ME325 EXAM II (Spring, 2001)

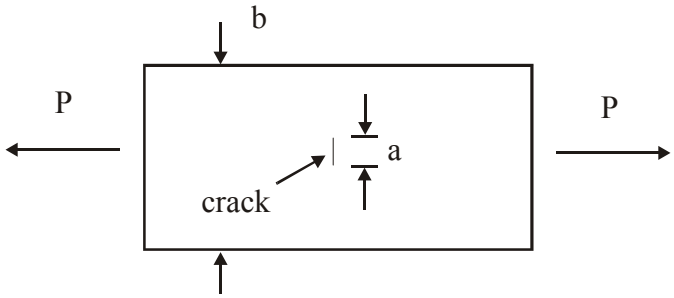
NAME: _____

NOTE:

- CLOSED BOOK, CLOSED NOTES. ONLY A SINGLE 8.5x11" FORMULA SHEET IS ALLOWED. ADDITIONAL INFORMATION IS ATTACHED TO 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) Which failure theory is the most accurate in predicting yield of a ductile material?
- (a) maximum normal stress theory
- (b) maximum shear stress theory
- (c) maximum distortion energy theory
- (d) fracture mechanics stress intensity factor theory

Questions 2 through 4 deal with the thin steel plate below of thickness t. The critical stress intensity factor for the steel is C and the yield strength is Y. The questions deal with applying the fracture mechanics theory and equations presented in the book and in class.



(2) What is the gross stress σ_g in the plate?
- (a) P / bt
- (b) P / 2bt
- (c) P / (2b-a)t
- (d) P / (2b-2a)t
- (e) P / (b-a)t

(3) What is the stress intensity factor K_I?

(a) $1.8\sqrt{a}\sigma_g$

(b) $1.8\sqrt{2a}\sigma_g$

(c) $1.8\sqrt{\frac{a}{2}}\sigma_g$

(d) $1.8\sqrt{b-a}\sigma_g$

(e) $1.8\sqrt{2(b-a)}\sigma_g$

(4) What is the most appropriate test for checking if the plate will yield? Assume "a" is much smaller than "b."

(a) $\sigma_g > C$

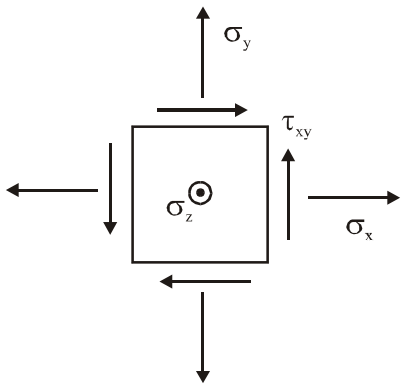
(b) $\sigma_g > Y$

(c) $\sigma_g > K_I$

(d) $K_I > C$

(e) $K_I > Y$

Questions 5 through 7 deal with the state of stress illustrated below where σ_x, σ_y, and τ_{xy} are in the plane and σ_z is a normal stress perpendicular to the plane. Assume the yield strength of the material is S_y.



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

(a) 0

(b) 50

(c) 75

(d) 100

(e) 200

(6) If $\sigma_x = -100$, $\sigma_y = -100$, $\sigma_z = 0$, and $\tau_{xy} = 100$, the minimum principal stress (σ_3) in the material is
(a) 0
(b) −50
(c) −75
(d) −100
(e) −200

(7) If $\sigma_x = 100$, $\sigma_y = -100$, $\sigma_z = 0$, and $\tau_{xy} = 0$, the maximum distortion energy theory predicts failure when [Note: pick the choice which is valid and whose limit is closest to the appropriate value]
(a) $S_y < 100$
(b) $S_y < 100\sqrt{3}$
(c) $S_y < 100 / \sqrt{3}$
(d) $S_y < 200\sqrt{3}$
(e) $S_y < 200 / \sqrt{3}$

(8) If the maximum shear stress in a material is 100 and the yield strength is 300, the safety factor is
(a) 1/3
(b) 1/6
(c) 1.5
(d) 2/3
(e) 3

(9) If the average load applied to a part is 100 and the average load strength of the part is 200, the average margin of safety is
(a) 100
(b) -100
(c) 50
(d) -50

(10) If the average load margin of safety for a part is –2 and the standard deviation is 1, what is the approximate probability that the part will fail?
(a) 100%
(b) 2%
(c) 17%
(d) 83%
(e) 98%

(11) A block of mass m is hoisted to the top of a column of stiffness k so that the mass is in contact with the column but the weight is supported entirely by the hoist cable. If the hoist is lowered slowly so the weight is applied to the column gradually, how much will the column deflect?

(a) mg / k
(b) kmg
(c) 2mg / k
(d) 2 kmg
(e) kmg / 2

(12) What's the smallest stress amplitude below that will cause fatigue failure after 1000 cycles for a steel tensile specimen ($S_u = 120$, $S_y = 80$) under alternating axial load?

(a) 45
(b) 65
(c) 85
(d) 95
(e) 125

(13) What is the fatigue strength gradient factor (C_G) for a 5 inch diameter ground steel bar under alternating bending load?

(a) 0.7
(b) 0.8
(c) 0.9
(d) 1.0
(e) 1.1

(14) A bar of cross sectional area 1 mm^2 is pulled in tension with a load alternating between 100 N and 200 N. What is σ_a?

(a) 50 MPa
(b) 75 MPa
(c) 100 MPa
(d) 125 MPa
(e) 150 MPa

(15) For question 14, what is σ_m?

(a) 50 MPa
(b) 75 MPa
(c) 100 MPa
(d) 150 MPa
(e) 200 MPa

Questions 16 through 19 deal with a steel part experiencing fatigue loading (σ_a and σ_m). The part has an endurance limit (S_n) of 50, a yield strength (S_y) of 100 and an ultimate strength (S_u) of 150.

(16) If $\sigma_a = 0$ and $\sigma_m = 50$ what is the safety factor for infinite fatigue life?
- (a) 1
- (b) 1/2
- (c) 2
- (d) 1/3
- (e) 3

(17) If $\sigma_a = 0$ and $\sigma_m = 50$ what is the safety factor for part yielding?
- (a) 1
- (b) 1/2
- (c) 2
- (d) 1/3
- (e) 3

(18) If $\sigma_a = 40$ and $\sigma_m = 0$ and N is the number of load cycles, when will the part experience fatigue failure?
- (a) never, even for $N = \infty$
- (b) for some N less than 10^6
- (c) only when $N = 10^6$
- (d) only when $N > 10^6$

(19) If $\sigma_a = 50$, the smallest σ_m that will result in yielding of the part is
- (a) 30
- (b) 60
- (c) 80
- (d) 110
- (e) 160

(20) For a very hard and strong steel part with a notch radius of 0.5 in, the fatigue stress concentration factor is closest to
- (a) 0
- (b) 1
- (c) 2
- (d) the geometric stress concentration factor (K_t)