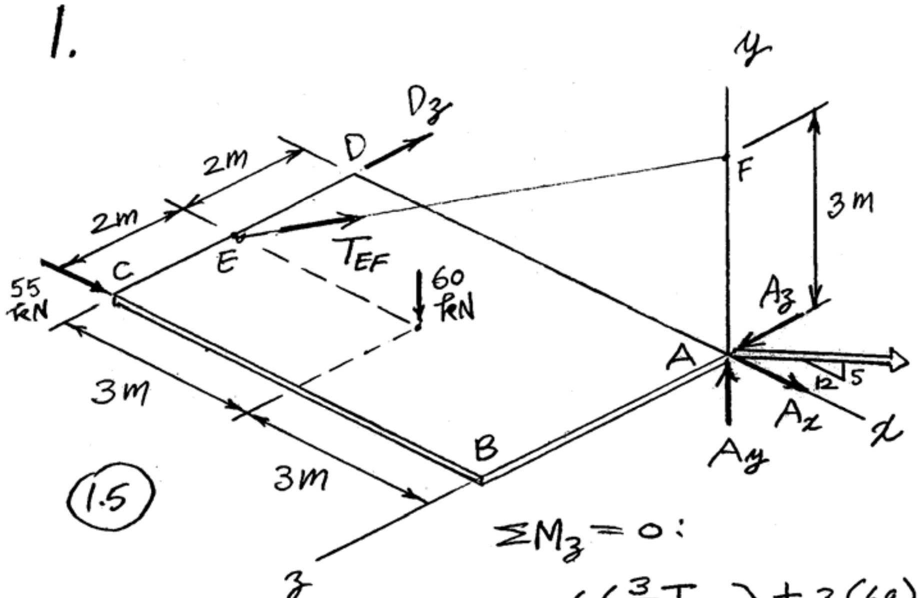
Solutions/Answers to MEEG 2003 Sample Test IIc

1.



$E(-6,0,2)$

$F(0,3,0)$

$\overrightarrow{EF} = \langle 6,3,-2\rangle$

$\vec{\lambda}_{EF} = \frac{1}{7}\langle 6,3,-2\rangle$

$\vec{T}_{EF} = \frac{T_{EF}}{7}\langle 6,3,-2\rangle$

$\Sigma M_z = 0:$

$-6\left(\frac{3}{7}T_{EF}\right) + 3(60) = 0$

$T_{EF} = 70$ $\quad \boxed{T_{EF} = 70 \text{ kN}}$ (1.5)

$\Sigma M_x = 0: \quad \frac{12}{13}M_A + 2(60) - 2\left(\frac{3}{7}T_{EF}\right) = 0$

$M_A = -65 \qquad \vec{M}_A = -\frac{65}{13}(12\vec{i} + 5\vec{j}) \qquad \boxed{\vec{M}_A = -60\vec{i} - 25\vec{j} \text{ kN}\cdot\text{m}}$ (2)

$\Sigma M_y = 0: \quad -6D_z + 4(55) + \frac{5}{13}M_A = 0 \qquad D_z = 32.5$ (1)

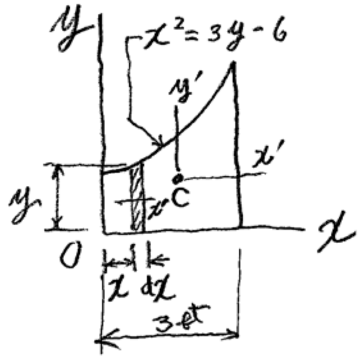
$\Sigma F_x = 0: \quad A_x + 55 + \frac{6}{7}T_{EF} = 0 \qquad A_x = -115$ (1)

$\Sigma F_y = 0: \quad A_y - 60 + \frac{3}{7}T_{EF} = 0 \qquad A_y = 30$ (1)

$\Sigma F_z = 0: \quad A_z - D_z - \frac{2}{7}T_{EF} = 0 \qquad A_z = 52.5$ (1)

$$\boxed{\vec{A} = -115\vec{i} + 30\vec{j} + 52.5\vec{k} \text{ kN}}$$ (1)

2.



$$dA = y\,dx = \frac{1}{3}(x^2+6)\,dx$$

$$A = \frac{1}{3}\int_0^3 (x^2+6)\,dx = \frac{1}{3}\left(\frac{1}{3}x^3+6x\right)\Big|_0^3 = \frac{1}{3}(9+18) = 9 \quad (1)$$

$$I_y = \int x^2 dA = \frac{1}{3}\int_0^3 (x^4+6x^2)\,dx = \frac{1}{3}\left(\frac{1}{5}x^5+2x^3\right)\Big|_0^3$$

$$= \frac{1}{3}\left(\frac{243}{5}+54\right) = \frac{243+270}{15} = \frac{171}{5} = 34.2$$

$$\boxed{I_y = 34.2 \text{ ft}^4} \quad (2)$$

$$I_y = k_y^2 A: \quad 34.2 = k_y^2(9) \quad k_y = \sqrt{3.8} = 1.9494 \quad \boxed{k_y = 1.949 \text{ ft}} \quad (1)$$

$$\text{POM}_2: \quad \bar{x}A = \int \bar{x}_{el}\,dA = \int_0^3 x\cdot\frac{1}{3}(x^2+6)\,dx = \frac{1}{3}\int_0^3 (x^3+6x)\,dx$$

$$= \frac{1}{3}\left(\frac{1}{4}x^4+3x^2\right)\Big|_0^3 = \frac{1}{3}\left(\frac{81}{4}+27\right) = \frac{81+108}{12} = \frac{189}{12} = 15.75$$

$$\bar{x} = \frac{15.75}{9} = 1.75 \qquad \boxed{\bar{x} = 1.75 \text{ ft}} \quad (2)$$

$$I_y = \bar{I}_{y'} + A\bar{x}^2: \qquad 34.2 = \bar{I}_{y'} + 9(1.75)^2$$

$$\bar{I}_{y'} = 6.6375 \qquad \boxed{\bar{I}_{y'} = 6.64 \text{ ft}^4} \quad (2)$$

$$dI_x = d\bar{I}_{x''} + (dA)\left(\frac{y}{2}\right)^2 = \frac{1}{12}(dx)y^3 + \frac{1}{4}y^2\cdot y\,dx = \frac{1}{3}y^3\,dx$$

$$I_x = \frac{1}{3}\int_0^3 y^3\,dx = \frac{1}{3}\int_0^3 \frac{1}{3^3}(x^2+6)^3\,dx = \frac{1}{81}\int_0^3 (x^6+18x^4+108x^2+216)\,dx$$

$$= \frac{1}{81}\left(\frac{1}{7}x^7+\frac{18}{5}x^5+36x^3+216x\right)\Big|_0^3 = 34.657$$

$$\boxed{I_x = 34.7 \text{ ft}^4} \quad (2)$$

3.
A. (e)
B. (g)
C. (g)
D. (b)

4. See text.