ME325 EXAM I (Sample)

NAME: ________________________________

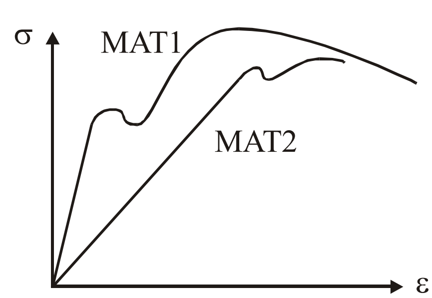
NOTE:

- CLOSED BOOK, CLOSED NOTES. ONLY A SINGLE 8.5x11" FORMULA SHEET IS ALLOWED. ADDITIONAL INFORMATION IS AVAILABLE ON THE LAST PAGE OF THIS EXAM.
- DO YOUR WORK ON THE EXAM ONLY (NO SCRATCH PAPER ALLOWED).
- READ THE QUESTION AND ALL ANSWERS CAREFULLY AND SELECT THE **BEST** ANSWER.
- ALL QUESTIONS ARE WEIGHTED EQUALLY.

(1) If a motor is turning a shaft with a torque of T ft-lb at a rate of n rpm, how much horsepower is being delivered?
(a) $\pi Tn / 550$
(b) $550\pi Tn$
(c) $\pi Tn / 16500$
(d) $16500\pi Tn$

(2) If an axial force is specified in units of kN and the cross section area is specified in mm^2, what is the appropriate unit for axial stress?
(a) mPa
(b) Pa
(c) kPa
(d) MPa
(e) GPa

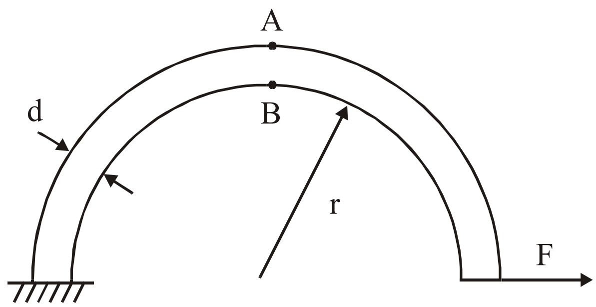
Questions 3 through 4 deal with the figure below:



(3) Which material has a higher yield strength?
(a) MAT1
(b) MAT2

(4) Which material has a higher ultimate strength?
(a) MAT1
(b) MAT2

Questions 5 through 8 deal with the curved rod of diameter d and inner radius of curvature r shown below.



(5) The bending moment M used to calculate the bending stress at point A is
(a) dF
(b) (d/2) F
(c) rF
(d) (r + d/2) F
(e) (r + d) F

(6) The $\bar{r}/\bar{c}$ ratio used to determine the K factors is
(a) r / d
(b) r / (d/2)
(c) (r + d) / (d/2)
(d) (r + d/2) / d
(e) (r + d/2) / (d/2)

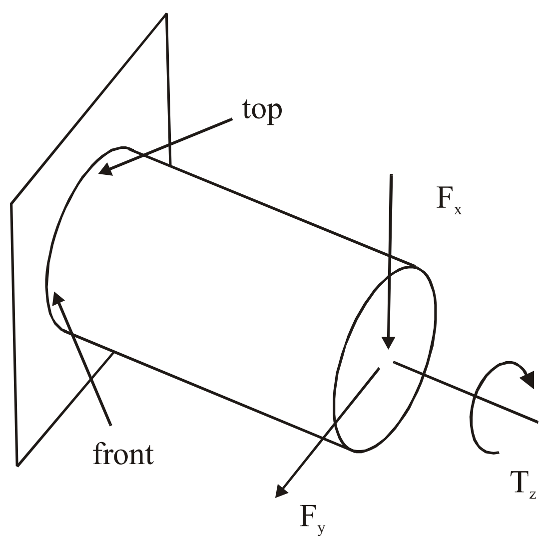
(7) The total normal stress at point B is calculated as
(a) $|\sigma_{bending}| + |\sigma_{axial}|$
(b) $|\sigma_{bending}| - |\sigma_{axial}|$
(c) $|\sigma_{axial}| - |\sigma_{bending}|$
(d) $-|\sigma_{axial}| - |\sigma_{bending}|$

(8) How does the magnitude of the actual normal stress due to bending at point A compare with the magnitude that would be obtained using the straight beam equation?
(a) it is larger
(b) it is smaller
(c) it is the same

Questions 9 through 12 deal with the bar of length L and diameter d shown below. The left end of the bar is fixed to a wall. The free end is loaded with two forces and a torque as shown. The stress magnitudes at the wall (not including signs for direction) will be referred to below using the following labels:

A: maximum bending stress magnitude due to F_x
B: maximum bending stress magnitude due to F_y
C: maximum torsion shear stress magnitude due to T_z
D: maximum transverse shear stress magnitude due to F_x
E: maximum transverse shear stress magnitude due to F_y

Note: the points labeled "top" and "front" are on the outer surface of the part on the vertical and horizontal planes of symmetry of the cross section.



(9) What is the value of "A: maximum bending stress magnitude due to F_x"?

(a) $32F_xL / \pi d^3$
(b) $64F_xL / \pi d^3$
(c) $32F_xL / \pi d^4$
(d) $16F_xL / \pi d^3$
(e) $128F_xL / \pi d^4$

(10) The total normal stress at the point labeled "front" is equal to

(a) A
(b) B
(c) -A
(d) -B
(e) A - B

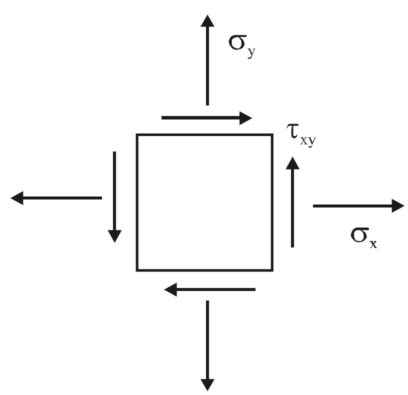
(11) The magnitude of the total shear stress at the point labeled "top" is equal to

(a) C
(b) E + C
(c) D + C
(d) E - C
(e) D - C

(12) The transverse shear due to F_y is zero on the

(a) top surface
(b) front surface

Questions 13 through 15 deal with the biaxial state of stress illustrated below where σ_z=0:



(13) If $\sigma_x = 100$, $\sigma_y = -100$, and $\tau_{xy} = 0$, the maximum shear stress in the material is

(a) 0
(b) 50
(c) 75
(d) 100
(e) 200

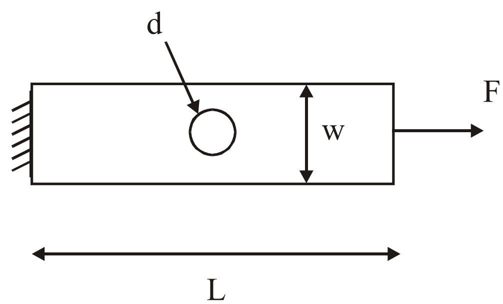
(14) If $\sigma_x = 100$, $\sigma_y = 100$, and $\tau_{xy} = 50$, the maximum shear stress in the material is

(a) 0
(b) 50
(c) 75
(d) 100
(e) 200

(15) If $\sigma_x = 100$, $\sigma_y = -100$, and $\tau_{xy} = 50$, which direction below corresponds to the smallest angle to the maximum principal stress?

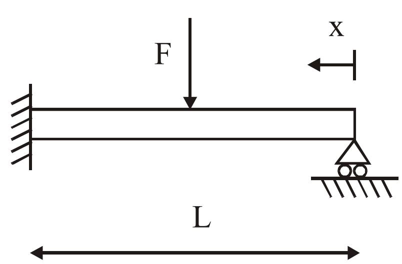
(a) clockwise from σ_x
(b) counterclockwise from σ_x
(c) clockwise from σ_y
(d) counterclockwise from σ_y

(16) If the plate below has a thickness t and a stress concentration factor of 2, what is the correct expression for the maximum normal stress at the hole?



(a) 2F / t(w - d)
(b) F / 2t(w - d)
(c) 2F / t(w - d/2)
(d) F / 2t(L - d)
(e) 2F / t(L - d)

Questions 17 through 19 deal with the beam shown below. Load F is applied at the center of the beam. Refer to the vertical reaction force at the right support as R_y. **NOTE: x is measured from the right side of the beam.** Neglect transverse shear effects.



(17) What is the correct expression for the bending moment M(x) for $0<x<L/2$ (using the positive bending moment sign convention)?

(a) xR_y
(b) xR_y - FL/2
(c) xR_y + FL/2
(d) FL/2
(e) -FL/2

(18) Which equation below is valid and can be used to help solve for the reaction force R_y?

(a) $0 = \frac{1}{EI}\int_0^{L/2} M\frac{\partial M}{\partial F}dx$

(b) $0 = \frac{1}{EI}\int_0^{L} M\frac{\partial M}{\partial F}dx$

(c) $L = \frac{1}{EI}\int_0^{L} M\frac{\partial M}{\partial R_y}dx$

(d) $F = \frac{1}{EI}\int_0^{L/2} M\frac{\partial M}{\partial R_y}dx$

(e) $0 = \frac{1}{EI}\int_0^{L} M\frac{\partial M}{\partial R_y}dx$

(19) Which expression below can be used to find the deflection at the center of the beam?

(a) $\frac{1}{EI}\int_0^{L} M\frac{\partial M}{\partial F}dx$

(b) $\frac{1}{EI}\int_0^{L/2} M\frac{\partial M}{\partial F}dx$

(c) $\frac{1}{EI}\int_0^{L/2} M\frac{\partial M}{\partial R_y}dx$

(d) $\frac{1}{EI}\int_0^{L} M\frac{\partial M}{\partial R_y}dx$

(20) If M(x) = Px, what is $\int_0^{L} M\frac{\partial M}{\partial P}dx$

(a) PL

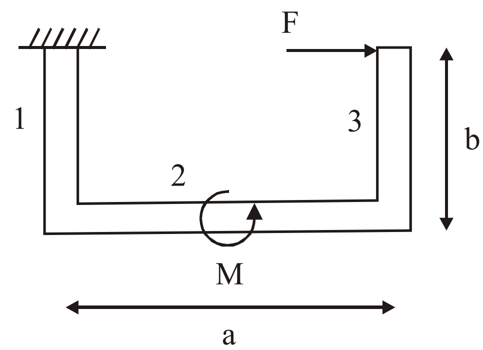
(b) PL^2

(c) $PL^2/2$

(d) PL^3

(e) $PL^3/3$

Questions 21 through 24 deal with applying Castigliano's Method to the frame below consisting of 3 segments. **Do not neglect any elastic energy terms and include all existing elastic terms (even if the partial derivative terms are zero).**



(21) What is the reaction bending moment at the fixed end of section 1?
- (a) M + aF
- (b) M + bF
- (c) M - aF
- (d) M - bF
- (e) M

(22) In finding the horizontal deflection of the free end of section 3, what energy terms need to be included for section 1?
- (a) none
- (b) transverse shear only
- (c) axial and bending only
- (d) transverse shear and bending only
- (e) axial, transverse shear, and bending

(23) In finding the horizontal deflection of the free end of section 3, what energy terms need to be included for section 2?
- (a) none
- (b) axial only
- (c) bending only
- (d) axial and bending only
- (e) axial, transverse shear, and bending

(24) In finding the vertical deflection of the free end of section 3, what energy terms need to be included for section 3?
- (a) none
- (b) transverse shear only
- (c) axial only
- (d) axial and transverse shear only
- (e) axial, transverse shear, and bending