ME-340 EXAM #01 October 22, 1998

Name: ANSWER KEY – BLUE

Read all questions carefully and thoroughly. Mark your answers on a SCANTRON sheet. The SCANTRON sheet will serve as the final authority regarding questions as to marking your exam sheet with one answer and the SCANTRON sheet with another.

(1) Failure is explicitly defined to be the instant a part reaches the yield point.
- (a) Yes
- (b) No

(2) A material has a BHN of 250. The predicted ultimate strength for the material is:
- (a) Need to know the material so can look up ultimate strength in table.
- (b) 100 ksi
- (c) 112.5 ksi
- (d) 225 ksi

(3) For a material with an ultimate strength of 150 ksi, the predicted endurance limit is:
- (a) 75 ksi
- (b) 100 ksi
- (c) Need to know material so can determine the ultimate strength.

(4) Some materials have an endurance limit of one million cycles.
- (a) Yes
- (b) No

(5) Material processing can have an effect upon material properties.
- (a) Yes
- (b) No
- (c) Need to know material

(6) Operating temperature has no effect upon material properties.
- (a) Yes
- (b) No

(7) Given the state of stress shown in Figure Q-7, the von-Mises equivalent stress is:
- (a) 8.7 ksi
- (b) 23.7ksi
- (c) 33.5ksi
- (d) 21.8ksi
- (e) 17.3 ksi

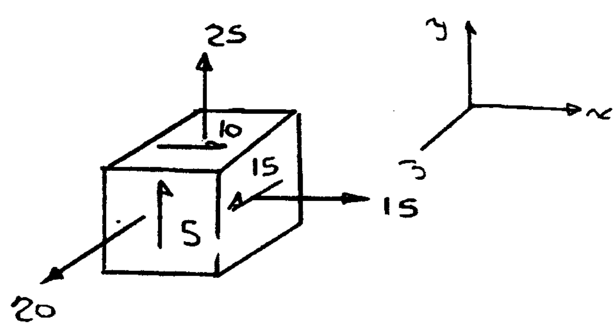

Figure Q-7

$$\sigma' = \sqrt{\frac{(15-25)^2+(20-25)^2+(20-15)^2+6(10^2+5^2+15^2)}{2}}$$

$$\sigma' = \sqrt{\frac{100+25+25+6(100+25+225)}{2}} = 33.5\ \text{ksi}$$

G1

(8) Referring to Figure Q-8, what reactions need to be shown to complete the free body diagram shown?

- ~~(a)~~ Moment at A and C only.
- (b) Moment at A only.
- (c) The diagram is complete as shown
- (d) Moment at A,B, and C
- (e) Moments at C only.

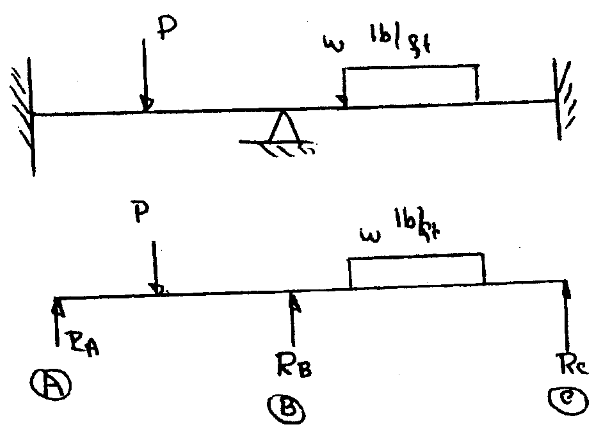

Figure Q-8

(9) For the diagrams shown in Figure Q-9, the moment at B is:

- (a) 8000 in-lb
- (b) -8000 in-lb
- (c) 2000 in-lb
- ~~(d)~~ 10,000 in-lb
- (e) 6,000 in-lb

$M_B = M_A + 8\,in(1{,}000\,lb)$

$= 2{,}000\,lb\,in + 8{,}000\,lb\,in = 10{,}000\,in\,lb$

PROF. DIPPERY INTENDED TO HAVE THE MOMENT AT A BE 2,000 lb in, BUT THIS IS NOT EXPLICIT, THUS, EITHER 10,000 OR 8,000 in lb IS OK

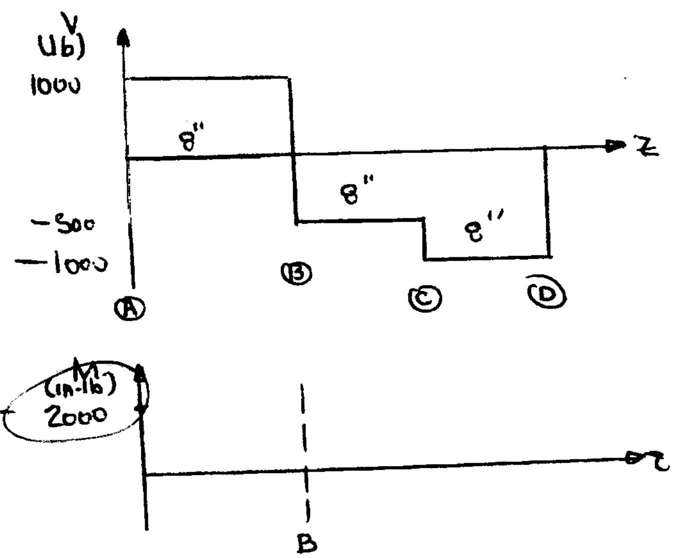

Figure Q-9

(10) The beam shown in Figure Q-8 is

- ~~(a)~~ Statically indeterminate
- (b) Statically determinate

(11) A shaft rotates at 1800 rpm. A component in the design has a critical or fundamental frequency of 30 Hz (cycles-per-second). This will present an operating problem?

- (a) No
- ~~(b)~~ Yes
- (c) Need to know what materials are involved and if the design is to operate for more than one million cycles.

$1800 \frac{cycles}{min} \times \frac{1\,min}{60\,sec} = 30 \frac{cycles}{sec}$ OR 30 Hz

(12) Deflections are considered to be an important concern in the design of shafts.

(a) True
(b) False

(13) Shafts are always made of solid circular cross-sections

(a) True
(b) False

(14) For the geometry shown in Figure Q-14, the static stress concentration factor is:

(a) 1.70
(b) 1.65
(c) 1.30
(d) 1.75
(e) 1.55

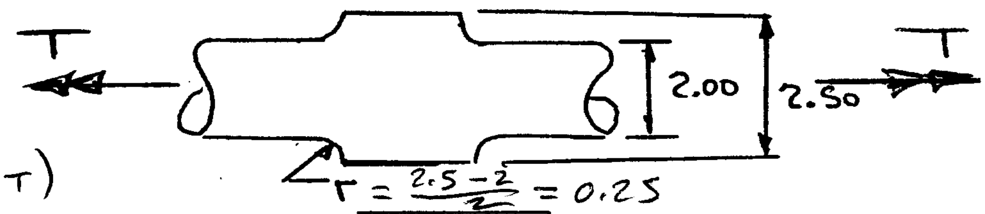

FIG E-3 (TEXT)

$r = \frac{2.5-2}{2} = 0.25$

$\frac{D}{d} = \frac{2.5}{2} = 1.25$

Figure Q-14

$\frac{r}{d} = \frac{0.25}{2} = 0.125$

(15) A steel shaft with a theoretical stress concentration factor of 3.0 and a notch radius of 3-mm is made from a steel which has an ultimate strength of 50 ksi. The fatigue stress concentration factor is:

$q = 0.72$ (FIG 6-36, TEXT)

$K_f = 1 + q(K_T - 1) = 1 + 0.72(3-1) = 2.44$

(a) 2.44
(b) 1.56
(c) 0.78
(d) 0.728
(e) Not enough data to solve.

(16) A machined steel shaft, 2.0 inch in diameter, made of 1020 cold rolled steel has a modified endurance limit of 18 ksi. Which modified Goodman line in Figure Q-16 is the correct diagram?

(a) Need loads and stresses to evaluate.

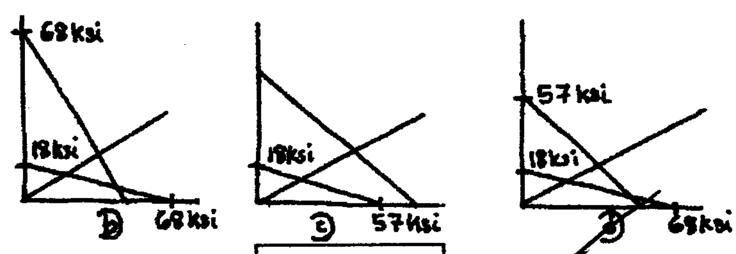

Figure Q-16

(17) For the S-N diagram shown in Figure Q-17, what is the expected life for a stress of 40-ksi?

(a) Infinite
(b) 10^6 cycles
(c) 10^4 cycles
(d) 10^5 cycles

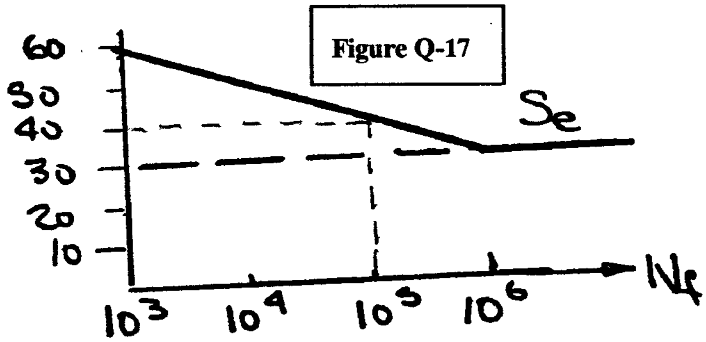

Figure Q-17

$M_a = \frac{15{,}000 + 5{,}000}{2} = 10{,}000$ $T_a = \frac{25{,}000 + 10{,}000}{2} = 17{,}500$ $C_{SIZE} = .869(3.7)^{-.097} = .765$

$M_m = \frac{15{,}000 - 5{,}000}{2} = 5{,}000$ $T_m = \frac{25{,}000 - 10{,}000}{2} = 7500$ $S_f = S_e = S_e' C_{LOAD} C_{SIZE} = \frac{85{,}000}{2}(.765) = 32{,}500$

(18) The critical point on a solid circular shaft has a moment that varies from –5,000 in-lb to 15,000 and a torque that varies from –10,000 lb-in to 25,000 lb-in. The theoretical (static) and fatigue stress concentrations are both equal to 2.5 for bending and torsion. If the design has a factor of safety of 3.0 and the material is cold rolled 1040 steel, what is the minimum allowable diameter of the shaft? Neglect surface, reliability and temperature corrections.

- (a) 3.7in
- (b) 2.5 in
- (c) 2.7 in
- (d) None of the above.

$$d = \left\{ \frac{32(3)2.5}{\pi} \left[\frac{\sqrt{10^2 + \frac{3}{4}(17.5)^2}}{32.5} + \frac{\sqrt{5^2 + \frac{3}{4}(7.5)^2}}{85} \right] \right\}^{1/3} = 3.7$$

(19) Attachment of a gear to a shaft requires no fatigue evaluations.

- (a) True
- (b) False

(20) Keys are not the only means for attaching components to rotating shafts.

- (a) True
- (b) False

(21) In the design of a shaft system in which the components are attached to the shaft by means of keys it is important the keys be made of materials which are softer than the shaft.

- (a) Yes
- (b) No

(22) A component has an equivalent stress of 50-ksi and is made from a steel having an ultimate strength of 120 ksi and a yield strength of 80 ksi. The margin of safety in yield is:

- (a) 0.63
- (b) 0.42
- (c) 2.4
- (d) 1.6

$M.S. = 1 - F.O.S. = 1 - \frac{80}{50} = 0.6$

(23) What is the uncorrected endurance limit for a 1.0 inch diameter, machined shaft made of heat treated 2024 aluminum?

- (a) 220.5 MPa
- (b) 176.4 MPa
- (c) None, aluminum has no endurance limit
- (d) Not enough information to evaluate.

(24) What is the slope of the load line for an equivalent alternating stress of $75/d^3$ and an equivalent mean stress of $150/d^3$?

- (a) 1/2
- (b) 3
- (c) 2
- (d) Need diameter of the shaft to determine.

$\frac{75/d^3}{150/d^3} = \frac{75}{150} = \frac{1}{2}$

(25) A fatigue failure consists of

- (a) Crack initiation
- (b) Crack propagation
- (c) Final failure
- (d) (a),(b) and (c) only
- (e) (b), and (c)