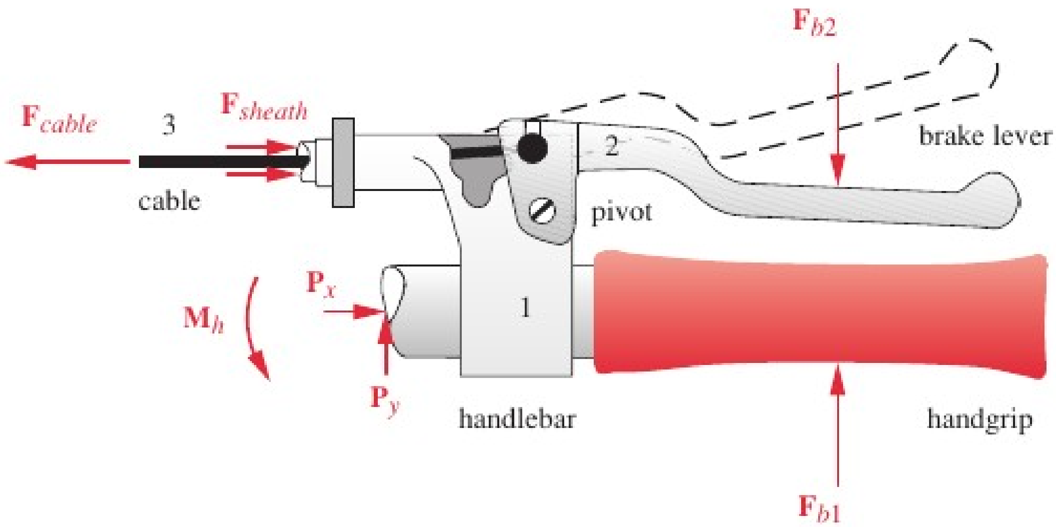
ME423 – Tutorial 1/ HW 1 – Due 26rd August 2024 – 11.00 pm

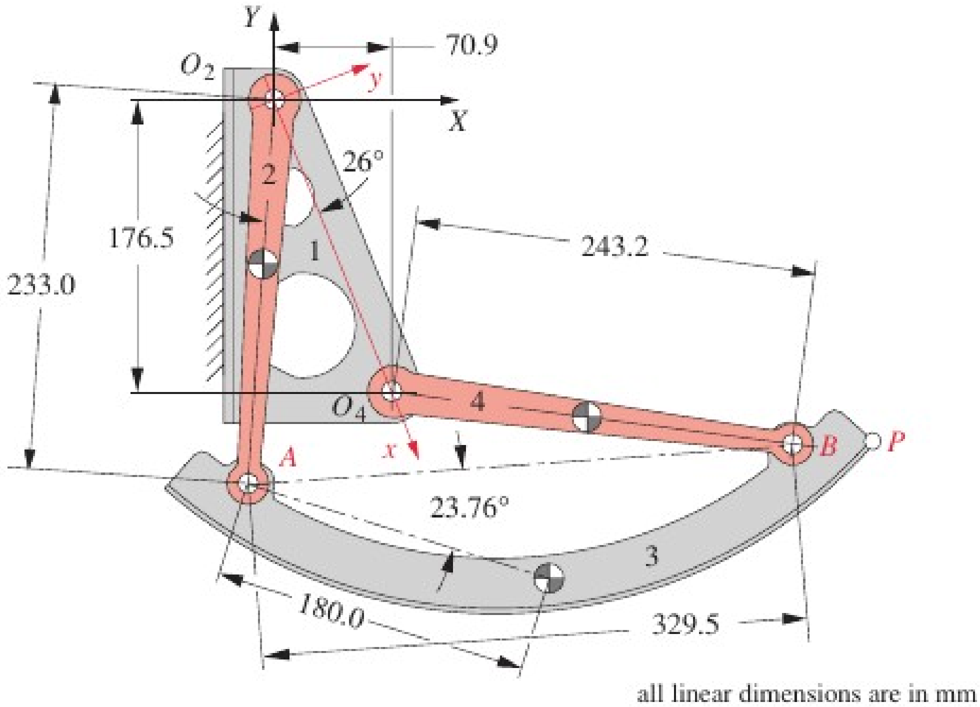
Two problems will have to be solved and submitted (hard copy) during the tutorial hour [Weddnesday, 5.30 pm] and the remaining three problems have to be submitted by 11.00 pm, 26/8/2024 [Moodle]. The problems to be solved during the tutorial hour and for homework will be informed during the tutorial hour.

1. [Norton, Chapter 3] Determine the forces on the elements of the bicycle brake lever assembly shown in Figure during braking. The geometry of each element is known. The average human's hand can develop a grip force of about 267 N in the lever position shown. You can make the following assumptions:
a. The accelerations are negligible.
b. All forces are coplanar and two dimensional.

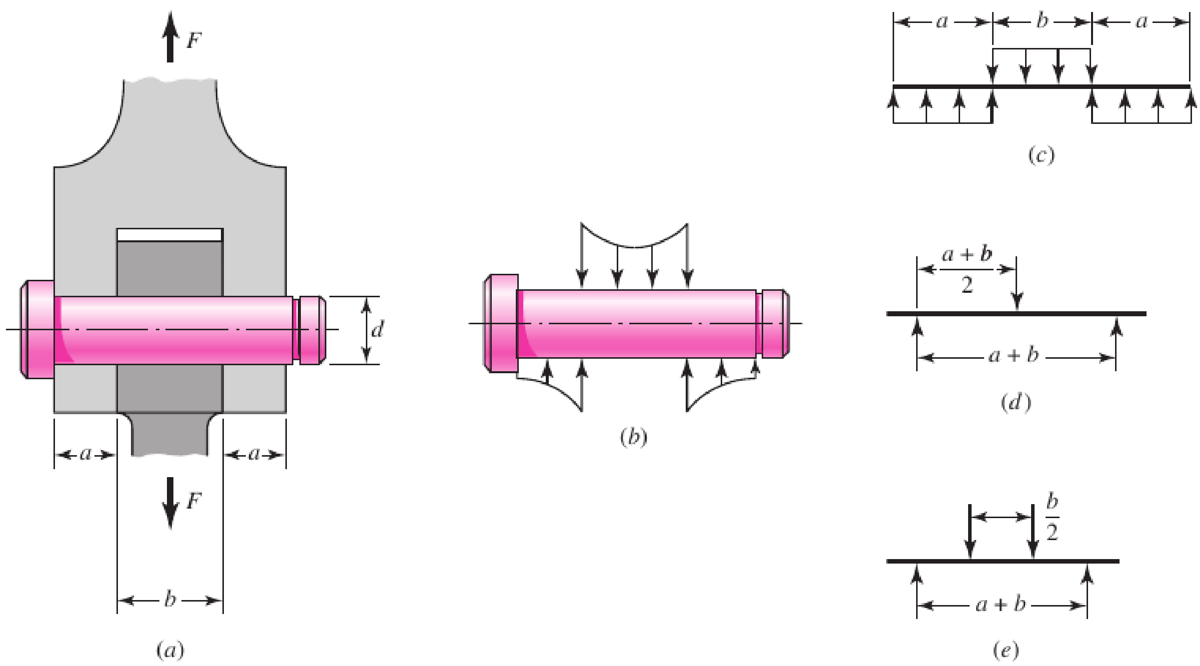


2. [Norton, Chapter 3] Figure shows an aircraft overhead bin mechanism in end view. For the position shown, draw free-body diagrams of links 2 and 4 and the door (3). There are stops that prevent further clockwise motion of link 2 (and the identical link behind it at the other end of the door) resulting in horizontal forces being applied to the door at points A. Assume that the mechanism is symmetrical so that each set of links 2 and 4 carry one half of the door weight. Ignore the weight of links 2 and 4 as they are negligible.
Also determine the pin forces on the door (3), and links 2 & 4 and the reaction force on each of the two stops. Available data:

R_{23}	180 mm @ 160.345°
R_{43}	180 mm @ 27.862°
W_3	45 N
θ_2	85.879°
θ_4	172.352°



3. [Shigley, Chapter 3] A pin in a knuckle joint carrying a tensile load F deflects somewhat on account of this loading, making the distribution of reaction and load as shown in part (b) of the figure. A common simplification is to assume uniform load distributions, as shown in part (c). To further simplify, designers may consider replacing the distributed loads with point loads, such as in the two models shown in parts d and e. If a = 1.20 cm, b = 1.8 cm, d = 1.20 cm, and F = 4500 N, estimate the maximum bending stress and the maximum shear stress due to V for the three simplified models. Compare the three models from a designer's perspective in terms of accuracy, safety, and modeling time.



4. [Shigley, Chapter 3] A countershaft carrying two V-belt pulleys is shown in the figure. Pulley A receives power from a motor through a belt with the belt tensions shown. The power is transmitted through the shaft and delivered to the belt on pulley B. Assume the belt tension on the loose side at B is 15 percent of the tension on the tight side.

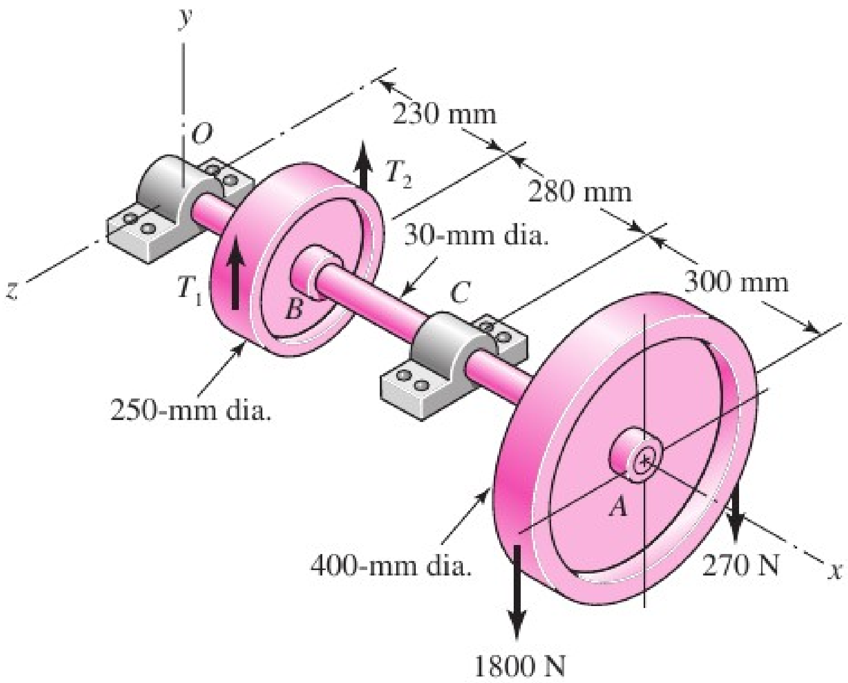
(a) Determine the tensions in the belt on pulley B, assuming the shaft is running at a constant speed.

(b) Find the magnitudes of the bearing reaction forces, assuming the bearings act as simple supports.

(c) Draw shear-force and bending-moment diagrams for the shaft. If needed, make one set for the horizontal plane and another set for the vertical plane.

(d) At the point of maximum bending moment, determine the bending stress and the torsional shear stress.

(e) At the point of maximum bending moment, determine the principal stresses and the maximum shear stress.



5. [Shigley, Chapter 3]. A gear reduction unit uses the countershaft shown in the figure. Gear A receives power from another gear with the transmitted force F_A applied at the 20° pressure angle as shown. The power is transmitted through the shaft and delivered through gear B through a transmitted force F_B at the pressure angle shown.

(a) Determine the force F_B, assuming the shaft is running at a constant speed.

(b) Find the magnitudes of the bearing reaction forces, assuming the bearings act as simple supports.

(c) Draw shear-force and bending-moment diagrams for the shaft. If needed, make one set for the horizontal plane and another set for the vertical plane.

(d) At the point of maximum bending moment, determine the bending stress and the torsional shear stress.

(e) At the point of maximum bending moment, determine the principal stresses and the maximum shear stress.