

Design the joint assuming the permissible tensile stress in the strap as 30 MPa and permissible shear stress in the cotter and gib as 20 MPa.

[Ans. $B_1 = 50 \text{ mm}$; $t = 15 \text{ mm}$; $t_1 = 15 \text{ mm}$; $t_2 = 22 \text{ mm}$; $B = 70 \text{ mm}$]

5. Design a cotter joint to connect a piston rod to the crosshead. The maximum steam pressure in the piston rod is 35 kN. Assuming that all the parts are made of the same material having the following permissible stresses:

$$\sigma_t = 50 \text{ MPa}; \tau = 60 \text{ MPa} \text{ and } \sigma_c = 90 \text{ MPa}.$$

6. Design and draw a cotter foundation bolt to take a load of 90 kN. Assume the permissible stresses as follows:

$$\sigma_t = 50 \text{ MPa}, \tau = 60 \text{ MPa} \text{ and } \sigma_c = 100 \text{ MPa}.$$

7. Design a knuckle joint to connect two mild steel bars under a tensile load of 25 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.

[Ans. $d = d_1 = 23 \text{ mm}$; $d_2 = 46 \text{ mm}$; $d_3 = 35 \text{ mm}$; $t = 29 \text{ mm}$; $t_1 = 18 \text{ mm}$]

8. A knuckle joint is required to withstand a tensile load of 25 kN. Design the joint if the permissible stresses are:

$$\sigma_t = 56 \text{ MPa}; \tau = 40 \text{ MPa} \text{ and } \sigma_c = 70 \text{ MPa}.$$

9. The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively. Draw full size two suitable views of the joint.

[Ans. $d = 36 \text{ mm}$; $t = 11 \text{ mm}$; $D = 45 \text{ mm}$; $D_1 = 39 \text{ mm}$]

QUESTIONS

- What is a cotter joint? Explain with the help of a neat sketch, how a cotter joint is made?
- What are the applications of a cotter joint?
- Discuss the design procedure of spigot and socket cotter joint.
- Why gibs are used in a cotter joint? Explain with the help of a neat sketch the use of single and double gib.
- Describe the design procedure of a gib and cotter joint.
- Distinguish between cotter joint and knuckle joint.
- Sketch two views of a knuckle joint and write the equations showing the strength of joint for the probable modes of failure.
- Explain the purpose of a turn buckle. Describe its design procedure.

OBJECTIVE TYPE QUESTIONS

- A cotter joint is used to transmit
 - axial tensile load only
 - combined axial and twisting loads
 - combined axial and compressive loads
 - axial tensile or compressive loads
- The taper on cotter varies from
 - 1 in 15 to 1 in 10
 - 1 in 32 to 1 in 24
 - 1 in 24 to 1 in 20
 - 1 in 48 to 1 in 24

b. Which of the following cotter joint is used to connect strap end of a connecting rod?

(a) Socket and spigot cotter joint

(b) Sleeve and cotter joint

(c) Gib and cotter joint

(d) none of these

4. In designing a sleeve and cotter joint, the outside diameter of the sleeve is taken as

(a) $1.5 d$

(b) $2.5 d$

(c) $3 d$

(d) $4 d$

where d = Diameter of the rod.

5. The length of cotter, in a sleeve and cotter joint, is taken as

(a) $1.5 d$

(b) $2.5 d$

(c) $3 d$

(d) $4 d$

6. In a gib and cotter joint, the thickness of gib is thickness of cotter.

(a) more than

(b) less than

(c) equal to

7. When one gib is used in a gib and cotter joint, then the width of gib should be taken as

(a) $0.45 B$

(b) $0.55 B$

(c) $0.65 B$

(d) $0.75 B$

where B = Total width of gib and cotter.

8. In a steam engine, the piston rod is usually connected to the crosshead by means of a

(a) knuckle joint

(b) universal joint

(c) flange coupling

(d) cotter joint

9. In a steam engine, the valve rod is connected to an eccentric by means of a

(a) knuckle joint

(b) universal joint

(c) flange coupling

(d) cotter joint

10. In a turn buckle; if one of the rods has left hand threads, then the other rod will have

(a) right hand threads

(b) left hand threads

(c) pointed threads

(d) multiple threads

ANSWERS

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|--------|--------|--------|--------|---------|
| 1. (d) | 2. (d) | 3. (c) | 4. (b) | 5. (d) |
| 6. (c) | 7. (b) | 8. (d) | 9. (a) | 10. (a) |

OBJECTIVE TYPE QUESTIONS

- 1.** A spring used to absorb shocks and vibrations is
 (a) closely-coiled helical spring
 (c) conical spring
- 2.** The spring mostly used in gramophones is
 (a) helical spring
 (c) laminated spring
- 3.** Which of the following spring is used in a mechanical wrist watch?
 (a) Helical compression spring
 (c) Torsion spring
- 4.** When a helical compression spring is subjected to an axial compressive load, the stress induced in wire is
 (a) tensile stress
 (c) shear stress
- 5.** In a close coiled helical spring, the spring index is given by D/d where D and d are the outer diameter and wire diameter respectively. For considering the effect of curvature, the factor K is given by
- (a) $\frac{4C - 1}{4C + 4} + \frac{0.615}{C}$
- (b) $\frac{4C - 1}{4C - 4} + \frac{0.615}{C}$
- (c) $\frac{4C + 1}{4C - 4} - \frac{0.615}{C}$
- (d) $\frac{4C + 1}{4C + 4} - \frac{0.615}{C}$
- 6.** When helical compression spring is cut into halves, the stiffness of the resulting spring will
 (a) same
 (c) one-half
- 7.** Two close coiled helical springs with stiffness k_1 and k_2 respectively are connected in series. Stiffness of an equivalent spring is given by
- (a) $\frac{k_1 \cdot k_2}{k_1 + k_2}$
- (b) $\frac{k_1 - k_2}{k_1 + k_2}$
- (c) $\frac{k_1 + k_2}{k_1 \cdot k_2}$
- (d) $\frac{k_1 - k_2}{k_1 \cdot k_2}$
- 8.** When two concentric coil springs made of the same material, having same length and compressed equally by an axial load, the load shared by the two springs will be to the square of the diameters of the wires of the two springs.
 (a) directly proportional
 (c) equal to
- 9.** A leaf spring in automobiles is used
 (a) to apply forces
 (c) to absorb shocks
- 10.** In leaf springs, the longest leaf is known as
 (a) lower leaf
 (c) upper leaf

ANSWERS

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|---------------|---------------|---------------|---------------|----------------|
| 1. (e) | 2. (d) | 3. (c) | 4. (c) | 5. (b) |
| 6. (b) | 7. (a) | 8. (a) | 9. (c) | 10. (b) |

QUESTIONS

1. What is the pressure vessel?
2. Make out a systematic classification of pressure vessels and discuss the role of statutory regulations.
3. How do you distinguish between a thick and thin cylinder?
4. What are the important points to be considered while designing a pressure vessel?
5. Distinguish between circumferential stress and longitudinal stress in a cylindrical shell, when subjected to an internal pressure.
6. Show that in case of a thin cylindrical shell subjected to an internal fluid pressure, the tendency to burst lengthwise is twice as great as at a transverse section.
7. When a thin cylinder is subjected to an internal pressure p , the tangential stress should be the criterion for determining the cylinder wall thickness. Explain.
8. Derive a formula for the thickness of a thin spherical tank subjected to an internal fluid pressure.
9. Compare the stress distribution in a thin and thick walled pressure vessels.
10. When the wall thickness of a pressure vessel is relatively large, the usual assumptions valid in thin cylinders do not hold good for its analysis. Enumerate the important violations. List any two theories suggested for the analysis of thick cylinders.
11. Discuss the design procedure for pressure vessels subjected to higher external pressure.
12. Explain the various types of ends used for pressure vessel giving practical applications of each.

OBJECTIVE TYPE QUESTIONS

1. A pressure vessel is said to be a thin cylindrical shell, if the ratio of the wall thickness of the shell to its diameter is
 - equal to 1/10
 - less than 1/10
 - more than 1/10
 - none of these
2. In case of pressure vessels having open ends, the fluid pressure induces
 - longitudinal stress
 - circumferential stress
 - shear stress
 - none of these
3. The longitudinal stress is of the circumferential stress.
 - one-half
 - two-third
 - three-fourth
4. The design of the pressure vessel is based on
 - longitudinal stress
 - hoop stress
 - longitudinal and hoop stress
 - none of these
5. A thin spherical shell of internal diameter d is subjected to an internal pressure p . If σ_t is the tensile stress for the shell material, then thickness of the shell (t) is equal to
 - $\frac{p d}{\sigma_t}$
 - $\frac{p d}{2 \sigma_t}$
 - $\frac{p d}{3 \sigma_t}$
 - $\frac{p d}{4 \sigma_t}$

$$(a) \frac{p d}{\sigma_t}$$

$$(b) \frac{p d}{2 \sigma_t}$$

$$(c) \frac{p d}{3 \sigma_t}$$

$$(d) \frac{p d}{4 \sigma_t}$$

How the piston rod is designed?

What is the design procedure of valve push rods?

Why an I-Section is usually preferred to a round section in case of connecting rods?

OBJECTIVE TYPE QUESTIONS

1. A machine part is designed as a strut, when it is subjected to
 - an axial tensile force
 - a tangential force
 - any one of these
2. Slenderness ratio is the ratio of
 - maximum size of a column to minimum size of column
 - width of column to depth of column
 - effective length of column to least radius of gyration of the column
 - effective length of column to width of column
3. Connecting rod is designed as a
 - long column
 - short column
 - strut
 - any one of these
4. Which of the following formula is used in designing a connecting rod?
 - Euler's formula
 - Rankine's formula
 - Johnson's straight line formula
 - Johnson's parabolic formula
5. Connecting rod subjected to an axial load may buckle with
 - X-axis as neutral axis
 - Y-axis as neutral axis
 - X-axis or Y-axis as neutral axis
 - Z-axis
6. In designing a connecting rod, it is considered like for buckling about X-axis.
 - both ends hinged
 - both ends fixed
 - one end fixed and the other end hinged
 - one end fixed and the other end free
7. Connecting rod should be
 - strong in buckling about X-axis
 - strong in buckling about Y-axis
 - equally strong in buckling about X-axis and Y-axis
 - any one of the above
8. The buckling will occur about Y-axis, if
 - $I_{xx} = I_{yy}$
 - $I_{xx} > 4I_{yy}$
 - $I_{xx} < 4I_{yy}$
9. The connecting rod will be equally strong in buckling about X-axis and Y-axis, if
 - $I_{xx} = I_{yy}$
 - $I_{xx} = 2I_{yy}$
 - $I_{xx} = 4I_{yy}$
10. The most suitable section for the connecting rod is
 - L-section
 - T-section
 - C-section

ANSWERS

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|--------|--------|--------|--------|---------|
| 1. (b) | 2. (c) | 3. (c) | 4. (b) | 5. (c) |
| 6. (a) | 7. (c) | 8. (c) | 9. (d) | 10. (c) |

3. Steel containing upto 0.15% carbon is known as
 (a) mild steel
 (c) medium carbon steel
4. According to Indian standard specifications, a plain carbon steel designated by 40 Cr has
 (a) carbon content is 0.04 per cent and manganese is 0.08 per cent
 (b) carbon content is 0.4 per cent and manganese is 0.8 per cent
 (c) carbon content is 0.35 to 0.45 per cent and manganese is 0.60 to 0.90 per cent
 (d) carbon content is 0.60 to 0.80 per cent and manganese is 0.8 to 1.2 per cent
5. The material commonly used for machine tool bodies is
 (a) mild steel
 (c) brass
6. The material commonly used for crane hooks is
 (a) cast iron
 (c) mild steel
7. Shock resistance of steel is increased by adding
 (a) nickel
 (c) nickel and chromium
8. The steel widely used for motor car crankshafts is
 (a) nickel steel
 (c) nickel-chrome steel
9. A steel with 0.8 per cent carbon is known as
 (a) eutectoid steel
 (c) hypoeutectoid steel
10. 18/8 steel contains
 (a) 18 per cent nickel and 8 per cent chromium
 (b) 18 per cent chromium and 8 per cent nickel
 (c) 18 per cent nickel and 8 per cent vanadium
 (d) 18 per cent vanadium and 8 per cent nickel
11. Ball bearing are usually made from
 (a) low carbon steel
 (c) medium carbon steel
12. The process which improves the machinability of steels, but lower the hardness and wear resistance is
 (a) normalising
 (c) process annealing
13. The metal suitable for bearings subjected to heavy loads is
 (a) silicon bronze
 (c) monel metal
14. The metal suitable for bearings subjected to light loads is
 (a) silicon bronze
 (c) monel metal
15. Thermoplastic materials are those materials which
 (a) are formed into shape under heat and pressure and results in a permanently hardened condition
 (b) do not become hard with the application of heat and pressure and no chemical change
 (c) are flexible and can withstand considerable wear under suitable conditions
 (d) are used as a friction lining for clutches and brakes

ANSWERS

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|---------|---------|---------|---------|
| 1. (a) | 2. (e) | 3. (b) | 4. (c) |
| 6. (b) | 7. (c) | 8. (b) | 9. (a) |
| 11. (c) | 12. (d) | 13. (b) | 14. (d) |

ANSWERS

- 1.** (b) **2.** (a) **3.** (d) **4.** (b) **5.** (b)
6. (c) **7.** (b) **8.** (a) **9.** (b) **10.** (c)
11. (b) **12.** (b) **13.** (c) **14.** (b) **15.** (d)

9. Two shafts under pure torsion are of identical length and identical weight and are made of same material. The shaft *A* is solid and the shaft *B* is hollow. We can say that
 (a) shaft *B* is better than shaft *A*
 (b) shaft *A* is better than shaft *B*
 (c) both the shafts are equally good
10. A solid shaft transmits a torque *T*. The allowable shear stress is τ . The diameter of the shaft is
 (a) $\sqrt[3]{\frac{16T}{\pi\tau}}$
 (b) $\sqrt[3]{\frac{32T}{\pi\tau}}$
 (c) $\sqrt[3]{\frac{64T}{\pi\tau}}$
 (d) $\sqrt[3]{\frac{16T}{\tau}}$
11. When a machine member is subjected to a tensile stress (σ_t) due to direct load or bending stress (τ) due to torsion, then the maximum shear stress induced in the member will be
 (a) $\frac{1}{2} \left[\sqrt{(\sigma_t)^2 + 4\tau^2} \right]$
 (b) $\frac{1}{2} \left[\sqrt{(\sigma_t)^2 - 4\tau^2} \right]$
 (c) $\left[\sqrt{(\sigma_t)^2 + 4\tau^2} \right]$
 (d) $(\sigma_t)^2 + 4\tau^2$
12. Rankine's theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) elastic materials
 (d) plastic materials
13. Guest's theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) elastic materials
 (d) plastic materials
14. At the neutral axis of a beam, the shear stress is
 (a) zero
 (b) maximum
 (c) minimum
15. The maximum shear stress developed in a beam of rectangular section is the maximum compressive stress.
 (a) equal to
 (b) $\frac{4}{3}$ times
 (c) 1.5 times

ANSWERS

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|---------|---------|---------|---------|---------|
| 1. (b) | 2. (a) | 3. (a) | 4. (d) | 5. (b) |
| 6. (c) | 7. (c) | 8. (a) | 9. (a) | 10. (a) |
| 11. (a) | 12. (a) | 13. (b) | 14. (b) | 15. (c) |

ANSWERS

1. (c) 2. (d) 3. (d) 4. (d) 5. (a)
6. (c) 7. (c) 8. (c) 9. (c) 10. (a)
11. (d) 12. (c) 13. (a) 14. (b) 15. (b)

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■ The temperature at which the new grains are formed in the metal is called

 3. The temperature at which the new grains are formed in the metal is called
 - (a) lower critical temperature
 - (c) eutectic temperature
 4. The hot working of metals is carried out
 - (a) at the recrystallisation temperature
 - (c) above the recrystallisation temperature
 5. During hot working of metals
 - (a) porosity of the metal is largely eliminated
 - (b) grain structure of the metal is refined
 - (c) mechanical properties are improved due to refinement of grains
 - (d) all of the above
 6. The parts of circular cross-section which are symmetrical about the axis of rotation are
 - (a) hot forging
 - (c) hot extrusion
 - (b) hot spinning
 - (d) hot drawing
 7. The cold working of metals is carried out the recrystallisation temperature
 - (a) above
 - (b) below
 8. The process extensively used for making bolts and nuts is
 - (a) hot piercing
 - (c) cold peening
 - (b) extrusion
 - (d) cold heading
 9. In a unilateral system of tolerance, the tolerance is allowed on
 - (a) one side of the actual size
 - (c) both sides of the actual size
 - (b) one side of the nominal size
 - (d) both sides of the nominal size
 10. The algebraic difference between the maximum limit and the basic size is called
 - (a) actual deviation
 - (c) lower deviation
 - (b) upper deviation
 - (d) fundamental deviation
 11. A basic shaft is one whose
 - (a) lower deviation is zero
 - (c) lower and upper deviations are zero
 - (b) upper deviation is zero
 - (d) none of these
 12. A basic hole is one whose
 - (a) lower deviation is zero
 - (c) lower and upper deviations are zero
 - (b) upper deviation is zero
 - (d) none of these
 13. According to Indian standard specifications, 100 H 6 / g 5 means that the
 - (a) actual size is 100 mm
 - (b) basic size is 100 mm
 - (c) difference between the actual size and basic size is 100 mm
 - (d) none of the above
 14. According to Indian standards, total number of tolerance grades are
 - (a) 8
 - (c) 18
 - (b) 12
 - (d) 20
 15. According to Indian standard specification, 100 H 6 / g 5 means that
 - (a) tolerance grade for the hole is 6 and for the shaft is 5
 - (b) tolerance grade for the shaft is 6 and for the hole is 5
 - (c) tolerance grade for the shaft is 4 to 8 and for the hole is 3 to 7
 - (d) tolerance grade for the hole is 4 to 8 and for the shaft is 3 to 7

ANSWERS

- | ANSWERS | |
|---------|---------|
| 1. (c) | 2. (d) |
| 6. (b) | 7. (b) |
| 11. (b) | 12. (a) |
| | 13. (b) |
| | 14. (c) |
| 3. (d) | 4. (c) |
| 8. (d) | 9. (b) |

3. Prove the relation: $M/I = \sigma/y = E/R$
where M = Bending moment, I = Moment of inertia, σ = Bending stress in a fibre at a distance y from the neutral axis, E = Young's modulus; and R = Radius of curvature.
4. Write the relations used for maximum stress when a machine member is subjected to tensile or compressive stresses along with shearing stresses.
5. Write short note on maximum shear stress theory *versus* maximum strain energy theory.
6. Distinguish clearly between direct stress and bending stress.
7. What is meant by eccentric loading and eccentricity?
8. Obtain a relation for the maximum and minimum stresses at the base of a symmetrical column, when it is subjected to
 - (a) an eccentric load about one axis, and (b) an eccentric load about two axes.

OBJECTIVE TYPE QUESTIONS

1. When a machine member is subjected to torsion, the torsional shear stress set up in the member is
 - (a) zero at both the centroidal axis and outer surface of the member
 - (b) Maximum at both the centroidal axis and outer surface of the member
 - (c) zero at the centroidal axis and maximum at the outer surface of the member
 - (d) none of the above
2. The torsional shear stress on any cross-section normal to the axis is the distance from the centre of the axis.
 - (a) directly proportional to
 - (b) inversely proportional to
3. The neutral axis of a beam is subjected to
 - (a) zero stress
 - (b) maximum tensile stress
 - (c) maximum compressive stress
 - (d) maximum shear stress
4. At the neutral axis of a beam,
 - (a) the layers are subjected to maximum bending stress
 - (b) the layers are subjected to tension
 - (c) the layers do not undergo any strain
 - (d) the layers are subjected to compression
5. The bending stress in a curved beam is
 - (a) zero at the centroidal axis
 - (b) zero at the point other than centroidal axis
 - (c) maximum at the neutral axis
 - (d) none of the above
6. The maximum bending stress, in a curved beam having symmetrical section, always occur, at the
 - (a) centroidal axis
 - (b) neutral axis
 - (c) inside fibre
 - (d) outside fibre
7. If d = diameter of solid shaft and τ = permissible stress in shear for the shaft material, then torsional strength of shaft is written as
 - (a) $\frac{\pi}{32} d^3 \tau$
 - (b) $d \log_e \tau$
 - (c) $\frac{\pi}{16} d^3 \tau$
 - (d) $\frac{\pi}{32} d^3 \tau$

8. If d_o and d_i are the inner and outer diameters of a hollow shaft, then its polar moment of inertia is
 - (a) $\frac{\pi}{32} [(d_o)^4 - (d_i)^4]$
 - (b) $\frac{\pi}{32} [(d_o)^3 - (d_i)^3]$
 - (c) $\frac{\pi}{32} [(d_o)^2 - (d_i)^2]$
 - (d) $\frac{\pi}{32} (d_o - d_i)$

OBJECTIVE TYPE QUESTIONS

ANSWERS

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|---------------|----------------|----------------|
| 1. (b) | ANSWERS | 5. (b) |
| 6. (c) | 2. (d) | 7. (d) |
| | 3. (d) | 8. (b) |
| | 4. (b) | 9. (c) |
| | | 10. (x) |

4. In transverse fillet welded joint, the size of weld is equal to
 (a) $0.5 \times$ Throat of weld
 (c) $\sqrt{2} \times$ Throat of weld
 (b) Throat of weld
 (d) $2 \times$ Throat of weld

5. The transverse fillet welded joints are designed for
 (a) tensile strength
 (c) bending strength
 (b) compressive strength
 (d) shear strength

6. The parallel fillet welded joint is designed for
 (a) tensile strength
 (c) bending strength
 (b) compressive strength
 (d) shear strength

7. The size of the weld in butt welded joint is equal to
 (a) $0.5 \times$ Throat of weld
 (c) $\sqrt{2} \times$ Throat of weld
 (b) Throat of weld
 (d) $2 \times$ Throat of weld

8. A double fillet welded joint with parallel fillet weld of length l and leg s is subjected to a tensile force P . Assuming uniform stress distribution, the shear stress in the weld is given by
 (a) $\frac{\sqrt{2} P}{s l}$
 (b) $\frac{P}{2 s l}$
 (c) $\frac{P}{\sqrt{2} s l}$
 (d) $\frac{2 P}{s l}$

9. When a circular rod welded to a rigid plate by a circular fillet weld is subjected to a twisting moment T , then the maximum shear stress is given by
 (a) $\frac{2.83 T}{\pi s d^2}$
 (b) $\frac{4.242 T}{\pi s d^2}$
 (c) $\frac{5.66 T}{\pi s d^2}$
 (d) none of these

10. For a parallel load on a fillet weld of equal legs, the plane of maximum shear occurs at
 (a) 22.5°
 (c) 45°
 (b) 30°
 (d) 60°

ANSWERS

- 1.** (a) **2.** (b) **3.** (d) **4.** (c) **5.** (d)
6. (d) **7.** (b) **8.** (c) **9.** (a) **10.** (c)

8. Two shafts under pure torsion are of identical length and identical weight per unit length. The shaft A is solid and the shaft B is hollow. We can say that
 (a) shaft B is better than shaft A
 (b) shaft A is better than shaft B
 (c) both the shafts are equally good
9. A solid shaft transmits a torque T . The allowable shear stress is τ . The diameter of the shaft is
 (a) $\sqrt{\frac{16T}{\pi\tau}}$
 (b) $\sqrt[3]{\frac{32T}{\pi\tau}}$
 (c) $\sqrt[3]{\frac{64T}{\pi\tau}}$
 (d) $\sqrt[3]{\frac{16T}{\tau}}$
10. When a machine member is subjected to a tensile stress (σ_t) due to direct loading and shear stress (τ) due to torsion, then the maximum shear stress induced in the member is
 (a) $\frac{1}{2} \left[\sqrt{(\sigma_t)^2 + 4\tau^2} \right]$
 (b) $\frac{1}{2} \left[\sqrt{(\sigma_t)^2 - 4\tau^2} \right]$
 (c) $\left[\sqrt{(\sigma_t)^2 + 4\tau^2} \right]$
 (d) $(\sigma_t)^2 + 4\tau^2$
11. Rankine's theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) elastic materials
 (d) plastic materials
12. Guest's theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) elastic materials
 (d) plastic materials
13. At the neutral axis of a beam, the shear stress is
 (a) zero
 (b) maximum
 (c) minimum
14. The maximum shear stress developed in a beam of rectangular section is —
 (a) equal to zero
 (b) maximum
 (c) minimum
15. The maximum shear stress developed in a beam of rectangular section is —
 (a) equal to zero
 (b) $\frac{4}{3}$ times

ANSWERS

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|---------|---------|---------|---------|
| 1. (b) | 2. (a) | 3. (a) | 4. (d) |
| 5. (c) | 6. (c) | 7. (c) | 8. (a) |
| 9. (a) | 10. (a) | 11. (a) | 12. (a) |
| 13. (b) | 14. (b) | 15. (b) | 16. (b) |

5. A transmission shaft subjected to bending loads must be designed on the basis of
 (a) maximum normal stress theory
 (b) maximum shear stress theory
 (c) maximum normal stress and maximum shear stress theories
 (d) fatigue strength
6. Which of the following loading is considered for the design of axles ?
 (a) Bending moment only
 (b) Twisting moment only
 (c) Combined bending moment and torsion
 (d) Combined action of bending moment, twisting moment and axial thrust
7. When a shaft is subjected to a bending moment M and a twisting moment T , then the equivalent twisting moment is equal to
 (a) $M + T$
 (b) $M^2 + T^2$
 (c) $\sqrt{M^2 + T^2}$
 (d) $\sqrt{M^2 - T^2}$
8. The maximum shear stress theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) plastic materials
 (d) non-ferrous materials
9. The maximum normal stress theory is used for
 (a) brittle materials
 (b) ductile materials
 (c) plastic materials
 (d) non-ferrous materials
10. The design of shafts made of brittle materials is based on
 (a) Guest's theory
 (b) Rankine's theory
 (c) St. Venant's theory
 (d) Von Mises Theory

ANSWERS

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (c) | 4. (d) | 5. (a) |
| 6. (a) | 7. (c) | 8. (b) | 9. (a) | 10. (b) |

3. Prove the relation: $M/I = \sigma/y = E/R$
where M = Bending moment; I = Moment of inertia; σ = Bending stress in a fibre at a distance y from the neutral axis; E = Young's modulus; and R = Radius of curvature.
4. Write the relations used for maximum stress when a machine member is subjected to tensile or compressive stresses along with shearing stresses.
5. Write short note on maximum shear stress theory *versus* maximum strain energy theory.
6. Distinguish clearly between direct stress and bending stress.
7. What is meant by eccentric loading and eccentricity?
8. Obtain a relation for the maximum and minimum stresses at the base of a symmetrical column, when it is subjected to:
 - (a) an eccentric load about one axis, and (b) an eccentric load about two axes.

OBJECTIVE TYPE QUESTIONS

1. When a machine member is subjected to torsion, the torsional shear stress set up in the member is:
 - (a) zero at both the centroidal axis and outer surface of the member
 - (b) Maximum at both the centroidal axis and outer surface of the member
 - (c) zero at the centroidal axis and maximum at the outer surface of the member
 - (d) none of the above.
2. The torsional shear stress on any cross-section normal to the axis is the distance from the centre of the axis.
 - (a) directly proportional to
 - (b) inversely proportional to
3. The neutral axis of a beam is subjected to:
 - (a) zero stress
 - (b) maximum tensile stress
 - (c) maximum compressive stress
 - (d) maximum shear stress
4. At the neutral axis of a beam,
 - (a) the layers are subjected to maximum bending stress
 - (b) the layers are subjected to tension
 - (c) the layers do not undergo any strain
 - (d) the layers are subjected to compression
5. The bending stress in a curved beam is:
 - (a) zero at the centroidal axis
 - (b) zero at the point other than centroidal axis
 - (c) maximum at the neutral axis
 - (d) none of the above.
6. The maximum bending stress, in a curved beam having symmetrical section, always occur, at the:
 - (a) centroidal axis
 - (b) neutral axis
 - (c) inside fibre
 - (d) outside fibre
7. If d = diameter of solid shaft and τ = permissible stress in shear for the shaft material, then torsional strength of shaft is written as
 - (a) $\frac{\pi}{32} d^4 \tau$
 - (b) $d \log_e \tau$
 - (c) $\frac{\pi}{16} d^3 \tau$
 - (d) $\frac{\pi}{32} d^3 \tau$
8. If d_o and d_i are the inner and outer diameters of a hollow shaft, then its polar moment of inertia is
 - (a) $\frac{\pi}{32} [(d_o)^4 - (d_i)^4]$
 - (b) $\frac{\pi}{32} [(d_o)^3 - (d_i)^3]$
 - (c) $\frac{\pi}{32} [(d_o)^2 - (d_i)^2]$
 - (d) $\frac{\pi}{32} (d_o - d_i)$

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 - (c) $\frac{\pi}{32} [(d_o)^2 - (d_i)^2]$
 - (d) $\frac{\pi}{32} (d_o - d_i)$

OBJECTIVE TYPE QUESTIONS

1. The standard length of the shaft is
 - (a) 5 m
 - (b) 6 m
 - (c) 7 m
 - (d) all of these
2. Two shafts A and B are made of the same material. The diameter of the shaft A is twice as that of shaft B . The power transmitted by the shaft A will be of shaft B .
 - (a) twice
 - (b) four times
 - (c) eight times
 - (d) sixteen times
3. Two shafts A and B of solid circular cross-section are identical except for their diameters d_A and d_B . The ratio of power transmitted by the shaft A to that of shaft B is
 - (a) $\frac{d_A}{d_B}$
 - (b) $\frac{(d_A)^2}{(d_B)^2}$
 - (c) $\frac{(d_A)^3}{(d_B)^3}$
 - (d) $\frac{(d_A)^4}{(d_B)^4}$
4. Two shafts will have equal strength, if
 - (a) diameter of both the shafts is same
 - (b) angle of twist of both the shafts is same
 - (c) material of both the shafts is same
 - (d) twisting moment of both the shafts is same

3. In a turning moment diagram, the variations of energy above and below the mean resisting torque line is called

 - fluctuation of energy
 - maximum fluctuation of energy
 - coefficient of fluctuation of energy
 - none of these

4. If E = Mean kinetic energy of the flywheel, C_s = Coefficient of fluctuation of speed and ΔE = Maximum fluctuation of energy, then

 - $\Delta E = E / C_s$
 - $\Delta E = E^2 \times C_s$
 - $\Delta E = E \times C_s$
 - $\Delta E = 2 E \times C_s$

5. The ratio of the maximum fluctuation of energy to the is called coefficient of fluctuation of energy.

 - minimum fluctuation of energy
 - workdone per cycle

6. Due to the centrifugal force acting on the rim, the flywheel arms will be subjected to

 - tensile stress
 - compressive stress
 - shear stress
 - none of these

7. The tensile stress in the flywheel rim due to the centrifugal force acting on the rim is given by

 - $\frac{\rho.v^2}{4}$
 - $\frac{\rho.v^2}{2}$
 - $\frac{3\rho.v^2}{4}$
 - $\rho.v^2$

where ρ = Density of the flywheel material, and
 v = Linear velocity of the flywheel.

8. The cross-section of the flywheel arms is usually

 - elliptical
 - rectangular
 - I-section
 - L-section

9. In order to find the maximum bending moment on the arms, it is assumed as a

 - simply supported beam carrying a uniformly distributed load over the arm
 - fixed at both ends (i.e. at the hub and at the free end of the rim) and carrying a uniformly distributed load over the arm.
 - cantilever beam fixed at the hub and carrying a concentrated load at the free end of the rim
 - none of the above

10. The diameter of the hub of the flywheel is usually taken

 - equal to the diameter of the shaft
 - twice the diameter of the shaft
 - three times the diameter of the shaft
 - four times the diameter of the shaft

ANSWERS

- 1.** (b) **2.** (b) **3.** (a) **4.** (d) **5.** (b)
6. (a) **7.** (d) **8.** (a) **9.** (c) **10.** (b)

3. A chain drive using bush roller chain transmits 5.6 kW of power. The driving shaft on an electric motor runs at 1440 r.p.m. and velocity ratio is 5. The centre distance of the drive is restricted to 550 ± 2% mm and allowable pressure on the pivot joint is not to exceed 10 N/mm². The drive is required to operate continuously with periodic lubrication and driven machine is such that load can be regarded as fairly constant with jerk and impact. Design the chain drive by calculating leading dimensions, number of teeth on the sprocket and specify the breaking strength of the chain. Assume a factor of safety of 13.

QUESTIONS

1. State the advantages and disadvantages of the chain drive over belt and rope drive.
2. Explain, with the help of a neat sketch, the construction of a roller chain.
3. What do you understand by simplex, duplex and triplex chains?
4. Write in brief on
 - (a) Hoisting and hauling chains,
 - (b) Conveyor chains, and
 - (c) Silent chains.
5. Write the design procedure for a chain drive.

OBJECTIVE TYPE QUESTIONS

1. Which one of the following is a positive drive?
 - (a) Crossed flat belt drive
 - (b) Rope drive
 - (c) V-belt drive
 - (d) Chain drive
2. The chain drive transmits power as compared to belt drive.
 - (a) more
 - (b) less
3. The relation between the pitch of the chain (p) and pitch circle diameter of the sprocket (D) is given by
 - (a) $p = D \sin \left(\frac{90^\circ}{T} \right)$
 - (b) $p = D \sin \left(\frac{120^\circ}{T} \right)$
 - (c) $p = D \sin \left(\frac{180^\circ}{T} \right)$
 - (d) $p = D \sin \left(\frac{360^\circ}{T} \right)$

where T = Number of teeth on the sprocket.
4. In order to have smooth operation, the minimum number of teeth on the smaller sprocket, for moderate speeds, should be
 - (a) 15
 - (b) 17
 - (c) 21
 - (d) 25
5. The speed of the sprocket reduces as the chain pitch for a given number of teeth.
 - (a) increases
 - (b) decreases

ANSWERS

1. (d)
2. (a)
3. (c)
4. (b)
5. (a)

9. Sketch a protective type flange coupling and indicate there on its leading dimensions for of 'd'.
 10. What are flexible couplings and what are their applications ? Illustrate your answer with examples and sketches.
 11. Write short note on universal coupling.
 12. Why are two universal joints often used when there is angular misalignment between two shafts?

OBJECTIVE TYPE QUESTIONS

1. The taper on a rectangular sunk key is
 - (a) 1 in 16
 - (b) 1 in 32
 - (c) 1 in 48
 - (d) 1 in 100
2. The usual proportion for the width of key is
 - (a) $d/8$
 - (b) $d/6$
 - (c) $d/4$
 - (d) $d/2$

where d = Diameter of shaft.
3. When a pulley or other mating piece is required to slide along the shaft, a sunk key is
 - (a) rectangular
 - (b) square
 - (c) parallel
4. A key made from a cylindrical disc having segmental cross-section, is known as
 - (a) feather key
 - (b) gib head key
 - (c) woodruff key
 - (d) flat saddle key
5. A feather key is generally
 - (a) loose in shaft and tight in hub
 - (b) tight in shaft and loose in hub
 - (c) tight in both shaft and hub
 - (d) loose in both shaft and hub.
6. The type of stresses developed in the key is/are
 - (a) shear stress alone
 - (b) bearing stress alone
 - (c) both shear and bearing stresses
 - (d) shearing, bearing and bending stresses
7. For a square key made of mild steel, the shear and crushing strengths are related as
 - (a) shear strength = crushing strength
 - (b) shear strength > crushing strength
 - (c) shear strength < crushing strength
 - (d) none of the above
8. A keyway lowers
 - (a) the strength of the shaft
 - (b) the rigidity of the shaft
 - (c) both the strength and rigidity of the shaft
 - (d) the ductility of the material of the shaft
9. The sleeve or muff coupling is designed as a
 - (a) thin cylinder
 - (b) thick cylinder
 - (c) solid shaft
 - (d) hollow shaft
10. Oldham coupling is used to connect two shafts
 - (a) which are perfectly aligned
 - (b) which are not in exact alignment
 - (c) which have lateral misalignment
 - (d) whose axes intersect at a small angle

ANSWERS

- | | | | |
|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (c) | 4. (d) |
| 6. (c) | 7. (a) | 8. (c) | 5. (b) |
| 9. (d) | | | 10. (c) |

3. The diameter of a pipe carrying steam $Q \text{ m}^3/\text{min}$ at a velocity $v \text{ m/min}$ is
- $\frac{Q}{v}$
 - $\sqrt{\frac{Q}{v}}$
 - $\frac{Q}{4} \sqrt{v}$
 - $1.13 \sqrt{\frac{Q}{v}}$
4. When the internal diameter of the pipe exceeds twenty times its wall thickness, then ... critical shell formula may be applied.
- thin
 - thick
5. Which of the following joint is commonly used for joining pipes carrying water at low pressure?
- union joint
 - spigot and socket joint
 - socket or a coupler joint
 - nipple joint
6. The pipes which are buried in the earth should be joined with
- union joint
 - spigot and socket joint
 - coupler joint
 - nipple joint
7. The expansion joint is mostly used for pipes which carry steam at pressures.
- low
 - high
8. The pipes carrying fluid pressure varying from 5 to 14 N/mm² should have
- square flanged joint
 - circular flanged joint
 - oval flanged joint
 - spigot and socket joint
9. An oval type flange is fastened by means of
- two bolts
 - four bolts
 - six bolts
 - eight bolts
10. A flanged pipe joint will be a leakproof, if the circumferential pitch of the bolts is
- less than $20\sqrt{d}$
 - greater than $30\sqrt{d}$
 - between $20\sqrt{d}$ and $30\sqrt{d}$
 - equal to one-third of inside diameter of flange
11. The flanges in a circular flanged pipe joint are strengthened by providing ribs between the bolt holes. The thickness of such ribs is taken as
- t
 - t_f
 - $\frac{t-t_f}{2}$
 - $\frac{t+t_f}{2}$
- where t = Thickness of pipe, and
 t_f = Thickness of flange.

ANSWERS

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (b) | 2. (d) | 3. (a) | 4. (c) | 5. (b) |
| 6. (a) | 7. (c) | 8. (a) | 9. (c) | 10. (d) |

OBJECTIVE TYPE QUESTIONS

1. Which of the following screw thread is adopted for power transmission in either direction?
 - Acme threads
 - Square threads
 - Buttress threads
 - Multiple threads
2. Multiple threads are used to secure
 - low efficiency
 - high efficiency
 - high load lifting capacity
 - high mechanical advantage
3. Screws used for power transmission should have
 - low efficiency
 - high efficiency
 - very fine threads
 - strong teeth
4. If α denotes the lead angle and ϕ , the angle of friction, then the efficiency of the screw is given by
 - $$\frac{\tan(\alpha - \phi)}{\tan \alpha}$$
 - $$\frac{\tan \alpha}{\tan(\alpha - \phi)}$$
 - $$\frac{\tan(\alpha + \phi)}{\tan \alpha}$$
 - $$\frac{\tan \alpha}{\tan(\alpha + \phi)}$$
5. A screw jack has square threads and the lead angle of the thread is α . The screw jack will self lock when the coefficient of friction (μ) is
 - $\mu > \tan \alpha$
 - $\mu = \sin \alpha$
 - $\mu = \cot \alpha$
 - $\mu = \operatorname{cosec} \alpha$
6. To ensure self locking in a screw jack, it is essential that the helix angle is
 - larger than friction angle
 - smaller than friction angle
 - equal to friction angle
 - such as to give maximum efficiency
7. A screw is said to be self locking screw, if its efficiency is
 - less than 50%
 - more than 50%
 - equal to 50%
 - none of these
8. A screw is said to be over hauling screw, if its efficiency is
 - less than 50%
 - more than 50%
 - equal to 50%
 - none of these
9. While designing a screw in a screw jack against buckling failure, the end conditions for the screw taken as
 - both ends fixed
 - both ends hinged
 - one end fixed and other end hinged
 - one end fixed and other end free
10. The load cup of a screw jack is made separate from the head of the spindle to
 - enhance the load carrying capacity of the jack
 - reduce the effort needed for lifting the working load
 - reduce the value of frictional torque required to be countered for lifting the load
 - prevent the rotation of load being lifted

ANSWERS

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (b) | 2. (b) | 3. (b) | 4. (d) | 5. (d) |
| 6. (b) | 7. (a) | 8. (b) | 9. (d) | 10. (d) |

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6. In case of thick cylinders, the tangential stress across the thickness of cylinder is
 (a) maximum at the outer surface and minimum at the inner surface
 (b) maximum at the inner surface and minimum at the outer surface
 (c) maximum at the inner surface and zero at the outer surface
 (d) maximum at the outer surface and zero at the inner surface
7. According to Lame's equation, the thickness of a cylinder is equal to

(a) $r_i \left[\sqrt{\frac{\sigma_t + (1 - 2\mu) p}{\sigma_t - (1 - 2\mu) p}} - 1 \right]$

(b) $r_i \left[\sqrt{\frac{\sigma_t + (1 - \mu) p}{\sigma_t - (1 - \mu) p}} - 1 \right]$

(c) $r_i \left[\sqrt{\frac{\sigma_t + p}{\sigma_t - p}} - 1 \right]$

(d) $r_i \left[\sqrt{\frac{\sigma_t}{\sigma_t - 2p}} - 1 \right]$

where

 r_i = Internal radius of the cylinder, σ_t = Allowable tensile stress, p = Internal fluid pressure, and μ = Poisson's ratio.

8. In a thick cylindrical shell, the maximum radial stress at the outer surfaces of the shell is
 (a) zero
 (b) p
 (c) $-p$
 (d) $2p$
9. For high pressure oil and gas cylinders, the thickness of the cylinder is determined by
 (a) Lame's equation
 (b) Clavarino's equation
 (c) Barlow's equation
 (d) Birnie's equation
10. The thickness of a dished head that is riveted or welded to the cylindrical wall is

(a) $\frac{4.16 p R}{\sigma_u}$

(b) $\frac{5.36 p R}{\sigma_u}$

(c) $\frac{6.72 p R}{\sigma_u}$

(d) $\frac{8.33 p R}{\sigma_u}$

where

 P = Internal pressure, R = Inside radius of curvature of the dished plate, and σ_u = Ultimate strength for the material of the plate.

1. Introduction
2. Stresses in Plain Stress
3. Design of Plain Stress
4. Pipe Joints
5. Standard Pressure Steam
6. Hydraulic and High Pressure
7. Design of Concentric Pipe Joint
8. Design of Oval Joint
9. Design of Spherical Pipe Joint

ANSWERS

1. (b)

2. (b)

3. (a)

4. (b)

5. (b)

6. (b)

7. (c)

8. (a)

9. (c)

10. (a)

- (c) pitch diameter
- 4.** The railway carriage coupling have
 (a) square threads
 (c) knuckle threads
- 5.** The square threads are usually found on
 (a) spindles of bench vices
 (c) feed mechanism of machine tools
- 6.** A locking device in which the bottom cylindrical portion is recessed to receive the tip of set screw, is called
 (a) castle nut
 (c) ring nut
- 7.** Which one is not a positive locking device ?
 (a) Spring washer
 (c) Tongued washer
- 8.** The washer is generally specified by its
 (a) outer diameter
 (c) thickness
- 9.** A locking device extensively used in automobile industry is a
 (a) jam nut
 (c) screw nut
- 10.** A bolt of M 24 × 2 means that
 (a) the pitch of the thread is 24 mm and depth is 2 mm
 (b) the cross-sectional area of the threads is 24 mm²
 (c) the nominal diameter of bolt is 24 mm and the pitch is 2 mm
 (d) the effective diameter of the bolt is 24 mm and there are two threads per cm
- 11.** When a nut is tightened by placing a washer below it, the bolt will be subjected to
 (a) tensile stress
 (c) shear stress
- 12.** The eye bolts are used for
 (a) transmission of power
 (c) lifting and transporting heavy machines
- 13.** The shock absorbing capacity of a bolt may be increased by
 (a) increasing its shank diameter
 (b) decreasing its shank diameter
 (c) tightening the bolt properly
 (d) making the shank diameter equal to the core diameter of the thread.
- 14.** The resilience of a bolt may be increased by
 (a) increasing its shank diameter
 (c) decreasing its shank diameter
- 15.** A bolt of uniform strength can be developed by
 (a) keeping the core diameter of threads equal to the diameter of unthreaded portion of the bolt
 (b) keeping the core diameter of threads smaller than the diameter of unthreaded portion of the bolt
 (c) keeping the nominal diameter of threads equal to the diameter of unthreaded portion of the bolt
 (d) none of the above
- (d) pitch
- (b) acme threads
 (d) buttress threads
- (b) railway carriage couplings
 (d) screw cutting lathes
- (b) jam nut
 (d) screw nut
- (b) Cotter pin
 (d) Spring wire lock
- (b) hole diameter
 (d) mean diameter
- (b) castle nut
 (d) ring nut
- (b) compressive stress
 (d) none of these
- (b) locking devices
 (d) absorbing shocks and vibrations
- (b) increasing its length
 (d) decreasing its length

ANSWERS

1. (b) 2. (a)
 6. (c) 7. (a)
 11. (a) 12. (c)
 3. (a) 8. (b)
 13. (b) 14. (b)
 4. (d) 9. (b)
 5. (c) 10. (c)
 15. (a)

ANSWERS

1. (d) 2. (d) 3. (b) 4. (c) 5. (b)
6. (a) 7. (c) 8. (d) 9. (a) 10. (a)

2. The diameter of the rivet hole is usually the nominal diameter of the rivet.
 (a) equal to (b) less than (c) more than

3. The rivet head used for boiler plate riveting is usually
 (a) snap head (b) pan head
 (c) counter sunk head (d) conical head

4. According to Unwin's formula, the relation between diameter of rivet hole (d) and thickness (t) is given by
 (a) $d = t$ (b) $d = 1.6 \sqrt{t}$
 (c) $d = 2t$ (d) $d = 6t$

where d and t are in mm.

5. A line joining the centres of rivets and parallel to the edge of the plate is known as
 (a) back pitch (b) marginal pitch
 (c) gauge line (d) pitch line

6. The centre to centre distance between two consecutive rivets in a row, is called
 (a) margin (b) pitch
 (c) back pitch (d) diagonal pitch

7. The objective of caulking in a riveted joint is to make the joint
 (a) free from corrosion (b) stronger in tension
 (c) free from stresses (d) leak-proof

8. A lap joint is always in shear.
 (a) single (b) double

9. A double strap butt joint (with equal straps) is
 (a) always in single shear (b) always in double shear
 (c) either in single shear or double shear (d) any one of these

10. Which of the following riveted butt joints with double straps should have the highest efficiency per Indian Boiler Regulations?
 (a) Single riveted (b) Double riveted
 (c) Triple riveted (d) Quadruple riveted

11. If the tearing efficiency of a riveted joint is 50%, then ratio of diameter of rivet hole to the pitch is
 (a) 0.20 (b) 0.30
 (c) 0.50 (d) 0.60

12. The strength of the unriveted or solid plate per pitch length is equal to
 (a) $p \times d \times \sigma_s$ (b) $p \times t \times \sigma_s$,
 (c) $(p - t) d \times \sigma_s$ (d) $(p - d) t \times \sigma_s$

13. The longitudinal joint in boilers is used to get the required
 (a) length of boiler (b) diameter of boiler
 (c) length and diameter of boiler (d) efficiency of boiler

14. For longitudinal joint in boilers, the type of joint used is
 (a) lap joint with one ring overlapping the other (b) butt joint with single cover plate
 (c) butt joint with double cover plates (d) any one of these

15. According to Indian standards, the diameter of rivet hole for a 24 mm diameter of rivet, should be
 (a) 23 mm (b) 24 mm
 (c) 25 mm (d) 26 mm

ANSWERS

- ANSWERS**

1. (a)	2. (c)	3. (a)	4. (d)	5. (b)
6. (b)	7. (d)	8. (a)	9. (b)	10. (d)
11. (c)	12. (b)	13. (b)	14. (c)	15. (c)

- 3.** A pair of helical gears consist of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 120 r.p.m. The normal pressure angle is 20° while the helix angle is 25° . The face width is 40 mm and gear strength is 40 MPa and heat treated to a surface hardness of 300 B.H.N. The service factor and factor of safety for the power transmitting capacity of the gears.

[Ans. 8.6 kW]

- 4.** A single stage helical gear reducer is to receive power from a 1440 r.p.m., 25 kW induction motor. The gear tooth profile is involute full depth with 20° normal pressure angle. The helix angle is 23° , gear stress of 90 MPa and hardness 250 B.H.N.

- Design the gears for 20% overload carrying capacity from standpoint of bending strength and wear.
- If the incremental dynamic load of 8 kW is estimated in tangential plane, what will be the safe power transmitted by the pair at the same speed?

QUESTIONS

- What is a herringbone gear? Where they are used?
- Explain the following terms used in helical gears :
 - Helix angle;
 - normal pitch; and
 - axial pitch.
- Define formative or virtual number of teeth on a helical gear. Derive the expression used to obtain its value.
- Write the expressions for static strength, limiting wear load and dynamic load for helical gears and explain the various terms used therein.

OBJECTIVE TYPE QUESTIONS

- If T is the actual number of teeth on a helical gear and ϕ is the helix angle for the teeth, the formative number of teeth is written as
 - $T \sec^2 \phi$
 - $T \sec^2 \phi$
 - $T \sec^2 \phi$
 - $T \cosec \phi$
- In helical gears, the distance between similar faces of adjacent teeth along a helix on the pitch cylinder normal to the teeth, is called
 - normal pitch
 - axial pitch
 - diametral pitch
 - module
- In helical gears, the right hand helices on one gear will mesh _____ helices on the other gear.
 - right hand
 - left hand
- The helix angle for single helical gears ranges from
 - 10° to 15°
 - 15° to 20°
 - 20° to 35°
 - 35° to 50°
- The helix angle for double helical gears may be made up to
 - 45°
 - 60°
 - 75°
 - 90°

ANSWERS

1. (a) 2. (a) 3. (b) 4. (c) 5. (a)

QUESTIONS

1. What is a lever? Explain the principle on which it works.
2. What do you understand by leverage?
3. Why are levers usually tapered?
4. Why are bushes of softer material inserted in the eyes of levers?
5. Why is a boss generally needed at the fulcrum of the levers?
6. State the application of hand and foot levers. Discuss the procedure for designing a hand or foot lever.
7. A lever is to be designed for a hoisting winch. Write the procedure for designing a lever for such operation.
8. Explain the design procedure of a lever for a lever safety valve.
9. Discuss the design procedure of a rocker arm for operating the exhaust valve.

OBJECTIVE TYPE QUESTIONS

In levers, the leverage is the ratio of

- load lifted to the effort applied
- mechanical advantage to the velocity ratio
- load arm to the effort arm
- effort arm to the load arm

In levers of first type, the mechanical advantage is _____ one.

- less than
- equal to
- more than

The bell crank levers used in railway signalling arrangement are of

- first type of levers
- second type of levers
- third type of levers

The rocker arm in internal combustion engines are of _____ type of levers.

- first
- second
- third

The cross-section of the arm of a bell crank lever is

- rectangular
- elliptical
- I-section
- any one of these

All the types of levers are subjected to

- twisting moment
- bending moment
- direct axial load
- combined twisting and bending moment

The method of manufacturing usually adopted for levers is

- casting
- fabrication
- forging
- machining

An I-section is more suitable for a

- rocker arm
- cranked lever
- foot lever
- lever of lever safety valve

The design of the pin of a rocker arm of an L.C. Engine is based on

- tensile, creep and bearing failure
- creep, bearing and shearing failure
- bearing, shearing and bending failure
- none of these

In designing a rocker arm for operating the exhaust valve, the ratio of the length to the diameter of the lever arm and roller pin is taken as

- 1.25
- 1.5
- 1.75
- 2

ANSWERS

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (c) | 4. (a) | 5. (d) |
| (d) | (c) | (c) | (a) | (a) |
| 6. (b) | 7. (c) | 8. (a) | 9. (c) | 10. (a) |

(d) Dimensions of the key for securing the pulley on to the shaft.

(e) Size of the arms six in number.

The section of the arms may be taken as elliptical, the major axis being twice the following stresses may be taken for design purposes :

Shaft and key : Tension – 80 MPa

Shear – 50 MPa

Belt : Tension – 2.5 MPa

Pulley rim : Tension – 4.5 MPa

Pulley arms : Tension – 15 MPa

QUESTIONS

1. Discuss the different types of pulleys used in belt drives.
2. Why the face of a pulley is crowned?
3. When a split pulley is used and how it is tightened on a shaft?
4. Explain the 'fast and loose pulley' with the help of a neat sketch.
5. Discuss the procedure used in designing a cast iron pulley.

OBJECTIVE TYPE QUESTIONS

1. The crowning on a 300 mm width of pulley face should be

(a) 9 mm	(b) 12 mm
(c) 15 mm	(d) 18 mm
2. The steel pulleys are in weight than cast iron pulleys of the same capacity.

(a) heavier	(b) lighter
-------------	-------------
3. For a steel pulley of 500 mm, the recommended number of spokes are

(a) 2	(b) 4
(c) 6	(d) 8
4. The thickness of rim for all sizes of steel pulleys should be

(a) 5 mm	(b) 10 mm
(c) 15 mm	(d) 20 mm
5. The width of the pulley should be

(a) equal to the width of belt	(b) less than the width of belt
(c) greater than the width of belt	

ANSWERS

1. (a)

2. (b)

3. (c)

4. (a)

5. (c)

OBJECTIVE TYPE QUESTIONS

1. The rolling contact bearings are known as

(a) thick lubricated bearings	(b) plastic bearings
(c) thin lubricated bearings	(d) antifriction bearings
2. The bearings of medium series have capacity over the light series.

(a) 10 to 20%	(b) 20 to 30%
(c) 30 to 40%	(d) 40 to 50%
3. The bearings of heavy series have capacity over the medium series.

(a) 10 to 20%	(b) 20 to 30%
(c) 30 to 40%	(d) 40 to 50%
4. The ball bearings are usually made from

(a) low carbon steel	(b) medium carbon steel
(c) high speed steel	(d) chrome nickel steel
5. The tapered roller bearings can take

(a) radial load only	(b) axial load only
(c) both radial and axial loads	(d) none of the above
6. The piston pin bearings in heavy duty diesel engines are

(a) needle roller bearings	(b) tapered roller bearings
(c) spherical roller bearings	(d) cylindrical roller bearings
7. Which of the following is antifriction bearing?

(a) journal bearing	(b) pedestal bearing
(c) collar bearing	(d) needle bearing
8. Ball and roller bearings in comparison to sliding bearings have

(a) more accuracy in alignment	(b) small overall dimensions
(c) low starting and running friction	(d) all of these
9. A bearing is designated by the number 405. It means that a bearing is of

(a) light series with bore of 5 mm	(b) medium series with bore of 15 mm
(c) heavy series with bore of 25 mm	(d) light series with width of 20 mm
10. The listed life of a rolling bearing, in a catalogue, is the

(a) minimum expected life	(b) maximum expected life
(c) average life	(d) none of these



Ball bearing

ANSWERS

- | | | | |
|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (b) | 4. (d) |
| 6. (a) | 7. (d) | 8. (d) | 5. (c) |
| | | | 10. (a) |

1. The size of gear is usually specified by
 (a) pressure angle
 (b) pitch circle diameter
 (c) circular pitch
 (d) diametral pitch
2. A spur gear with pitch circle diameter D has number of teeth T . The module m is defined as
 (a) $m = d/T$
 (b) $m = T/D$
 (c) $m = \pi D/T$
 (d) $m = D \cdot T$
3. In a rack and pinion arrangement, the rack has teeth of _____ shape.
 (a) square
 (b) trapezoidal
4. The radial distance from the _____ to the clearance circle is called working depth.
 (a) addendum circle
 (b) dedendum circle
5. The product of the diametral pitch and circular pitch is equal to
 (a) 1
 (b) $1/\pi$
 (c) π
 (d) $\pi \times \text{No. of teeth}$
6. The backlash for spur gears depends upon
 (a) module
 (b) pitch line velocity
 (c) tooth profile
 (d) both (a) and (b)
7. The contact ratio for gears is
 (a) zero
 (b) less than one
 (c) greater than one
 (d) none of these
8. If the centre distance of the mating gears having involute teeth is increased, then the pressure angle
 (a) increases
 (b) decreases
 (c) remains unchanged
 (d) none of these
9. The form factor of a spur gear tooth depends upon
 (a) circular pitch only
 (b) pressure angle only
 (c) number of teeth and circular pitch
 (d) number of teeth and the system of teeth
10. Lewis equation in spur gears is used to find the
 (a) tensile stress in bending
 (b) shear stress
 (c) compressive stress in bending
 (d) fatigue stress
11. The minimum number of teeth on the pinion in order to avoid interference for 20° stub system is
 (a) 12
 (b) 14
 (c) 18
 (d) 32
12. The allowable static stress for steel gears is approximately _____ of the ultimate tensile stress.
 (a) one-fourth
 (b) one-third
 (c) one-half
 (d) double
13. Lewis equation in spur gears is applied
 (a) only to the pinion
 (b) only to the gear
 (c) to stronger of the pinion or gear
 (d) to weaker of the pinion or gear
14. The static tooth load should be the dynamic load.
 (a) less than
 (b) greater than
 (c) equal to

ANSWERS

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (b) | 2. (b) | 3. (a) | 4. (b) | 5. (a) |
| 6. (c) | 7. (d) | 8. (c) | 9. (a) | 10. (d) |
| 11. (c) | 12. (b) | 13. (b) | 14. (d) | 15. (b) |

- Q. 1. What is back stop action in band brakes? Explain the condition for it.
- Q. 2. Describe with the help of a neat sketch the principle of operation of an internal expanding shoe brake.
- Q. 3. Derive the expression for the breaking torque.



Front suspension system: Front Pivot ball suspension soaks up the bumps and provides unmatched adjustability. Chrome 8 mm CVA joints give added strength.

OBJECTIVE TYPE QUESTIONS

1. A brake commonly used in railway trains is
 - (a) shoe brake
 - (b) band brake
 - (c) band and block brake
 - (d) internal expanding brake
2. A brake commonly used in motor cars is
 - (a) shoe brake
 - (b) band brake
 - (c) band and block brake
 - (d) internal expanding brake
3. The material used for brake lining should have coefficient of friction.
 - (a) low
 - (b) high
4. When the frictional force helps to apply the brake, then the brake is said to be
 - (a) self-energizing brake
 - (b) self-locking brake
5. For a band brake, the width of the band for a drum diameter greater than 1 m, should not exceed
 - (a) 150 mm
 - (b) 200 mm
 - (c) 250 mm
 - (d) 300 mm

ANSWERS

1. (a) 2. (d) 3. (b) 4. (a) 5. (a)

OBJECTIVE TYPE QUESTIONS

1. A jaw clutch is essentially a
 - (a) positive action clutch
 - (b) cone clutch
 - (c) friction clutch
 - (d) disc clutch
2. The material used for lining of friction surfaces of a clutch should have
 - (a) low
 - (b) high
3. The torque developed by a disc clutch is given by
 - (a) $T = 0.25 \mu W R$
 - (b) $T = 0.5 \mu W R$
 - (c) $T = 0.75 \mu W R$
 - (d) $T = \mu W R$

where W = Axial force with which the friction surfaces are held together;
 μ = Coefficient of friction; and
 R = Mean radius of friction surfaces.
4. In case of a multiple disc clutch, if n_1 are the number of discs on the driving shaft and n_2 number of the discs on the driven shaft, then the number of pairs of contact surfaces will be
 - (a) $n_1 + n_2$
 - (b) $n_1 + n_2 - 1$
 - (c) $n_1 + n_2 + 1$
 - (d) none of these
5. The cone clutches have become obsolete because of
 - (a) small cone angles
 - (b) exposure to dirt and dust
 - (c) difficulty in disengaging
 - (d) all of these
6. The axial force (W_e) required for engaging a cone clutch is given by
 - (a) $W_n \sin \alpha$
 - (b) $W_n (\sin \alpha + \mu \cos \alpha)$
 - (c) $W_n (\sin \alpha + 0.25 \mu \cos \alpha)$
 - (d) none of these

where W_n = Normal force acting on the contact surfaces,
 α = Face angle of the cone, and
 μ = Coefficient of friction.
7. In a centrifugal clutch, the force with which the shoe presses against the driven member is the sum of the centrifugal force and the spring force.
 - (a) difference
 - (b) sum

ANSWERS

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (a) | 2. (b) | 3. (d) | 4. (b) | 5. (d) |
| 6. (c) | 7. (a) | | | |

QUESTIONS

1. How the bevel gears are classified? Explain with neat sketches.
2. Sketch neatly the working drawing of bevel gears in mesh.
3. For bevel gears, define the following :
 - (i) Cone distance; (ii) Pitch angle; (iii) Face angle; (iv) Root angle; (v) Back cone distance; and (vi) Crown height.
4. What is Tredgold's approximation about the formative number of teeth on bevel gear?
5. What are the various forces acting on a bevel gear?
6. Write the procedure for the design of a shaft for bevel gears.

OBJECTIVE TYPE QUESTIONS

1. When bevel gears having equal teeth and equal pitch angles connect two shafts whose axes intersect at right angle, then they are known as

(a) angular bevel gears	(b) crown bevel gears
(c) internal bevel gears	(d) mitre gears
2. The face angle of a bevel gear is equal to

(a) pitch angle - addendum angle	(b) pitch angle + addendum angle
(c) pitch angle - dedendum angle	(d) pitch angle + dedendum angle
3. The mett angle of a bevel gear is equal to

(a) pitch angle - addendum angle	(b) pitch angle + addendum angle
(c) pitch angle - dedendum angle	(d) pitch angle + dedendum angle
4. If b denotes the face width and L denotes the cone distance, then the bevel factor is written as

(a) b/L	(b) $b/2L$
(c) $1 - 2b/L$	(d) $1 - b/L$
5. For a bevel gear having the pitch angle θ , the ratio of formative number of teeth (T_p) to actual number of teeth (T) is

(a) $\frac{1}{\sin \theta}$	(b) $\frac{1}{\cos \theta}$
(c) $\frac{1}{\tan \theta}$	(d) $\sin \theta \cos \theta$

ANSWERS

1. (d)

2. (b)

3. (c)

4. (d)

5. (b)