The Hashemite University
Faculty of Engineering
Mechanical Engineering Department

Machine Design I
Fall 2008
Instructor: Dr. Ala Hijazi

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

Please Read Questions Carefully – Good Luck!

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

Two identical bars, one is made of aluminum and the other is made of steel. The two bars are subjected to the same axial tensile force. The strain energy will be higher in the aluminum bar. T F

Two identical columns, one is made of aluminum and the other is made of steel. The two columns have the same slenderness ratio. T F

The endurance limit of a shaft will increase as its diameter increases. T F

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

A filleted bar, made out of a ductile material, is subjected to static tensile load. The critical stress of the bar will depend on the fillet radius. T F

A steel part is subjected to a fully reversed fatigue stress where the magnitude of the stress is $S_{ut} \geq \sigma \geq S_e$. Which of the following is true?

a) The part will have infinite life.
b) The part will fail during the first loading cycle.
c) The static factor of safety is larger than one.
d) The fatigue factor of safety is less than one.

The surface finish of a machine element affects its

a) Fatigue strength.
b) Ultimate strength.
c) Yield strength.
d) All of the above.
e) None of the above.

For a long column with a circular cross section subjected to compressive central load. If the diameter of the column is doubled, the critical buckling load will:

a) Increase two times.
b) Increase four times.
c) Increase sixteen times.
d) Generally increase but the exact amount can not be determined without knowing the exact diameter.

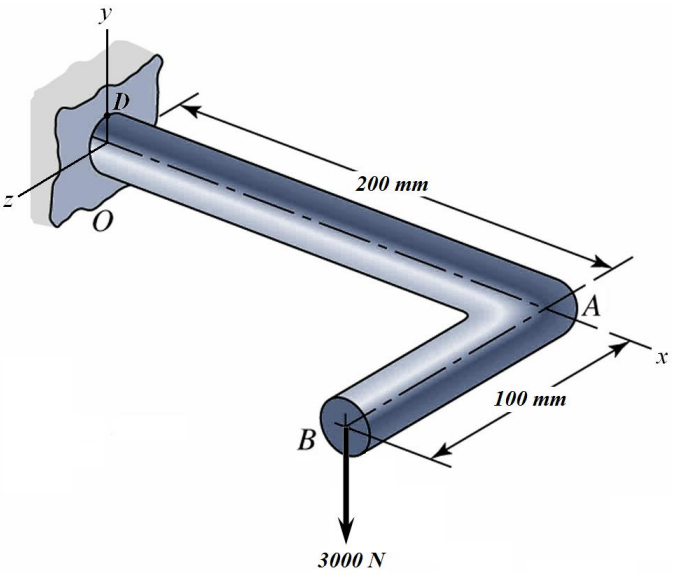
Part II – Open Book ***Name:*** _____

(30 points)

2. The *25 mm* diameter steel (*E = 210 GPa*) bar is subjected to a force of *3000 N* as shown.

a) Using Castigliano's theorem, determine the vertical deflection of point ***A***. *Ignore transverse shear.*

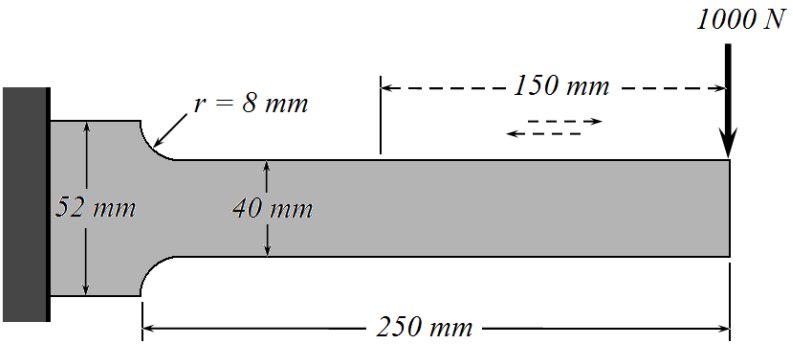
b) Knowing that the bar is made of AISI 1050 cold-drawn steel, find the factor of safety at point ***D*** *(located on the top surface along the y axis as seen in the figure)* using the DE theory.



(30 points)

3. The beam shown has a rectangular cross section with *10 mm* thickness and it was machined out of AISI 1030 cold-drawn steel plate. The beam is subjected to a *1000 N* load which translates back and forth along the *150 mm* distance as shown in the figure. Find:

a) The static factor of safety.
b) The fatigue factor of safety at 90% reliability based on the Soderberg criterion.



(30 points)

4. The beam is simply supported at ***A*** and ***B*** and subjected to an overhanging load ***P*** = *2000 N* at end ***C***. The beam is also pin connected to a *20 mm* diameter steel rod at ***D*** as shown in the figure. The stiffness of the beam is ***EI*** = 2×10^{11} $N.mm^2$.

a) Assuming that rod ***DE*** will not buckle; find the deflection at point ***D***.

b) Find the value of the load ***P*** at which buckling will occur in rod ***DE*** *(use the long columns formula)*.