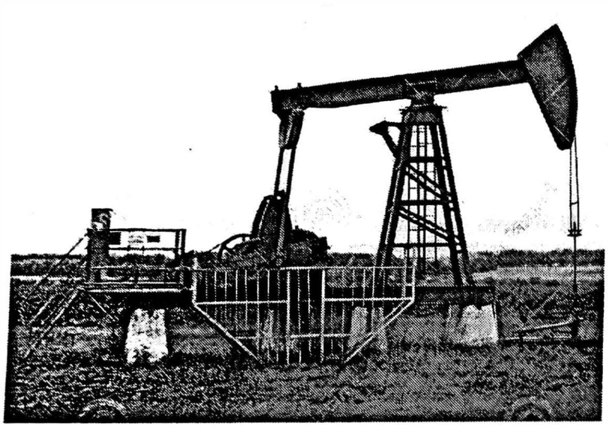
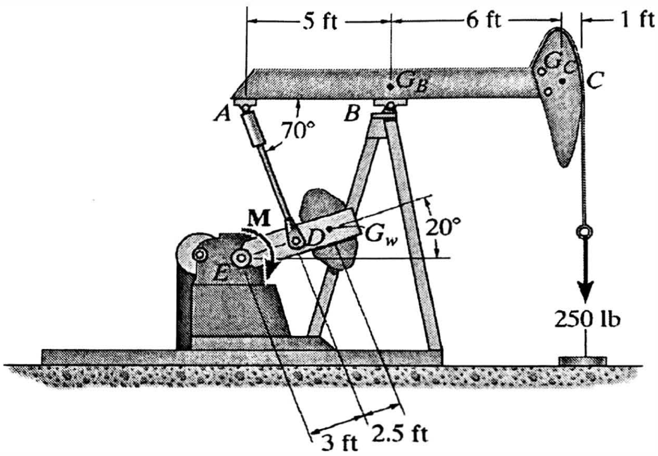
Name: ______________

Group members: ______________ ______________ ______________

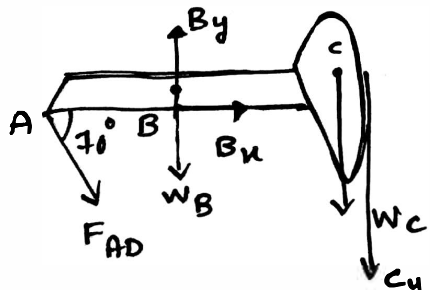
TAM 210/211 - Worksheet 9

1) A pumping unit is used to recover oil. When the walking beam ABC is horizontal, the force acting in the wireline at the well head is 250 lb. The horse-head C weighs 60 lb and has a center of gravity at G_c. The walking beam ABC has a weight of 130 lb and a center of gravity at G_B, and the counterweight has a weight of 200 lb and a center of gravity at G_W. The pitman, AD, is pin connected at its end and has negligible weight (a two-force member). Determine the torque M which must be exerted by the motor in order to overcome the force at the well head through the following steps.





a) Draw a free-body diagram for the walking beam ABC

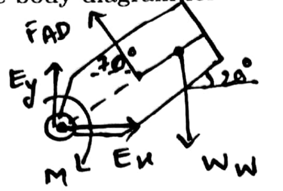


b) Use equilibrium equations to find the force from link AD.

$$\sum M_B = AD \sin 70^\circ (5) - 60(6) - 250(7) = 0$$

$$\Rightarrow \quad AD = 449.08 \text{ lb}$$

c) Draw a free-body diagram for the member ED



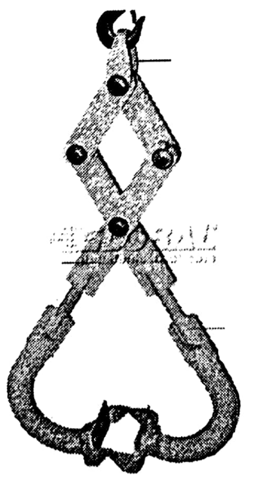
d) Use equilibrium equations to determine the torque M which must be exerted by the motor in to keep member ED at equilibrium. This is also the force necessary to overcome the force at the well head.

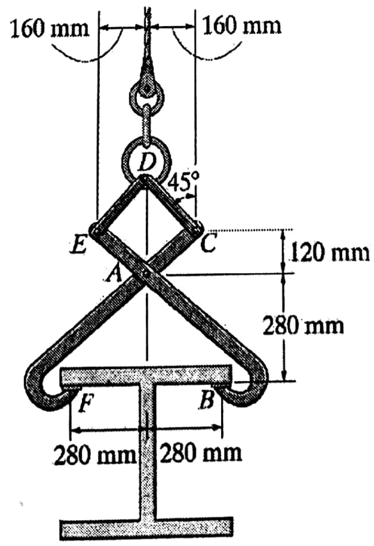
$$\Sigma M_E = -M + AD(3) - W_w \cos(20)\left[3+2\cdot5\right] = 0$$

$$M = (449\cdot08)(3) - (200)\cos 20^\circ \left[3+2\cdot5\right]$$

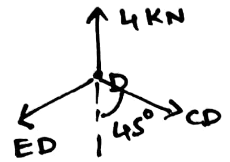
$$\boxed{M = 313\cdot6 \text{ lb-ft}}$$

2) The double link grip is used to lift a beam that weighs 4kN. The interactions between the grip and the beam at points F and B are not smooth surfaces, so horizontal forces from friction are present. Determine the magnitude of these friction (horizontal) forces at B and F necessary to keep the I-beam at equilibrium.





a) Draw a free-body diagram for ring D (use particle assumption). Then write the equations of equilibrium to find the force from link CD.



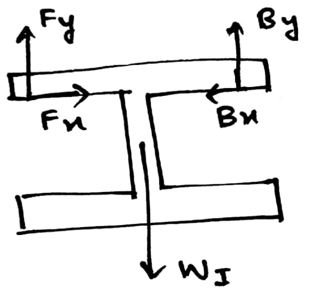
$$\Sigma F_y = 4 - 2CD/\sqrt{2} = 0$$

$$\boxed{CD = ED = 2.83 \text{ KN}}$$

$$\Sigma F_x = -\frac{ED}{\sqrt{2}} + \frac{CD}{\sqrt{2}} = 0$$

$$ED = CD$$

b) Draw the free-body diagram for the I-beam. Use the equilibrium equation $(\sum M)_F = 0$ and $\sum F_y = 0$ to determine the vertical reactions that the flange of the beam exerts on the jaw at F and B.



$$W_I = 4 \text{KN}$$

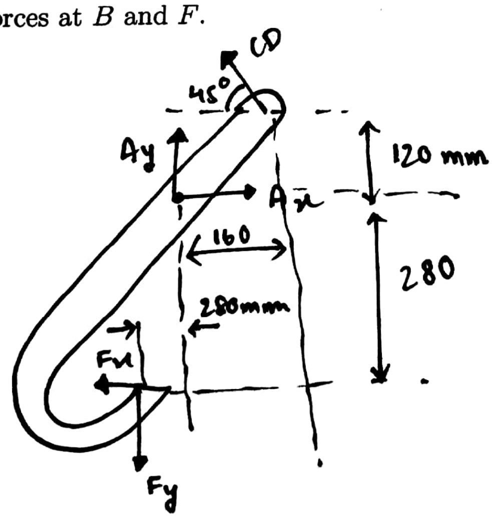
$$\Sigma F_x = 0 \Rightarrow F_x = B_x$$

$$\Sigma F_y = 0 \Rightarrow F_y + B_y - 4 = 0$$

$$\Sigma M_F = B_y(560) - 4(280) = 0$$

$$\Rightarrow \boxed{B_y = 2\text{KN} \qquad F_y = 2\text{KN}}$$

c) Draw the free-body diagram for member CAF . Then use equilibrium equations to determine the friction forces at B and F.



$$CD = 2.83\text{KN}$$

$$F_y = 2\text{KN}$$

$$\Sigma F_x = -\frac{2.83}{\sqrt{2}} + A_x - F_x = 0$$

$$\Sigma F_y = -F_y + A_y + \frac{2.83}{\sqrt{2}} = 0$$

$$\Rightarrow \boxed{A_y = 0}$$

$$\Sigma M_F = \cancel{A_y}(280) - A_x(280) + \frac{2.83}{\sqrt{2}}(280 + 160) + \frac{2.83}{\sqrt{2}}[280 + 120] = 0$$

$$\Rightarrow \boxed{A_x = 6\text{KN}}$$

$$\boxed{F_x = 4\text{KN}}$$

$$\boxed{B_x = F_y = 4\text{KN}}$$