24-261 Statics September 25, 2001

Problem Set #5 Due: October 2, 2001

1. In the clamp shown on the web site (http://www.andrew.cmu.edu/course/24-261/images/clamp.html), the jaws come together and separate as the screw is turned (by rotating the screw handle). Once the jaws clamp an object, turning the screw further increases the clamping force. Eventually, one stops turning the screw, lets go of the screw bar and the clamping force remains. Before attempting to do the following tasks, read the comments on configuration below.

?? Draw the essential elements of the entire clamp with the block between the jaws in a planar view. In the analysis below, if you find that you need a particular dimension, scale it from the original image and place it on your drawing of the clamp and block.

?? On your drawing, identify the pins that allow different members to pivot with respect to one another. (The members do not actually pivot while the clamp is in a single configuration, but if the block were removed and the screw were turned, such pivoting would occur.)

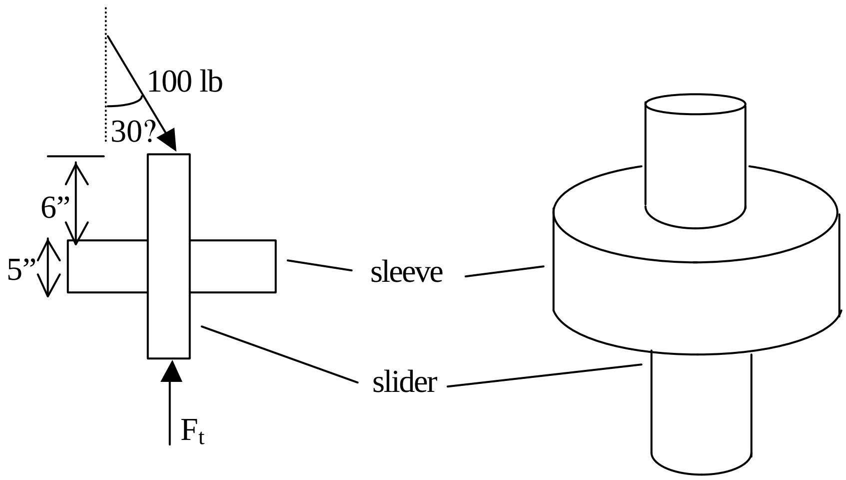
?? Conceptually separate the block from the clamp and dismember the clamp into distinct parts that can move with respect to each other. Draw the parts of the clamp and the block separately. Label each of the bodies by a distinct number enclosed in a circle (1,2,3,…). Label each of the points at which pairs of now-separated bodies interact with each other by a letter (A,B,…) Each letter should appear exactly twice, once on each of the two interacting bodies. You need not treat the pins that allow pivoting as separate bodies. Why not?

?? Take the jaws to apply known equal and opposite forces P to the block. Draw free body diagrams of each body showing known and unknown interactions using x- and y-components as appropriate. Indicate your definition for axes. Then, write down the equations of equilibrium for each of the bodies. Solve these equations of equilibrium to determine the unknown forces and/or moments in terms of the magnitude P. Draw the separated bodies one more time and indicate the forces and/or moments of interaction, now drawn in the correct senses and labeled with magnitudes (for example, magnitude could be written as 2.5 P).

COMMENTS ON CONFIGURATION

Here are some comments to help you with these tasks. Remember that nothing is touching the handle that turns the screw once the screw is tightened. Treat the screw and the brass parts to which it is connected as one single body; this body has a fixed length in the given configuration. Notice that there are two pairs of parallel plates. The plates making up each pair are separated but move together; hence, each pair can be treated as a single rigid body. Some of the rivets serve only to connect the plates (Fixed Rivets), but other rivets serve as pins. We are ignoring the weight of the clamp.

2. A slider slides in a sleeve, and a 100 lb force is applied to the slider at its top end. The slider has a diameter of 4”. There is friction between the slider and the sleeve, and hence not all of the force is transmitted. The transmitted axial force is denoted by F_t.



Take the fit between the slider and the sleeve to be such that there is contact at only two points. The slider is moving steadily (no acceleration) and kinetic friction prevails.

Determine the axial force for two cases

(a) Zero sliding friction ($u_k = 0$)
(b) kinetic friction coefficient $u_k = 0.1$

What would happen if you made the sleeve thicker (greater than 5”)? What about thinner (less than 5”)? You need not do additional calculations, just explain the trends in words.