

NAME: \_\_\_\_\_

8:00 AM

- ▶ *Read all problems carefully. Check the board for any additions or corrections.*
  - ▶ *Show all work, which must be neat and orderly to be graded. That is, sloppy work will not be graded! Clearly identify all answers.*
  - ▶ *Return this page with your solutions. Show no work on this page.*
- (1) A helical compression spring with squared and ground ends is made of oil-tempered wire 0.25 inch in diameter and has a spring index of 15.2. The spring is peened and has a total of 18 coils. Determine the spring stiffness, the force that will cause the spring to yield at the solid height, and the free length of the spring. If the load varies from 30 pounds to 90 pounds, what is the factor of safety in fatigue?
- (2) A steel cantilever beam, 25 inches long, with a cross section of 2 inches wide by 4 inches high is subjected to a load of 30,720 pounds. What is the stiffness of the beam and the total end deflection? What is the flexibility of the spring?
- (3) A pressure vessel contains a toxic gas at a high temperature where preload relaxation is a concern. The clamped members are made of A387D-class 4 steel and the nut and bolt are made of B4A56A2-2 steel. The ultimate strength of the bolt material is 180-ksi, with a yield strength of 75% of the ultimate, a proof-strength equal to 65% of the ultimate, and an endurance limit of 33% of the proof strength. The clamped length of the members is 8-inches. The threads are rolled with a theoretical stress concentration factor of 2.8, the surface finish is considered to be machined. The design has a total load which varies from 0 to 7,200,000 pounds. The design requires a factor of safety of 1.25 in fatigue and a positive margin of safety in yield. In the design of the horizontal joint, the design engineer, using the effective cylinder method, specified a total of 48, 1"-12 bolts. Do you agree with that decision (yes or no)? Explain your answer and show the necessary calculations to verify your answer. If the design is not satisfactory, what changes would you recommend?
- (4) A 1.25 inch, single-thread, diameter automobile screw jack has ACME threads and is used to lift a 5500 pound car. Determine the torque required to raise this load if the design has a collar with a radius of 1.50 inch and the coefficient of friction for the threads and collar is 0.15. How many turns of the screw will it require to raise the load 2.0 inches? What is the efficiency of the device?

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- (1) A helical compression spring with squared ends is made of chrome-silicon wire 0.25 inch in diameter and has a spring index of 15.2. The spring is unpeened and has a total of 18 coils. Determine the spring stiffness, the force that will cause the spring to yield at the solid height, and the free length of the spring. If the load varies from 60 pounds to 120 pounds, what is the factor of safety in fatigue?
- (2) A steel cantilever beam, 20 inches long, with a cross section of 4 inches wide by 2 inches high is subjected to a load of 30,000 pounds. What is the stiffness of the beam and the total end deflection? What is the flexibility of the spring?
- (3) A pressure vessel contains a toxic gas at a high temperature where preload relaxation is a concern. The clamped members are made of A387D-class 4 steel and the nut and bolt are made of B4A56A2-2 steel. The ultimate strength of the bolt material is 190-ksi, with a yield strength of 85% of the ultimate, a proof-strength equal to 85% of the yield, and an endurance limit of 38% of the proof strength. The clamped length of the members is 10-inches. The threads are rolled with a theoretical stress concentration factor of 2.5, the surface finish is considered to be machined. The design has a total load which varies from 0 to 14,400,000 pounds. The design requires a factor of safety of 1.50 in fatigue and a positive margin of safety in yield. In the design of the horizontal joint, the design engineer, using the effective cylinder method, specified a total of 96, 1"-8 bolts. Do you agree with that decision (yes or no)? Explain your answer and show the necessary calculations to verify your answer. If the design is not satisfactory, what changes would you recommend?
- (4) A 1.50 inch, double-thread, diameter automobile screw jack has ACME threads and is used to lift a 6600 pound car. Determine the torque required to raise this load if the design has a collar with a radius of 1.75 inch and the coefficient of friction for the threads and collar is 0.125. How many turns of the screw will it require to raise the load 4.0 inches? What is the efficiency of the device?

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- (1) A helical compression spring with plain and ground and ground ends is made of oil-tempered wire 6.35 mm in diameter and has a coil diameter of 96.52 mm. The spring is unpeened and has a total of 18 coils. Determine the spring stiffness, the force that will cause the spring to yield at the solid height, and the free length of the spring, assuming no clash allowance. If the load varies from 133.5 N to 391.5 N, what is the factor of safety in fatigue?
- (2) A steel cantilever beam, .635 m long, with a cross section of 50.8 mm wide by .1016m high is subjected to a load of 133.63 kN. What is the stiffness of the beam and the total end deflection? What is the flexibility of the spring?
- (3) A pressure vessel contains a toxic gas at a high temperature where preload relaxation is a concern. The clamped members are made of Titanium 6-4 and the nut and bolt are made of Titanium 6-4-1.5. The ultimate strength of the bolt material is 180-ksi, with a yield strength of 85% of the ultimate, a proof-strength equal to 65% of the ultimate, and an endurance limit of 38% of the proof strength. The clamped length of the members is 6-inches. The threads are rolled with a theoretical stress concentration factor of 2.3, the surface finish is considered to be machined. The design has a total load which varies from 0 to 3,600,000 pounds. The design requires a factor of safety of 1.75 in fatigue and a positive margin of safety in yield. In the design of the horizontal joint, the design engineer, using the effective cylinder method, specified a total of 24, 1"-8 bolts. Do you agree with that decision (yes or no)? Explain your answer and show the necessary calculations to verify your answer. If the design is not satisfactory, what changes would you recommend?
- (4) A 1.25 inch, triple-thread, diameter automobile screw jack has ACME threads and is used to lift a 5000 pound car. Determine the torque required to raise this load if the design has a collar with a radius of 1.38 inch and the coefficient of friction for the threads and collar is 0.13. How many turns of the screw will it require to raise the load 2.5 inches? What is the efficiency of the device?

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- (1) A helical compression spring with plain and ground ends is made of chromium-vanadium wire 0.25 inch in diameter and has a spring index of 14.2. The spring is unpeened and has a total of 16 coils. Determine the spring stiffness, the force that will cause the spring to yield at the solid height, and the free length of the spring. If the load varies from 80 pounds to 140 pounds, what is the factor of safety in fatigue?
- (2) A cantilever beam, 25 inches long, with a cross section of 4 inches wide by 4 inches high is subjected to a load of 61,440 pounds. What is the stiffness of the beam and the total end deflection? What is the flexibility of the spring?
- (3) A pressure vessel contains a toxic gas at a high temperature where preload relaxation is a concern. The clamped members are made of Ti-6-4 and the nut and bolt are made of a high-strength Titanium alloy. The ultimate strength of the bolt material is 1240 MPa, with a yield strength of 70% of the ultimate, a proof-strength equal to 85% of the yield, and an endurance limit of 33% of the proof strength. The clamped length of the members is 200 mm. The threads are rolled with a theoretical stress concentration factor of 2.2, the surface finish is considered to be machined. The design has a total load which varies from 0 to 32 MN. The design requires a factor of safety of 1.75 in fatigue and a positive margin of safety in yield. In the design of the horizontal joint, the design engineer, using the effective cylinder method, specified a total of 48, M30X3.50 nuts and bolts. Do you agree with that decision (yes or no)? Explain your answer and show the necessary calculations to verify your answer. If the design is not satisfactory, what changes would you recommend?
- (4) A 1.375 inch, double-thread, diameter automobile screw jack has ACME threads and is used to lift a 6600 pound car. Determine the torque required to raise this load if the design has a collar with a radius of 1.63 inch and the coefficient of friction for the threads and collar is 0.11. How many turns of the screw will it require to raise the load 6.0 inches? What is the efficiency of the device?

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