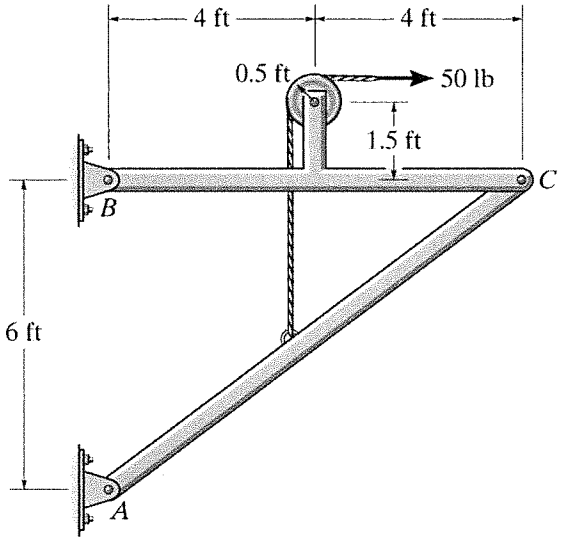
Name: _____ CWID #:_____ Section Number:_____

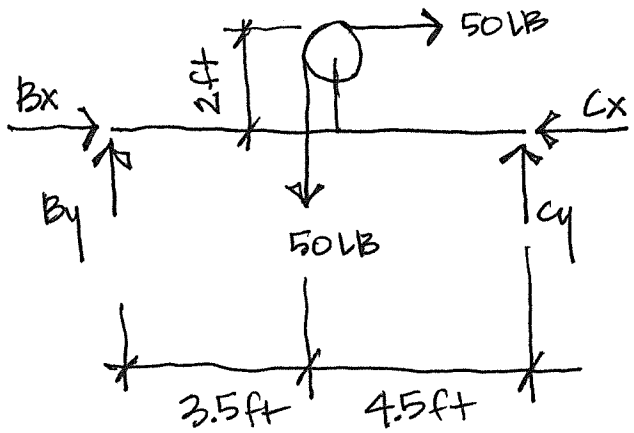
ENSC 2113 – FALL 19 – EXAM #3

EACH PROBLEM IS WORTH 25 POINTS. BOX YOUR ANSWERS AND PROVIDE PROPER UNITS, WHERE APPLICABLE. CALCULATIONS AND FREE BODY DIAGRAMS MUST BE SHOWN THAT SUPPORT THE ANSWER TO RECEIVE CREDIT.

1) The frame below consists of two members, AC and BC. Determine the external support reactions at the pins A and B. Indicate direction in your answer with directional arrows and draw any pertinent free-body diagrams.



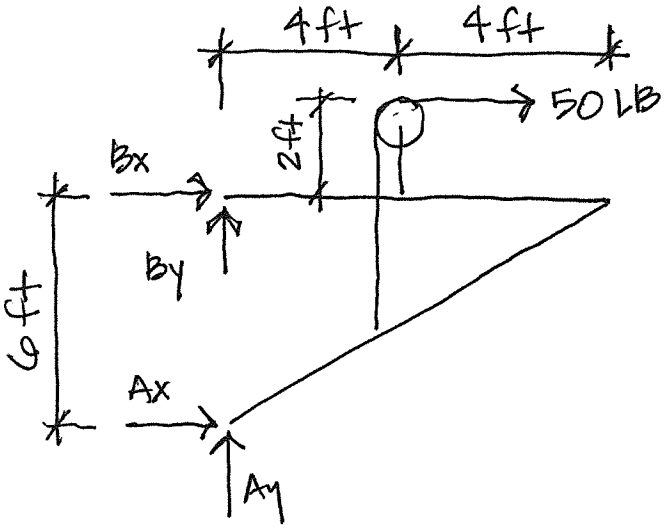
MEMBER BC:



$+\circlearrowleft \Sigma M_C = 0 = 50(4.5) - 50(2) - B_y(8)$

$\boxed{B_y = 15.625 \text{ LB} \uparrow}$

OVERALL FBD:



FROM OVERALL:

$+\uparrow \Sigma F_y = 0 = 15.625 + A_y$

$\boxed{A_y = 15.625 \text{ LB} \downarrow}$

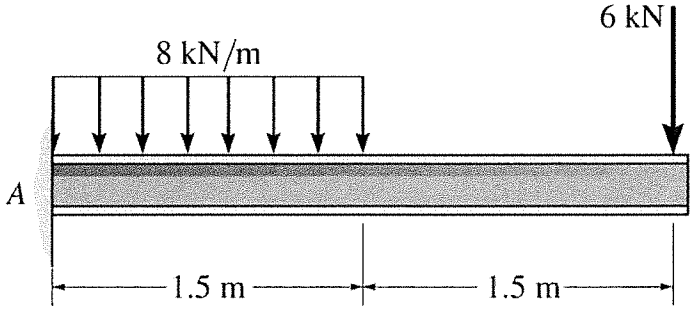
$+\circlearrowleft \Sigma M_B = 0 = A_x(6) - 50(2)$

$\boxed{A_x = 16.67 \text{ LB} \rightarrow}$

$+\rightarrow \Sigma F_x = 0 = 16.67 + B_x + 50$

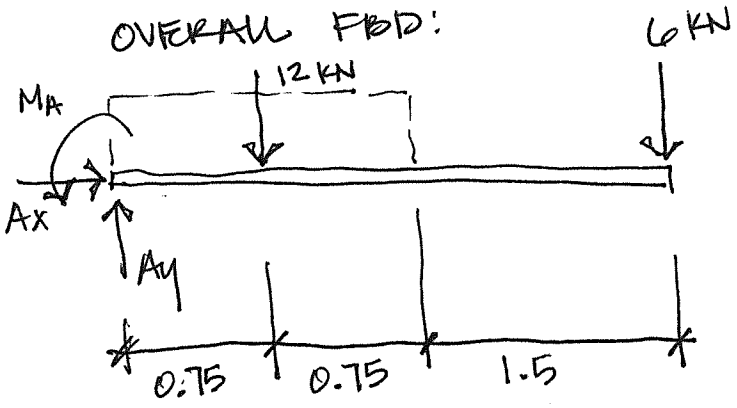
$\boxed{B_x = 66.67 \text{ LB} \leftarrow}$

2) Determine the shear and bending moment equations for the beam below for the load region 0 m<x<1.5 m utilizing equilibrium equations. Point A is a fixed support. Draw any pertinent free-body diagrams.



LEFT CUT SOLUTION:

OVERALL FBD:



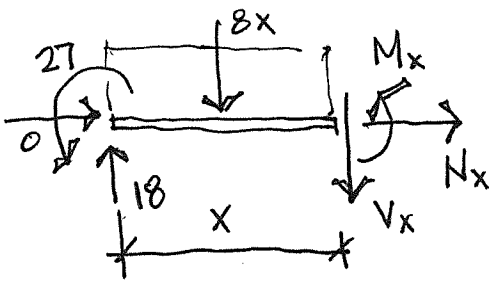
$\uparrow \Sigma F_y = 0 = A_y - 12 - 6 \quad A_y = 18\ kN \uparrow$

$\rightarrow \Sigma F_x = 0 = A_x = 0$

$+\circlearrowleft \Sigma M_A = 0 = M_A - 12(0.75) - 6(3)$

$M_A = 27\ kN \cdot m \circlearrowleft$

CUT FBD:



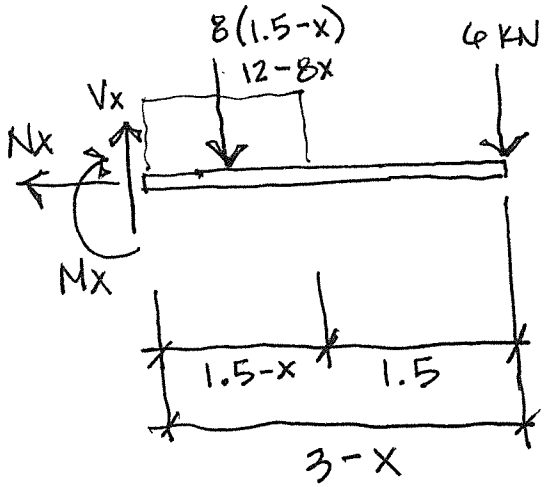
$\uparrow \Sigma F_y = 0 = 18 - 8x - V_x$

$\boxed{V_x = 18 - 8x\ (kN)}$

$+\circlearrowleft \Sigma M_x = 0 = 27 + 8x\left(\frac{x}{2}\right) - 18x + M_x$

$\boxed{M_x = -27 + 18x - 4x^2\ (kN \cdot m)}$

RIGHT CUT SOLUTION:



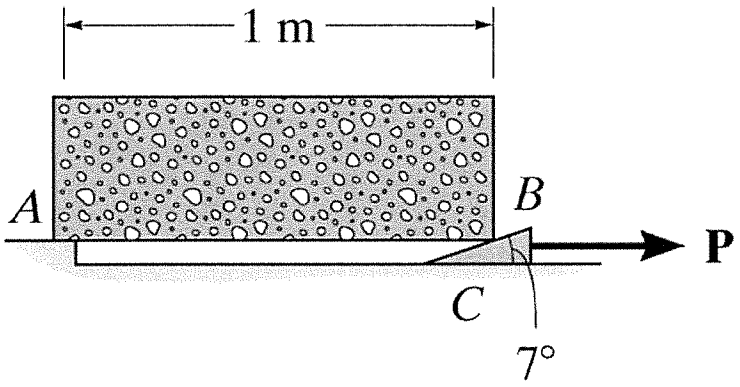
$\uparrow \Sigma F_y = 0 = V_x - (12 - 8x) - 6$

$\boxed{V_x = 18 - 8x\ (kN)}$

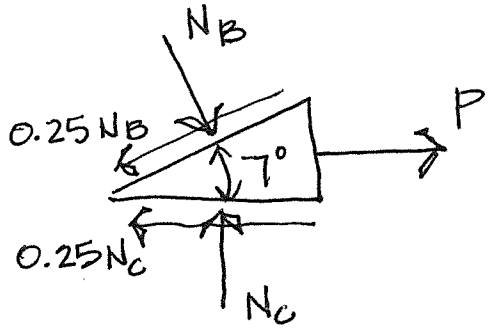
$+\circlearrowleft \Sigma M_x = 0 = -M_x - (12 - 8x)\left(\frac{1.5 - x}{2}\right) - 6(3 - x)$

$\boxed{M = -27 + 18x - 4x^2\ (kN \cdot m)}$

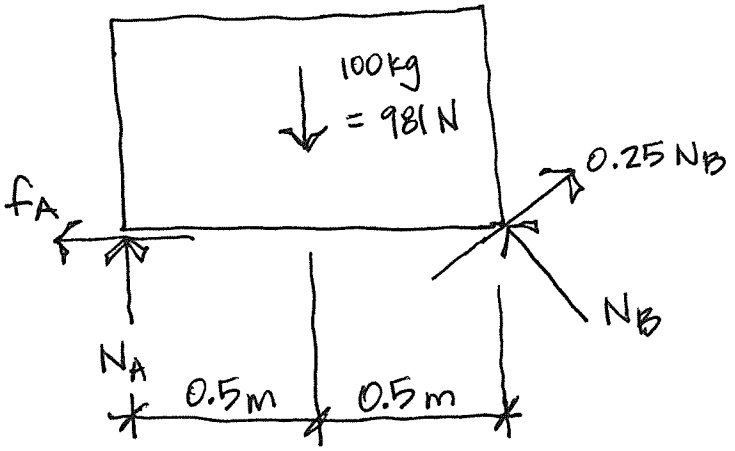
3) Determine the force required to move the wedge to the right as the 100 kg block remains in equilibrium. The static coefficient of friction between the block and the wedge and the wedge and the floor is 0.25. Neglect the size and weight of the wedge. Draw all pertinent free-body diagrams.



WEDGE FBD:



BLOCK FBD:



BLOCK FBD:

$+\circlearrowleft \Sigma M_A = 0 = -981(0.5) + N_B \cos 7(1) + 0.25 N_B \sin 7(1)$

$490.5 = 0.918 N_B$

$N_B = 479.5\ N$

WEDGE FBD:

$+\uparrow \Sigma F_y = 0 = N_C - N_B \cos 7 - 0.25 N_B \sin 7$

$N_C = (0.25)479.5 \sin 7 + 479.5 \cos 7$

$N_C = 490.5\ N$

$+\rightarrow \Sigma F_x = 0 = -0.25 N_B \cos 7 + N_B \sin 7 - 0.25 N_C + P$

$P = (0.25)479.5 \cos 7 - 479.5 \sin 7 + (0.25)490.5$

$\boxed{P = 183.2\ N}$

4) Draw the shear and bending moment diagrams for the loading condition below. The reactions for the fixed support are shown. Label all diagrams appropriately.