The Hashemite University
Faculty of Engineering
Mechanical Engineering Department

Machine Design I
Spring 2008
Instructor: Dr. Ala Hijazi

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

Please Read Questions Carefully – Good Luck!

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

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 part will fail after a certain number of cycles.
   d) The static factor of safety is larger than one.

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

The Von-Mises stress will be equal to zero when
   a) $\sigma_x = \sigma_y \neq 0$ and $\sigma_z = \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$
   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

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. Which of the flowing is true?
   a) The two bars will have the same strain energy.
   b) The strain energy will be higher in the bar mad of aluminum.
   c) The strain energy will be higher in the bar mad of steel.
   d) The value of the strain energy depends only on the magnitude of the force.

For a ductile material subjected to pure shear 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.

(15 points)

2. A column is made of steel ($E = 210\ GPa$) and has a rectangular ($20\ mm \times 10\ mm$) cross section. Knowing that both ends of the column are fixed and it is subjected to an axial compressive load of $P = 1000\ N$, find the critical length of the column.

(34 points)
3. The bar shown is made out of AISI 1050 cold-drawn steel and is subjected to a load **P** which fluctuates between *4 to 12 kN*. Find:
   a) The static factor of safety
   b) The fatigue factor of safety at 90% reliability and 100° C temperature based on the ASME-elliptic criteria

5 mm

P ← | 30 mm | 20 mm | → **P**

4 mm
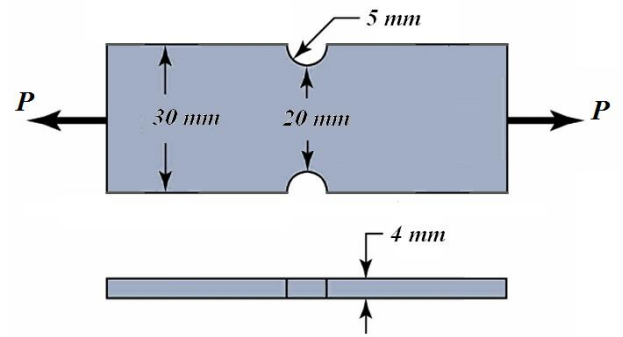
(22 points)

4. The bar shown is made of steel ($E = 210\ GPa$) and it has a square ($10\ mm \times 10\ mm$) cross section. End C is subjected to a bending moment $M = 10\ N.m$ as shown.

Using Castigliano's theorem, find the <u>horizontal deflection</u> of end C.
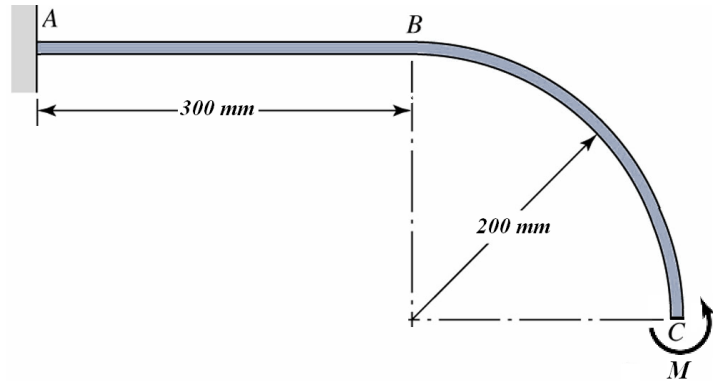
(24 points)
5. The beam has three supports and is subjected to a force of 5 kN as shown. Knowing that $EI = 1000$ kN.m^2, find the deflection at point C.