COE 2001 Statics

Fall 2013

Exam 2

NAME Solution

The exam is closed books and closed notes. Scientific calculators are allowed. No ipods, cellphones, laptops etc.

Linearly document all steps and show all supporting work. Answers given without supporting work will be given zero credit. Write legibly and box all your final answers.
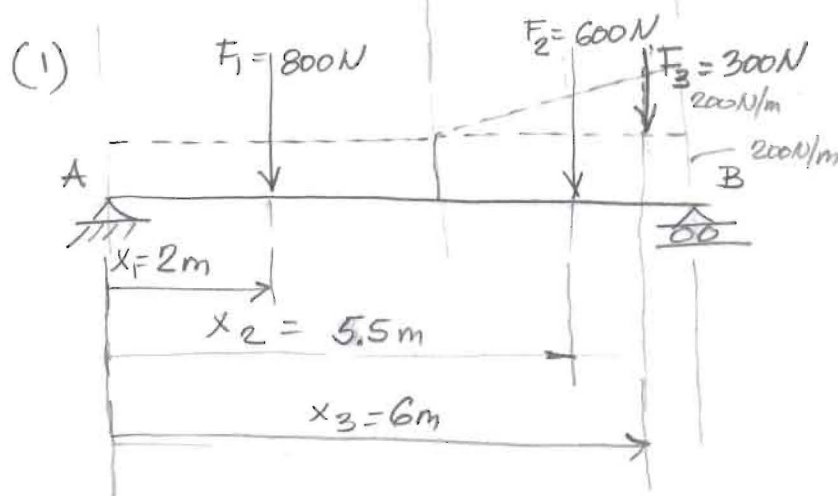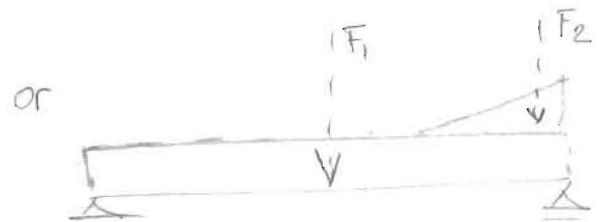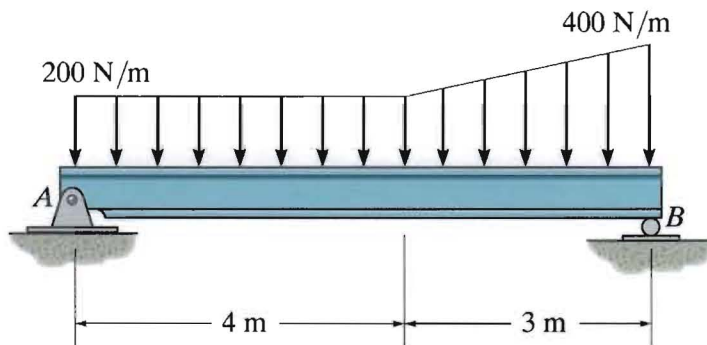
HONOR STATEMENT: I have red and strictly abided by all conditions set forth by Georgia Tech Honor Code and thus have neither given nor recived assistance of any type regarding the content or solution of the problems in this examination, nor will I discuss the content with other students until the exam has been graded and returned.

SIGNATURE:

Problem 1 *(30 points)*

For the beam shown determine the following:

1. The resultant forces for the distributed load and their positions measured from point A. Show the sketch of the beam with resultant forces. (10 pts)

2. Replace the distributed loading by an equivalent force and specify its location on the beam measured from point A. Show the sketch of the beam with the resultant force and its location. (10 pts)

3. The reactions at the supports A and B. Show FBD of the beam. (10 pts)

400 N/m

200 N/m

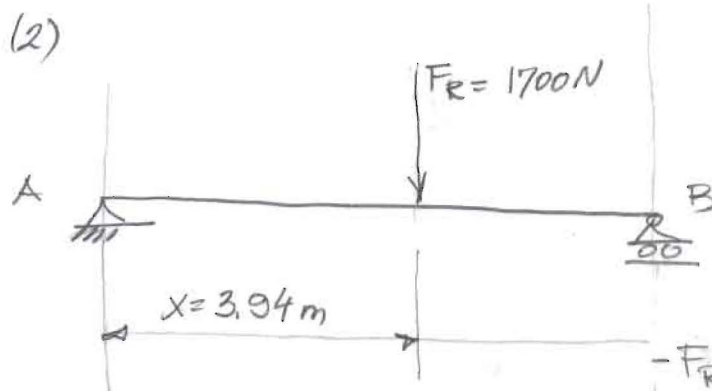*A*   *B*

4 m   3 m

or

F_1 F_2

V

(1) $F_1 = 800N$ $F_2 = 600N$ $F_3 = 300N$ $F_1 = ^-200(4) = ^-800N$

200N/m

A   200N/m $x_1 = 2m$

B   200N/m

$x_1 = 2m$

$x_2 = 5.5m$ $F_2 = ^-200(3) = ^-600N$

$x_2 = 4+1.5 = 5.5m$

$x_3 = 6m$

$F_3 = ^-\frac{1}{2}(200)(3) = ^-300\,N$

$x_3 = 4+2 = 6m$

(2)

$F_R = 1700N$

A   B $F_R = ^-800 - 600 - 300 = ^-1700N$
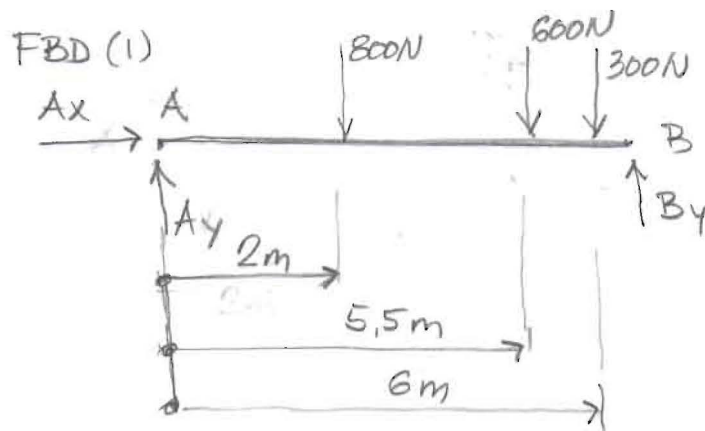
$M_{RA} = \Sigma M_A$

$x = 3.94m$

$-F_R(x_R) = -800(2) - 600(5.5) - 300(6)$

$x_R = \dfrac{6700}{1700} = 3.94m$

(3) Reactions

  (* use result from (1) or (2) to find reactions)

FBD (1)

$$\Sigma F_x = 0 \quad : \quad A_x = 0$$

$$\Sigma M_A = 0 \quad : \quad -800 \cdot (2) - 600(5.5) - 300(6) + B_y(7) = 0$$

$$B_y = 957.14 \ N$$

$$\Sigma F_y = 0 \qquad A_y - 800 - 600 - 300 + 957.14 = 0$$

$$A_y = 742.86 \ N$$

*

FBD (2)
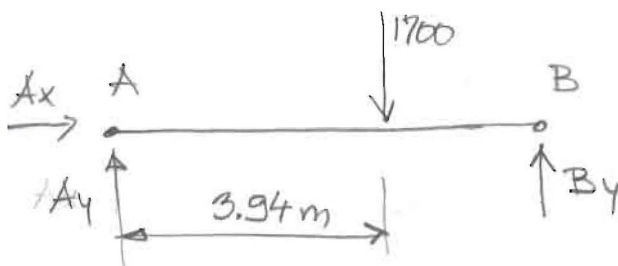
$$\Sigma F_x = 0 \quad : \quad A_x = 0$$
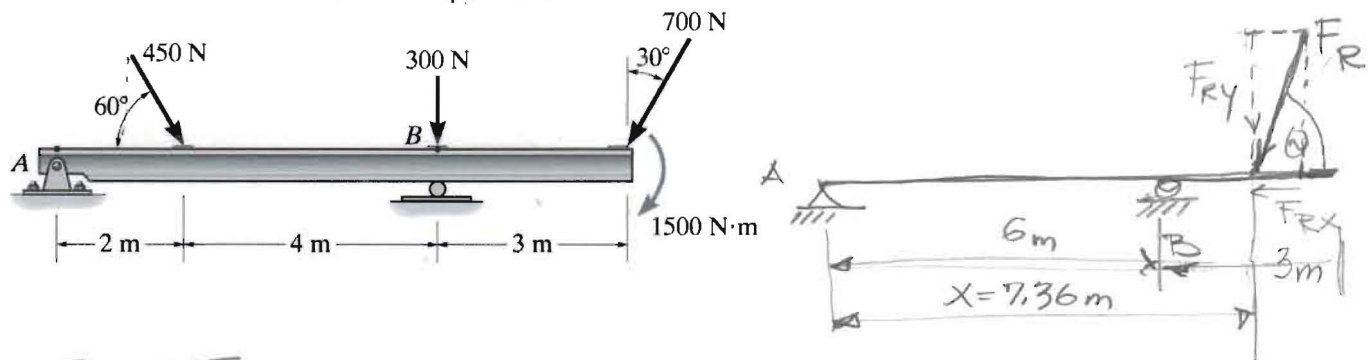
$$\Sigma M_A = 0 \qquad -1700(3.94) + B_y(7) =$$

$$B_y = \boxed{957.14 \ N}$$

$$\Sigma F_y = 0 \quad : \quad A_y = 742.86 \ N$$

Problem 2 *(25 points)*

Replace the loading acting on the beam by a force-only resultant. Specify the angle between the resultant force and the beam (line AB) and where the force acts, measured from the end A. Show the sketch of the beam with the resultant force and its position.

$$F_R = \Sigma F_i$$

$$F_{RX} = \Sigma F_x = 450\cos 60° - 700\sin 30° = -125 N$$

$$F_{RY} = \Sigma F_y = -450\sin 60° - 300 - 700\cos 30° = -1296 N$$

$$F_R = \sqrt{(F_{RX})^2 + (F_{RY})^2} = \sqrt{(-125)^2 + (-1296)^2} = 1302 N$$

$$\boxed{\theta = \tan^{-1}\left(\frac{1296}{125}\right) = 84.5°}$$

$$M_{RA} = \Sigma M_A$$

$$F_{RY}(x_R) = -450\sin 60°(2) - 300(6) - 700\cos 30°(9) - 1500$$

* *Note : Moment about point A due to F_{RX} is zero*

$$-1296(x_R) = -9535.38$$

$$\boxed{x_R = 7.36 \, m}$$

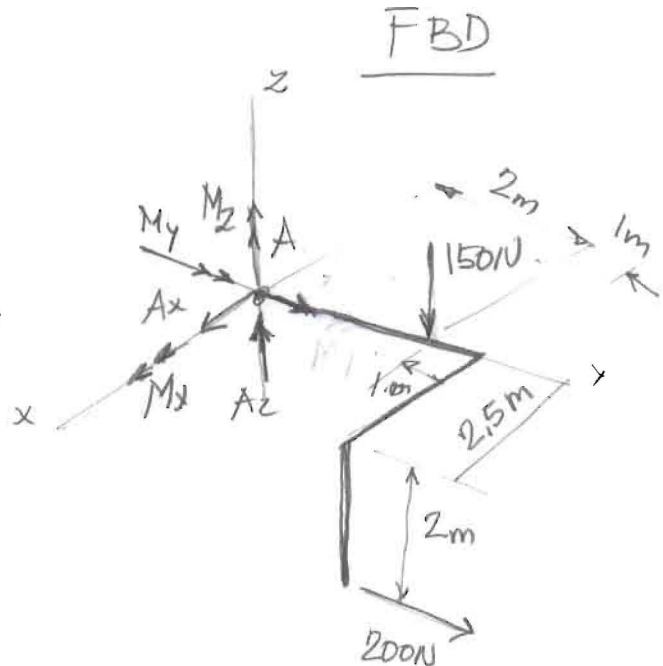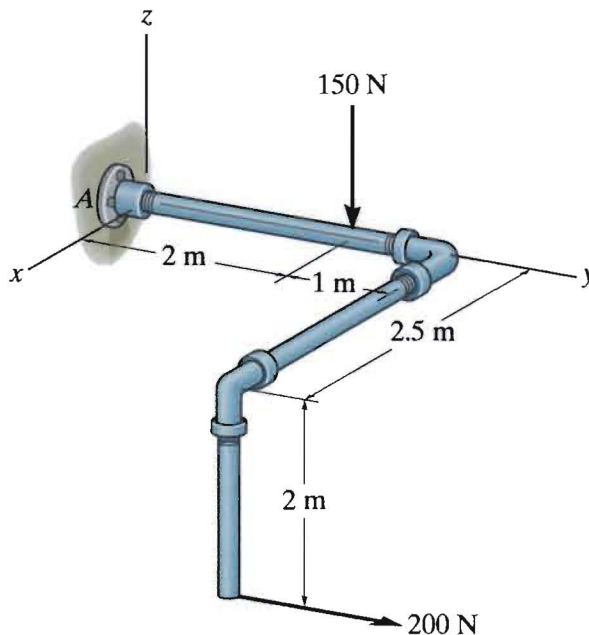**Problem 3** *(30 points)*

The pipe assembly is fixed at the wall at A. The 150 N force is parallel to the *z* axis and 200 N force is parallel to the *y* axis.

1. List the reactions that are exerted on the assembly at the wall at A (fixed support). (5 pts)

$$A_x, \; A_y, \; A_z, \; M_x^A, \; M_y^A, \; M_z^A$$

2. Draw the FBD of the assembly **(5 pts)**
3. Calculate the reactions at A. (20 pts)

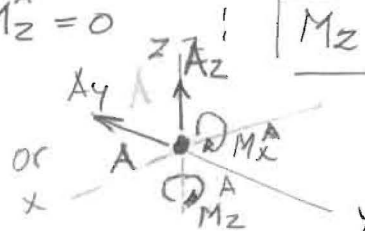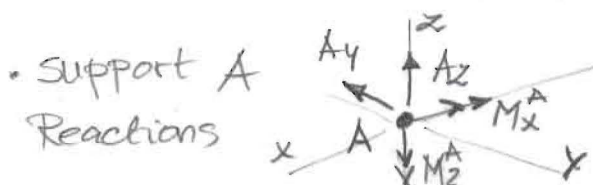$\Sigma F_x = 0$: $\boxed{A_x = 0}$

$\Sigma F_y = 0$: $A_y + 200 = 0$ $\Rightarrow$ $\boxed{A_y = -200 \, N}$

$\Sigma F_z = 0$: $A_z - 150 = 0$ $\Rightarrow$ $\boxed{A_z = 150 \, N}$

$\Sigma M_x = 0$; $-150(2) + 200(2) + M_x^A = 0$: $\boxed{M_x = -100 \, Nm}$

$\Sigma M_y = 0$: $\boxed{M_y^A = 0}$ (150N force intersects y-axis
                                              200N force is parallel to y-axis)

$\Sigma M_z = 0$: $200(2.5) + M_z^A = 0$: $\boxed{M_z = -500 \, Nm}$

• Support A
  Reactions

Problem 4 (*15 points*)

The plate shown is supported by ball-and-socket at A, roller at B and the cord CD.

1. What are reaction components at A if the rotation about *x*, *y* and *z* axis are allowed?(3 pts)

   A_x, A_y, A_z

2. What are reaction components at B if only displacement in *z* direction is prevented? (3 pts)

   B_z

3. What is reaction at C? (3 pts)

   C_z (in direction CD)

4. Sketch the FBD of the plate. (6 pts)

FBD