POSTAL Book Package 2023

GATE • PSUs

PRODUCTION AND INDUSTRIAL ENGINEERING

Objective Practice Sets

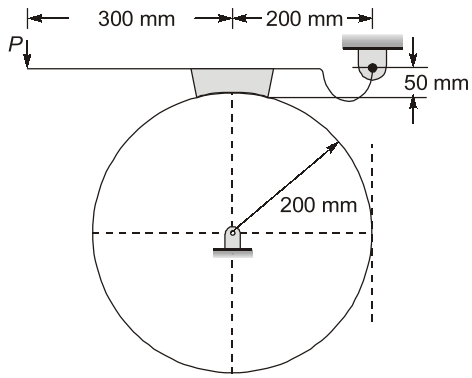
General Engineering : Volume III

Machine Design

MADE EASY Publications

Machine Design

Q.1 A single block brake with a torque capacity of 250 Nm is shown in figure. The brake drum rotates at 100 rpm and the friction coefficient is 0.35. The hinge-pin reaction for clockwise rotation of the drum is



(a) 2373.66 N (b) 2589.53 N
(c) 3216.82 N (d) 3728.88 N

Q.2 A compressive force P is applied to a column. The minimum slenderness ratio for which the buckling is considered as the design criteria is _____.
Use: Critical strength for the material = 350 MPa, Young's modulus = 210 GPa.

Q.3 A solid shaft is subjected to a torque of 22 kNm. What will be the diameter of the shaft if the allowable shear stress is 64 MPa and allowable twist is 1° for 2.2 m length of shaft? Use G = 98 GPa
(a) 60 mm (b) 120 mm
(c) 270 mm (d) 130 mm

Q.4 Which of the following is not type of failure in rivet design?
(a) Shear failure of the rivet.
(b) Shear failure of the plate between two consecutive rivets.
(c) Shear failure of the plate in the margin area.
(d) Tearing of the plate in the margin area.

Q.5 The longitudinal joint in a boiler shell is usually
(a) butt joint
(b) lap joint
(c) double strap butt joint
(d) single strap butt joint

Q.6 For an anti friction bearing normal life is 14282 hour at some load, the life of the same bearing at the same load for 40% reliability is
(a) 14282 hour (b) 28162 hour
(c) 48126 hour (d) 54986 hour

Q.7 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:
List-I
A. Boundary lubricated bearing
B. Ball and roller bearing
C. Hydrostatic lubrication
D. Hydrodynamic lubrication
List-II
1. Thick film lubrication
2. Thin film bearing
3. Antifriction bearing
4. Starting friction is low
Codes:

	A	B	C	D
(a)	2	3	1	4
(b)	3	2	1	4
(c)	2	3	4	1
(d)	3	2	4	1

Q.8 A disk brake has to be applied on wheel of a motorcycle. Outer diameter of brake pads is 300 mm. Brake pad makes an angle of 80° with the center of rotation of wheels and have an area of 8460 mm^2. What is the inner diameter of brake pad?
(a) 203.8 mm (b) 201.9 mm
(c) 101.9 mm (d) Insufficient data

Q.9 An electric motor weighing 10 kN is lifted by means of an eye bolt. The eyebolt is screwed in

Q.85 A thin cylinder of 100 mm internal diameter and 5 mm thickness is subjected to an internal pressure of 10 MPa and a torque of 2000 Nm. Calculate the magnitudes of the principal stresses.

(a) 1098, 45.2 (b) 1098, 40.2
(c) 1098, 31 (d) 1098, 50

Q.86 A thin cylinder of inner radius 500 mm and thickness 10 mm subjected to an internal pressure of 5 MPa. The average circumferential (hoop) stress in MPa is

(a) 100 (b) 250
(c) 500 (d) 1000

Q.87 A cylindrical tank with closed ends is filled with compressed air at a pressure of 500 kPa. The inner radius of the tank is 2 m, and it has wall thickness of 10 mm. The magnitude of maximum in-plane shear stress (in MPa) is _____.

Q.88 A thin cylindrical pressure vessel with closed-ends is subjected to internal pressure. The ratio of circumferential (hoop) stress to the longitudinal stress is

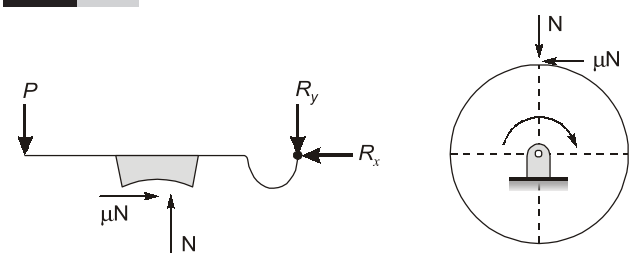
(a) 0.25 (b) 0.50
(c) 1.0 (d) 2.0

Answers Machine Design

1. (b)	**2.** (76.95)	**3.** (d)	**4.** (b)	**5.** (c)	**6.** (d)	**7.** (c)	**8.** (a)
9. (17.27)	**10.** (693.36)	**11.** (14.54)	**12.** (a)	**13.** (d)	**14.** (576.47)	**15.** (317.73)	**16.** (a)
17. (c)	**18.** (c)	**19.** (d)	**20.** (c)	**21.** (a)	**22.** (a)	**23.** (b)	**24.** (b)
25. (b)	**26.** (d)	**27.** (b)	**28.** (c)	**29.** (d)	**30.** (c)	**31.** (b)	**32.** (a)
33. (d)	**34.** (d)	**35.** (d)	**36.** (b)	**37.** (c)	**38.** (a)	**39.** (a)	**40.** (b)
41. (a)	**42.** (c)	**43.** (c)	**44.** (a)	**45.** (b)	**46.** (b)	**47.** (d)	**48.** (a)
49. (a)	**50.** (d)	**51.** (d)	**52.** (b)	**53.** (a)	**54.** (a)	**55.** (b)	**56.** (a)
57. (b)	**58.** (b)	**59.** (b)	**60.** (c)	**61.** (c)	**62.** (b)	**63.** (c)	**64.** (c)
65. (d)	**66.** (a)	**67.** (c)	**68.** (b)	**69.** (b)	**70.** (1839.83)	**71.** (b)	**72.** (c)
73. (b)	**74.** (512)	**75.** (a)	**76.** (b)	**77.** (b)	**78.** (c)	**79.** (b)	**80.** (30)
81. (b)	**82.** (b)	**83.** (64 Nm)	**87.** (2.2482)	**85.** (1098, 40.2)		**86.** (b)	**87.** (25)
88. (d)							

Explanations Machine Design

1. (b)



The free body diagram from clockwise rotation of drum is shown above.

Now, $N = \dfrac{M_t}{\mu R} = \dfrac{250 \times 10^3}{0.35 \times 200}$

$= 3571.43$ N

Taking moment about hinge point

$\mu N(50) + P(500) - N(200) = 0$

$\therefore \quad P = 1303.57$ N

Now, $R_x = \mu N$

$= 0.35 \times 3571.43 = 1250$ N

and, $R_y = N - P$

$= 3571.43 - 1303.57$

$= 2267.86$ N

$\therefore \quad R = \sqrt{R_x^2 + R_y^2}$

$$= \sqrt{(1250)^2 + (2267.86)^2}$$
$$= 2589.53\ \text{N}$$

2. (76.95)

For failure to happen by buckling

$(P_{critical})_{buckling} < (P_{critical})_{compression}$

$$\frac{\pi^2 EA}{\lambda^2} < \sigma_c \times A$$

$$\lambda > \pi\sqrt{\frac{E}{\sigma_c}}$$

$$\lambda > 76.95$$

So, $(\lambda_{min}) = 76.95$

3. (d)

$$T = 22 \times 10^3\ \text{Nm}$$
$$\tau_{allowable} = 64\ \text{MPa}$$
$$\theta_{allowable} = 1^\circ \text{ per } 2.2\ \text{m length}$$

Using $T = \left(\frac{\pi}{16}d^3\right) \times \tau_{allowable}$

$$\Rightarrow \quad d = \sqrt[3]{\frac{16T}{\pi\tau_{allowable}}}$$

$$d = \sqrt[3]{\frac{16 \times 22 \times 10^3}{\pi \times 64 \times 10^6}} = 0.120\ \text{m}$$

$$d = 120\ \text{mm} \qquad ...(1)$$

Using $\frac{T}{J} = \frac{G\theta}{L}$

$$\frac{22 \times 10^3}{\frac{\pi}{32} \times d^4} = \frac{98 \times 10^9 \times 1 \times \frac{\pi}{180}}{2.2}$$

$$d = 0.130 \text{ or } 130\ \text{mm} \qquad ...(2)$$

Hence, allowable minimum diameter is 130 mm.

4. (b)

Tensile failure of the plate between two consecutive rivets.

6. (d)

Given: $L_{10} = 14282$ hour

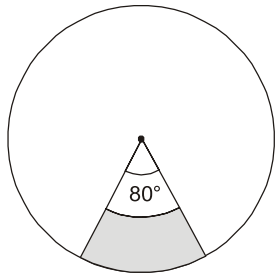
We know that

$$\frac{L_R}{L_{10}} = \left[\frac{\log_e\left(\frac{1}{R}\right)}{\log_e\left(\frac{1}{0.90}\right)}\right]^{1/1.17}$$

$$\frac{L_{40}}{L_{90}} = \frac{L_{60}}{L_{90}} = \left[\frac{\log_e\left(\frac{1}{0.60}\right)}{\log_e\left(\frac{1}{0.90}\right)}\right]^{1/1.17}$$

$$= 3.85$$
$$L_{40} = 3.85 \times 14282$$
$$= 54985.7\ \text{hour} \simeq 54986\ \text{hour}$$

8. (a)



In general, $A = \frac{2\pi}{8}\left(D_0^2 - D_i^2\right)$

$$A = \frac{\pi}{4}\left(D_0^2 - D_i^2\right)$$
$$= \frac{360}{8}\left(D_0{}^2 - D_i^2\right)$$

$$\Rightarrow \quad A = \frac{\theta}{8}\left(D_0^2 - D_i^2\right)$$

$$8460 = \frac{80^\circ \times \frac{\pi}{180^\circ}}{8}\left(300^2 - D_i^2\right)$$

$$D_i = 203.8\ \text{mm}$$

9. (17.27)

Permissible tensile stress,

$$\sigma_t = \frac{S_{yt}}{(f_s)} = \frac{400}{6} = 66.67\ \text{MPa}$$

$$\sigma_t = \frac{P}{(\pi/4)d^2}$$

$$66.67 = \frac{10 \times 10^3}{\pi/4(d_c)^2}$$

$$d_c = 13.82\ \text{mm}$$

$$d = \frac{d_c}{0.8} = \mathbf{17.27\ mm}$$

10. (693.36)

For roller bearing

$$L = \left(\frac{C}{P}\right)^{10/3}$$