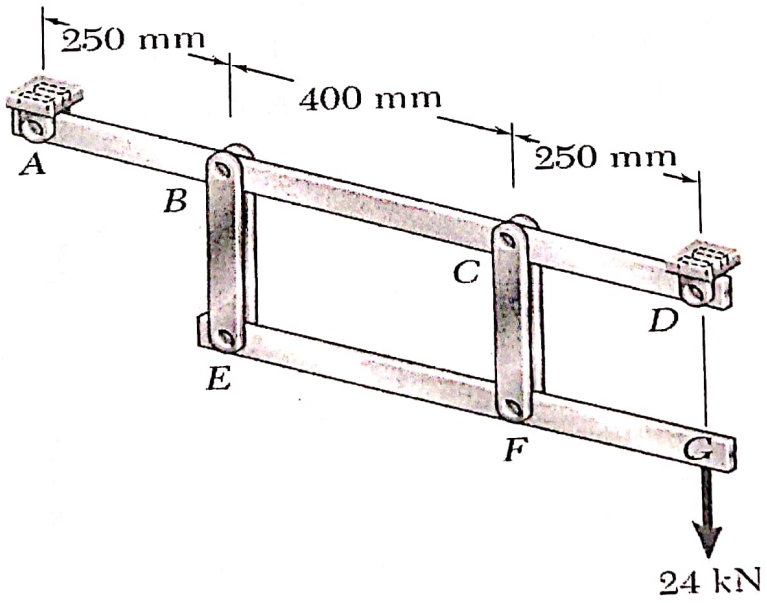
Mechanics of Materials (I)
Exam I (4/12/2019)

1. (15%) Explain the following terms:
   (a) fatigue
   (b) endurance limit
   (c) Hooke's Law
   (d) thermal effect
   (e) isotropic.

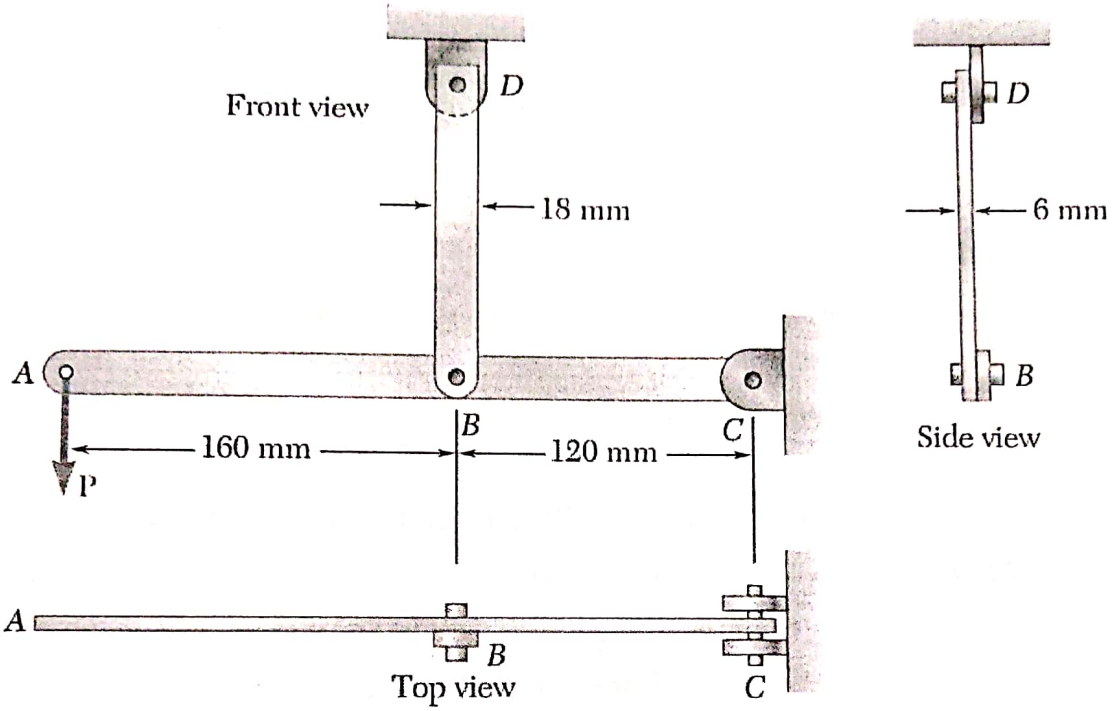
   isotropic

2. (10%) Suppose a unit cubic subjected to biaxial stresses σ_y, and σ_z. Please determine the normal strains ε_x and ε_y. Assume that the material has Young's modulus E and Poisson's ratio ν.

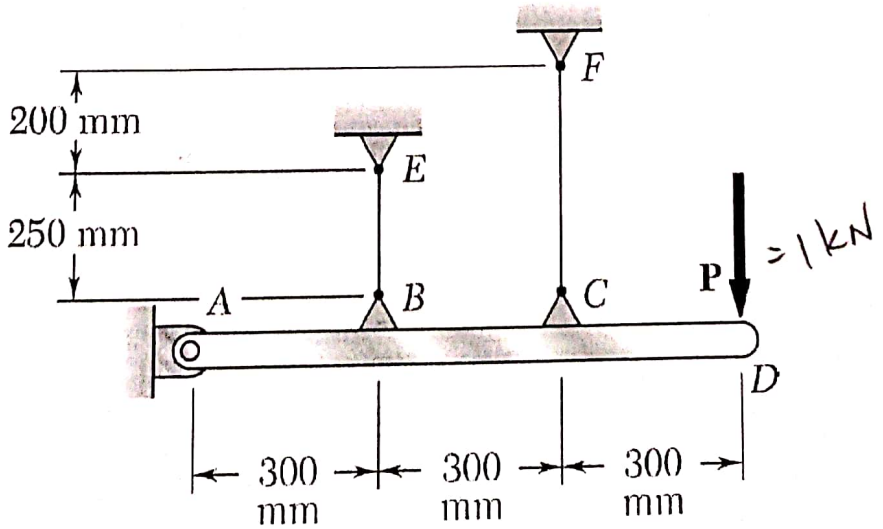
3. (15%) Each of the two vertical links CF connecting the two horizontal members AD and EG has a 10×40-mm uniform rectangular cross section and is made of a steel with an ultimate strength in tension of 400 MPa, while each of the pins at C and F has a 30-mm diameter and are made of a steel with an ultimate strength in shear of 150 MPa. Determine the overall factor of safety for the links CF and the pins connecting them to the horizontal members.



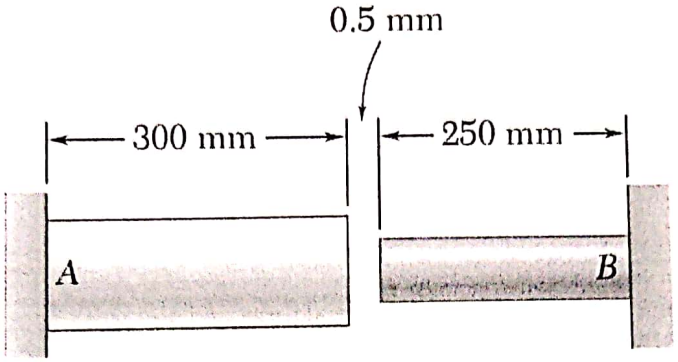
4. (16%) In the steel structure shown, a 6-mm-diameter pin is used at C and 10-mm-diameter pins are used at B and D. The ultimate shearing stress is 150 MPa at all connections, and the ultimate normal stress is 400 MPa in link BD. Knowing that a factor of safety of 3.0 is desired, determine the largest load **P** that can be applied at A. Note that link BD is not reinforced around the pin holes.



5. (16%) The rigid bar AD is supported by two steel wires of 1.5 mm diameter (E = 200 GPa) and a pin and bracket at D. Knowing that the wires were initially taught, determine (a) the additional tension in each wire when a 1.0 kN load **P** is applied at D, (b) the corresponding deflection of point D.



6. (16%) At room temperature (20°C) a 0.5-mm gap exists between the ends of the rods shown. At a later time when the temperature has reached 140°C, determine (a) the normal stress in the aluminum rod, (b) the change in length of the aluminum rod.



Aluminum	Stainless steel
$A = 2000\ \text{mm}^2$	$A = 800\ \text{mm}^2$
$E = 75\ \text{GPa}$	$E = 190\ \text{GPa}$
$\alpha = 23 \times 10^{-6}/°\text{C}$	$\alpha = 17.3 \times 10^{-6}/°\text{C}$

7. (12%) The axially loaded bar *ABCD* shown in the figure is held between rigid supports. The bar has cross-sectional area A_1 from A to C and $1.5A_1$ from C to D.

(a) Obtain formulas for the reactions R_A and R_D at the ends of the bar.

(b) Determine the displacements δ_B and δ_C at points B and C, respectively.