ADDITIONAL OBJECTIVE TYPE QUESTIONS

I. UNIVERSITIES' QUESTIONS

A. Choose the Correct Answer :

1. Limit within which Hooke's law holds good is known as
   (*a*) elastic limit
   (*b*) plastic limit
   (*c*) yield point
   (*d*) proportional limit.

2. The magnitude of shear stress induced in a shaft due to applied torque varies
   (*a*) from maximum at the centre to zero at the circumference
   (*b*) from zero at the centre to maximum at the circumference
   (*c*) from maximum at the centre to minimum at the circumference and not zero
   (*d*) from minimum at the centre and not zero to maximum at the circumference.

3. Polar moment of inertia of the cross-section of a shaft of diameter *d* is
   (*a*) $\frac{\pi}{32}d^3$ (*b*) $\frac{\pi}{32}d^4$
   (*c*) $\frac{\pi}{16}d^3$ (*d*) $\frac{\pi}{16}d^4$.

4. A hollow shaft of the same cross-sectional area as that of a solid shaft can
   (*a*) resists less torque
   (*b*) resist more torque
   (*c*) resist equal torque.

5. The flexural rigidity of a beam is
   (*a*) EI (*b*) E/I
   (*c*) I/E (*d*) E/I^2.

6. A thick curved bar has an original curvature which
   (*a*) is large
   (*b*) is small
   (*c*) is zero
   (*d*) could be any one of the above.

7. A thin curved bar has an original curvature which
   (*a*) is large
   (*b*) is small
   (*c*) is zero
   (*d*) could be any one of the above.

8. A beam is said to be loaded in pure bending when
   (*a*) bending moment and shear force are constant but not zero
   (*b*) bending moment is changing linearly
   (*c*) bending moment and shear force both are changing linearly
   (*d*) bending moment is constant.

9. A high carbon steel specimen as compared with mild steel specimen
   (*a*) is more ductile
   (*b*) is stronger
   (*c*) has a more defined yeild point
   (*d*) has more Poisson's ratio.

10. One kgf / cm^2 when converted into SI unit is
    (*a*) 0.0981 MPa (*b*) 0.981 Pa
    (*c*) 10^4 Pa (*d*) 1 Pa.

11. To express the stress-strain relations for a homogeneous isotropic, linearly elastic material, minimum number of material constant needed is
    (*a*) two (*b*) three
    (*c*) six (*d*) nine.

12. Deflection of the free end of a cantilever beam, subjected to a concentrated load at the middle of its span is given by
    (*a*) $\frac{Pl^3}{3EI}$ (*b*) $\frac{Pl^3}{8EI}$
    (*c*) $\frac{Pl^3}{24EI}$ (*d*) $\frac{5Pl^3}{48EI}$.

13. Shear centre
    (*a*) always coincides with the centroid of the beam cross-section
    (*b*) always lies within the boundaries of the cross-section
    (*c*) is a point in the plane of the beam cross-section through which the resultant of shear forces must pass
    (*d*) is a point in the beam cross-section representing zero shear stress.

14. The maximum eccentricity of a compressive load acting on a short strut of diameter *d*

without producing tension at the base section is

(a) d/2 (b) d/4

(c) d/6 (d) d/8.

15. Pure torsion of a circular shaft produces

(a) longitudinal normal stress in the shaft

(b) only direct shear stress in the transverse section of the shaft

(c) circumferential shear stress on a surface element of the shaft

(d) a longitudinal shear stress and a circumferential shear stress on a surface element of the shaft.

16. The rigidity modulus G, in terms of modulus of elasticity E and Poisson's ratio ν is given by

(a) $\frac{2E}{(1+\nu)}$ (b) $\frac{E}{2(1-\nu)}$

(c) $\frac{E}{2(1+\nu)}$ (d) $\frac{E}{(1-\nu)}$.

17. A bar is subjected to an uniaxial load P, having length = l, area of cross-section A, and E is modulus of elasticity. The strain energy stored in the bar is given by

(a) $\frac{Pl}{AE}$ (b) $\frac{Pl^2}{AE}$

(c) $\frac{P^2l}{AE}$ (d) $\frac{P^2l}{2AE}$.

18. If σ_1 and σ_2 are principal stresses, the shear stress on the principal planes is given by

(a) $\frac{\sigma_1 - \sigma_2}{2}$ (b) zero

(c) $\frac{\sigma_1 + \sigma}{2}$ (d) $\sigma_1 - \sigma_2$.

19. A circular shaft of length l subjected to a torque T, G is rgidity modulus and J is polar moment of inertia, then the total angle of twist is given by

(a) $\frac{Tl}{GJ}$ (b) $\frac{TJ}{Gl}$

(c) $\frac{TG}{Jl}$ (d) $\frac{GJ}{Tl}$.

20. Point of contraflexure where

(a) bending moment is maximum

(b) shear force is maximum

(c) shear force is zero

(d) bending moment is zero.

21. The deflection of a cantilever beam at the free end due to concentrated load P at the free end is given by

(a) $\frac{Pl^3}{2EI}$ (b) $\frac{Pl^2}{2EI}$

(c) $\frac{Pl^3}{3EI}$ (d) $\frac{Pl^3}{4EI}$.

22. The maximum stress used in the analysis of bending beyond elastic limit is

(a) ultimate stress

(b) allowable stress

(c) yield stress

(d) none of the above.

23. If two springs with stiffness k_1 and k_2 are connected in series, then stiffness of the composite spring is given by

(a) $k_1 + k_2$ (b) $\frac{1}{k_1} + \frac{1}{k_2}$

(c) $\frac{1}{k_1} - \frac{1}{k_2}$ (d) $k_1 - k_2$.

24. A compressive member always tends to buckle in the direction of

(a) axis of load

(b) minimum cross-section

(c) least radius of gyration

(d) perpendicular to the axis of load.

25. If the normal cross-section a of a member is subjected to a tensile force P, the resulting normal stress on an oblique plane inclined at θ to the transverse plane will be

(a) $\frac{P}{A}\sin^2\theta$ (b) $\frac{P}{A}\cos^2\theta$

(c) $\frac{P}{2A}\sin 2\theta$ (d) $\frac{P}{2A}\cos 2\theta$.

26. The maximum bending moment due to a moving load on a simply supported beam occurs

(a) at the midspan

(b) at the supports

(c) under the load

(d) anywhere on the beam.

27. A simply supported beam carries two equal concentrated load W at distance $L/3$ from either support. The maximum BM is

(a) $\frac{WL}{3}$ (b) $\frac{WL}{4}$

(c) $\frac{5WL}{8}$ (d) $\frac{2}{5}WL$.

28. The equivalent length of a column fixed at both ends is
(a) 0.7 l (b) 0.5 l
(c) l (d) 2 l.

29. The maximum deflection of a simply supported beam of length L with central concentrated load W is

(a) $\frac{WL^2}{48\,EI}$ (b) $\frac{WL^2}{24\,EI}$

(c) $\frac{WL^3}{48\,EI}$ (d) $\frac{WL^2}{8\,EI}$.

30. If a solid shaft is subjected to a torque T at its end such that maximum shear stress does not exceed τ_a, the diameter of shaft will be

(a) $\frac{16T}{\pi\tau_a}$

(b) $\sqrt{\frac{16T}{\pi\tau_a}}$

(c) $\left(\frac{16T}{\pi\tau_a}\right)^{1/3}$

(d) None of the above.

31. If a shaft is simultaneously subjected to a torque T and bending moment M, the ratio of the maximum bending stress to maximum shearing stress is

(a) $\frac{M}{T}$ (b) $\frac{T}{M}$

(c) $\frac{2M}{T}$ (d) $\frac{2T}{M}$.

32. Euler's formula states that the buckling load P for a column of length L, both ends hinged and whose least moment of inertia and modulus of elasticity of the material of column are I and E respectively is given by

(a) $P = \frac{\pi EI}{L^2}$ (b) $P = \frac{\pi^2 EI}{L^2}$

(c) $P = \frac{\pi L^2}{EI}$ (d) $P = \frac{\pi EI}{L^2}$.

33. A closely coiled helical spring of radius R contains W. The radius of the coil wire is r and the modulus of rigidity of the coil material is G. The deflection of the coil is

(a) $\frac{WR^3N}{Gr^4}$ (b) $\frac{2WR^3}{Gr^4}$

(c) $\frac{3WR^3N}{Gr^4}$ (d) $\frac{4WR^3N}{Gr^4}$.

34. Strain energy of a member may be equated to
(a) average resistance × displacement
(b) $\frac{1}{2}$ stress × strain × area of its cross-section
(c) $\frac{1}{2}$ stress × strain × volume of the member
(d) $\frac{1}{2}\,\frac{(\text{stress})^2 \times \text{volume of member}}{\text{Young's modulus } E}$.

35. The work done on a unit volume of material as a simple tensile force is gradually increased from zero to the value causing ruputre is called
(a) modulus of resilience
(b) modulus of toughness
(c) tangent modulus
(d) none of the above.

36. The ratio of maximum shear stress to average shear is 4/3 in a beam of
(a) circular cross-section
(b) rectangular cross-section
(c) triangular cross-section
(d) none of the above.

37. The Young's modulus E, the shear modulus G and the Poisson's ratio μ are related by
(a) $E = 2G(1 - \mu)$;
(b) $E = 2G(1 + 2\mu)$;
(c) $E = 2G(1 + \mu)$
(d) none of these.

38. Poisson's ratio, μ is defined as
(a) ratio of transverse strain to axial strain;
(b) modulus of ratio of transverse strain to axial strain;
(c) modulus of ratio of axial strain to transverse strain
(d) none of the above.

39. The point of contraflexure in a loaded beam is the point where
(a) the bending moment is maximum;
(b) the bending moment changes sign;
(c) the shear force changes sign
(d) none of the above.

40. A thin cylindrical tube of inner diameter d, and thickness t is closed at both ends and subjected to an internal pressure p. The tube also carries a torque T. The stresses at any point (σ_y, σ_q and τ_{xq}) are

(a) $\frac{pd}{2t}, \frac{pd}{4t}, \frac{2T}{\pi d^2 t}$

(b) $\frac{pd}{4t}, \frac{pd}{2t}, \frac{T}{\pi d^2 t}$

(c) $\frac{pd}{4t}, \frac{pd}{2t}, \frac{T}{2\pi d^2 t}$

(d) None of the above.

41. A rod of length L and area of cross-section A, whose material has a modulus of elasticity E and coefficient of thermal expansion α is subjected to a change of temperature ΔT. The change in length is

(a) $L\alpha\Delta T$; (b) $L\alpha\Delta T/E$;
(c) $L\alpha\Delta T/AE$; (d) none of these.

42. An axial core of 100 mm is bored throughout the length of a 200 mm diameter solid circular shaft. For the same maximum shear stress, the percentage torque carrying capacity lost by this operation is

(a) $6\frac{1}{4}$; (b) $12\frac{1}{2}$;
(c) 25 (d) 30.

43. A hole is to be punched in a mild steel plate of 10 mm thickness with the help of a hardened punch. The allowable crushing strength of the punch is 4 times the shearing strength of the plate. The diameter of the smallest hole that can be punched in the plate is

(a) 20 mm; (b) 10 mm;
(c) 5 mm. (d) 2 mm.

44. A close-coiled helical spring with wire diameter d, mean coil radius R and active number of coils n is subjected to an axial compressive load P. The shear modulus of the spring material is G. The deflection of the spring is given by

(a) $8\,PR^3n/Gd^4$;
(b) $64\,PR^3n/Gd^4$;
(c) $32PR^3n/Gd^4$
(d) none of the above.

45. In a two-dimensional problem the principal stress at a point are σ_1, and σ_2. The normal stress associated with the plane of maximum shear is

(a) $(\sigma_1+\sigma_2)/2$; (b) $(\sigma_1-\sigma_2)/2$;
(c) zero (d) none of these.

46. When mild steel is subjected to axial tension, the ratio of engineering stress to actual stress is

(a) < 1; (b) = 1;
(c) > 1 (d) none of above.

47. A uniform rod of length L, cross-sectional area A and modulus of elasticity E is held rigidly by fixed supports at the ends. An axial load P is applied at mid-length of the rod. The elastic strain energy stored is

(a) $P^2L/8AE$; (b) $P^2L/4\,AE$;
(c) $P^2L/16\,AE$ (d) none of these.

48. Maximum normal stress theory is used for

(a) ductile materials
(b) brittle materials
(c) visco-elastic materials.
(d) none of the above.

49. A circular shaft is subjected to a torque T. The maximum shear stress develped is τ. The maximum tensile stress developed in the shaft is

(a) $\tau/2$ (b) 2τ;
(c) τ (d) 3τ.

50. The moment of inertia of a rectangular lamina of sides b and d about its centroidal axis parallel to the side d is given by

(a) $bd^3/12$
(b) $db^3/12$
(c) $bd^3/36$
(d) none of the these.

51. Number of elastic constants sufficient for homogeneous isotropic materials is

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

52. Number of equilibrium equations for a two-dimensional system is

(a) 6; (b) 3;
(c) 2 (d) 1

53. For an element under a biaxial state of stress $\sigma_x = -\sigma_y$ in the $x-y$ plane, the radius of the Mohr's circle is

(a) $2\sigma_x$; (b) $2\sigma_y$;
(c) σ_x (d) $3\sigma_x$.

54. The buckling load for a fixed-fixed column is

(a) π^2EI/L^2 (b) $\pi^2EI/4L^2$
(c) $\pi^2\,EI/2L^2$ (d) none of these.

55. Stress developed in an elastic body due to external force
(a) does not depend on elastic constants
(b) depends on elastic constants
(c) depends partly on elastic constants
(d) none of the above.

56. Modulus of resilience is defined by
(a) strain energy stored in an elastic body
(b) strain energy per unit volume of the elastic body
(c) percentage of elongation of a ductile metal
(d) any of the above.

57. In the simple bending formula relating the B.M, bending stress and curvature, plane of external loading should pass through
(a) the shear centre at any angle
(b) the shear centre vertically
(c) the principal axis of the section
(d) none of the above.

58. Relation amongst Young's modulus, Poisson's ratio and Bulk modulus is given by
(a) $E = 3K(1-2\mu)$ (b) $E = 3K/(1-2\mu)$
(c) $E = 2K(1+\mu)$ (d) none of these

59. In a beam of I-Section the maximum shear force is carried by
(a) the upper flange (b) the web
(c) the lower flange (d) any of these.

60. In a short column with eccentric loading, the neutral axis
(a) passes through the centroid of the section
(b) passes through the point of application of load
(c) does not pass through the centroid of the section
(d) none of the above.

61. In a long column with hinged ends, the critical stress is
(a) more than the yield stress
(b) equal to the yield stress
(c) less than the yield stress
(d) any of these.

62. In a thick walled cylinder subject to internal pressure, the maximum hoop stress occurs at the
(a) inner wall
(b) outer wall
(c) middle point of thickness
(d) none of these.

63. Castigliano's theorem is valid for
(a) any structure
(b) non-linear structure
(c) linear structure
(d) any of these.

64. In a curved beam subjected to pure bending the neutral axis
(a) passes through the centroid of the section
(b) is shifted towards the centre of curvature
(c) is shifted away from the centre of curvature
(d) none of these.

65. A beam with hinged ends is subjected to a moment at one end. The slope at the other end is given by
(a) $\frac{Ml}{2EI}$ (b) $\frac{Ml}{6EI}$
(c) $\frac{Ml}{3EI}$ (d) $\frac{Ml}{12EI}$.

66. A hollow prismatic beam of circular section is subjected to a torsional moment. The maximum shear stress occurs at
(a) the inner wall of the cross-section
(b) the middle of the thickness
(c) the outer surface of the shaft
(d) none of the above.

67. A beam of length l and thermal coefficient α is fixed at two ends without stress. Then temperature drops by $T°C$. Axial force developed is
(a) $AE\alpha T$ tensile (b) $\frac{AE}{\alpha T}$ tensile
(c) $A \propto T$ compressive (d) none of these.

68. The reaction at the prop in a propped cantilever beam subjected to u.d.l. is
(a) $\frac{wl}{4}$ (b) $\frac{3wl}{8}$
(c) $\frac{5wl}{8}$ (d) $\frac{6wl}{7}$

69. In a long column, with one end fixed and the other free, if slenderness ratio increases, critical stress
(a) remains constant (b) increases
(c) decreases (d) any of these.

70. The ratio of maximum shear stress to average shear stress is 1.5 in a beam of
(a) circular cross-section
(b) rectangular cross-section
(c) triangular cross-section
(d) any cross-section

71. A material having identical properties in all directions, is called :
(a) elastic (b) homogeneous
(c) isotropic (d) any of these.

72. The ratio of the deformation of a bar due to its own weight, to the deformation due to axial load equal to its weight is:
(a) 1 (b) $\frac{1}{2}$
(c) 2 (d) 4.

73. If the Poisson's ratio of a material is 0.4, then the ratio of the shear modulus of elasticity to modulus of elasticity is:
(a) $\frac{5}{7}$ (b) $\frac{7}{5}$
(c) $\frac{5}{14}$ (d) $\frac{5}{12}$.

74. At a point in a strained material there acts a tensile stress of 100 N/mm^2 on one plane and a tensile stress of 50 N/mm^2 on a plane at right angles to it. These planes also carry a shear stress of 50 N/mm^2. The angle of inclination of principal stresses with the 100 N/mm^2 stress is :
(a) $\tan^{-1}(2)$; (b) $\frac{1}{2}\tan^{-1}(2)$;
(c) $\frac{1}{2}\tan^{-1}\left(\frac{2}{3}\right)$ (d) none of these.

75. A cantilever beam is loaded uniformly throughout its length. The shape of the shear force diagram will be
(a) a right angle triangle
(b) an isosceles triangle
(c) a rectangle
(d) none of these.

76. Two prismaic beams A and B have same length. The one having larger .... will be stronger in flexure:
(a) moment of inertia
(b) section modulus
(c) area of cross-section
(d) none of these.

77. The strength of a beam of square cross-section placed with its diagonal horizontal is ......times the strength when it is placed with its sides horizontal;
(a) $\frac{1}{2}$ (b) $\sqrt{2}$
(c) $\frac{1}{\sqrt{2}}$ (d) $\frac{1}{3}$.

78. Leaf springs are subjected to :
(a) shear stress (b) direct stress
(c) bending stress (d) none of these.

79. Load required to produce unit deflection is known as :
(a) toughness (b) stiffness
(c) flexibility (d) none of these.

80. The maximum energy stored at ...... is called proof resilience
(a) elastic limit
(b) plastic limit
(c) limit of proportionality
(d) any of these.

81. A cylinder is said to be thick if :
(a) it is made of thick plates
(b) the internal pressure is large
(c) the ratio of its wall thickness to its diameter is more than $\frac{1}{10}$
(d) none of these.

82. The maximum stress produces in a thin cylinder is ...... times that in a thin spherical shell, having same diameter, thickness and internal pressure:
(a) 1 (b) 2
(c) $\frac{1}{2}$ (d) $\frac{1}{3}$.

83. The strength of a column with both ends fixed is .... times the strength when its one end is fixed and other free, other parameters remaining same.
(a) two (b) four
(c) sixteen (d) eighteen.

84. Euler's formula is applicable to :
(a) only long columns
(b) only short columns
(c) long as well as short columns
(d) any of these.

85. The variation of the shear stress on the transverse plane of a normal beam section caused by a transverse shear force is usually:
(a) linear
(b) parabolic
(c) non-linear
(d) none of these.

86. In all sections having symmetry about the load axis, the shear centre is at
(a) centroid of the section
(b) neutral axis of the section
(c) geometric centre of the section
(d) any of these.

87. The Poisson's ratio is given by :

(a) $\frac{-\text{Lateral strain}}{\text{Longitudinal strain}}$

(b) $\frac{+\text{Lateral strain}}{\text{Longitudinal strain}}$

(c) $\frac{\text{Longitudinal strain}}{\text{Lateral strain}}$

(d) $\frac{\text{Longitudinal strain}}{-\text{Lateral strain}}$.

88. The work done per unit volume in elongating a body by a uniaxial force is :

(a) $\frac{\text{Stress}}{\text{Strain}}$ (b) Stress × strain

(c) $\frac{1}{2}$ Stress × strain (d) none of these.

89. 4 wires of same material are stretched by same load. Their dimensions are given below. In which wire will the extension be a max.?

(a) length 2m, dia. 1 mm
(b) $l = 1$m, $d = 0.5$ mm
(c) $l = 4$m, $d = 2$mm
(d) $l = 6$ m, $d = 3$mm.

90. The stresses in thick cylinder subjected to uniform pressure vary proportional to

(a) r (b) $\frac{1}{r}$

(c) r^2 (d) $\frac{1}{r^2}$.

91. Max. deflection for a cantilever of span L, loaded at the free end by P is given by:

(a) $\frac{PL^2}{3EI}$ (b) $\frac{PL^2}{6EI}$

(c) $\frac{PL^3}{8EI}$ (d) $\frac{PL^3}{3EI}$.

92. A helical spring is subjected to an axial tensile force. The predominant effect of this force on the spring is:

(a) twisting (b) bending
(c) tension (d) compression.

93. Polar moment of inertia of a circular area is

(a) $\frac{\pi}{32}d^4$ (b) $\frac{\pi}{64}d^4$

(c) $\frac{\pi}{4}d^4$ (d) $\frac{\pi}{4}d^3$.

94. A bar of square cross-section of side a is subjected to a tensile load P. On a plane inclined at 45° to the axis of the bar, the normal stress will be

(a) $\frac{2P}{a^2}$ (b) $\frac{P}{a^2}$

(c) $\frac{P}{2a^2}$ (d) $\frac{P}{4a^2}$.

95. The ratio of lateral strain to linear strain is known as

(a) Modulus of elasticity
(b) Modulus of rigidity
(c) Poisson's ratio
(d) Elastic limit.

96. In a cantilever carrying a load whose intensity varies uniformly from zero at the free end to w per unit run at the fixed end, the S.F. changes following a

(a) linear law
(b) parabolic law
(c) cubic law
(d) none of the above.

97. At the point of application of a concentrated load on a beam there is

(a) sudden change of slope of B.M. diagram
(b) maximum B.M.
(c) point of contraflexure
(d) maximum deflection.

98. The diameter of kernel of a circular section of diameter d is

(a) $\frac{d}{2}$ (b) $\frac{d}{3}$

(c) $\frac{d}{\sqrt{2}}$ (d) $\frac{d}{4}$.

99. A simply supported beam of span 4m carries a u.d.l. of 30 kN/m throughout. If $EI = 25000$ kN-m^2, the maximum deflection of the beam is

(a) 0.5 mm (b) 1.5 mm
(c) 3.5 mm (d) 4.0 mm.

100. Maximum shear stress theory of failure was postulated by

(a) St. Venant (b) Rankine
(c) Castigliano (d) Tresca.

101. The secant formula is used for

(a) long column under eccentric loading
(b) long column under axial loading
(c) short column under eccentric loading
(d) short column under axial loading.

102. The stress due to suddenly applied load is ..... times that of gradually applied load.
(a) 1.5 (b) 2
(c) 3 (d) 4.

103. Castigliano's theorems are valid for
(a) elastic structure
(b) truss
(c) beam
(d) linear structure.

104. Over a part of the beam, carrying transverse loads, where S.F. is zero, the B.M. is
(a) maximum (b) indeterminate
(c) constant (d) zero.

105. In I-section of a beam subjected to transverse S.F. the maximum shear stress occurs at the
(a) centre of the web
(b) top edge of the top flange
(c) bottom edge of the top flange;
(d) none of the above.

106. A strut of length l is fixed at one end and free at the other end. The Euler's buckling load for this strut is 20 kN. If both ends of the strut are fixed, the buckling load will be
(a) 80 kN (b) 160 kN
(c) 240 kN (d) 320 kN.

107. A close-coiled helical spring absorbs 80 N mm of energy while extending by 4 mm. The stiffness of the spring is
(a) 5 N/mm; (b) 10 N/mm;
(c) 16 N/mm; (d) 20 N/mm.

108. A solid circular shaft under pure torsion develops a maximum shear stress of 50 N/m^2. The maximum principal stress on the surface of the shaft is
(a) 100 N/mm^2 (b) 50 N/mm^2
(c) 25 N/mm^2 (d) none of these.

109. A mild steel beam develops a bending stress of 80 N/mm^2 at a distance of 8 cm from the neutral layer. If E = 200 GPa, the radius of curvature is
(a) 400 m
(b) 200 m
(c) 100 m
(d) none of these.

110. If the load passes through the shear centre of the section of a beam, then there will be
(a) no bending of the beam
(b) only bending
(c) bending with twisting
(d) only twisting.

II. COMPETITIVE EXAMINATION QUESTIONS

(ESE, CSE, etc. from 1996 onwards)
* (With Solutions – Comments)

111. If the principle stresses corresponding to a two-dimensional state of stress are σ_1 and σ_2 (σ_2 is greater than σ_1) and both are tensile, then which one of the following would be the correct for failure by yielding, according to the maximum shear stress criterion?

(a) $\dfrac{(\sigma_1 - \sigma_2)}{2} = \pm\dfrac{\sigma_{yp}}{2}$

(b) $\dfrac{\sigma_1}{2} = \pm\dfrac{\sigma_{yp}}{2}$

(c) $\dfrac{\sigma_2}{2} = \pm\dfrac{\sigma_{yp}}{2}$

(d) $\sigma_1 = \pm 2\,\sigma_{yp}$.

***112.** A length of 10 mm diameter steel wire is coiled to a close helical spring having 8 coils of 75 mm mean diameter, and the spring has a stiffness k. If the same length of wire is coiled to 10 coils of 60 mm mean diameter, then the spring stiffness will be.
(a) k (b) 1.25 k
(c) 1.56 k (d) 1.95 k.

113. The unit of elastic modulus is the same as those of
(a) stress, shear modulus and presssure
(b) strain, shear modulus and force
(c) shear modulus, stress and force
(d) stress, strain and pressure.

114. In the case of an engineering material under unidirectional stress in the x-direction, the Poisson's ratio is equal to (symbols have their usual meanings)
(a) $\varepsilon_y / \varepsilon_x$ (b) ε_y / σ_x
(c) ε_y / σ_y (d) σ_y / ε_x.

***115.** A rod of length 'l' and cross-section area 'A' rotates about an axis passing through one end of the rod. The extension production in the rod due to centrifugal forces is (w is the weight of the rod per unit length and ω is angular velocity of rotation of the rod)

(a) $\omega wl^2/gE$ (b) $\omega^2 wl^3/3gE$
(c) $\omega^2\ wl^3/gE$ (d) $3gE/\omega wl^3$.

116. The buckling load will be maximum for a column, if

(a) one end of the column is clamped and the other end is free
(b) both ends of the column are clamped
(c) both ends of the column are hinged
(d) one end of the column is hinged and the other end is free.

117. For the loaded beam shown in Fig. 1 the correct shear force diagram is

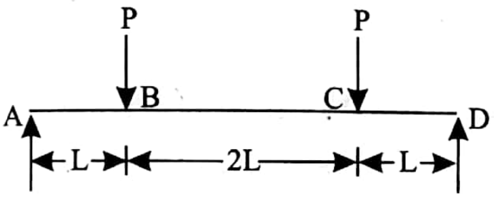


Fig. 1

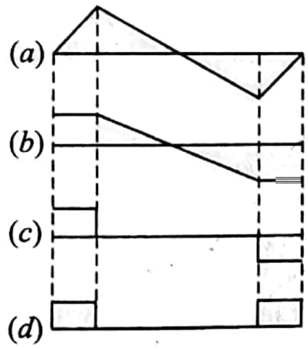


Fig. 2

*118. Which one of the following materials is highly elastic?

(a) Rubber (b) Brass
(c) Steel (d) Glass.

*119. The state of stress at a point in a loaded member is shown in the Fig. 3. The magnitude of maximum shear stress is:

(a) 10 MPa (b) 30 MPa
(c) 50 MPa (d) 100 MPa.

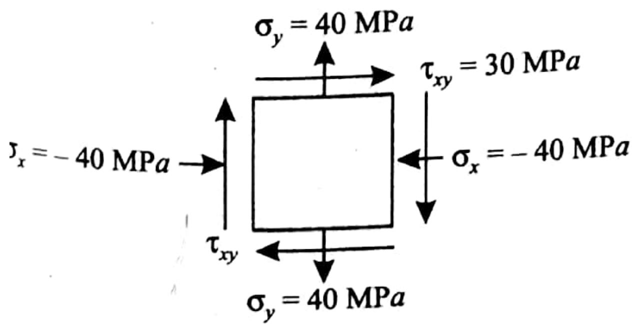


Fig. 3

*120. For a linearly elastic, isotropic and homogeneous material, the number of elastic constants required to relate stress and strain are:

(a) two (b) three
(c) four (d) six.

*121. A horizontal beam with square cross-section is simply supported with sides of the square horizontal and vertical and carries a distributed loading that produces maximum bending stress s in the beam. When the beam is placed with one of the diagonals horizontal the maximum bending stress will be

(a) $\frac{1}{\sqrt{2}}\sigma$ (b) 2s

(c) $\sqrt{2}\sigma$ (d) 3s.

*122. Shear stress distribution diagram of a beam of rectangular cross-section, subjected to transverse loading will be

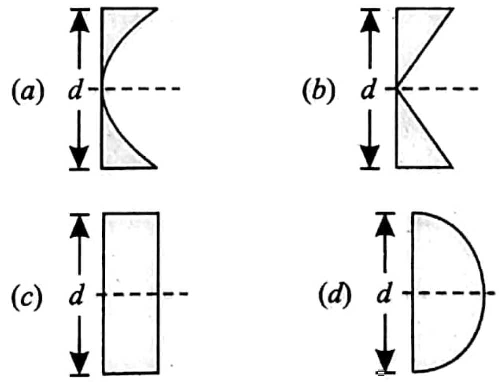


Fig. 4

*123. A shaft was initially subjected to bending moment and then was subjected to torsion. If the magnitude of bending moment is found to be the same as that of the torque, then the ratio of maximum bending stress to shear stress would be

(a) 0.25 (b) 0.50
(c) 2.0 (d) 4.0.

124. In a homogenous, isotropic elastic material, the modulus of elasticity E in terms of G and K is equal to

(a) $\frac{G+3K}{9KG}$ (b) $\frac{3G+K}{9KG}$

(c) $\frac{9KG}{G+3K}$ (d) $\frac{9KG}{G+3K}$.

***125.** The Fig. 5 shows a bending moment diagram for the beam *CABD*:

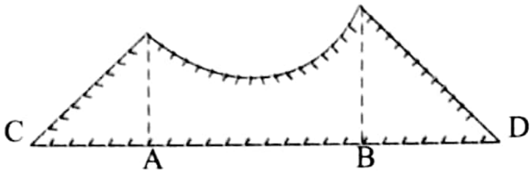
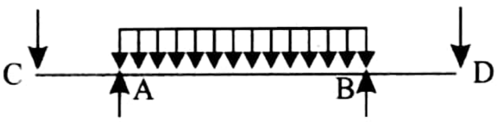
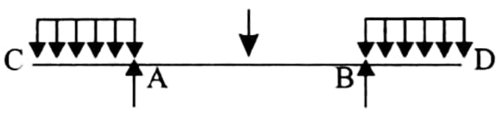
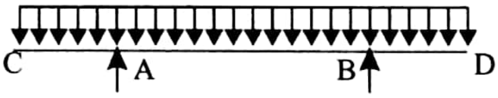


Fig. 5

Load diagram for the above ebam will be

(*a*) 

(*b*) 

(*c*) 

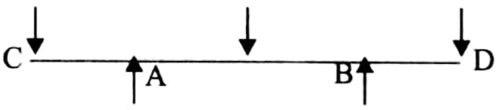
(*d*) 

Fig. 6

***126.** Young's modulus of elasticity and Poisson's ratio of a material are 1.25×10^5 MPa and 0.34 respectively. The modulus of rigidity of the matierial is:

(*a*) 0.4025×10^5 MPa
(*b*) 0.4664×10^5 MPa
(*c*) 0.8375×10^5 MPa
(*d*) 0.9469×10^5 MPa.

127. The ends of the leaves of a semi-elliptical leaf spring are made triangular in plane in order to

(*a*) obtain variable *I* in each leaf
(*b*) Permit each leaf to act as a overhanging beam
(*c*) have variable bending moment in each leaf
(*d*) make M/I constant throughout the length of the leaf.

128. The ratio of circumferential stress to longitudinal stress in a thin cylinder subjected to internal hydrostatic pressure is:

(*a*) 1/2 (*b*) 1
(*c*) 2 (*d*) 4.

129. The independent elastic constants for a homogeneous and isotropic material are:

(*a*) E, G, K, ν (*b*) E, G, K
(*c*) E, G, ν (*d*) E, G.

***130.** A simply supported beam of rectangular section 4 cm by 6 cm carries a mid-span concentrated load such that the 6 cm side lies parallel to line of action of loading; deflection under the load is δ. If the beam is now suppported with the 4 cm side parallel to line of action of loading, the deflection under the load will be

(*a*) $0.44\ \delta$ (*b*) $0.67\ \delta$
(*c*) $1.5\ \delta$ (*d*) $2.25\ \delta$.

***131.** A circular shaft fixed at *A* has diameter *D* for half of its length and diameter *D*/2 over the other half. What is the rotation of *C* relative to *B* if the rotation of *B* relative to A is 0.1 radian ?

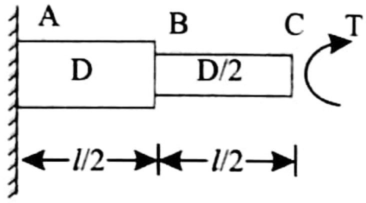


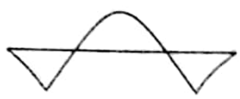
Fig. 7

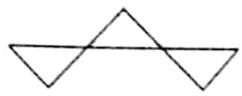
(*a*) 0.4 radian (*b*) 0.8 radian
(*c*) 1.6 radian (*d*) 3.2 radian

*** 132.** The shear stress at a point in a shaft subjected to a torque is

(*a*) directly proportional to the polar moment of inertia and to the distance of the point from the axis
(*b*) directly proportional to the applied torque and inversely proportional to the polar moment of inertia
(*c*) directly proportional to the applied torque and polar moment of inertia
(*d*) inversely proportional to the applied torque and the polar moment of inertia.

***133.** A beam carries a uniformly distributed load and is supported with two equal overhangs. Which one of the following correctly shows the bending moment diagram for the beam ?

(*a*) 

(*b*) 

(*c*) 

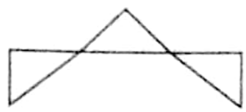
(*d*) 

Fig. 8

*134. A beam AB is hinge-supported at its ends and is loaded by couple P.c. as shown in the Fig. 9. The magnitude of shearing force at a section X of the beam is

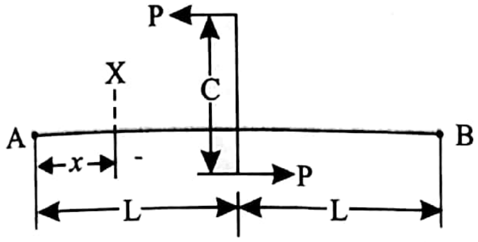


Fig. 9

(*a*) 0 (*b*) P
(*c*) $P/2L$ (*d*) P.c./$2L$

*135. A 0.2 mm thick tape goes over a frictionless pulley of 25 mm diameter. If E of material is 100 GPa, then the maximum stress induced in the tape is

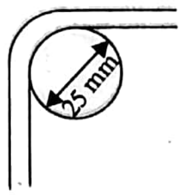


Fig. 10

(*a*) 100 MPa (*b*) 200 MPa
(*c*) 400 MPa (*d*) 800 MPa.

136. A solid circular shaft is subjected to a maximum shearing stress of 140 MPa. The magnitude of the maximum normal stress developed in the shaft is
(*a*) 140 MPa (*b*) 80 MPa
(*c*) 70 MPa (*d*) 60 MPa.

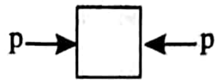
* 137. A metal pipe of 1 m diameter contains a fluid having a pressure of 1 N/mm^2. If the permissible tensile stress in the metal is 20 N/mm^2, then the thickness of the metal required for making the pipe would be
(*a*) 5 mm (*b*) 10 mm
(c) 20 mm (*d*) 25 mm.

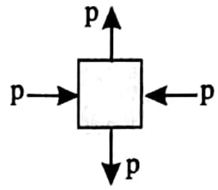
138. Total strain energy stored in simply supported beam of span 'L' and flexural rigidity 'EI' subjected to a concentrated load 'W' at the centre is equal to

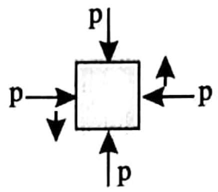
(*a*) $\dfrac{W^2L^3}{40EI}$ (*b*) $\dfrac{W^2L^3}{60EI}$

(c) $\dfrac{W^2L^3}{96EI}$ (*d*) $\dfrac{W^2L^3}{240EI}$.

*139. A solid thick cylinder is subjected to an external hydrostatic pressure p. The state of stress in the material of the cylinder is represented as:

(*a*)


(*b*)


(*c*)


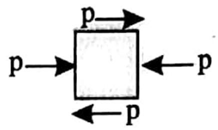
(*d*)


Fig. 11

*140. Circumferential and longitudinal strains in a cylindrical boiler under steam pressure are ε_1 and ε_2 respectively. Change in volume of the boiler cylinder per unit volume will be

(*a*) $\varepsilon_1 + 2\,\varepsilon_2$ (*b*) $\varepsilon_1 \varepsilon_2^2$

(*c*) $2\varepsilon_1 + \varepsilon_2$ (*d*) $\varepsilon_1^2 \varepsilon_2$.

*141. If two shafts of the same length, one of which is hollow, transmit equal torque and have equal maximum stress, then they should have equal
(*a*) polar moment of inertia
(*b*) polar modulus of section
(*c*) diameter
(*d*) angle of twist.

*142. In the assembly of pulley, key and shaft
(*a*) pulley is made the weakest
(*b*) key is made the weakest
(*c*) key is made the strongest
(*d*) all the three are designed for equal strength.

143. A column of length 'l' is fixed at its both ends. The equivalent length of the column is:
(*a*) $2\,l$ (*b*) $0.5\,l$
(*c*) $4\,l$ (*d*) l.

*144. The shafts of same length and material are joined in series. If the ratio of their diameters is 2, then the ratio of their angles of twist will be

(*a*) 2 (*b*) 4
(*c*) 8 (*d*) 16.

145. An open-coiled helical spring of mean diameter D, number of coils N and wire diameter d is subjected to an axial force P. The wire of the spring is subjected to
(*a*) direct shear only
(*b*) combined shear and bending only
(*c*) combined shear, bending and twisting
(*d*) combined shear and twisting only.

***146.** If a material has a modulus of elasticity of 210 GN/m^2 and a modulus of rigidity of 80 GN/m^2, then the approximate value of the Poisson s ratio of the material would be
(*a*) 0.26
(*b*) 0.31
(*c*) 0.47
(*d*) 0.5

147. In an axi-symmetric plane strain problem, let u be the radial displacement at r. Then the strain components, ε_r, ε_θ, $\gamma_{r\theta}$ are given by:

(*a*) $\varepsilon_r = \dfrac{u}{r}, \varepsilon_\theta = \dfrac{\partial u}{\partial r}, \gamma_{r\theta} = \dfrac{\partial^2 u}{\partial r\,\partial\theta}$

(*b*) $\varepsilon_r = \dfrac{\partial u}{\partial r}, \varepsilon_\theta = \dfrac{u}{r}, \gamma_{r\theta} = 0$

(*c*) $\varepsilon_r = \dfrac{u}{r}, \varepsilon_\theta = \dfrac{\partial u}{\partial r}, \gamma_{r\theta} = 0$

(*d*) $\varepsilon_r = \dfrac{\partial u}{\partial r}, \varepsilon_\theta = \dfrac{\partial u}{\partial \theta} = \gamma_{r\theta} = \dfrac{\partial^2 u}{\partial r\,\partial\theta}$.

148. A beam AB of length $2L$ having a concentrated load P at its mid-span is hinge-supported at its two ends A and B or two identical cantilevers as shown in the Fig. 12. The correct value of bending moment at A is:

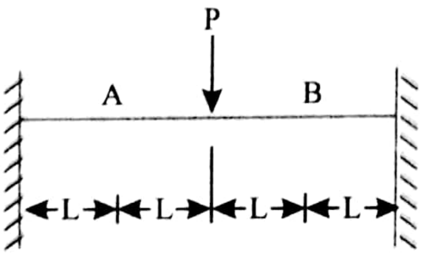


Fig. 12

(*a*) zero
(*b*) $PL/2$
(*c*) PL
(*d*) $2PL$.

***149.** Match List I with List II and select the correct answer from the codes given below :

List I (*Property*)	List II (*Testing machines*)
A. Tensile strength	1. Rotating bending machine
B. Impact strength	2. Three-point loading machine
C. Bending strength	3. Universal testing machine
D. Fatigue strength	4. Izod testing machine

Codes:

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

150.

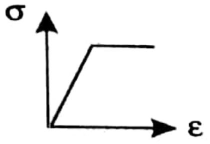
List I (*Condition of beam*)	List II (*Bending moment diagram*)
A. Subject to bending moment at the end of cantilever	1. Triangle
B. Cantilever carrying uniformly distributed load over the whole length	2. Cubic parabola
C. Cantilever carrying linearly varying load from zero at the fixed end to maximum at the support	3. Parabola
D. A beam having load at the centre and supported at the ends	4. Rectangle

Codes :

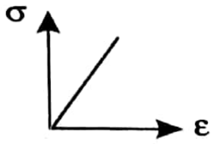
	A	*B*	*C*	*D*
(*a*)	4	1	2	3
(*b*)	4	3	2	1
(*c*)	3	4	2	1
(*d*)	3	4	1	2

151. **List I** **List II**

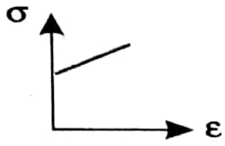
A. Rigid-perfectly



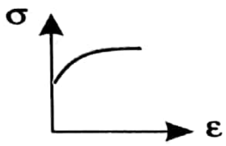
B. Elastic-perfectly



C. Rigid-strain hardening



D. Linearly elastic



Codes:

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

152.

(*Material properties*)	(*Tests to determine material properties*)
A. Ductility	1. Impact test
B. Toughness	2. Fatigue test
C. Endurance limit	3. Tension test
D. Resistance to penetration	4. Hardness test

Codes :

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

153.

List I	**List II**
A. The ... is the deformation producedby the stress	1. Cantilever
B. ...... is the property that enables the formation of a permanent deformation in a material.	2. Section modulus
C. A .... is a beam whose one end is fixed and the other end free.	3. Plasticity
D. The strength of the beam mainly depends on	4. Strain

Codes:

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

154.

List I	**List II**
A. ..... loading induces direct and bending stresses at the section.	1. Middle third
B. The brick chimney is stable if the resultant thrust lies within the	2. Eccentric
C. If the bending moment is consistent there will be no	3. Zero
D. If a beam is fixed at both ends, then slope and deflection at both ends are	4. Shearing stress

Code:

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

155.

List I	**List II**
A. Longitudinal stresses act ..... to the longitudinal axis of the shell.	1. Welding
B. In thick cylinders the ..... stress varies along the thickness.	2. Gauge distance
C. The ......provides very rigid joints.	3. Circumferential
D. The distance between the consecutive rivets is called........	4. Parallel

Codes :

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

156.

	List I	List II
A..	The angle of twiset is directly proportional to the ...	1. Quarter ellptical
B.	.....springs are called cantilever laminated springs.	2. Twisting moment
C.	In case of a laminated spring the load at which the plates become straight is called .....load.	3. Resilience
D.	The strain energy stored by the body within elastic limit when loaded externally is called......	4. Proof

Codes:

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

157.

	List I	List II
A.	Stress due to suddenly applied load is two times that of .... load.	1. Secant formula
B.	A member of structure or bar which carries an axial compressive load is called....	2. Maximum principal stress
C.	The .... is used for long columns under eccentric loading	3. Strut
D.	.... theory is suitable for brittle materials	4. Gradually applied

Codes :

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

158.

	List I	List II
A.	In case of a solid rotating circular disc the radial stress is maximum at the	1. Inner radius
B.	The circumferential stress in a hollow circular rotating disc is at the	2. Centre
C.	The radial stress in a rotating hollow circular cylinder is maximum at the	3. Winkler-Bach
D.	The theory of curved beam was postulated by.......	4. Geometric mean radius

Codes:

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

159. Consider the following statemnts:

State of stress at a point when completely specified, enables one to determine the
1. principal stresses at the point
2. maximum shearing stress at the point
3. stress components on any plane containing the point

Of these statements:

(a) 1, 2 and 3 are correct
(b) 1 and 3 are correct
(c) 2 and 3 are correct
(d) 1 and 2 are correct

***160.** State of stress at a point in a strained body is shown in Fig 13. Which one of the figures given below represents correctly the Mohr's circle for the state of stress ?

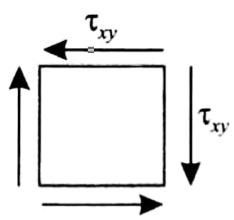
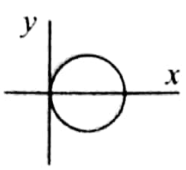
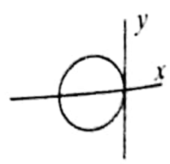
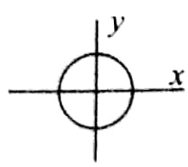
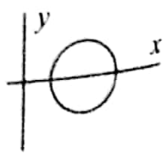


Fig. 13

(a) 

(b) 

(c) 

(d) 

***161.** The given figure shows the shear force diagram for the beam

ABCD. Bending moment in the portion *BC* of the beam

(*a*) is a non-zero constant
(*b*) is zero
(*c*) varies linearly from *B* to *C*
(*d*) varies parabolically from *B* to *C*.

162. The maximum bending moment in a simply supported beam of length *L* loaded by a concentrated load *W* at the mid-point is given by

(*a*) WL (*b*) $\frac{WL}{2}$

(*c*) $\frac{WL}{4}$ (*d*) $\frac{WL}{8}$.

***163.** A beam, built-in at both ends, carries a uniformly distributed load over its entire span as shown in figure. 14. Which one of the diagrams given below, represents bending moment distribution along the length of the beam ?

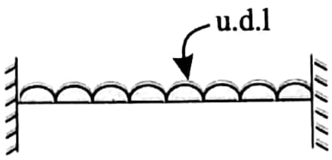
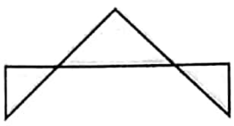


Fig. 14

(*a*)


(*b*)


(*c*)


(*d*)


***164.** If the shear force acting at every section of a beam is of the same magnitude and of the same direction then it represents a

(*a*) simply supported beam with a concentrated load at the centre
(*b*) overhang beam having equal overhang at both supports and carrying equal concentrated loads acting in the same direction at the free ends
(*c*) cantilever subjected to concentrated load at the free end
(*d*) simply supported beam having concentrated loads of equal magnitude and in the same direction acting at equal distances from the supports.

***165.** A cantilever beam carries a load *W* uniformly distributed over its entire length. If the same load is placed at the free end of the same cantilever, then the ratio of maximum deflection in the first case to that in the second case will be:

(*a*) $\frac{3}{8}$ (*b*) $\frac{8}{3}$

(*c*) $\frac{5}{8}$ (*d*) $\frac{8}{5}$.

166. The Fig. 15 shows a cantilever of span '*L*' subjected to a concentrated load '*P*' and a moment '*M*' at the free end. Deflection at the free end is given by:

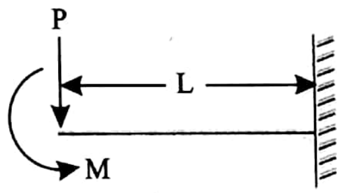


Fig.15

(*a*) $\frac{PL^2}{2EI} + \frac{ML^2}{3EI}$

(*b*) $\frac{ML^2}{2EI} + \frac{PL^3}{3EI}$

(*c*) $\frac{ML^2}{3EI} + \frac{PL^3}{2EI}$

(*d*) $\frac{ML^2}{2EI} + \frac{PL^3}{48EI}$

167. For a cantilever beam of length '*l*', flexural rigidity *EI* and loaded at its free end by a concentrated load *W*, match List I with List II and select the correct answer using the codes given below the lists :

	List I		**List II**
A.	Maximum bending moment	1.	Wl
B.	Strain energy	2.	$\frac{Wl^2}{2EI}$
C.	Maximum slope	3.	$\frac{Wl^3}{3EI}$
D.	Maximum deflection	4.	$\frac{W^2l^3}{6EI}$

Codes :

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

***168.** A hollow shaft is subjected to torsion. The shear stress variation in the shaft along the radius is given by:

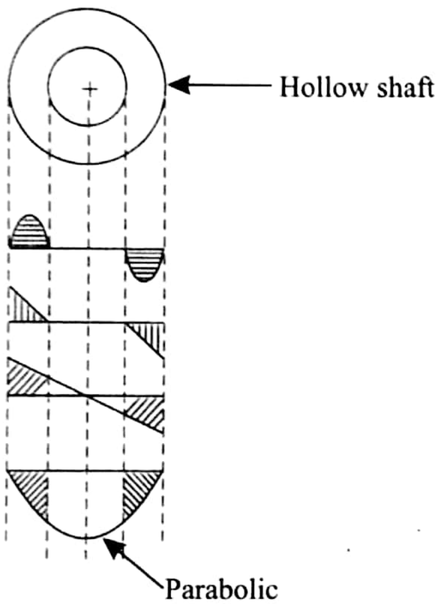


Fig. 16

169. The equivalent bending moment under combined action of bending moment M and torque T is:

(a) $\sqrt{M^2+T^2}$

(b) $\frac{1}{2}\sqrt{M^2+T^2}$

(c) $M+\sqrt{M^2+T^2}$

(d) $\frac{1}{2}\left[M+\sqrt{M^2+T^2}\right]$

170. The bending moment (M) is constant over a length segment (l) of a beam. The shearing force will also be constant over this length and is given by:

(a) $\frac{M}{l}$ (b) $\frac{M}{2l}$

(c) $\frac{M}{4l}$ (d) none of these.

***171.** In a thick cylinder, subjected to internal and external presssures, let r_1 and r_2 be the internal and external radii respectively. Let u be the radial displacement of a material element at radius r, $r_2 \geqslant r \geqslant r_1$. Identifying the cylinder axis as z-axis, the radial strain component is

(a) $\frac{u}{r}$ (b) $\frac{u}{\theta}$

(c) $\frac{du}{dr}$ (d) $\frac{du}{d\theta}$.

172. Auto frettage is the method of

(a) joining thick cylinders
(b) calculating stresses in thick cylinders
(c) prestressing thick cylinders
(d) increasing the life of thick cylinders.

173. Given that, d = diameter of spring, R = mean radius of coils, n = number of coils and G = modulus of rigidity, the stiffness of the close-coiled helical spring subject to an axial load W is equal to:

(a) $\frac{Gd^4}{64R^3n}$ (b) $\frac{Gd^3}{64R^3n}$

(c) $\frac{Gd^4}{32R^3n}$ (d) $\frac{Gd^4}{64R^2n}$.

174. When a close-coiled helical spring is subjected to a couple about its axis, the stress induced in the wire material of the spring is

(a) bending stress only
(b) direct shear stress only
(c) a combination of torsional shear stress and bending
(d) a combination of bending stress and direct shear stress.

***175.** If a shaft made from ductile material is subjected to combined bending and twisting moments, calculations based on which one of the following failure theories would give the most conservative value?

(a) Maximum principal stress theory
(b) Maximum shear stress theory
(c) Maximum strain energy theory
(d) Maximum distortion energy theory.

176. During tensile-testing of a specimen using a Universal testing machine, the parameters actually measured include:

(a) true stress and true strain
(b) Poisson s ratio and Young s modulus
(c) engineering stress and engineering strain
(d) load and elongation.

177. A bar of uniform cross-section of one sq. cm is subjected to a set of five forces as shown in Fig. 17, resulting in its equilibrium. The maximum tensile stress (in kg/cm^2) produced in the bar is

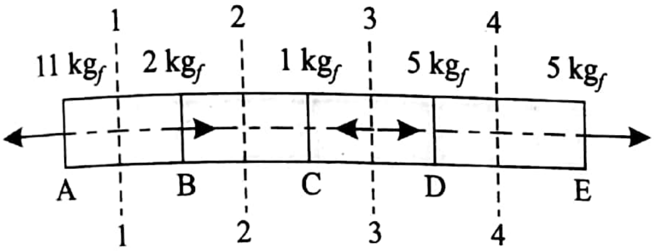


Fig. 17

(a) 1 (b) 2
(c) 10 (d) 11

178. A plane stressed element is subjected to the state of stress given by $\sigma_x = \tau_{xy} = 100$ kgf/cm^2 and σ = 0. Maximum shear stress in the element is equal to

(a) $50\sqrt{3}$ kgf/cm^2 (b) 100 kgf/cm^2

(c) $50\sqrt{5}$ kgf/cm^2 (d) 150 kgf/cm^2.

179. Match List-I (Elastic properties of an isotropic elastic material) with List-II (Nature of strain produced) and select the correct answer using the codes given below the Lists :

List I	List II
A. Young s modulus	1. Shear strain
B. Modulus of rigidity	2. Normal strain
C. Bulk modulus of rigidity	3. Transverse strain
D. Poisson s ratio	4. Volumetric strain

Codes:

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

180. The relationship between the Lame s constant λ, Young s modulus E and the Poisson s ratio ± is:

(a) $\lambda = \dfrac{E\mu}{(1+\mu)(1-2\mu)}$

(b) $\lambda = \dfrac{E\mu}{(1+2\mu)(1-\mu)}$

(c) $\lambda = \dfrac{E\mu}{(1+\mu)}$

(d) $\lambda = \dfrac{E\mu}{(1-\mu)}$.

181. A 10 cm long and 5 cm diameter steel rod fits snugly between two rigid walls 10 cm apart at room temperature. Young s modulus of elasticity and coefficient of linear expansion of steel are 2 × 10^6 kgf/cm^2 and 12 × 10^{-6}/°C respectively. The stress developed in the rod due to a 100°C rise in temperature will be

(a) 6 × 10^{-10} kgf/cm^2
(b) 6 × 10^{-9} kgf/cm^2
(c) 2.4 × 10^3 kgf/cm^2
(d) 2.4 × 10^4 kgf/cm^2.

182. A beam subjected to a load P is shown in the given Fig. 18. The bending moment at the support AA of the beam will be

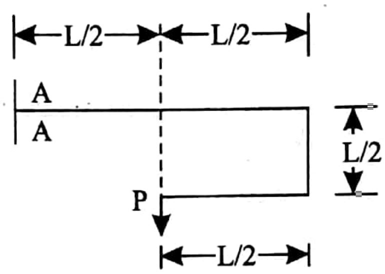


Fig. 18

(a) PL (b) $PL/2$
(c) $2PL$ (d) Zero.

183. A 2m long beam BC carries a single concentrated load at its mid-span and is simply supported at its ends by two cantilevers AB 1 m long and CD 2m long as shown in the Fig. 19.

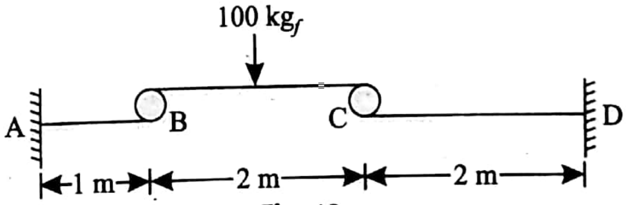


Fig. 19

The shear force at end A of the cantilever AB will be:

(a) Zero (b) 40 kgf
(c) 50 kgf (d) 60 kgf.

184. If a beam is subjected to a constant bending moment along its length then the shear force will

(a) also have a constant value everywhere along its length
(b) be zero at all section along the beam
(c) be maximum at the centre and zero at the ends
(d) zero at the centre and maximum at the ends.

185. A simply supported beam with width b and depth d carries a central load W and under -

goes deflection δ at the centre. If the width and depth are interchanged, the deflection at the centre of the beam would attain the value

(*a*) $\frac{d}{b}\delta$ (*b*) $\left(\frac{d}{b}\right)^2 \delta$

(*c*) $\left(\frac{d}{b}\right)^3 \delta$ (*d*) $\left(\frac{d}{b}\right)^4 \delta$.

186. A round shaft of diameter '*d*' and length '*l*' fixed at both ends '*A*' and '*B*', is subjected to a twisting moment *T* at *C* at a distance of *l*/4 from A (see Fig 20). The torsional stresses in the parts *AC* and *CB* will be:

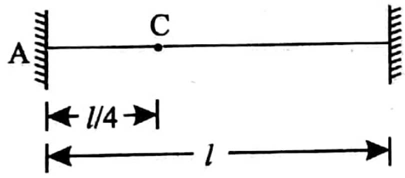


Fig. 20

(*a*) equal
(*b*) in the ratio of 1 : 3
(*c*) in the ratio of 3 : 1
(*d*) indeterminate.

187. A wooden beam of rectangular cross-section 10 cm deep by 5 cm wide carries maximum shear force of 2000 kgf. Shear stress at neutral axis of the beam section is

(*a*) zero (*b*) 49 kgf/cm^2
(*c*) 260 kgf/cm^2 (*d*) 80 kgf/cm^2.

188. A beam cross-section is used in two different orientations as shown in Fig. 21 given below. Bending moments applied to the beam in both cases are same. The maximum bending stresses induced in cases (*A*) and (*B*) are related as

(*a*) $s_A = s_B$ (*b*) $s_A = 2s_B$

(*c*) $\sigma_A = \frac{\sigma_B}{2}$ (*d*) $\sigma_A = \frac{\sigma_B}{4}$.

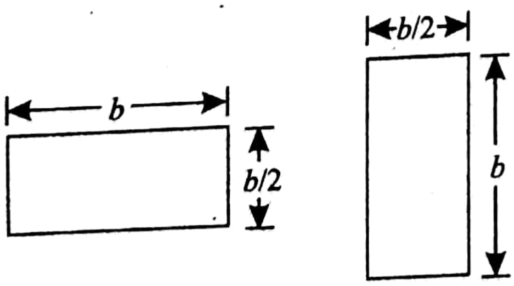


Fig. 21

189. The curve *ABC* is the Euler's curve for stability of column. The horizontal line *DEF* is the strength limit. With reference to Fig. 22 Match List-I with List-II and select the correct answer using the codes given below the

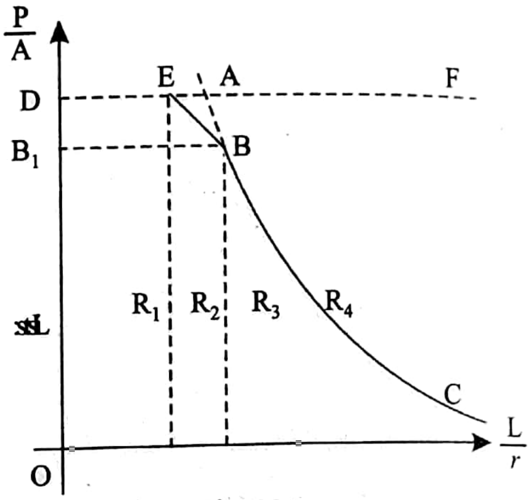


Fig. 22

List I (Regions)	List II (Column specifications)
A. R_1	1. Long, stable
B. R_2	2. Short
C. R_3	3. Medium
D. R_4	4. Long unstable

Codes:

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

190. The ratio of the compressive critical load for a long column fixed at both the ends and a column with one end fixed and the other end free is:

(*a*) 1 : 2 (*b*) 1 : 4
(*c*) 1 : 8 (*d*) 1 : 16

***191.** Maximum shear stress in a solid shaft of diameter *D* and length *L* twisted through an angle θ is τ. *A* hollow shaft of same material and length having outside and inside diameters of *D* and *D*/2 respectively is also twisted through the same angle of twist θ. The value of maximum shear stress in the hollow shaft will be:

(*a*) $\frac{16}{15}\tau$ (*b*) $\frac{8}{7}\tau$

(*c*) $\frac{4}{3}\tau$ (*d*) τ.

192. From design point of view, spherical pressure vessels are preferred over cylindrical pressure vessels because they:
(*a*) are cost effective in fabrication
(*b*) have uniform higher circumferential stress
(*c*) uniform lower circumferential stress
(*d*) have a larger volume for the same quantity of material used.

*193. If two identical helical springs are connected in parallel and to these two, another identical spring is connected in series and the system is loaded by a weight W, as shown in the Fig. 23, then the resulting deflection will be given by (δ = deflection, S = stiffness, W = load)

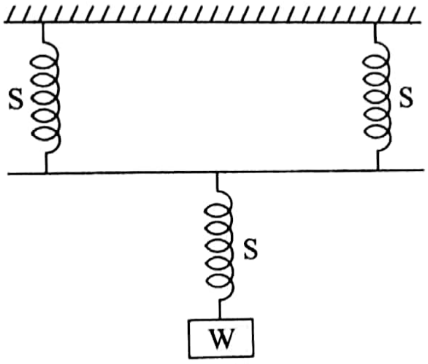


Fig. 23

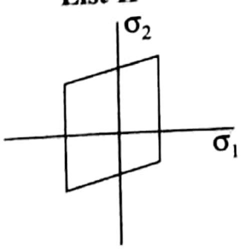
(*a*) $\delta = \dfrac{3W}{2S}$ (*b*) $\delta = \dfrac{W}{2S}$
(*c*) $\delta = \dfrac{2W}{3S}$ (*d*) $\delta = \dfrac{W}{3S}$.

194. Which one of the following gives the correct expression for strain energy stored in a beam of length L and of uniform cross-section having moment of inertia I and subjected to constant bending moment M:
(*a*) $\dfrac{ML}{EI}$ (*b*) $\dfrac{ML}{2EI}$
(*c*) $\dfrac{M^2L}{EI}$ (*d*) $\dfrac{M^2L}{2EI}$.

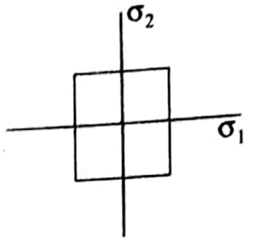
195. Match List (Failure theories) with List-II (Fig. 24 representing boundaries of these theories) and select the correct answer using the codes given below the Lists:

List-I | List II

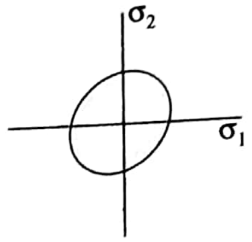
A. Max. principal stress theory



B. Max. shear stress theory



C. Max-octahedral shear stress theory



D. Max. shear strain energy theory

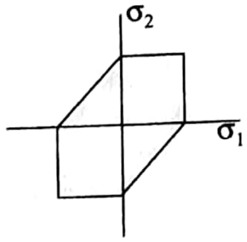


Fig. 24

Codes:

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

196. Two metal plates of thickness '*t*' and width '*w*' are jointed by a fillet weld of 45° as shown in the Fig. 25. When subjected to a pulling force '*F*', the stress induced in the weld will be

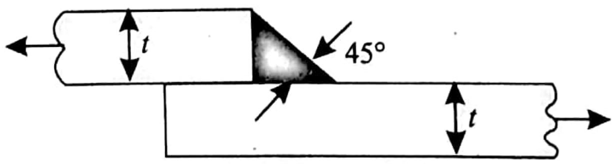


Fig. 25

(*a*) $\dfrac{F}{wt\sin 45°}$ (*b*) $\dfrac{F}{wt}$
(*c*) $\dfrac{F\sin 45°}{wt}$ (*d*) $\dfrac{2F}{wt}$.

197. Consider the following statements:
A splined shaft is used for
1. transmitting power
2. holding a flywheel rigidly in position
3. moving axially the gear wheels mounted on it
4. mounting *V*-belt pulleys on it

(a) 2 and 3 are correct
(b) 1 and 4 are correct
(c) 2 and 4 are correct
(d) 1 and 3 are correct.

198. When two shafts are neither parallel nor intersecting, power can be transmitted by using
(a) a pair of spur gears
(b) a pair of helical gears
(c) an Oldham's coupling
(d) a pair of spiral gears.

199. In the assembly desing of shaft, pulley and key, the weakest member is:
(a) pulley (b) key
(c) shaft (d) none.

200. In the formulation of Lewis equation for toothed gearing, it is assumed that tangential tooth load, F_1 acts on the
(a) pitch point
(b) tip of the tooth
(c) root of the tooth
(d) whole face of the tooth.

201. For a two-dimensional state stress ($\sigma_1 > \sigma_2$, $\sigma_1 > 0$, $\sigma_2 < 0$) the designed values are most conservative if which one of the following failure theories were used:
(a) Maximum principal strain theory
(b) Maximum distortion energy theory
(c) Maximum shear stress theory
(d) Maximum principal stress theory.

202. Match List I with List II and select the correct answer using the codes given below the lists:

List I	List II
A. Single-plate friction clutch	1. Scooters
B. Multi-plate friction clutch	2. Rolling mills
C. Centrifugal clutch	3. Trucks
D. Jaw clutch	4. Mopeds

Codes:

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

203. Which of the following stresses are associated with the design of pins in bushed pin type flexible coupling?
1. Bearing stress
2. Bending stress,
3. Axial tensile stress
4. Transverse shear stress.

Codes :
(a) 1, 3 and 4 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) 1, 2 and 4

204. The state of plane stress at a point is described by $\sigma_x = \sigma_y = \sigma$ and $\tau_{xy} = 0$. The normal stress on the plane inclined at 45° to the x-plane will be:
(a) σ (b) $\sqrt{2}\sigma$
(c) $\sqrt{3}\sigma$ (d) 2σ.

205. Consider the following statements:
State of stress in two-dimensions at a point in a loaded component can be completely specified by indicating the normal and shear stresses on
1. a plane containing the point
2. any two planes passing through the point
3. two mutually perpendicular planes through the point.

Of these statements:
(a) 1 and 3 are correct
(b) 2 alone is correct
(c) 1 alone is correct
(d) 3 alone is correct.

206. For a composite bar consisting of a bar enclosed inside a tube of another material and when compressed under a load 'W' as a whole through rigid collars at the end of the bar, the equation of compability is given by (suffices 1 and 2 refer to bar and tube respectively)
(a) $W_1 + W_2 = W$
(b) $W_1 + W_2 =$ Constant
(c) $\dfrac{W_1}{A_1 E_1} = \dfrac{W_2}{A_2 E_2}$
(d) $\dfrac{W_1}{A_1 E_2} = \dfrac{W_2}{A_2 E_1}$.

207. A tapering bar (diameters of end sections being d_1 and d_2) and a bar of uniform cross-section 'd' have the same length and are subjected to the same axial pull. Both the bars will have the same extension if 'd' is equal to:
(a) $\dfrac{d_1 + d_2}{2}$ (b) $\sqrt{d_1 d_2}$
(c) $\sqrt{\dfrac{d_1 d_2}{2}}$ (d) $\dfrac{\sqrt{d_1 + d_2}}{2}$.

208. The number of independent elastic constants required to express the stress-strain relationship for a linearly elastic isotropic material is:

(*a*) one (*b*) two
(*c*) three (*d*) four.

209. The deformation of bar under its own weight as compared to that when subjected to a direct axial load equal to its own weight will be:

(*a*) the same (*b*) one-fourth
(*c*) half (*d*) double.

210. A slender bar of 100 mm² cross-section is subjected to loading as shown in the Fig. 26. If the modulus of elasticity is taken as 200 × 10^9 Pa, then the elongation produced in the bar will be

(*a*) 10 mm (*b*) 5 mm
(*c*) 1 mm (*d*) nil.

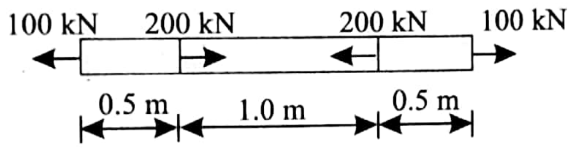


Fig. 26

211. For the beam shown in the figure 27, the elastic curve between the supports *B* and *C* will be

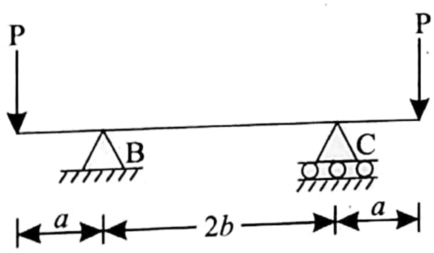


Fig. 27

(*a*) circular (*b*) parabolic
(*c*) elliptic (*d*) a straight line.

***212.** A simply supported beam is loaded as shown in the Fig. 28. The maximum shear force in the beam will be:

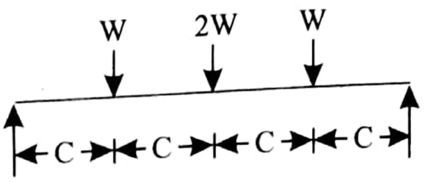


Fig. 28

(*a*) zero (*b*) *W*
(*c*) 2W (*d*) 4W.

***213.** A lever is supported on two hinges at *A* and *C*. It carries a force of 3 kN as shown in the Fig. 29. The bending moment at *B* will be:

(*a*) 3 kN-m (*b*) 2 kN-m
(*c*) 1 kN-m (*d*) zero.

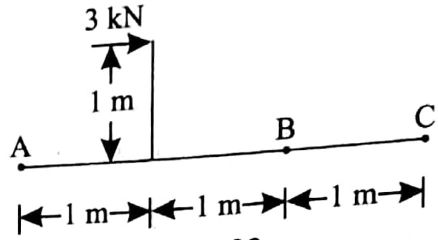


Fig. 29

214. Two hollow shafts of the same material have the same length and outside diameter. Shaft 1 has internal diameter equal to one-third of the outer diameter and shaft 2 has internal diameter equal to half of the outer diameter. If both the shafts are subjected to the same torque, the ratio of their twists $\frac{\theta_1}{\theta_2}$ will be equal to:

(*a*) 16/81 (*b*) 8/27
(*c*) 19/27 (*d*) 243/256.

215. A simply supported beam of constant flexural rigidity and length 2*L* carries a concentrated load '*P*' at its mid-span and the deflection under the load is δ. If a cantilever beam of the same flexural rigidity and length '*L*' is subjected to a load '*P*' at its free end, then the deflection at the free end will be:

(*a*) $\frac{1}{2}\delta$ (*b*) δ
(*c*) 2δ (*d*) 4δ.

216. A solid shaft of diameter 100 mm, length 1000 mm is subjected to a twisting moment *T*. The maximum shear stress developed in the shaft is 60 N/mm². A hole of 50 mm diameter is now drilled throughout the length of the shaft. To develop a maximum shear stress of 60 N/mm² in the hollow shaft, the torque '*T*' must be reduced by

(*a*) *T*/4 (*b*) *T*/8
(*c*) *T*/12 (*d*) *T*/16.

217. A circular shaft is subjected to the combined action of bending, twisting and direct axial loading. The maximum bending stress σ, maximum shearing stress $\sqrt{3}\sigma$ and a uniform axial stress σ (compressive) are produced. The maximum compressive normal stress produced in the shaft will be:

(*a*) 3σ (*b*) 2σ
(*c*) σ (*d*) zero.

218. Two close-coiled springs are made from the small diameter wire, one wound on 2.5 cm diameter core and the other on 1.25 cm diameter core. If each spring had 'n' coils, then the ratio of their spring constants would be:

(*a*) 1/16 (*b*) 1/8
(*c*) 1/4 (*d*) 1/2.

219. A closed coil helical spring is subjected to a torque about its axis. The spring wire would experience a

(*a*) bending stress
(*b*) direct tensile stress of uniform intensity at its cross-section
(*c*) direct shear stress
(*d*) torsional shearing stress.

220. When a thin cylinder of diameter 'd' and thickness 't' is pressurized with an internal pressure of 'p' (1/m is the Poissin's ratio and E is the modulus of elasticity), then

(*a*) the circumferential strain will be equal to

$$\frac{pd}{2tE}\left(\frac{1}{2}-\frac{1}{m}\right)$$

(*b*) the longitudinal strain will be equal to

$$\frac{pd}{2tE}\left(1-\frac{1}{2m}\right)$$

(*c*) the longitudinal stress will be equal to

$$\frac{pd}{2t}$$

(*d*) the ratio of the longitudinal strain to circumferential strain will be equal to

$$\frac{m-2}{2m-1}.$$

221. A thick-walled hollow cylinder having outside and inside radii of 90 mm and 40 mm respectively is subjected to an external pressure of 800 MN/m^2. The maximum circumferential stress in the cylinder will occur at a radius of

(*a*) 40 mm
(*b*) 60 mm
(*c*) 65 mm
(*d*) 90 mm.

222. In a thick cylinder pressurized from inside, the hoop stress is maximum at

(*a*) the centre of the wall thickness
(*b*) the outer radius
(*c*) the inner radius
(*d*) both the inner and the outer radii.

223. The Euler's crippling load for a 2 m long slender steel rod of uniform cross-section hinged at both the ends is 1 kN. The Euler's crippling load for a 1 m long steel rod of the same cross-section and hinged at both ends will be:

(*a*) 0.25 kN (*b*) 0.5 kN
(*c*) 2kN (*d*) 4kN.

224. For the state of stress of pure shear τ, the strain energy stored per unit volume in the elastic, homogeneous isotropic material having elastic constants E and ν will be

(*a*) $\frac{\tau^2}{E}(1+\nu)$ (*b*) $\frac{\tau^2}{2E}(1+\nu)$

(*c*) $\frac{2\tau^2}{E}(1+\nu)$ (*d*) $\frac{\tau^2}{2E}(2+\nu)$.

225. Euler's formula gives 5 to10% error in crippling load as compared to experimental results in practice because

(*a*) effect of direct stress is neglected
(*b*) pin joints are not free from friction
(*c*) the assumptions made in using the formula are not met in practice
(*d*) the material does not behave in an ideal elastic way in tension and compression.

226. According to the maximum shear stress theory of failure permissible twisting moment in a circular shaft is 'T'. The permissible twisting moment in the same shaft as per the maximum principal stress theory of failure will be

(*a*) $\frac{1}{2}T$ (*b*) T

(*c*) $\sqrt{2}T$ (*d*) $2T$.

***227.** $\alpha = 12.5 \times 10^{-6}$/°C, $E = 200$ GPa

If the rod fitted snugly between the supports as shown in the Fig. 30, is heated, the stress induced in it due to 20°C rise in temperature will be

(*a*) 0.07945 MPa (*b*) – 0.07945 MPa
(*c*) – 0.03972 MPa (*d*) 0.03972 MPa.

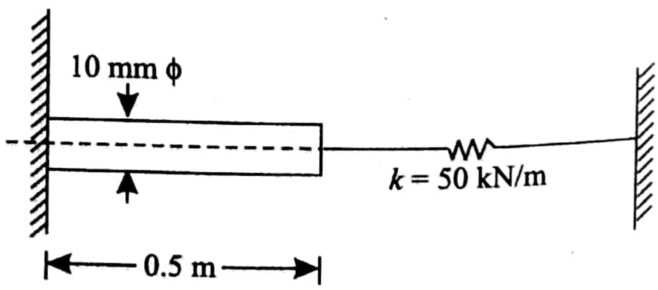


Fig. 30

***228.** If permissible stress in plates of joint through a pin as shown in Fig. 31 is 200 MPa, then the width w will be:

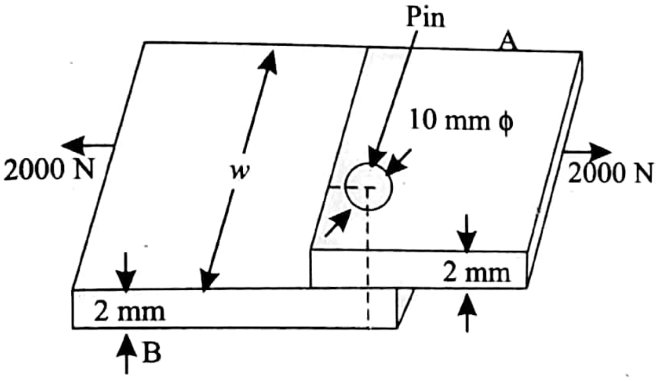


Fig. 31

(*a*) 15 mm (*b*) 18 mm
(*c*) 20 mm (*d*) 25 mm.

***229.** Circumferential stress in a cylindrical steel boiler shell under internal pressure is 80 MPa, Young's modulus of elasticity and Poisson's ratio are respectively 2×10^5 MPa and 0.28. The magnitude of circumferential strain in the boiler will be

(*a*) 3.44×10^{-4} (*b*) 3.84×10^{-4}
(*c*) 4×10^{-4} (*d*) 4.56×10^{-4}

***230.** A thin cylinder with closed lids is subjected to internal pressure and supported at the ends as shown in the Fig. 32.

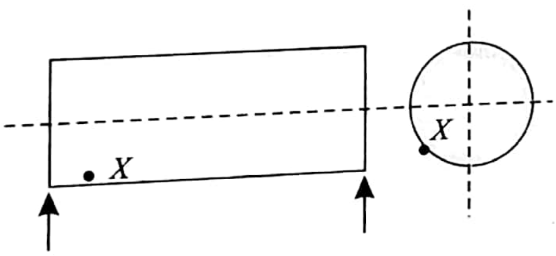
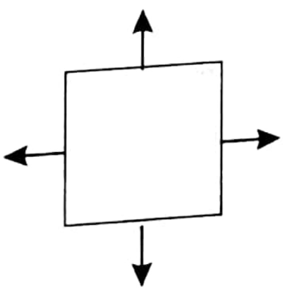


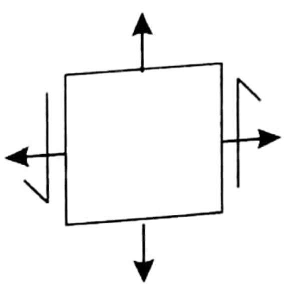
Fig. 32

The state of stress at point X is as represented in

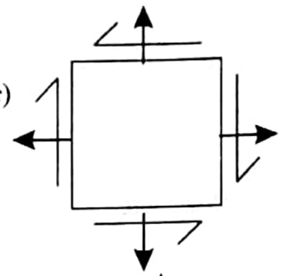
(*a*)



(*b*)



(*c*)



(*d*)

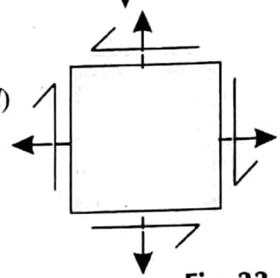


Fig. 33

***231.** The number of elastic constants for a completely anisotropic elastic material which follows Hooke's law is:

(*a*) 3 (*b*) 4
(*c*) 21 (*d*) 25.

***232.** The bending moment equation, as a function of distance x measured from the left end, for a simply supported beam of span L m carrying a uniformly distributed load of intensity w N/m will be given by:

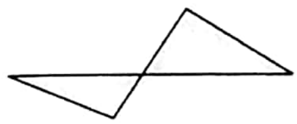
(*a*) $M = \dfrac{wL}{2}(L - x) - \dfrac{w}{2}(L - x)^2$ N-m

(*b*) $M = \dfrac{wL}{2}x - \dfrac{wx^2}{2}$ N-m

(*c*) $M = \dfrac{wL}{2}(L - x)^2 - \dfrac{w}{2}(L - x)^3$ N-m

(*d*) $M = \dfrac{wx^2}{2} - \dfrac{wLx}{2}$ N-m.

***233.** The bending moment diagram shown in Fig. 34 corresponds to the shear force diagram in



B.M. diagram

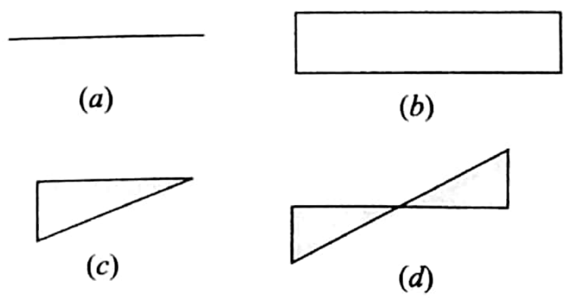


Fig. 34

***234.** Two beams of equal cross-sectional area are subjected to equal bending moment. If one beam has square cross-section and the other has circular section, then

(*a*) both beams will be equally strong
(*b*) circular section beam will be stronger
(*c*) square section beam will be stronger
(*d*) the strength of the beam will depend on the nature of loading .

***235.** A cantilever beam of rectangular cross-section is subjected to a load *W* at its free end. If the depth of the beam is doubled and the load is halved, the deflection of the free end as compared to original deflection will be:

(*a*) half (*b*) one-eighth
(*c*) one-sixteenth (*d*) double.

***236.** Which one of the following portions of the loaded beam shown in the given figure is subjected to pure bending ?

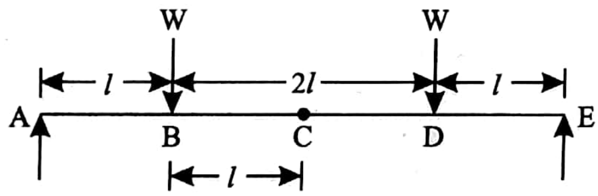


Fig. 35

(*a*) *AB* (*b*) *DE*
(*c*) *AE* (*d*) *BD*

***237.** A solid circular shaft is subjected to pure torsion. The ratio of maximum shear to maximum normal stress at any point would be

(*a*) 1 : 1 (*b*) 1 : 2
(*c*) 2 : 1 (*d*) 2 : 3.

238. A short column of external diameter *D* and internal diameter *d* carries an eccentric load *W*. The greatest eccentricity which the load can have without producing tension on the cross-section of the column would be:

(*a*) $\frac{D+d}{8}$ (*b*) $\frac{D^2+d^2}{8d}$

(*c*) $\frac{D^2+d^2}{8D}$ (*d*) $\sqrt{\frac{D^2+d^2}{8}}$.

***239.** A bar of length *L* and of uniform cross-sectional area *A* and second moment of area *I* is subjected to a pull *P*. If Young's modulus of elasticity of the bar material is *E*, the expression for strain energy stored in the bar will be

(*a*) $\frac{P^2L}{2AE}$ (*b*) $\frac{PL^2}{2EI}$

(*c*) $\frac{PL^2}{AE}$ (*d*) $\frac{P^2L}{AE}$.

***240.** If a thick cylindrical shell is subjected to internal pressure, then hoop stress, radial streas and longitudinal stress at a point in the thickness will be

(*a*) tensile, compressive and compressive respectively
(*b*) all compressive
(*c*) all tensile
(*d*) tensile, compressive and tensile respectively.

***241.** A thin cylinder with both ends closed is subjected to internal pressure *p*. The longitudinal stress at the surface has been calculated as σ_0. Maximum shear stress at the surface will be equal to

(*a*) $2\sigma_0$ (*b*) $1.5\ \sigma_0$
(*c*) σ_0 (*d*) $0.5\ \sigma_0$.

242. The maximum shear stress occurs on the outermost fibres of a circular shaft under torsion. In a close coiled helical spring, the maximum shear stress occurs on the

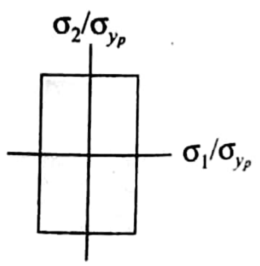
(*a*) outermost fibres
(*b*) fibres at mean diameter
(*c*) innermost fibres
(*d*) end coils.

***243.** A helical spring has *N* turns of coil of diameter *D*, and a second spring, made of same wire diameter and of same material has *N*/2 turns of coil of diameter 2*D*. If the stiffness of the first spring is *k*, then the stiffness of the second spring will be

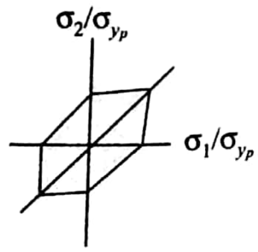
(*a*) *k*/4 (*b*) *k*/2
(*c*) 2*k* (*d*) 4*k*.

244. Which one of the following figures represents the maximum shear stress theory of Tresca criterion?

(*a*)



(*b*)



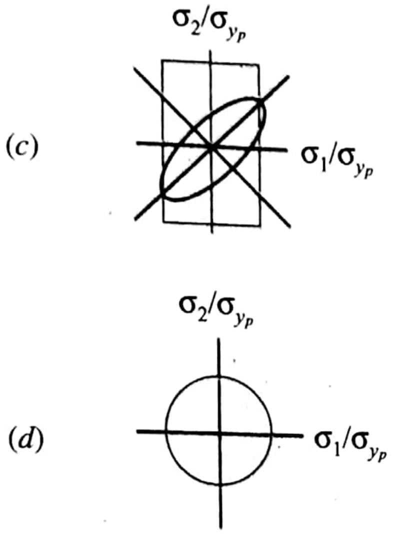


Fig. 36

245. Match List I (*End conditions of columns*) with List II (*Equivalent length in terms of length of hinged column*) and select the correct answer using the codes given below the Lists:

List I		**List II**	
A.	Both ends hinged	1.	L
B.	One end fixed and other end free	2.	$\sqrt{2}$L
C.	One end fixed and the other pin-joined	3.	L/2
D.	Both ends fixed	4.	2L

Codes :

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

246. Match List I with List II and select the correct answer using the codes given below the Lists :

List I		**List II**	
A.	Bending moment is constant	1.	Point of contraflexure
B.	Bending moment is maximum or minimum	2.	Shear force changes sign
C.	Bending moment is zero	3.	Slope of shear force diagram is zero over the portion of the beam
D.	Loading is constant	4.	Shear force is zero over the portion of the beam

Codes:

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

247. A load beam is shown in the Fig. 37. The bending moment diagram of the beam is best represented as

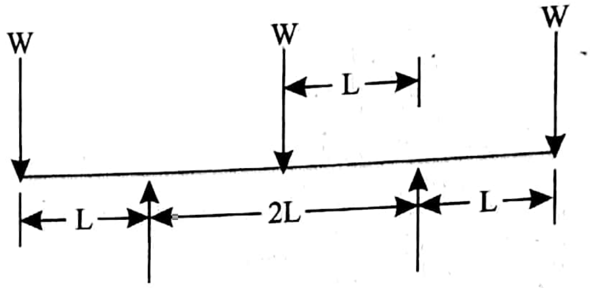


Fig. 37

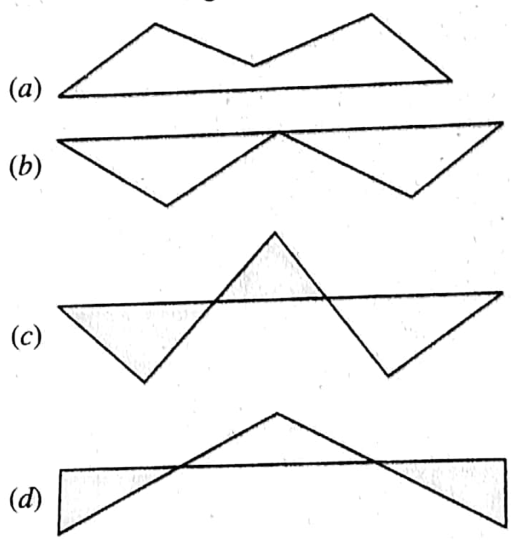


Fig. 38

248. At a certain section at a distance '*x*' from one of the supports of a simply supported beam the intensity of loading, bending moment and shear force are W_x, M_x, and V_x respectively. If the intensity of loading is varying continuously along the length of the beam, then the *invalid* relation is:

(*a*) Slope $Q_x = \dfrac{M_x}{V_x}$ (*b*) $V_x = \dfrac{dM_x}{dx}$

(*c*) $W_x = \dfrac{d^2M_x}{dx^2}$ (*d*) $W_x = \dfrac{dV_x}{dx}$.

249. Plane stress at a point in a body is defined by principal stresses 3σ and σ. The ratio of the normal stress to the maximum shear stress on the plane of maximum shear stress is

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

250. Which one of the following Mohr's circles Fig. 39 represents the state of pure shear ?

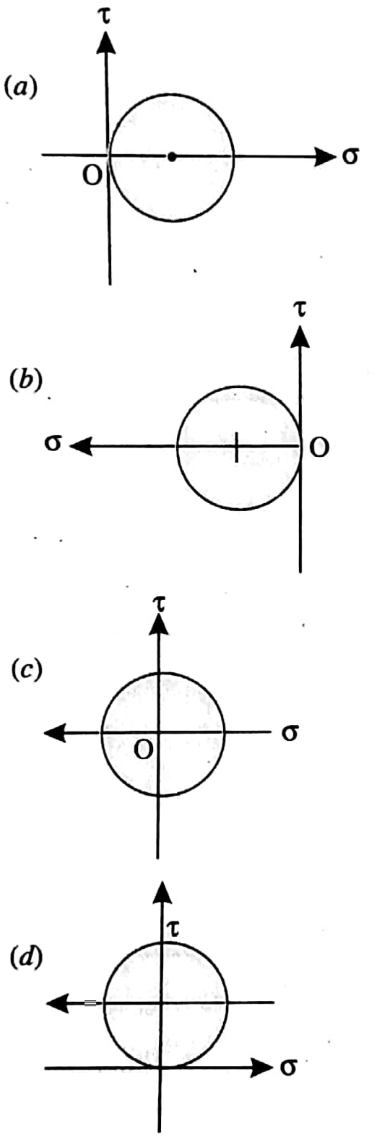


Fig. 39

251. The state of plane stress in a plate of 100 mm thickness is given as:
$\sigma_{xx} = 100$ N/mm^2; $\sigma_{yy} = 200$ N/mm^2; Young's modulus = 300 N/mm^2; Poisson's ratio = 0.3. The stress developed in the direction of thickness is

(a) zero (b) 90 N/mm^2
(c) 100 N/mm^2 (d) 200 N/mm^2

252. A rod of material with $E = 200 \times 10^3$ MPa and $\alpha = 10^{-3}$ mm/mm°C is fixed at both the ends. It is uniformly heated such that the increase in temperature is 30°C. The stress developed in the rod is

(a) 6000 N/mm^2 (tensile)
(b) 6000 N/mm^2 (compressive)
(c) 2000 N/mm^2 (tensile)
(d) 2000 N/mm^2 (compressive).

253. A circular solid shaft is subject to a bending moment of 400 kN.m and a twisting moment of 300 kN.m On the basis of the maximum principal stress theory, the direct stress is σ and according to the maximum shear stress theory, the shear stress is τ. The ratio σ/τ is

(a) $\frac{1}{5}$ (b) $\frac{3}{9}$
(c) $\frac{9}{5}$ (d) $\frac{11}{6}$.

254. The two cantilevers A and B shown in the Fig. 40 have the same uniform cross-section and the same material. Free end deflection of cantilever 'A' is δ. The value of mid-span deflection of the cantilever 'B' is

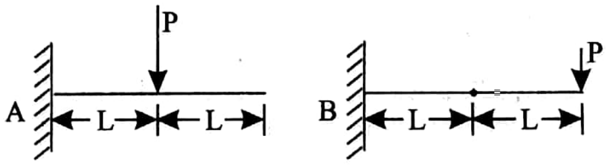


Fig. 40

(a) $\frac{1}{2}\delta$ (b) $\frac{2}{3}\delta$
(c) δ (d) 2δ.

255. A link is under a pull which lies on one of the faces as shown in the figure 40. The magnitude of maximum compressive stress in the link would be:

(a) 21.3 N/mm^2 (b) 16.0 N/mm^2
(c) 10.7 N/mm^2 (d) zero.

256. Two coiled springs, each having stiffness K, are placed in parallel. The stiffness of the combination will be:

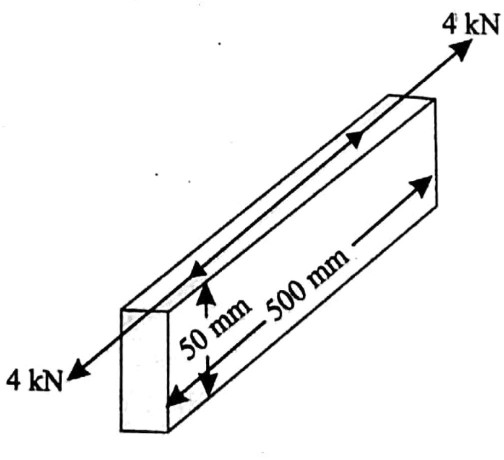


Fig. 41

(a) $4K$ (b) $2K$

(c) $\frac{K}{2}$ (d) $\frac{K}{4}$.

257. A long slender bar having uniform rectangular cross-section '$B \times H$' is acted upon by an axial compressive force. The sides B and H are parallel to x-and y-axes respectively. The ends of the bar are fixed such that they behave as pin-joined when the bar buckles in a plane normal to x- and they behave as built-in when the bar buckles in a plane normal to y-axis. If load capacity in either mode of buckling is same, then the value of H/B will be:

(a) 2 (b) 4

(c) 8 (d) 16.

258. The property by which an amount of energy is absorbed by material without plastic determation, is called

(a) toughness (b) impact strength

(c) ductility (d) resilience.

259. When a weight of 100 N falls on a spring of stiffness 1 kN/m from a height of 2m, the deflection caused in the first fall is:

(a) equal to 0.1 m

(b) between 0.1 and 0.2 m

(c) equal to 0.2 m

(d) more than 0.2 m.

260. Which one of the following features improves the fatigue strength of a metallic material?

(a) Increasing the temperature

(b) Scratching the surface

(c) Overstressing

(d) Understressing.

261. Cermets are

(a) metals for high temperature use with ceramic like properties

(b) ceramics with metallic strength and lustre

(c) coated tool materials

(d) metal-cermamic composites.

262. Percentage of various alloying elements present in different steel materials are given below:

1. 18% W; 4% Cr; 1% V; 5% Co; 0.7% C
2. 8% Mo; 4% Cr; 2% V; 6% W; 0.7% C
3. 27% Cr; 3% Ni; 5% Mo; 0.25% C
4. 18% Cr; 8% Ni; 0.15% C

Which of these relate to that of high speed steel ?

(a) 1 and 3 (b) 1 and 2

(c) 2 and 3 (d) 2 and 4.

263. A thin cylinder contains fluid at a pressure of 500 N/m^2, the internal diameter of the shell is 0.6 m and the tensile stress in the material is to be limited to 9000 N/m^2. The shell must have a minimum wall thickness of nearly

(a) 9 mm (b) 11 mm

(c) 17 mm (d) 21 mm.

264. From a tension test, the yield strength of steel is found to be 200 N/mm^2. Using a factory of safety of 2 and applying maximum principal stress theory of failure the permissible stress in the steel shaft subjected to torque will be

(a) 50 N/mm^2 (b) 57.7 N/mm^2

(c) 86.6 N/mm^2 (d) 100 N/mm^2.

265. Which one of the following properties is more sensitive to increase in strain rate?

(a) Yield strength

(b) Proportional limit

(c) Elastic limit

(d) Tensile strength.

266. Two identical spring labelled as 1 and 2 are arranged in series and subjected to force F as shown in Fig. 42.

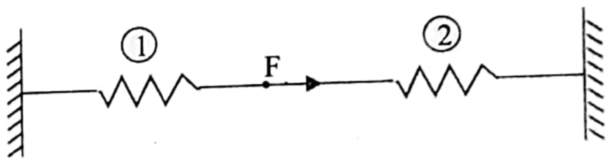


Fig. 42

Assume that each spring constant is K. The strain energy stored in spring 1 is:

(a) $\frac{F^2}{2K}$ (b) $\frac{F^2}{4K}$

(c) $\frac{F^2}{8K}$ (d) $\frac{F^2}{16K}$.

267. A rod having cross-sectional area 100×10^{-6} m^2 is subjected to a tensile load. Based on the Tresca failure criterion, if the uniaxial yield stress of the material is 200 MPa, the failure load is

(a) 10 kN (b) 20 kN

(c) 100 kN (d) 200 kN.

268. If diameter of a long column is reduced by 20%, the percentage of reduction in Euler buckling load is:

(a) 4 (b) 36

(c) 49 (d) 59.

269. With one fixed end and other free end, a column of length L buckles at load P_1. Another column of same length and same cross-section fixed at both ends buckles at load P_2. The ratio of P_2/P_1 is

(a) 1 (b) 2

(c) 4 (d) 16.

270. In a two-dimensional problem. the state of pure shear at a point is characterized by

(a) $\varepsilon_x = \varepsilon_y$ and $\gamma_{xy} = 0$

(b) $\varepsilon_x = -\varepsilon_y$ and $\gamma_{xy} \neq 0$

(c) $\varepsilon_x = 2\varepsilon_y$ and $\gamma_{xy} \neq 0$

(d) $\varepsilon_x = 0.5\ \varepsilon_y$ and $\gamma_{xy} \neq 0$.

271. The principal stresses σ_1, σ_2 and σ_3 at a point respectively are 80 MPa, 30 MPa and −40 MPa. The maximum shear stress is

(a) 25 MPa (b) 35 MPa

(c) 55 MPa (d) 60 MPa.

272. The Poisson's ratio of a material which has Young's modulus of 120 GPa and shear modulus of 50 GPa is

(a) 0.1 (b) 0.2

(c) 0.3 (d) 0.4.

273. Bending moment distribution in a built beam is shown in the given figure.

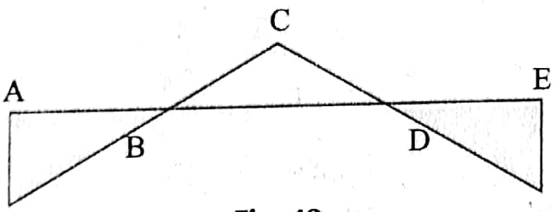


Fig. 43

The shear force distribution in the beam is represented by:

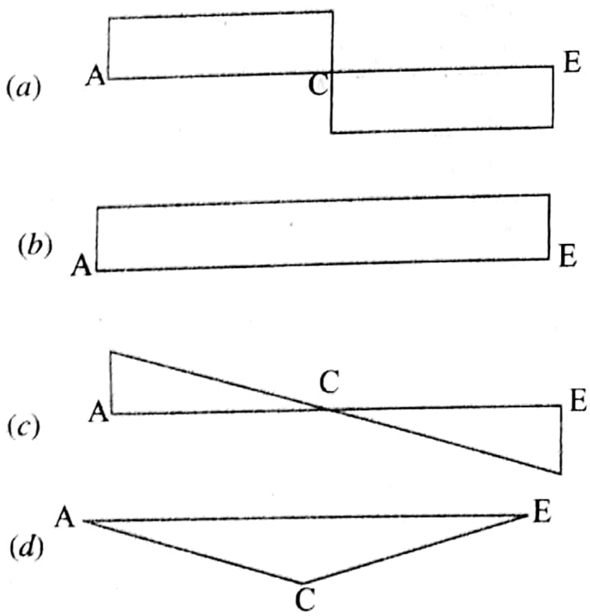


Fig. 44

274. A thick cylinder is subjected to internal pressure of 100 N/mm². If hoop stress developed at the outer radius of the cylinder is 100 N/mm², the hoop stress developed at the inner radius is

(a) 100 N/mm²

(b) 200 N/mm²

(c) 300 N/mm²

(d) 400 N/mm².

275. The outside diameter of a hollow shaft is twice that of its inside diameter. The torque-carrying capacity of this shaft is M_{t_1}. A solid shaft of the same material has the diameter equal to the outside diameter of the hollow shaft. The solid shaft can carry a torque of M_{t_2}. The ratio M_{t_1}/M_{t_2} is

(a) $\frac{15}{16}$ (b) $\frac{3}{4}$

(c) $\frac{1}{2}$ (d) $\frac{1}{16}$.

276. A body having weight of 1000 N is dropped from a height of 10 cm over a close-coiled helical spring of stiffness 200 N/cm. The resulting deflection of spring is nearly.

(a) 5 cm

(b) 16 cm

(c) 35 cm

(d) 100 cm.

277. The diameter of shaft A is twice the diameter of shaft B and both are made of the same material. Assuming both the shafts to rotate at he same speed. the maximum power transmitted by B is:

(a) the same as that of A

(b) half of A

(c) 1/8th of A

(d) 1/4th of A.

278. The given figure (all dimensions are in mm) shows an I-section of the beam.

The shear stress at point P (very close to the bottom of the flange) is 12 MPa. The stress at point Q in the web (very close to the flange) is

(a) indeterminable due to incomplete data

(b) 60 MPa

(c) 18 MPa

(d) 12 MPa.

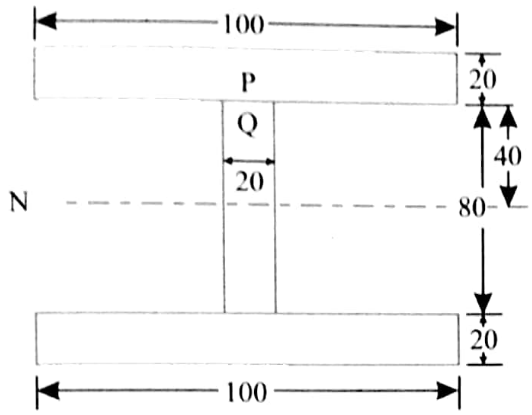


Fig. 45

279. A close-coiled helical spring is made of 5 mm diameter wire coiled to 50 mm mean diameter. Maximum shear stress in the spring under the action of an axial force is 20 N/mm^2. The maximum shear stress in a spring made of 3 mm diameter wire coiled to 30 mm mean diameter, under the action of the same force will be nearly

(*a*) 20 N/mm^2 (*b*) 33.3 N/mm^2
(*c*) 55.6 N/mm^2 (*d*) 92.6 N/mm^2.

280. A horizontal beam carrying uniformly distributed load is supported with equal overhangs as shown in the Fig. 46.

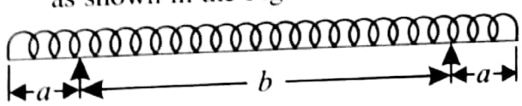


Fig. 46

The resultant bending moment at the mid-span shell be zero if a/b is

(*a*) 3/4 (*b*) 2/3
(*c*) 1/2 (*d*) 1/3.

281. A short column of symmetric cross-section made of a brittle material is subjected to an eccentric vertical load P at an eccentricity e. To avoid tensile stress in the short column, the eccentricity e should be less than or equal to:

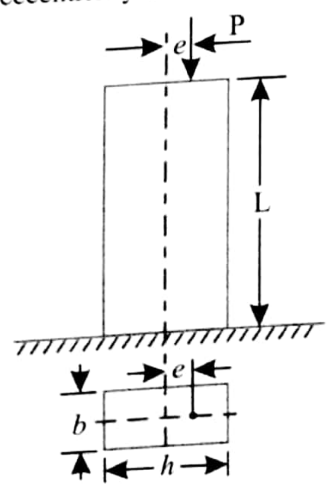


Fig. 47

(*a*) $h/12$ (*b*) $h/6$
(*c*) $h/3$ (*d*) $h/2$.

282. A thin cylindrical shell is subjected to internal pressure p. The Poisson's ratio of the material of the shell is 0.3. Due to internal pressure, the shell is subjected to circumferential strain and axial strain. The ratio of circumferential strain to axial strain is:

(*a*) 0.425 (*b*) 2.25
(*c*) 0.225 (*d*) 4.25.

283. A cantilever of length L, moment of inertia I, Young's modulus E carries a concentrated load W at the middle of its length. The slope of cantilever at the free end is

(*a*) $\dfrac{WL^2}{2EI}$ (*b*) $\dfrac{WL^2}{4EI}$

(*c*) $\dfrac{WL^2}{8EI}$ (*d*) $\dfrac{WL^2}{16EI}$.

284. For a given material, the modulus of rigidity is 100 GPa an Poisson's ratio is 0.25. The value of modulus of elasticity in GPa is

(*a*) 125 (*b*) 150
(*c*) 200 (*d*) 250.

285. A rigid beam of negligible weight is supported in a horizontal position by two rods of steel and aluminium, 2 m and 1 m long having values of cross-sctional areas 1 cm^2 and 2 cm^2 and E of 200 GPa and 100 GPa respectively. A load P is applied as shown in the figure.

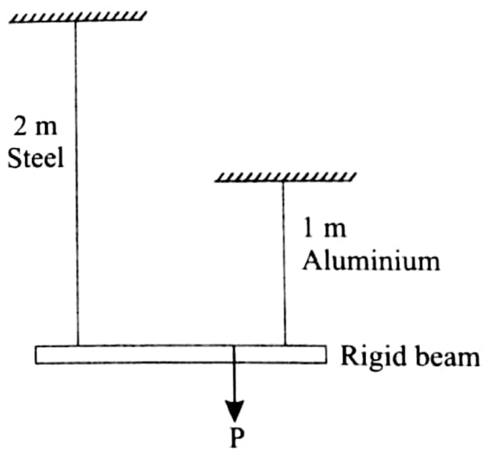


Fig. 48

If the rigid beam is to remain horizontal, then

(*a*) the force on both rods should be equal
(*b*) the force on aluminium rod should be twice the force on steel

(c) the force on the steel rod should be twice the force on aluminium

(d) the force P must be applied at the centre of the beam.

286. A shaft is subjected to torsion as shown.

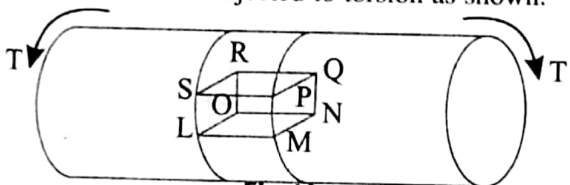
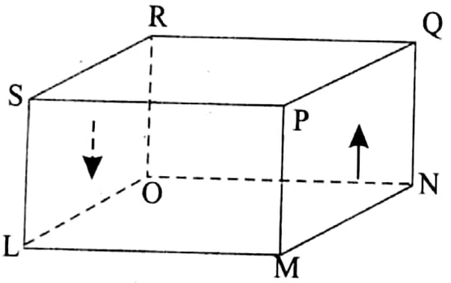
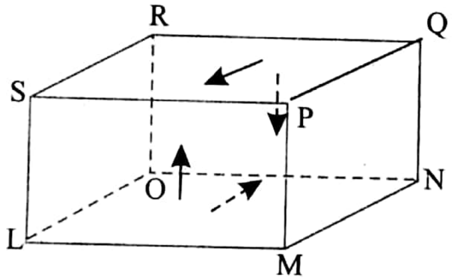
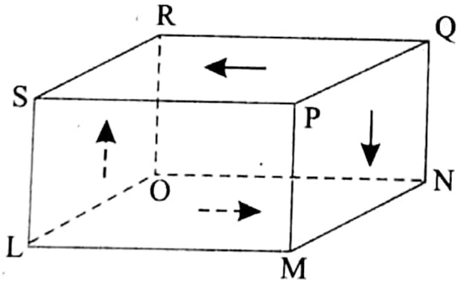


Fig.49

Which of the following figures represents the shear stress on the element LMNOPQRS?

(a)


(b)


(c)


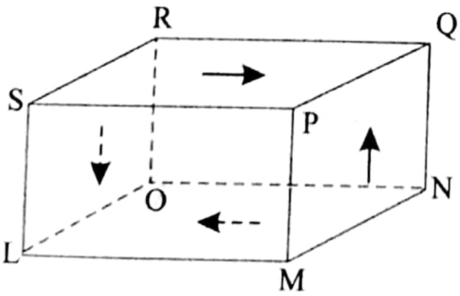
(d)


Fig. 50

287. A cantilever is loaded by a concentrated load P at the free end as shown (Fig.51). The shear stress in the element LMNOPQRS is under consideration. Which of the following figures represents the shear stress directions in the cantilever?

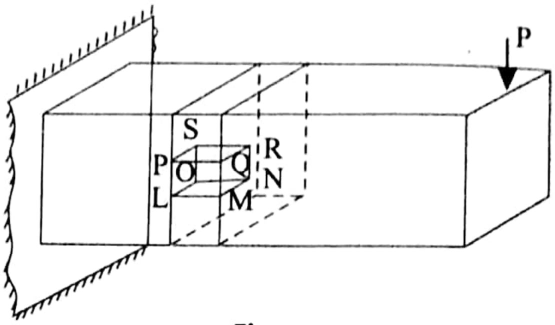
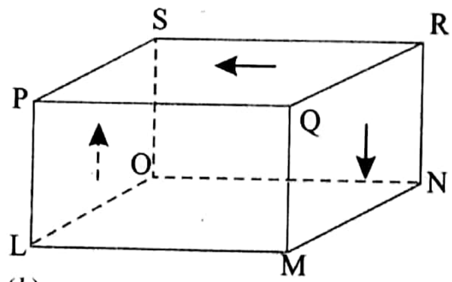
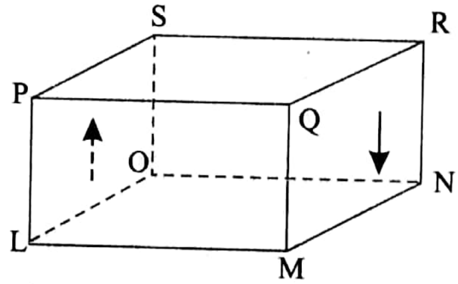
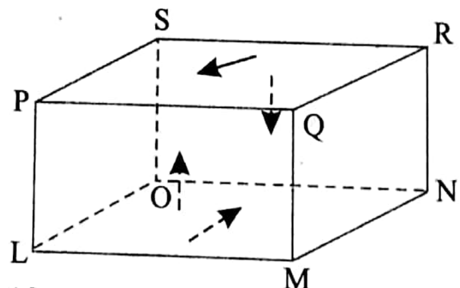


Fig. 51

(a)


(b)


(c)


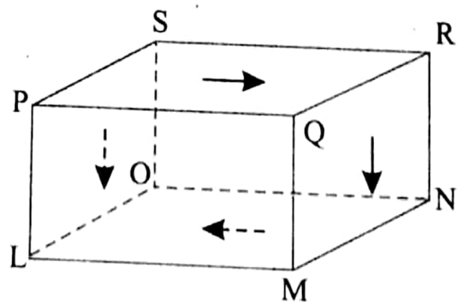
(d)


Fig. 52

288. A thin cylinder of radius r and thickness t when subjected to an internal hydrostatic pressure P causes a radial displacement u, then the tangential strain caused is

(a) $\dfrac{du}{dr}$ (b) $\dfrac{1}{r} \cdot \dfrac{du}{dt}$

(c) $\frac{u}{r}$ (d) $\frac{2u}{r}$.

*289.

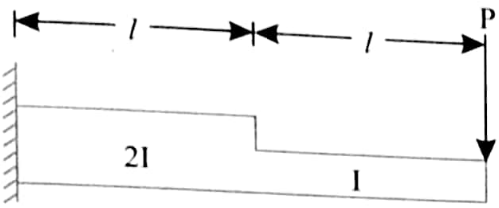


Fig. 53

$I = 375 \times 10^{-6}\ m^4$

$l = 0.5$ m

$E = 200$ GPa

Determine the stiffness of the beam shown in the above Fig.53.

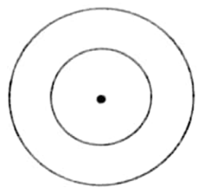
(a) 12×10^{10} N/m (b) 10×10^{10} N/m
(c) 4×10^{10} N/m (d) 8×10^{10} N/m.

290. Strain energy stored in a body of volume V subjected to uniform stress s is

(a) $\frac{sE}{V}$ (b) $\frac{sE^2}{V}$

(c) $\frac{sV^2}{E}$ (d) $\frac{s^2V}{2E}$

***291.** A thick open ended cylinder as shown in the Fig. 54, is made of a material with permissible normal and shear stresses 200 MPa and 100 MPa respectively. The ratio of permissible pressure based on the normal and shear stress is:



$d_i = 10$ cm

$d_o = 20$ cm

Fig. 54

(a) 9/5 (b) 8/5
(c) 7/5 (d) 4/5

ANSWERS

1. (d)	**2.** (b)	**3.** (b)	**4.** (b)	**5.** (a)	**6.** (a)	**7.** (b)	**8.** (b)
9. (a)	**10.** (a)	**11.** (a)	**12.** (d)	**13.** (c)	**14.** (d)	**15.** (b)	**16.** (c)
17. (d)	**18.** (a)	**19.** (a)	**20.** (d)	**21.** (c)	**22.** (c)	**23.** (b)	**24.** (c)
25. (b)	**26.** (c)	**27.** (a)	**28.** (b)	**29.** (c)	**30.** (c)	**31.** (c)	**32.** (b)
33. (d)	**34.** (d)	**35.** (b)	**36.** (a)	**37.** (c)	**38.** (a)	**39.** (b)	**40.** (b)
41. (a)	**42.** (a)	**43.** (b)	**44.** (b)	**45.** (b)	**46.** (c)	**47.** (a)	**48.** (b)
49. (c)	**50.** (b)	**51.** (b)	**52.** (b)	**53.** (c)	**54.** (d)	**55.** (a)	**56.** (b)
57. (a)	**58.** (a)	**59.** (b)	**60.** (a)	**61.** (c)	**62.** (a)	**63.** (a)	**64.** (a)
65. (c)	**66.** (c)	**67.** (a)	**68.** (b)	**69.** (c)	**70.** (b)	**71.** (c)	**72.** (b)
73. (c)	**74.** (b)	**75.** (a)	**76.** (b)	**77.** (b)	**78.** (c)	**79.** (b)	**80.** (a)
81. (c)	**82.** (b)	**83.** (c)	**84.** (a)	**85.** (b)	**86.** (a)	**87.** (b)	**88.** (c)
89. (b)	**90.** (d)	**91.** (d)	**92.** (a)	**93.** (a)	**94.** (c)	**95.** (c)	**96.** (b)
97. (a)	**98.** (d)	**99.** (d)	**100.** (d)	**101.** (a)	**102.** (b)	**103.** (a)	**104.** (a)
105. (a)	**106.** (d)	**107.** (b)	**108.** (a)	**109.** (b)	**110.** (b)	**111.** (a)	***112.** (c)
113. (a)	***114.** (a)	***115.** (c)	**116.** (b)	**117.** (c)	***118.** (c)	***119.** (c)	***120.** (c)
***121.** (a)	***122.** (d)	***123.** (c)	**124.** (c)	***125.** (a)	***126.** (b)	**127.** (c)	**128.** (c)
***129.** (a)	***130.** (d)	**131.** (c)	***132.** (b)	**133.** (a)	***134.** (d)	***135.** (d)	**136.** (a)
137. (d)	**138.** (c)	***139.** (b)	***140.** (c)	***141.** (b)	***142.** (b)	**143.** (b)	***144.** (d)
145. (d)	***146.** (b)	**147.** (a)	**148.** (a)	***149.** (d)	**150.** (b)	**151.** (a)	**152.** (c)
153. (a)	**154.** (b)	**155.** (c)	**156.** (d)	**157.** (a)	**158.** (b)	**159.** (a)	***160.** (c)
161. (a)	**162.** (c)	***163.** (d)	***164.** (c)	***165.** (a)	**166.** (b)	**167.** (b)	***168.** (c)
169. (d)	**170.** (d)	**171.** (c)	**172.** (c)	**173.** (a)	**174.** (a)	***175.** (d)	**176.** (d)
177. (d)	**178.** (c)	**179.** (c)	**180.** (c)	**181.** (c)	**182.** (c)	**183.** (c)	**184.** (b)

185. (*a*)	**186.** (*c*)	**187.** (*a*)	**188.** (*d*)	**189.** (*b*)	**190.** (*d*)	***191.** (*a*)	**192.** (*d*)
***193.** (*a*)	**194.** (*d*)	**195.** (*d*)	**196.** (*a*)	**197.** (*a*)	**198.** (*d*)	**199.** (*b*)	**200.** (*a*)
201. (*d*)	**202.** (*b*)	**203.** (*d*)	**204.** (*a*)	**205.** (*d*)	**206.** (*c*)	**207.** (*b*)	**208.** (*a*)
209. (*c*)	**210.** (*d*)	**211.** (*b*)	***212.** (*c*)	***213.** (*d*)	**214.** (*d*)	**215.** (*b*)	**216.** (*d*)
217. (*d*)	**218.** (*b*)	**219.** (*a*)	**220.** (*b*)	**221.** (*d*)	**222.** (*c*)	**223.** (*d*)	**224.** (*c*)
225. (*b*)	**226.** (*b*)	***227.** (*a*)	***228.** (*a*)	***229.** (*a*)	***230.** (*a*)	***231.** (*a*)	***232.** (*b*)
***233.** (*b*)	***234.** (*b*)	***235.** (*c*)	***236.** (*d*)	***237.** (*b*)	**238.** (*b*)	***239.** (*a*)	***240.** (*d*)
241. (*d*)	**242.** (*c*)	***243.** (*a*)	**244.** (*b*)	**245.** (*b*)	**246.** (*b*)	**247.** (*c*)	**248.** (*d*)
249. (*b*)	**250.** (*c*)	**251.** (*a*)	**252.** (*b*)	**253.** (*c*)	**254.** (*d*)	**255.** (*d*)	**256.** (*b*)
257. (*a*)	**258.** (*d*)	**259.** (*b*)	**260.** (*d*)	**261.** (*c*)	**262.** (*b*)	**263.** (*c*)	**264.** (*d*)
265. (*b*)	**266.** (*b*)	**267.** (*b*)	**268.** (*d*)	**269.** (*d*)	**270.** (*b*)	**271.** (*a*)	**272.** (*b*)
273. (*a*)	**274.** (*b*)	**275.** (*a*)	**276.** (*b*)	**277.** (*c*)	**278.** (*d*)	**279.** (*c*)	**280.** (*c*)
281. (*b*)	**282.** (*d*)	**283.** (*a*)	**284.** (*d*)	**285.** (*b*)	**286.** (*b*)	**287.** (*b*)	**288.** (*a*)
289. (*a*)	**290.** (*d*)	**291.** (*b*)					

SOLUTIONS-COMMENTS

***112.** Stiffness of spring $k = \dfrac{Cd^4}{64R^3n}$

where,
C = Modulus of rigidity (same in both cases),
d = Diameter of wire (same in both cases),
n = Number of coils (8 and 10 respectively), and

R = Mean radius of coil $\left(\dfrac{75}{2}\text{mm and } \dfrac{60}{2}\text{mm respectively}\right)$.

$$\therefore \quad k_1 \,\alpha\, \frac{1}{\left(\frac{75}{2}\right)^3 \times 8} \quad \text{and} \quad k_2 \propto \frac{1}{\left(\frac{60}{2}\right)^3 \times 10}$$

$$\therefore \quad \frac{k_2}{k_1} = \left(\frac{75}{60}\right)^3 \times \frac{8}{10} = 1.56 \quad \text{or} \quad k_2 = \mathbf{1.56\ k1} \quad \textbf{(Ans.)}$$

Thus, (*c*) is the correct choice.

***115.** Centrifugal force

$$= \frac{\text{Weight}}{g} \times \omega^2 \times \text{radius} = \frac{w/A}{g} \times \omega^2 \times l = \frac{w\omega^2 l^2 A}{g}$$

$$\therefore \text{ Stress due to this force} = \frac{w\omega^2 l^2 A}{g \times A} = \frac{w\,\omega^2 l^2}{g}$$

Also,
$$E = \frac{\text{Stress}}{\text{Strain}} \text{ or Strain} = \frac{\text{Stress}}{E} \text{ or } \frac{\delta l}{l} = \frac{\text{Stress}}{E}$$

or, δl (extension)
$$= l \times \frac{\text{Stress}}{E} = l \times \frac{w\omega^2 l^2}{gE} = \frac{w\omega^2 l^3}{gE} \quad \textbf{(Ans.)}$$

***118.** Steel is highly elastic because it undergoes least deformation when loaded, and it regains its original shape/form when the load is removed.

***119.** The maximum shear stress

$$= \sqrt{\left(\frac{\sigma_y - \sigma_x}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left[\frac{40-(-40)}{2}\right]^2 + 30^2} = 50\,\text{MPa} \quad \textbf{(Ans.)}$$

Thus, (c) is the corrrect choice.

***120.** The number of elastic constants required to relate stress and strain, for a linearly elastic, isotropic and homogeneous material, is four (viz. E, C, K and ν).

***121.** Bending stress, $\sigma = \frac{M}{Z}$, where M = bending moment, and Z = section modulus.

For rectangular beam with sides horizontal and vertical, $Z = \frac{a^3}{6}$

For the same section with horizontal diagonal, $Z = \frac{a^3\sqrt{2}}{6}$

$\therefore$ Ratio of stress = $\frac{1}{\sqrt{2}}$. Hence maximum bending stress in the second case $= \frac{1}{\sqrt{2}}\sigma$.

Thus, (a) is the correct choice.

***123.** In case of shaft, subjected to bending:

$$\frac{M}{I} = \frac{\sigma}{y} \text{ or } \sigma \text{ (bending stress)} = \frac{M}{I} \times r = \frac{M}{\frac{\pi}{4}r^4} \times r = \frac{4M}{\pi r^3}$$

In case of shaft, subjected to torsion; $\frac{T}{I_p} = \frac{\tau}{r}$ or $\frac{T(=M)}{\frac{\pi r^4}{2}} = \frac{\tau}{r}$ or τ (shear stress) $= \frac{2M}{\pi r^3}$

$\therefore$ Ratio of bending stress and shear stress, $\frac{\sigma}{\tau} = \frac{4M}{\pi r^3} \times \frac{\pi r^3}{2M} = 2$

Thus correct choice is (c).

***125.** The correct choice is (a) since B.M. diagram between A and B is parabola which is possible with U.D.L. in ths region.

***126.** $E = 1.25 \times 10^5$ MPa, $\frac{1}{m} = 0.34$

$$E = 2C\left(1 + \frac{1}{m}\right) \quad \text{or} \quad 1.25 \times 10^5 = 2C\,(1 + 0.34)$$

or, $$C = \frac{1.25 \times 10^5}{2 \times 1.34} = \mathbf{0.4664 \times 10^5\ MPa} \quad \textbf{(Ans.)}$$

Thus, (b) is the correct choice.

***130.** In case of a simply supported beam, deflection at centre with concentrated load in centre,

$$\delta = \frac{wl^3}{48EI} \quad i.e., \quad \delta \times \frac{1}{l}\left(\text{where, } I = \frac{bd^3}{12}\right)$$

$$\therefore \text{ New deflection } = \delta \times \frac{6^3 \times 4 \times 12}{4^3 \times 6 \times 12} = 2.25\delta$$

Thus, (d) correct choice.

***131.** $\frac{T}{I_p} = \frac{C\theta}{l}$ or $\theta \propto \frac{1}{I_p}$ or $\theta \propto \frac{1}{D^4}$

$$\therefore \quad \frac{0.1}{\theta} = \frac{(D/2)^4}{D^4} \text{ or } \theta = \mathbf{1.6\ radian} \quad \textbf{(Ans.)}$$

Thus, correct choice is (c).

***132.** For shaft, $\frac{T}{I_p} = \frac{\tau}{r}$ or $\tau \propto \frac{T}{I_p}$ (where, T = torque and I_p = polar moment of inertia).

Hence (b) is the correct choice.

***134.** Let F = Shearing force at section x, then

$$F \times 2L = P \times c \text{ or } F = \frac{P \times c}{2L}$$

Thus, (*d*) is the correct choice.

***135.** $E = 100$ GPa or 100×10^3 MPa, $R = \frac{25}{2} = 12.5 \text{ mm} = 0.0125\text{m}$, $t = 0.2$ mm

Now, $$\frac{\sigma}{y} = \frac{E}{R} \quad \text{where} \quad y = \frac{t}{2} = \frac{0.2}{2} = 0.1 \text{ mm} = 0.0001\text{m}$$

$\therefore$ $$\sigma = \frac{E \times y}{R} = \frac{100 \times 10^3 \times 0.0001}{0.0125} = \mathbf{800\ MPa} \quad \textbf{(Ans.)}$$

Hence (*d*) is the correct choice.

***137.** Circumferential or hoop stress, $\sigma_c = \frac{pd}{2t}$

or, $$20 = \frac{1 \times 1000}{2 \times t}$$

or, $$t = \frac{1 \times 1000}{20 \times 2} = 25 \text{ mm}$$

***138.** Total strain energy stored in a simply supported beam of span, 'L' and flexural rigidity 'EI' subjected to a concentrated load 'W' at the centre.

$$= 2\int_0^{L/2} \frac{M^2 dx}{2EI} = 2 \times \frac{1}{EI}\int_0^{L/2} \left(\frac{W}{2} \times x\right)^2 dx$$

$$\left[M = \text{Bending moment up to middle of the shaft} = \frac{W}{2} \times x \right]$$

$$= 2 \times \frac{1}{2EI}\int_0^{L/2} \left(\frac{W^2 \times x^2}{4}\right) dx = \frac{W^2}{4EI}\left[\frac{x^3}{3}\right]_0^{L/2} = \frac{W^2 L^2}{90\,EI}$$

Thus, (c) is the correct choice.

***139.** (*c*) is the correct choice since whenever a solid thick cylinder is subjected to an external hydrostatic pressure p, it is compressed equally from all sides.

***140.** For a cylindrical boiler under internal pressure,

Volumetric strain $\left(\frac{\delta V}{V}\right) = 2 \times$ circumferential strain (ε_1) + longitudinal strain (ε_2)

$\therefore$ $$\delta V = (2\varepsilon_1 + \varepsilon_2)V = 2\varepsilon_1 + \varepsilon_2 \qquad (\because V = \text{volume} = 1, \text{ in this case})$$

***141.** For a shaft, under torsion, $\frac{T}{I_p} = \frac{\tau}{r}$

Since T (torque) and τ (shear stress) are same for hollow and solid shaft, so $\frac{I_p}{r}$ (polar modulus of section) should also be the same. Thus, (*b*) is the correct choice.

***142.** In the assembly of pulley, key and shaft, key is made the weakest because it is easy to replace (when failure occurs) and is cheap also.

***144.** For a shaft, $\frac{T}{I_p} = \frac{C\theta}{l}$ or $\theta \propto \frac{1}{I_p}$ (where, I_p = polar moment of inertia) or $\theta \propto \frac{1}{d^4}$. Therefore, the ratio of angles of twist of the two shafts, having diameters in the ratio of 2, will be 16. Thus, (*d*) is the correct choice.

***146.** E 210 GN/m^2, $C = 80$ GN/m^2, Poisson's ratio, $\frac{1}{m} = ?$

$$E = 2C\left(1 + \frac{1}{m}\right) \quad \text{or} \quad 210 = 2 \times 80\left(1 + \frac{1}{m}\right) \quad \text{or} \quad \frac{1}{m} = \mathbf{0.31} \quad \textbf{(Ans.)}$$

Thus, (*b*) is the correct choice.

* **148.** The correct value of bending moment at A (or B) is zero since due to hinge support between AB and cantilevers, the bending moment cannot be transmitted to cantilever.
Thus, (a) is the correct choice.

***149.** The correct choice is (d) because tensile, impact, bending and fatigue strengths are measured on universal testing, izod testing, three-point loading and rotating bending machines respectively.

***160.** As no tensile or compressive stress exists, the Mohr's diagram is simply a circle of radius = xy and centre at the intersection of the axes.

161. Whenever shear force is zero, bending moment is constant, as depicted in Fig. 55.

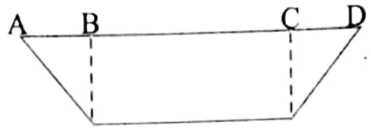


Fig. 55

163. For fixed beams, resultant B.M. diagram is the algebraic addition of fixed B.M. and free B.M. diagram.

165. When W is uniformly distributed over entire length, $\delta_1 = \frac{WL^3}{8EIZ}$ and W is concentrated at free end,

$$\delta_2 = \frac{WL^3}{3EI} \quad \therefore \quad \frac{\delta_1}{\delta_2} = \frac{3}{8}$$

168. As $\frac{\tau}{r} = \frac{T}{I_p}$, or $\tau = \frac{T.r}{I_p}$

which is a linear function and at internal radius there is a certain value of τ (shear stress).

171. Radial strain $= \frac{d(r+u) - dr}{dr} = \frac{du}{dr}$

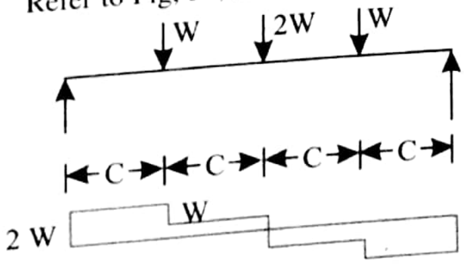
175. Most conservative value means safest design, i.e. largest diameter, in case of maximum principal stress theory, maximum shear stress = maximum tensile stress for the material, giving it the highest value.

191. $$\tau_{hollow} = \frac{16T}{\pi d^3\left[1 - \left(\frac{d/2}{d}\right)^4\right]} = \frac{16}{15} \times \frac{16T}{\pi d^3}$$

$$\tau_{solid} = \frac{16T}{\pi d^3} \quad \therefore \quad \tau_{hollow} = \frac{16}{15}\tau_{solid}$$

193. $$\delta = \delta_1 + \delta_2 = \frac{W}{2S} + \frac{W}{S} = \frac{3W}{2S}$$

Refer to Fig. 56, the maximum shear force is 2W.



Shear force diagram
Fig. 56

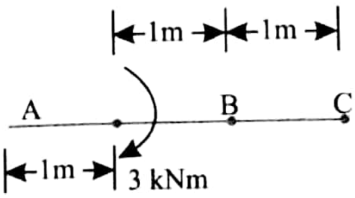


Fig. 57

213. Refer Fig. 57, which shows the equivalent diagram.

227. Expansion of rod = $l\,\alpha\,\Delta t = 0.5 \times 12.5 \times 10^{-6} \times 20 = 0.125 \times 10^{-3}$ m
Force will be induced due to spring and same = $0.125 \times 10^{-3} \times 50 \times 10^3$ N = 6.25 N

$$\text{Stress} = \frac{F}{A} = \frac{6.25}{(\pi/4) \times 0.01^2} = 0.07945\ 0.07945 \text{ MPa}$$

228. **Ans.** (*a*). $(w - 10)\ 2 \times 10^{-6} \times 200 \times 10^6 = 2000$ N; or $w - 10 = 5$, and $w = 15$ mm.

229. **Ans.** (*a*). Circumferential strain $= \frac{1}{E}\left(\sigma_c - \frac{1}{m}\sigma_l\right)$

Since circumferential stress $\sigma_c = 80$ MPa, longitudinal stress $\sigma_l = 20$MPa

$$\therefore \text{ Circumferential strain } = \frac{1}{2 \times 10^5 \times 10^6}[80 - 0.28 \times 40]10^6 = \frac{68.8}{20} \times 10^{-4} = 3.44 \times 10^{-4}$$

230. **Ans.** (*a*). Point '*X*' is subjected to circumferential and longitudinal stress, *i.e.* tension on a all faces, but there is no shear stress because vessel is supported freely outside.

231. **Ans.** (*a*). The three elastic constants for anisotropic material following Hooke's law are Young's modulus, elastic limit stress and yield stress.

232. **Ans.** (*b*). $M = \frac{wL}{2}\ x - \frac{wx^2}{2}$ Nm

233. **Ans.** (*b*). If shear force is zero, B.M. will also be zero. If shear force varies linearly with length, B.M. diagram will be curved line.

234. **Ans.** (*b*). If D is diameter of circle and '*a*' the side of square section, $\frac{\pi}{4}d^2 = a^2$ or $d = \sqrt{\frac{4}{\pi}}a$

Z for circular section $= \frac{\pi d^3}{32} = \frac{\pi}{32}\frac{4}{\pi}a^2 = \frac{a^2}{8}$; and Z for square section $= \frac{a^3}{6}$.

Since Z for square section is more, it is stronger.

235. **Ans.** (*c*). Deflection in cantilever $= \frac{Wl^3}{3EI} = \frac{Wl^3 \times 12}{3Eah^3} = \frac{4Wl^3}{Eah^3}$

If *h* is doubled, and *W* is halved, new deflection $= \frac{4Wl^3}{2Ea(2h)^3} = \frac{1}{16} \times \frac{4Wl^3}{Eah^3}$

236. **Ans.** (*d*). Pure bending takes place in the section between two weights *W*.

237. **Ans.** (*b*). Shear stress $= \frac{16T}{\pi d^3}$ and normal stress $= \frac{32T}{\pi d^3}$

$\therefore$ Ratio of shear stress and normal stress = 1 : 2

239. **Ans.** (*a*) Strain energy $= \frac{1}{2} \times$ load $\times$ increase in length $= \frac{1}{2} \times P \times \frac{P}{A} \cdot \frac{L}{E} = \frac{P^2 L}{2AE}$

240. **Ans.** (*d*) Hoop stress-tensile, radial stress-compressive, and longitudinal stress-tensile

241. **Ans.** (*d*) Longitudinal stress = σ_0; hoop stress = $2\ \sigma_0$

Max. shear stress $= \frac{2\sigma_0 - \sigma_0}{2} = \frac{\sigma_0}{2}$

243. **Ans.** (*a*).

$$\text{Stiffness} = \frac{Cd^4}{64R^3N} = k$$

For second spring, stiffness $= \frac{Cd^4}{64(2R)^3 \times \frac{N}{2}} = \frac{k}{4}$

284. **Ans.** (*d*).

$$E = 2C\left(1 + \frac{1}{m}\right) = 2 \times 100(1 + 0.25) = 250 \text{ GPa}$$

285. **Ans.** (*b*). Elongation in both rods should be same to keep beam horizontal

$$\frac{P_S l_S}{A_S E_S} = \frac{P_A l_A}{A_A E_A}$$

$$\frac{P_S}{P_A} = \frac{1}{2} \times \frac{1}{2} \times \frac{200}{100} = \frac{1}{2}$$

289. Ans. (*b*). Deflection $\delta = \frac{1}{EI}\left[\frac{Pl^3}{2}\right]$

∴ Stiffness $= \frac{P}{\delta} = \frac{2EI}{l^3} = \frac{2 \times 200 \times 10^9 \times 375 \times 10^{-6}}{0.5^2} = 12 \times 10^{10}$ N/m

B. Fill in the blanks:

1. The maximum shear stres in a thin cylinder subjected to internal pressure is ....
2. The relation between *E*. *K* and *ν* is ....
3. The point of contraflexure in a beam is a point where bending moment ....
4. The most important assumption in the theory of bending of beams is ....
5. In a concrete beam with rectangular section subjected to lateral loads the reinforcing with steel rods should be done near .... surface.
6. On a principal plane the shear stress is ....
7. The equivalent length of a Euler's column with one end fixed and the other end hinged is .....
8. In a thick cylinder subjected to external pressure the maximum hoop stress occurs at a point ....
9. The best theory of failure for ductile materials is ....
10. The stress concentration due to a small circular hole in a plate subjected to uniaxial tensile force is approximately ....
11. Shear deflection should be taken into account when the length of the beam is ....
12. In a curved beam of rectangular section the maximum stress due to bending occurs at a point on ....
13. The shear centre for the *L*-section is located at ....
14. When a helical spring is cut into two halves the stiffness of the new springs is ....
15. The degree of statical determinacy of a beam with both ends fixed is ....
16. The maximum shear stress in a rectangular bar subjected to torsion occurs at the centre of the ....
17. The fully plastic moment for rectangular beam is .... times the maximum elastic bending moment.
18. For infinite life of machine member made of steel the fatigue stress should be less than......
19. The strain energy stored in a circular shaft subject to a constant twisting moment is ....
20. The shear stress in a cross-section of a beam subjected to lateral load is maximum at ....
21. Hooke's law is valid only for.......... materials.
22. The modulus of resilence of the material is given by............
23. The maximum shear stress on the surface of thin cylinder subjected to internal pressure is....
24. The maximum possible compressive strain in a cylindrical beam subjected to axial force is ......
25. The shear force at a point in the beam is given by the slope ....
26. The maximum bending moment in a simply supported beam subjected to uniform loading of unit length is ....
27. The point through which the resultant of shear stress of a cross-section passes is known as ....
28. The maximum shear stress in a beam with T-section occurs at ....
29. The angle between the principal plane and plane of maximum shear stress is ....
30. For a column with one end fixed and the other end free the effective length is..........
31. In a thick cylinder subjected to external pressure the maximum hoop stress occurs at ....
32. When two equal springs are joined in series the stiffness of the new spring is .... that of original spring.
33. The best theory of failure for the brittle material is ....
34. The strain energy for unit length due to transverse shear force *S* in a beam with rectangular cross-section is...........
35. In a curved beam subjected to bending moment the maximum stress always occurs at ....

36. The fatigue strength of mild steel for infinite number of cycles is known as............
37. If the two principal strains at a point are 1000×10^{-6} and -400×10^{-6}, then the maximum shear strain is...........
38. In a built in-beam (at both the ends) carrying uniformly distributed load the maximum bending moment occurs at ....
39. Stress concentration occurs due to....... in cross-section.
40. For rectangular shafts subjected to torsion the maximum shear stress occurs at ....
41. In a thin-walled cylindrical pressure vessel subjected to internal pressure, the hoop stress is .... the longitudinal stress.
42. The bending moment is ...... at a section where the shear force changes sign.
43. In a rectangular cross-section of a beam, the ratio of the maximum shear stress to average shear stress is ....
44. In a curved beam subejcted to pure moment, the nature of variation of bending stress across the section is ....
45. An axially loaded bar is subjected to a longitudinal strain of 0.0007. The lateral strain in the rod for a Poisson's ratio of 0.35 will be ....
46. The ratio of maximum deflection of a simply supported beam with (*a*) a central concentrated load *P* and (*b*) a U.D.L. of P over the entire length is given by ....
47. The critical load for a long column with both ends fixed is ..... than that for a column with one end fixed and the other end hinged.
48. If the bending in a beam does not occur about a principal axis, the bending is called ....
49. If the depth of a simply supported beam of rectangular section carrying a concentrated load at the centre is halved, the deflection of the beam at the centre will increase by ....
50. Endurance limit is the maximum stress at which a material, undergoing cyclic stress will not fail in .... number of cylces.
51. In a spring the load to cause unit deflection is called .... of the spring.
52. The ductility of cast-iron is ..... than that of mild steel.
53. For a circular shaft subjected to torsional moment, the value of shear stress at the centre of cross-section is ....
54. Modulus of resilience is the maximum ....stored per unit volume of the material.
55. The central deflection of a simply supported beam when a load is suddenly applied at its centre is .... times the deflection produced when the load is gradually applied.
56. The zone in a short column section within which a compressive load applied parallel to axis will produce no tension is called the ...... of the section.
57. The deflection of a beam at a point is given by the bending moment of ....
58. For a beam subjected to pure bending, the horizontal shear stress is ....
59. In a two-dimensional element, the angle between the planes where the maximum shear stress occurs is ....
60. In a thick-walled cylinder with internal pressure, the maximum hoop stress occurs at the ....
61. Percentage elongation is a measure of............
62. Modulus of rigidity is related to modulus of elasticity through ....
63. A chalk piece, when twisted, breaks along a 45° helix because the fracture is due to ..... stress.
64. Cast-iron is more .... than mild steel.
65. Fatigue life is .... if the amplitude of cyclic loading is less than the endurance limit.
66. Modulus of rupture is equal to the area under the tensile test stress-strain diagram up to ......
67. .... stresses do not produce any distortion of a body.
68. Flange of an I-beam takes most of the .... load.
69. As per the Tresca criterion failure is defined in terms of ....stresses.
70. A steel sheet is heated uniformly. Temperatuer rise is *T*. The sheet is free to expand in all directions. Stress produced in the sheet is ....
71. If a moment acts at a point in a beam the bending moment diagram will be .... at the location.
72. For simply supported beam with uniformly distributed load the maximum bending stress occurs at the .... section of beam.

73. The ratio of buckling loads of fixed and pin-ended beam is ....

74. For a curved beam the maximum bending stress occurs at the ...... radius.

75. Shear stress at the corner of a rectangular shaft subjected to torsion is ....

76. The ratio of fully plastic and limit moments of a rectangular section is ....

77. Angle between the maximum principal stress and shear stress direction is ....

78. For a welded joint the design area is the area at the ....

79. Mohr's circle diagram for an element under equibiaxial tension is a ....

80. The principal of superposition is applicable when the material is .... elastic.

81. The unit of power is ....

82. The modulus of rigidity of rolled aluminium may be .... GN/m^2.

83. The torsional rigidity of a bar is the product of its .... and modulus of rigidity.

84. Elastic strain energy stored per unit volume up to elastic limit is called ....

85. Shear resistance developed on a cross-section of a beam per unit length along the section is called ....

86. The maximum shear stress theory of failure was propounded by ....

87. The range of stress in cyclic loading is given by the algebraic .... of σ_{max} and σ_{min} of the cycle.

88. Endurance ratio is the ratio of .... and endurance limit.

89. Deflection due to shear in a beam is negligible if the ratio of span and ...... is large.

90. The slope of bending moment diagram for a loaded beam at a section gives the .... at that section.

91. A close-coiled helical spring, subjected to axial couple, produces a .... stress in the spring wire material.

92. A theory of failure is necessary when a component is subjected to ....

93. Lame's relations are used for evaluation of ....stress and ..... stress along the wall thickness of a thick cylinder subjected to external and internal and internal fluid pressure.

94. Deflection of a beam for a given load and span is inversely proportional to its ....

95. Maximum bending moment occurs in a beam where the shear force is ..... zero or ....

96. In a lap riveted joint the rivets are subjected to .....stress.

97. The limit up to which the stress is linearly proportional to strain is called ..... limit.

98. Principal planes and planes of maximum shear stress are inclined at .... degree to each other.

99. Bending stresses are maximum at the ...... of the cross-section.

100. The shear stress in a beam of rectangular cross-section varies .... along the depth.

101. Two simply supported beams A and B having the same span, depth are subjected to same central point load, but the breadth of beam B is twice that of beam A. The central deflection of the beam B will be .... as compared to beam A.

102. The ratio between equivalent length and actual length of a column for both ends fixed is .....

103. For an angle section the shear centre is at the point of intersection of the ....

104. For a curved beam the linear stress distribution formula can be applied when the radius of curvature of the centre line of the beam to the depth of the beam ratio is greater than ....

105. The stress at which extension of a material takes place more quickly as compared to the increase in load is called ....

106. A steel rod of 15 mm diameter and 5 m long is subjected to an axial pull of 30 kN. If $E = 200 \times 10^9$ Pa, the elongation of the rod will be .... mm.

107. A cylinder is said to be thick if the ratio of its thickness and diameter is less than ....

108. The stress in the wall of a cylinder normal to its longitudinal axis due to force acting along the circumference is known as ...... stress.

109. Shear deflection of a cantilever of length L, cross-sectional area A, and shear modulus C under a concentrated load W at its free end is..........

110. The energy stored in a beam of length L (EI constant) subjected to a constant bending moment M is expressed as ....

111. A shaft turning at 150 rpm is transmitting a torque at 1500 Nm. Horse power transmitted by the shaft is ....

112. Maximum shear theory at the failure of a material at elastic limit is known as ....

113. If p is the internal pressure in a thin-walled cylinder of diameter d and thickness of plates t, the hoop stress developed is ....

114. Slenderness ratio of a long column is the length of the column divided by ....

115. The point of contraflexure is the point where ..... changes sign.

116. The maximum stress in a cylinder subjected to internal pressure occurs at .... surface.

117. The maximum possible value of Poisson's ratio is.........

118. The normal stress assumes the maximum value on the plane on which the .... is zero.

119. A timber and a steel beam, having identical dimensions are subjected to identical loads. Then the stress in timber beam will be....... the stress in steel beam.

120. The expression for deflection of a closed coiled helical spring with mean radius R, diameter of wire d and number of coils n is ....

121. If the tensile stress in a specimen under uniaxial tension is 0, the value of maximum shear stress in the specimen is ....

122. The angle of twist in a shaft of length L and torsional rigidity GJ, subjected to a torque T is equal to ....

123. The conjugate beam method is used to obtain .... and .... in a beam.

ANSWERS

B. Fill in the Blanks :

1. $\frac{pd}{8t}$ **2.** $E = 3K\left(1 - \frac{2}{m}\right)$ **3.** is zero or changes sign
4. elastic limit is not exceeded **5.** lateral **6.** zero
7. $l/\sqrt{2}$ **8.** on the inner radius **9.** maximum shear stress theory
10. 3 **11.** large **12.** the outside surface
13. its c.g. **14.** halved **15.** 3
16. longer side **17.** 2 **18.** maximum allowable stress
19. $\frac{T^2 l}{2 C I_p}$ **20.** the top of the surface **21.** elastic
22. $\frac{\sigma^2}{2E}$ **23.** $\frac{pd}{8t}$ **24.** $\frac{\sigma}{E}$
25. M diagram **26.** $\frac{wl^2}{2}$ **27.** c.g.
28. N.A. **29.** 45° **30.** $2l$
31. inner radius **32.** half **33.** principal stress theory
34. $\frac{S^2}{2C}d$ **35.** outer surface **36.** limiting fatigue range
37. 700×10^{-6} **38.** centre **39.** rapid change
40. $y = \pm\frac{t}{2}$ **41.** double **42.** maximum
43. 1.5 **44.** hyperbola **45.** 0.000245
46. 1.6 **47.** double **48.** pure
49. eight times **50.** infinite **51.** stiffness
52. less **53.** maximum **54.** energy
55. two **56.** core **57.** conjugate beam

58. $\dfrac{SA\bar{y}}{Ib}$	**59.** 90°	**60.** inner radius
61. ductility of the material	**62.** Poisson's ratio	**63.** shear
64. brittle	**65.** infinite	**66.** yield point
67. Direct	**68.** tensile	**69.** maximum and minimum principal
70. zero	**71.** vertical line	**72.** outermost
73. 4	**74.** outer	**75.** zero
76. 1.5	**77.** 45°	**78.** throat of filled weld
79. point	**80.** perfectly	**81.** watt
82. 1.0	**83.** polar moment of inertia	**84.** resilience
85. shear centre	**86.** Tresca	**87.** difference
88. fatigue strength (stress)	**89.** depth	**90.** shearing force
91. shear	**92.** combined loading	**93.** circumferential, radial
94. EI	**95.** zero, changes sign	**96.** shear
97. proportional	**98.** 90°	**99.** top layer or bottom layer
100. parabolically	**101.** half	**102.** $\dfrac{1}{2}$
103. principal axes of the section and plane of the loads	**104.** 1	**105.** yield
106. 4.244	**107.** 20	**108.** hoop
109. $\dfrac{3}{10}\dfrac{Wl}{CA}$	**110.** $\dfrac{M^2L}{2EI}$	**111.** 23.5 kW
112. Tresca	**113.** $\dfrac{pd}{2t}$	**114.** radius of gyration
115. bending moment	**116.** inner	**117.** four
118. shear stress	**119.** $\dfrac{E_{timber}}{E_{steel}}$	**120.** $\dfrac{64WR^3}{Cd^4}$
121. zero	**122.** $\dfrac{TL}{GJ}$	**123.** slope, deflection