The Tutorial Notes & the Quizs for Engineering Mechanics Students

Abstract

For ENG1210 sec01 and sec02 students. These are the tutorial notes that we did not go over and answer to the quizs.

1 Jan 15th

1.1 Quiz1

Given the resultant force of F_A and F_B is directed horizontally to the right. Find F_A.

$$\begin{aligned} F_{R_x} &= F_{B_x} + F_{A_x} \\ F_{R_x} &= F_B \sin 40 + F_A \sin 55 \\ 10.5 &= 6 \sin 40 + F_A \sin 55 \\ F_A &= 7.99 \end{aligned}$$

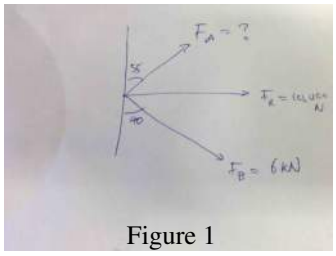


Figure 1

1.2 Quiz2

The resultant force $F_R = 1030.5$N and the angle $\theta = 2.5$. Calculate force F_1 acting along x-axis.

$$\begin{aligned} F_R &= F_{R_x} + F_{R_y} = 1030.5 \sin 2.5i + 1030.5 \cos 2.5j \\ &= 44.95i + 1029.52j \\ F_2 &= F_{2_x} + F_{2_y} = 400 \cos 30i + 400 \sin 30j \\ &= 346.41i + 200j \\ F_3 &= F_{3_x} + F_{3_x} = -600 \cos 36.87i + 600 \sin 36.87j \\ &= -480i + 360 \\ F_{R_x} &= F_{1_x} + F_{2_x} + F_{3_x} = 44.95 = F_{1_x} + 346.41 - 480 \\ &= 179\text{N} \end{aligned}$$

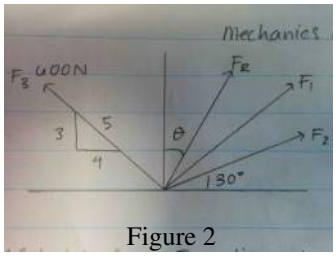
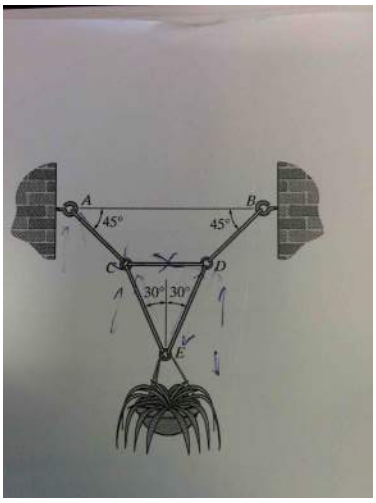


Figure 2

2 Jan 22nd

2.1 Tutorial question

If the tension developed in each of the wires in not allowed to exceed 40lb, determine the maximum weight of the flowerpot that can be safely supported.



We will apply the equations of equilibrium along the x and y axes to the free-body iagram of joint E shown in Fig.

Along the horizontal direction,

$$F_{ED} \sin 30 - F_{EC} \sin 30 = 0 \tag{1}$$

$$F_{ED} \cos 30 + F_{EC} \cos 30 - W = 0 \tag{2}$$

Then $F_{ED} = F_{EC}$ from 1 and we get $F_{ED} = 0.5774W$ after the substitution.

Using the results $F_{ED} = 0.5774W$ and applying the quations of equilibrium along the x and y axes to the free-body diagram of joint C shown in the Figure, we have

$$F_{CA} \sin 45 - 0.5774W \cos 30 = 0 \Rightarrow F_{CA} = 0.7071W \tag{3}$$

$$\tag{4}$$

Due to the Symmetry,

$$F_{DB} = F_{CA} = 0.7071W$$

From this results, notice that calbes DB and CA are subjected tothe grater tensile foces. Thus, they will achieve the maximum allowable tensile force first.

$$\begin{aligned} F_{DB} &= F_{CA} = 0.7071W \\ W &= 56.6LB \end{aligned}$$

3 Jan 27th

3.1 Quiz3

Determine the moment of the force about point O.

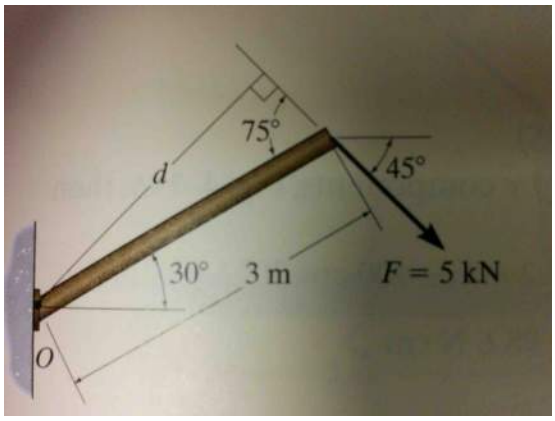


Figure 3

The moment are d in Figure 3 can be found frmo trigonometry.

$$d = (3m)\sin 75 = 2.898m$$
$$\mathcal{M}_O = Fd = (5k\mathcal{N})(2.898m) = 14.5k\mathcal{N} \cdot m$$

For $\mathcal{F}$ acts at the end of bracket in Figure 4. Determine the moment of the force about point O. Using a

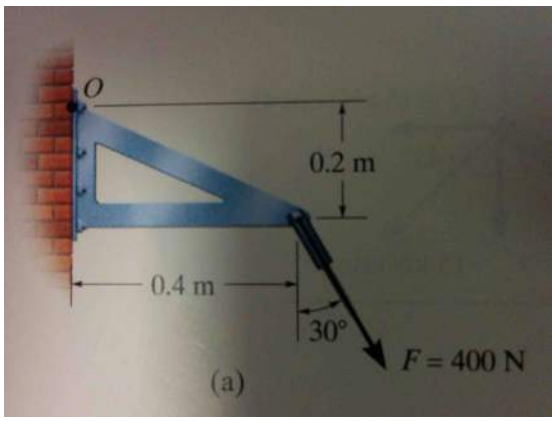


Figure 4

Cartesian vector approach, the force and position vectors are

$$\mathbf{r} = 0.4i - 0.2jm$$
$$\mathcal{F} = 400\sin 30i - 400\cos 30j = 200i - 346.4j\mathcal{N}$$
$$\mathcal{M}_0 = \mathbf{r} \times \mathcal{F} = 0.4(-346.4) - (-0.2)(200)k = -98.6k\mathcal{N} \cdot m$$

4 Feb 5 & 6

4.1 Tutorial Question

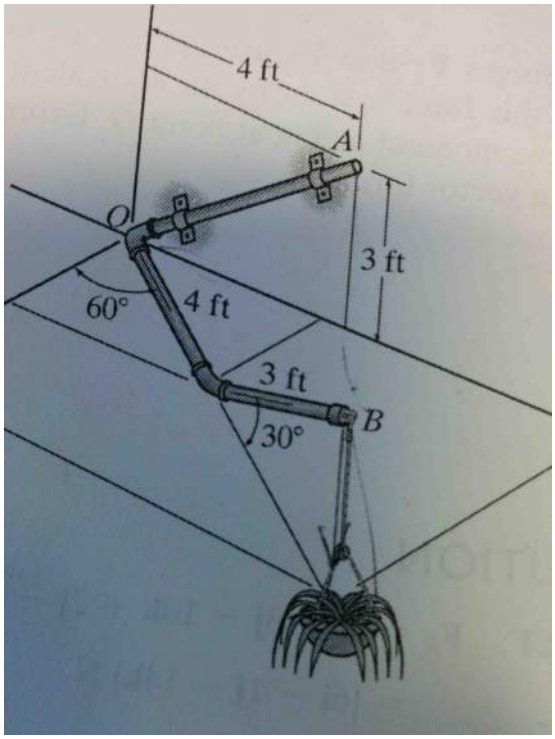


Figure 5

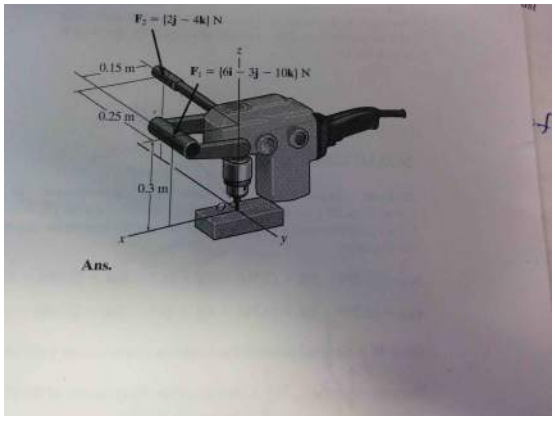


Figure 6

5 Feb 26 & 27

5.1 Tutorial

Determine the force in member JE and GF of the truss. By inspection of joint B, D, H, and I. AB,

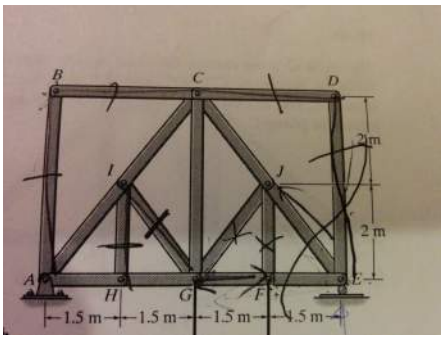


Figure 7

BC, CD, HI, and GI are zero-force members. Joint E:

$$\sum M_A = 0 = 6E_y - 6(3) - 6(4.5) \Rightarrow E_y = 7.5 \tag{5}$$

$$\sum F_y = 0 = 7.5 - \frac{4}{5}F_{JE} \Rightarrow F_{JE} = 9.38kN \tag{6}$$

$$\sum F_y = 0 = \frac{3}{5}(F_{JE}) - F_{FE} = \frac{3}{5}(F_{JE}) - F_{GF} \Rightarrow F_{GF} = 5.62kN \tag{7}$$

Determine the force in member CD and CM of the Baltimore bridge truss. By inspection, member

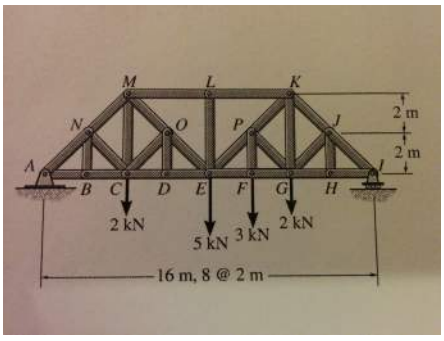


Figure 8

BN, NC, DO, OC, HJ, LE, JG are zero force members.

$$\sum M_I = 0 = 2(12) + 5(8) + 3(6) + 2(4) - A_y(16) \Rightarrow A_y = 5.625kN \tag{8}$$

$$\sum M_M = 0 = F_{CD}(4) - A_y(4) \Rightarrow F_{CD} = 5.625kN \tag{9}$$

$$\sum M_A = 0 = F_{CM}(4) - 2(4) \Rightarrow F_{CM} = 2kN \tag{10}$$

5.2 Quiz

Determine the force in each member of the truss. θ=20.

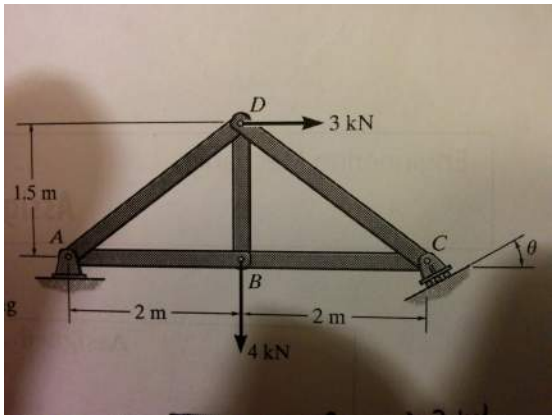


Figure 9

From the equation of equilbrium, we have

$$\sum M_A = 0 = M_c \cos 20(2+2) - 3(1.5) - 4(2) \Rightarrow M_c = 2.21kN \tag{11}$$

$$\sum F_x = 0 = 3 - M_c \sin 20 - A_x \Rightarrow A_x = 0.923kN \tag{12}$$

$$\sum F_y = 0 = A_y + M_c \sin 20 - 4 \Rightarrow A_y = 1.92kN \tag{13}$$

We will use the above result to analyze the equilbrium of joints C and A, and then proceed to analyze of joint B.
Joint C:

$$\sum F_y = 0 = M_c \sin 30 - F_{CD}(\frac{3}{5}) \Rightarrow F_{CD} = 3.46kN \tag{14}$$

$$\sum F_x = 0 = F_{CD}(\frac{4}{5}) - M_c \sin 20 - F_{CB} \Rightarrow F_{CB} = 2.01kN \tag{15}$$

Joint A:

$$\sum F_y = 0 = A_y - F_{AD}(\frac{3}{5}) \Rightarrow F_{AD} = 3.2kN \tag{16}$$

$$\sum F_x = 0 = F_{AB} - F_{AD}(\frac{4}{5}) - A_x \Rightarrow F_{AB} = 3.483kN \tag{17}$$

Joint B:

$$\sum F_y = 0 = F_{BD} - 4 \Rightarrow F_{BD} = 4kN \tag{18}$$

6 March 5 & 6

6.1 Tutorial

Consider the beam shwon in Figure **??**.
a) Write the equations for sheer and moment for the beam using an origin at end A.
b) Using the equations, evalute the moment at section C.
c) Locate the point of zero sheer between $B\&D$.
d) Evaluate the maximum moment betwee point $B\&D$.
e) Draw the sheer and bending moment diagrams. The free diagrm is shown in Figure 11

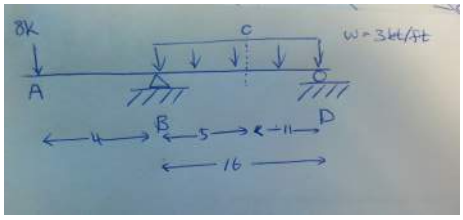


Figure 10

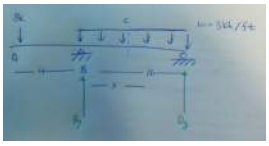


Figure 11

$$\sum F_x = 0 \tag{19}$$

$$\sum F_y = 0 = -9 + B_y + D_y - 48 \Rightarrow B_y + D_y = 56k \tag{20}$$

$$\sum M_B = 0 = D_y(16) - 48(8) - 4(8) \Rightarrow D_y = 22k, B_y = 34k \tag{21}$$

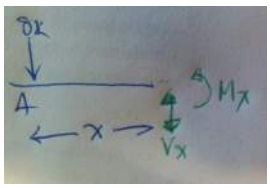


Figure 12

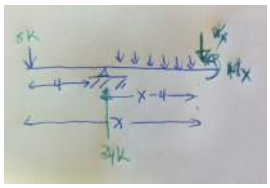


Figure 13

a) Write the equations for sheer and moment for the beam using an origin at end A.
Case of 0 ft $< x <$ 4 ft. Free-diagram shown in Figure 15.

$$\sum F_y = 8k + V_x = 0 \Rightarrow V_x = -8k \tag{22}$$

$$\sum M_x = 9x + M_x = 0 \Rightarrow M_x = -8x \tag{23}$$

Case of 4 gt $< x <$ 15 ft. Free-diagram shown in Figure **??**.

$$\sum F_y = 034 - 3(x-4) - V_x - 8 \Rightarrow V_x = -3x + 38 \tag{24}$$

$$\sum M_x = 0 = M_x + 8x - 34(x-4) - 3(x-4)\frac{(x-4)}{2} \Rightarrow M_y = -1.5x^2 + 38x - 160 \tag{25}$$

b) Using the equations, evalute the moment at section C, which is at x=9.

$$M_x = 1.5x^2 + 38x - 160 \tag{26}$$

$$1.5(9)^2 + 38(9) - 150 \Rightarrow M_x = 60.5 \tag{27}$$

c & d) Locate the point of zero sheer between $B\&D$.

$$V_x = -3x + 38 \Rightarrow x = 12.66 \tag{28}$$

$$M_x|_{x=12.66} = 1.5(12.66)^2 + 38(12.66) - 160 = 80.76 \tag{29}$$

Moment is maximum when sheer force is 0. d) Evaluate the maximum moment betwee point $B\&D$.

$$0 = 1.5x^2 + 38x - 160 \Rightarrow x = 5.33, 20.0 \tag{30}$$

e) Draw the sheer and bending moment diagrams.)

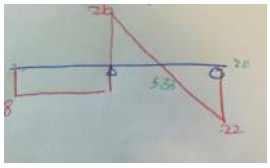


Figure 14

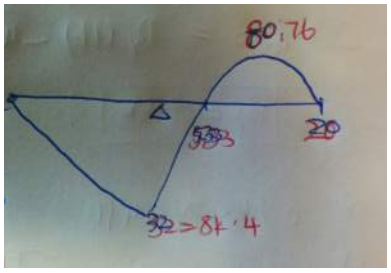


Figure 15