The Hashemite University
Faculty of Engineering
Mechanical Engineering Department

Machine Design I
Fall 2007
Instructor: Dr. Ala Hijazi

Second Exam ***Name:***_____
Part I – Closed Book ***Student #:***_____

Please Read Questions Carefully – Good Luck!

(16 points)
1. For the flowing statements circle the correct answer.

The larger the diameter of a shaft, the smaller its endurance limit. T F

According to the maximum normal stress failure theory, the material will never fail under hydrostatic stress. T F

For a material subjected to pure shear stress ($\sigma_y = -\sigma_x$), both the maximum shear stress theory and the distortion energy theory will predict the same critical stress. T F

If the fatigue factor of safety for a certain part was found to be more than one, this means that the part will fail after one million cycles of loading. T F

The surface finish of a machine element affects its
a) Fatigue strength
b) Fatigue life
c) Endurance limit
d) All of the above

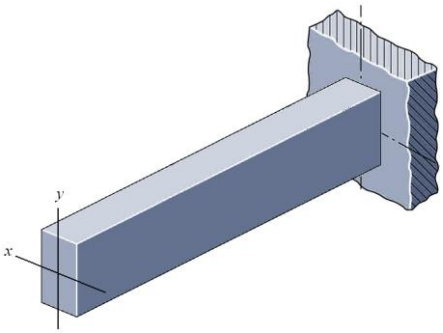
Two columns have the same length, cross sectional area and are subjected to compressive central load. The slenderness ratio for the two columns will be different if
a) The two columns are made of different materials
b) The two columns have different end conditions
c) The two columns have different cross sectional shapes
d) Non of the above
e) All of the above

The value of the fatigue stress concentration factor (K_f) is:
a) $1 \geq K_f \geq 0$
b) $K_t \geq K_f \geq 1$
c) $K_t \geq K_f \geq 0$
d) $K_t \leq K_f$

The Von-Mises stress will be equal to zero when

a) $\sigma_x = \sigma_y = \sigma_z$ and $\tau_{xy} = \tau_{yz} = \tau_{zx} = 0$
b) $\sigma_x \neq 0$ and $\sigma_y = \sigma_z = \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$
c) $\tau_{xy} \neq 0$ and $\sigma_x = \sigma_y = \sigma_z = \tau_{yz} = \tau_{zx} = 0$
d) None of the above
e) All of the above

A cantilever beam having a rectangular cross section as shown. A force ***F*** is to be applied at the free end. The strain energy in the beam



a) will be higher if the force is applied in the direction of the *x* axis.
b) will be higher if the force is applied in the direction of the *y* axis.
c) will be the same whether the force is applied in the direction of the *x* or *y* axis.
d) depends only on the magnitude of the force.

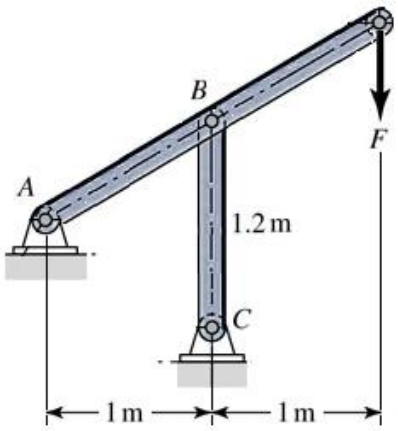
For a ductile material subjected to uni-axial stress, which of the flowing is true?

a) The factor of safety obtained using the DE theory will be smaller than that obtained using the MSS theory.
b) The factor of safety obtained using the DE theory will be larger than that obtained using the MSS theory.
c) Both the DE and MSS theories will give the same factor of safety.
d) The MSS theory can not be used for ductile materials.

Part II – Open Book ***Name:*** _____

(24 points)

2. Member ***BC*** has a square (0.05 m × 0.05 m) cross section and is made of AISI 1050 cold-drawn steel *(E = 210 GPa)*. If the structure is subjected to loading as shown in the figure, find the value of load ***F*** that will cause buckling.

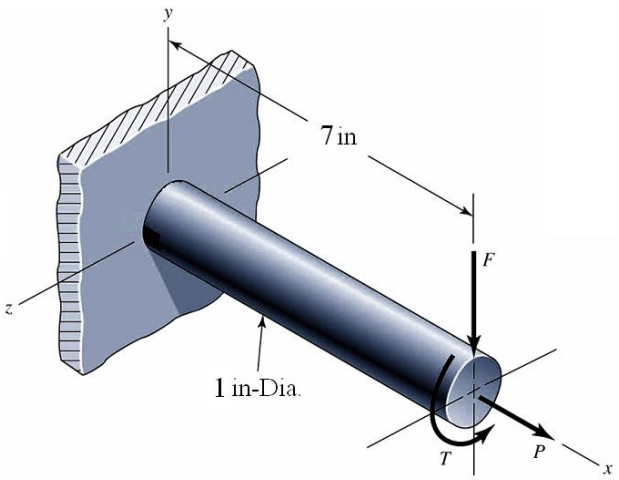


(36 points)

3. The bar is made of AISI 1015 hot-rolled steel and is subjected to the loading shown in the figure.

a) For $\boldsymbol{F}$ = 500 lb , $\boldsymbol{P}$ = 1500 lb and $\boldsymbol{T}$ = 400 lb.in, find the factor of safety based on the distortion energy theory.

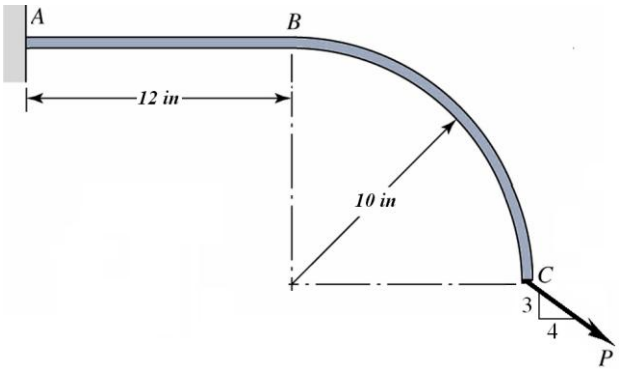
b) For $\boldsymbol{P}$ = $\boldsymbol{T}$ = 0 and $\boldsymbol{F}$ fluctuates from -100 to 500 lb, find the fatigue factor of safety at 90% reliability and 100º C temperature based on the modified-Goodman criterion.



Choose problem 4 or 5

(24 points)

4. The bar shown is made of steel ($E = 30 \times 10^6$ psi) and it has a square cross section (0.5 in × 0.5 in). End ***C*** is subjected to load ***P*** = 150 lb as shown.
Using Castigliano's theorem, find the vertical deflection of end ***C*** (ignore transverse shear).



(24 points)

5. The beam has three supports and is subjected to a force of 5 kN as shown. Knowing that $\boldsymbol{EI}$ = 1000 kN.m^2, find the deflection at point ***D***.