Revisions are shown in red.

Question 8, p. 13
An initial analysis of the critical speed of the cylindrical, steel lead screw for a proposed linear positioning system is to be performed using the equation given below.

\[
\text{Critical speed (rad/s)} = \frac{215 \sqrt{g_c EI}}{L^2 \sqrt{\rho A}}
\]

where:

- \( L \) = length of lead screw
- \( E \) = modulus of elasticity
- \( I \) = area moment of inertia
- \( \rho \) = density
- \( A \) = cross-sectional area
- \( g_c \) = acceleration of gravity

Other Data:

- Length of lead screw: 48 in.
- Root diameter of lead screw: 0.84 in.
- Young's modulus of steel: 30,000,000 psi
- Density of steel: 490 lb/ft³
- \( g_c \): 386 in./s²

The critical speed (rad/s) of the lead screw is most nearly:

- A. 1,150
- B. 3,950
- C. 91,250
- D. 190,000
Question 28, p. 26
The second line should read:

If this is used in an application where the vertical load is 1,000 lb, the shear stress (psi) in the adhesive would be most nearly:

Question 36, p. 30

Question 56, p. 41
The first line should read:

A machine element 10 m long with a cross section 100 mm × 150 mm is loaded in compression as shown in the top figure.

Question 62, p. 44
A single-row ball bearing is subjected to a radial load of 75 lb (with no axial load), has a catalog-rated life of 180,000 min, and a catalog-rated speed of 500 rpm. The radial load (lb) of the bearing when rotating at 10 rad/sec with a design life of 268,000 min is most nearly:

- A. 264
- B. 114
- C. 90
- D. 66
Question 73, p. 50

- A.  1.11
- B.  1.25
- C.  1.57
- D.  2.22

Solution Table, p. 58
28: C
56: C
71: B
73: B
Solution 28, p. 72

\[ \tau = \frac{VQ}{It} \]

\[ I = \frac{bH^3}{12} = \frac{(1)(3)^3}{12} = 2.25 \text{ in}^4 \]

\[ t = 1 \text{ in. wide} \]

\[ Q \text{ (first moment of inertia) at location of shear stress} = 1 \times 1 \times 1 = 1 \]

\[ \tau = \frac{VQ}{It} = \frac{(500 \text{ lb})(1 \text{ in}^3)}{(2.25 \text{ in}^4)(1 \text{ in.})} = 222 \text{ lb/in}^2 \]

THE CORRECT ANSWER IS: C
Solution 31, p. 74
Grade 5 rod has a yield of 81,000 lb/in²

For a 1 1/4-7 thread the tensile stress area is 0.969 in². A factor of safety of 4 is required.

\[
\left( \frac{P}{0.969} \right) = \left( \frac{81,000 \text{ lb/in}^2}{4} \right) \Rightarrow P = \left( 0.969 \text{ in}^2 \right) \left( \frac{81,000 \text{ lb/in}^2}{4} \right)
\]

\[
P = 19,622 \text{ lb}
\]

Solution 37, p. 77

\[
5.290 = 5.000 + D
\]

\[
D = 0.290
\]

Solution 42, p. 78
The last line should read:

\[
|v_c| = \frac{5}{2} = 2.5 \text{ m/s}
\]
Solution 56, p. 85
Check to see if column is "slender":

Calculate radius of gyration

\[ r = \frac{0.1 \text{ m}}{2\sqrt{3}} = 0.029 \text{ m} \]

Verify \( \frac{L}{r} > 100 \) to make sure "slender" column assumption is valid even if the length is halved by the addition of intermediate supports.

\[ \frac{L}{r} = \frac{5 \text{ m}}{0.029 \text{ m}} = 172 \quad \text{OK} \]

Check buckling at \( L = 10 \text{ m} \):

Calculate moment of inertia

\[ I = \frac{bh^3}{12} = \frac{(0.150 \text{ m})(0.100 \text{ m})^3}{12} = 1.25 \times 10^{-5} \text{ m}^4 \]

\( C = 1 \) for pinned

\[ F_{h1} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 \left( 70 \times 10^9 \text{ Pa} \right) \left( 1.25 \times 10^{-5} \text{ m}^4 \right)}{(10 \text{ m})^2} = 86,271 \text{ N} \]

Check buckling at \( L = 5 \text{ m} \):

\[ F_{h1} = \frac{\pi^2 \left( 70 \times 10^9 \text{ Pa} \right) \left( 1.25 \times 10^{-5} \text{ m}^4 \right)}{(5 \text{ m})^2} = 345,086 \text{ N} \]

Check maximum compressive load:

\[ \sigma = \frac{F}{A} \]

\[ F_{\text{compressive}} = A\sigma = (0.100 \text{ m})(0.150 \text{ m})(432 \times 10^6 \text{ N/m}^2) \]

\[ = 6,480,000 \text{ N} \]

In either case, the column fails from buckling before compression.

By adding intermediate support, failure load increases from 86,271 N to 345,086 N, or by a factor of 4:

\[ \frac{345,086 \text{ N}}{86,271 \text{ N}} = 4 \]

**THE CORRECT ANSWER IS: C**
Solution 71, p. 91
Intermediate column

$$1.5 \times 500 = \frac{\pi d^2}{4} \left[ 60 \times 10^6 - \frac{1^2}{30 \times 10^6} \cdot 3.6 \times 10^9 \times \left( \frac{4 \left( 7.07 \right)^2}{d^2 \times 4 \pi^2} \right) \right]$$

$$\frac{3,000}{\pi} = d^2 \left[ 60 \times 10^3 \right] - d^2 \left[ \frac{607.74}{d^2} \right]$$

$$\sqrt{\frac{1,562.67}{60 \times 10^3}} = d = 0.161$$

Check \((S_r)_D\) = \(\frac{2 \pi^2 E}{K^2 S_y} = \sqrt{\frac{2 \pi^2 \left( 30 \times 10^6 \right)}{1^2 \left( 60 \times 10^3 \right)}} = 99.34$$

\(S_r = \frac{2(7.07)}{0.161} = 87\)

\(S_r < (S_r)_D\); hence, intermediate column

Compression strength = \(\frac{500}{\pi \left( \frac{d^2}{4} \right)} = 30,000\) psi

\(\sqrt{\frac{2,000}{\pi \left( 30,000 \right)}} = d \quad d = 0.145\) required

Compression governs diameter.

0.146

Check compressive stress required diameter.

Yield factor of safety = 2.0

\(P = \sigma A\)

\((500)(2) = (60,000 \pi d^2)/4\)

1,000 = 47,124 \(d^2\)

\(d = 0.146\) in.

The correct answer is: B
Solution 73, p. 92

Compressive Yield:

\[ \sigma_y = \frac{36,500 \text{ lbf}}{\text{in}^2} \]

\[ F = 35,620 \text{ lb} \]

\[ \sigma = \frac{F}{A} \quad A = \frac{F}{\sigma_y} = 0.97 \quad r = \frac{\sqrt{A}}{\pi} = 0.55 \]

\[ d = 1.11 \text{ in.} \]

\[ 1.57 > 1.11 \]

**THE CORRECT ANSWER IS:** B
Solution 76, p. 93

\[ \phi = 80^\circ = 1.4 \text{ rad} \]

\[ \mu' = \frac{\mu \left( \frac{4 \sin \phi}{\phi} \right)}{\phi + \sin \phi} = 0.864 \]