AEM 2011 Exam #2 Wednesday, November 20

You may only use a simple calculator that does not communicate in any wireless manner. Pagers, cell phones, and all other communications devices must be turned off during the quiz.

1. Consider the L-shaped wire shown below. The thickness of the wire is negligible and the wire has a uniform density per unit length of 1kg/m. Assume gravity acts in the $-z$ direction.

   (a) (10 points) What is the location of the center of gravity of the wire?

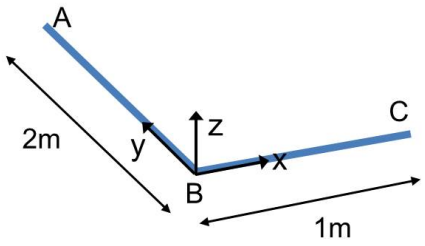
   (b) (7 points) Can you support the wire in static equilibrium by placing a single finger somewhere under the wire? If yes, then provide a location of your finger that will maintain equilibrium. Assume that your finger only applies a force on the wire in the $+z$ direction.

   (c) (7 points) Next, assume you place one finger under the wire along AB and another finger under the wire along BC. Provide one set of locations for your two fingers (one on AB and one on BC) that will support the wire in static equilibrium.

   (d) (7 points) Again assume you place one finger under the wire along AB and another finger under the wire along BC. Let $(0, y_0, 0)$ denote the point where the first finger is placed along AB. For what values of y_0 is it *not* possible to support the wire in static equilibrium?

   (e) (4 points) Finally, assume that density per unit length of the wire was increased to 2kg/m. How will the location of the center of gravity be changed by this increase in density?

   Answers for all parts should be justified.

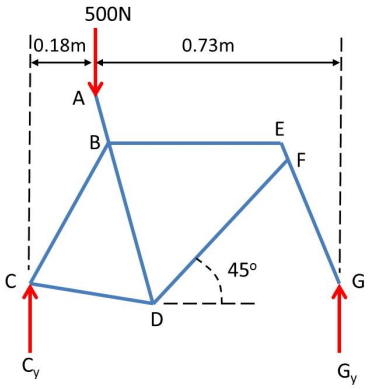


2. The Colnago Master is a road bike constructed with a steel frame. The right figure below shows a free-body diagram of the bicycle frame. Assume that beams ABD and EFG are multi-force members. The remaining beams (BE, DF, CB, and CD) are connected by welds that provide negligible moment, i.e. they act as hinges.

   (a) (10 points) What are the reaction forces C_y and G_y required for the bicycle to maintain static equilibrium?

   (b) (15 points) What are the forces in beams BE and DF?

   (c) (10 points) Assume that point C is moved to the left. This would require lengthening beams BC and CD while leaving the rest of the frame unchanged. Would the magnitude of the force in beam DF increase, decrease, or stay the same?



3. Consider the L-shaped beam ABF shown below. The beam is connected to a hinge at A and a cable FG. The mass of the beam is negligible but there is a distributed load $w(x) = 4\text{N/m}$ acting on AB.

   (a) (10 points) What are the reaction forces at hinge A and tension in cable FG required to support the L-beam in static equilibrium?

   (b) (10 points) What are the internal forces (axial force, shearing force, and bending moment) at location D? You should clearly indicate the sign convention being used in your free body-diagrams (axial force positive upwards or downwards, shear force positive left or right, bending moment positive into or out of the page).

   (c) (5 points) Is the magnitude of the axial force at C larger, smaller, or the same as the magnitude of the axial force at D?

   (d) (5 points) Is the magnitude of the bending moment at E larger, smaller, or the same as the magnitude of the bending moment at D?

   An explanation for your answers in parts (c) and (d) should be provided.