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# 3200 MCQs

Useful For

## ESE | GATE | PSUs

# Civil Engineering

*by*

**B. Singh** (Ex. IES)

**CMD,** MADE EASY Group

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# PREFACE

**B. Singh** (Ex. IES)

It gives me great happiness to introduce the second edition on Civil Engineering containing nearly 3200 MCQs which focuses in-depth understanding of subjects at basic and advanced level which has been segregated topic-wise to disseminate all kind of exposure to students in terms of quick learning and deep apt. The chapter wise segregation has been done to align with contemporary competitive examination pattern. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for ESE, GATE, PSU. The content of this book ensures threshold level of learning and wide range of practice questions which is very much essential to boost the exam time confidence level and ultimately to succeed in all prestigious engineer's examinations. It has been ensured from MADE EASY team to have broad coverage of subjects at chapter level.

Year by year number of competitors are increasing and the variety of questions asked in examination is widening, under such scenario this book will definitely help students to enhance their skills required to succeed in competitive exams like ESE, GATE, PSUs, State Engineering Services etc.

While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exams. The solutions and answers provided are upto the closest possible accuracy. The full efforts have been made by MADE EASY Team to provide error free solutions and explanations.

I have true desire to serve student community by way of providing good sources of study and quality guidance. I hope this book will be proved an important tool to succeed in competitive examinations. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

# CONTENTS

# Unit I / Strength of Materials

## 1. Properties of Metals, Simple Stress-Strain and Elastic Constants

Q.1 A material has identical properties in all directions, it is said to be
(a) homogeneous (b) isotropic
(c) elastic (d) orthotropic

Q.2 The term nominal stress in stress-strain curve for mild steel implies
(a) average stress (b) actual stress
(c) yield stress (d) stress at necking

Q.3 For metallic minerals creep becomes an important consideration at
(a) 500°C
(b) 550°C
(c) half of the melting point temperature on absolute scale
(d) any temperature

Q.4 Clapeyron's theorem is associated with the analysis of
(a) simply supported beams
(b) fixed beams
(c) continuous beams
(d) cantilever beams

Q.5 A rubber band is elongated to double its initial length, its true strain is
(a) 0.500 (b) 0.693
(c) 1.00 (d) 1.386

Q.6 A prismatic beam has uniform
(a) depth (b) width
(c) strength (d) cross-section

Q.7 In the case of pure bending, the beam will bend into an arc of a
(a) circle (b) parabola
(c) ellipse (d) hyperbola

Q.8 If the modulus of elasticity is zero, the material is said to be
(a) rigid (b) elastic
(c) flexible (d) plastic

Q.9 The compressibility of a material is proportional to
(a) Poisson's ratio $\mu$
(b) modulus of elasticity ($E$)
(c) reciprocal of $E$
(d) reciprocal of $\mu$

Q.10 If a beam with the rectangular cross-section is obtained by cutting from circular log of timber, then for the beam to have strongest section in bending, the ratio of breadth to depth should be
(a) 0.500 (b) 0.707
(c) 0.717 (d) 0.786

Q.11 According to St. Venant's principle
(a) Deformations of all materials for a given loading are equal
(b) It is a method of determining stress conditions at the end of the plates
(c) Stress conditions approach uniformly as the distance from the point of applications of the load increase
(d) After a point of time the stresses in a loaded member tend to relieve

Q.12 Notched bar tests are frequently used for testing the
(a) impact strength of a material
(b) hardness of a material
(c) machinability of a metal
(d) corrosion resistance of the material

**Q.13** In the creep test, the following type of stress is applied to the specimen
(a) uniaxial compression
(b) uniaxial tension
(c) biaxial compression or tension
(d) alternating stress

**Q.14** A free bar of length $l$ is uniformly heated from 0°C to a temperature t°C, $\alpha$ is the coefficient of linear expansion and E is the modulus of elasticity. The stress in the bar is
(a) $\alpha\, t\, E$ (b) $\alpha\, t\, E/2$
(c) zero (d) None of these

**Q.15** A test specimen is stressed slightly beyond the yield point and then unloaded. Its yield strength
(a) decreases
(b) increases
(c) remains same
(d) becomes equal to ultimate tensile strength

**Q.16** Cup-and-cone type fracture occurs in the case of
(a) cast iron
(b) round specimen of ductile metals
(c) tough steel
(d) soft brass

**Q.17** Materials having elongation less than 5% are considered brittle. In such cases, factor of safety is based on
(a) yield stress
(b) endurance limit
(c) limit of proportionality
(d) ultimate stress

**Q.18** A rod of length '$l$' and cross-sectional area '$A$' rotates about an axis passing through one end of the rod. The extension produced in the rod due to centrifugal forces is ($w$ is the weight of the rod per unit length and $\omega$ is the angular velocity of rotation of the rod)
(a) $\omega w l^2 gE$ (b) $\omega^2 w l^3/3gE$
(c) $\omega^2 w l^3/gE$ (b) $3gE/\omega^2 W l^3$

**Q.19** Young's modulus of elasticity and Poisson's ratio of a material are 1.25 x $10^5$ MPa and 0.34 respectively. The modulus of rigidity of the material is
(a) $0.4025 \times 10^5$ MPa
(b) $0.4664 \times 10^5$ MPa
(c) $0.8375 \times 10^5$ MPa
(d) $0.9469 \times 10^5$ MPa

**Q.20** In a homogeneous, isotropic elastic material, the modulus of elasticity $E$ in terms of $G$ and $K$ is equal to
(a) $(G + 3K)/9KG$ (b) $(3G + K)/9KG$
(c) $9KG/(G + 3K)$ (d) $9KG/(K + 3G)$

**Q.21** The unit of elastic modulus is the same as those of
(a) stress, shear modulus and pressure
(b) strain, shear modulus and force
(c) shear modulus, stress and force
(d) stress, strain and pressure

**Q.22** For a linearly elastic, isotropic and homogeneous material, the number of elastic constants required to relate stress and strain is
(a) two (b) three
(c) four (d) six

**Q.23** If the cross-section of a member is subjected to a uniform shear stress of intensity '$q$', then the strain energy stored per unit volume is equal to ($G$ = modulus of rigidity)
(a) $2q^2/G$ (b) $2G/q^2$
(c) $q^2/2G$ (d) $G/2q^2$

**Q.24** In the case of an engineering material under unidirectional stress in the $x$-axis, the Poisson's ratio is equal to (symbols have their usual meanings)
(a) $\varepsilon_y/\varepsilon_x$ (b) $\varepsilon_y/\sigma_x$
(c) $\varepsilon_y/\sigma_s$ (d) $\sigma_y/\varepsilon_x$

**Q.25** A 100 mm long and 50 mm diameter steel rod fits snugly between two rigid walls 100 mm apart at room temperature. Young's modulus of elasticity and coefficient of linear expansion of steel are 2 × $10^5$ N/mm$^2$ and 12 × $10^{-6}$/°C respectively. The stress developed in the rod due to a 100°C rise in temperature will be
(a) $6 \times 10^{-11}$ N/mm$^2$ (b) $6 \times 10^{-10}$ N/mm$^2$
(c) 240 N/mm$^2$ (d) 2400 N/mm$^2$

**Q.26** 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 deflection

**Q.27** If the value of Poisson's ratio is zero, then it means that
(a) the material is rigid
(b) the material is perfectly plastic
(c) there is no longitudinal strain in the material
(d) the longitudinal strain in the material is infinite

**Q.28** The stretch in a steel rod of circular section, having a length $l$ subjected to a tensile load $P$ and tapering uniformly from a diameter $d_1$, at one end to a diameter $d_2$ at the other end, is given by
(a) $Pl/4Ed_1d_2$ (b) $Pl\pi/Ed_1d_2$
(c) $Pl/4E(d_1 - d_2)$ (d) $4Pl/\pi Ed_1d_2$

**Q.29** If Poisson's ratio for a material is 0.5, then the elastic modulus for the material is
(a) three times its shear modulus
(b) four times its shear modulus
(c) equal to its shear modulus
(d) indeterminate

**Q.30** 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

**Q.31** A rod of material $E = 200 \times 10^3$ 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)

**Q.32** The deformation of a 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

**Q.33** The number of independent elastic constants required to express the stress-strain relationship for linearly elastic isotropic material is
(a) one (b) two
(c) three (d) four

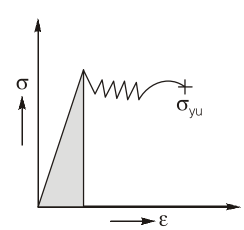
**Q.34** A tapering bar (diameters of end sections being $d_1$ and $d_2$) and a bar of uniform cross-section '$d$' have the same length and are subjected to the same axial pull. Both the bars will have the same extension if '$d$' is equal to
(a) $(d_1 + d_2)/2$ (b) $\sqrt{d_1 d_2}$
(c) $\sqrt{d_1 d_2 / 2}$ (d) $\sqrt{(d_1 + d_2)/2}$

**Q.35** The number of elastic constants for a completely anisotropic elastic material which follows Hooke's law is
(a) 2 (b) 4
(c) 21 (d) 25

**Q.36** For a given material, the modulus of rigidity is 100 GPa and Poisson's ratio is 0.25. The value of modulus of elasticity in GPa is
(a) 125 (b) 150
(c) 200 (d) 250

**Q.37** A cube having each side of length '$a$' is constrained in all directions and is heated uniformly so that the temperature is raised to T°C. If $\alpha$ is the thermal coefficient of expansion of the cube material and $E$ is the modulus of elasticity, the stress developed in the cube is
(a) $\dfrac{\alpha TE}{\nu}$ (b) $\dfrac{\alpha TE}{(1-2\nu)}$
(c) $\dfrac{\alpha TE}{2\nu}$ (d) $\dfrac{\alpha TE}{(1+2\nu)}$

**Q.38** Toughness for mild steel under uniaxial tensile loading is given by the shaded portion of the stress-strain diagram as shown in

(a)
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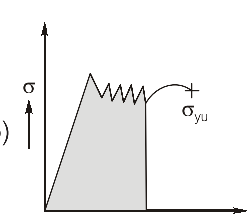
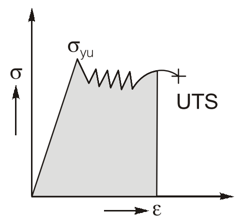
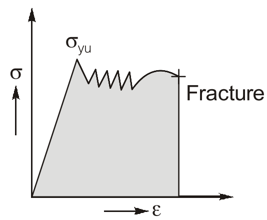


(c) 


(d) 


**Q.39** Which one of the following is correct in respect of Poisson's ratio (ν) limits for an isotropic elastic solid?
(a) $-\infty \le \nu \le \infty$ (b) $1/4 \le \nu \le 1/3$
(c) $-1 \le \nu \le 1/2$ (d) $-1/2 \le \nu \le 1/2$

**Q.40** A bar of copper and steel form a composite system. They are heated to a temperature of 40°C. What type of stress is induced in the copper bar?
(a) tensile (b) compressive
(c) shear (d) None of these

**Q.41** A cube with a side length of 1 cm is heated uniformly 1°C above the room temperature and all the sides are free to expand. What will be the increase in volume of the cube? (Given coefficient of thermal expansion is α per °C)
(a) $3\alpha$ cm$^3$ (b) $2\alpha$ cm$^3$
(c) $\alpha$ cm$^3$ (d) zero

**Q.42** If $E$, $G$ and $K$ denote Young's modulus of elasticity, Modulus of rigidity and Bulk modulus, respectively, for an elastic material then which one of the following can be possibly true?
(a) $G = 2K$ (b) $G = E$
(c) $K = E$ (d) $G = K = E$

**Q.43** Consider the following statements:
1. Strength of steel increases with carbon content
2. Young's modulus of steel increases with carbon content
3. Young's modulus of steel remains unchanged with variation of carbon content

Which of these statements is/are correct?
(a) 1 only (b) 2 only
(c) 1 and 2 (d) 1 and 3

**Q.44** A solid uniform metal bar of diameter $D$ and length $L$ is hanging vertically from its upper end. The elongation of the bar due to self weight is
(a) Proportional to $L$ and inversely proportional to $D^2$
(b) Proportional to $L^2$ and inversely proportional to $D^2$
(c) Proportional to $L$ but independent of $D$
(d) Proportional to $L^2$ but independent of $D$

**Q.45** $E$, $G$, $K$ and ν represent the elastic modulus, shear modulus, bulk modulus and Poisson's ratio respectively of a linearly elastic, isotropic and homogeneous material. To express the stress-strain relations completely for this material, at least
(a) $E$, $G$ and ν must be known
(b) $E$, $K$ and ν must be known
(c) any two of the four must be known
(d) All the four must be known

**Q.46** Steel has its yield strength of 400 N/mm$^2$ and modulus of elasticity of $2 \times 10^5$ MPa. Assuming the material to obey Hooke's law up to yielding, what is its proof resilience?
(a) 0.8 N/mm$^2$ (b) 0.4 N/mm$^2$
(c) 0.6 N/mm$^2$ (d) 0.7 N/mm$^2$

**Q.47** In a tensile test, near the elastic limit zone
(a) tensile stress increases at a faster rate
(b) tensile stress decreases at a faster rate
(c) tensile stress increases in linear proportion to the strain
(d) tensile stress decreases in linear proportion to the strain

**Q.48** Given that for an element in a body of homogeneous isotropic material subjected to plane stress; $e_x$, $e_y$ and $e_z$ are normal strains in $x$, $y$ and $z$ directions respectively and μ is the Poisson's ratio, the magnitude of unit volume change of the element is given by
(a) $e_x + e_y + e_z$ (b) $e_x - (e_y + e_z)$
(c) $\mu(e_x + e_y + e_z)$ (d) $\frac{1}{e_x} + \frac{1}{e_y} + \frac{1}{e_z}$

**Q.49** The ratio of the lateral pressure of the bulk storage material at the time of emptying to that at the time of filling is
(a) less than one
(b) equal to or less than one
(c) equal to one
(d) greater than one

**Q.50** The stress below which a material has a high probability of not failing under reversal of stress is known as
(a) tolerance limit (b) elastic limit
(c) proportional limit (d) endurance limit

**Q.51** Consider the following statements:
The principal of super position is applied to:
1. Linear elastic bodies.
2. Bodies subjected to small deformations.
Which of these statements is/are correct?
(a) 1 alone (b) 1 and 2
(c) 2 alone (d) Neither 1 nor 2

**Q.52** If all the dimensions of a bar are increased in the proportion $n$ : 1, the proportion with which the maximum stress produced in the prismatic bar by its own weight, will increase in the ratio
(a) $1 : n$ (b) $n : 1$
(c) $1 : \frac{1}{n}$ (d) $\frac{1}{n} : 1$

**Q.53** A bar is subjected to an axial tensile stress. If the volumetric strain in the bar is 0.44 times the axial strain, what is the Poisson's ratio of the material?
(a) 0.44 (b) 0.30
(c) 0.28 (d) None of these

**Q.54** On a plane, resultant stress is inclined at an angle of 30° with the plane. If the normal stress on the plane is 50 MPa, what is the shear stress on the plane.
(a) 43.3 MPa (b) 86.6 MPa
(c) 100 MPa (d) None of these

**Q.55** A bar of a square section $a \times a$ subjected to a tensile load $P$ on a plane inclined at 45° to the axis of the bar, normal stress will be
(a) $\frac{2P}{a^2}$ (b) $\frac{P}{a^2}$
(c) $\frac{P}{2a^2}$ (d) $\frac{P}{4a^2}$

**Q.56** Two tie rods are connected, through a pin of a cross-sectional area of 40 mm$^2$. If the tie rods carry a tensile load of 10 kN, the shear stress in the pin is
(a) 125 MPa (b) 250 MPa
(c) 500 MPa (d) None of these

**Q.57** A spherical ball of volume 1000 cm$^3$ is subjected to a hydrostatic pressure of 90 N/mm$^2$ and bulk modulus of the material is 190 kN/mm$^2$. What is the change in volume of the ball?
(a) 473 mm$^3$ (b) 940 mm$^3$
(c) 502 mm$^3$ (d) None of these

**Q.58** In stress-strain curve, the area upto elastic limit stress indicates which mechanical property?
(a) Ductility (b) Strength
(c) Resilience (d) None of these

**Q.59** In $\sigma$-$\epsilon$ curve for mild steel, load at which considerable extension occurs with decrease in resistance is known as?
(a) Upper yield point (b) Breaking load
(c) Ultimate load (d) None of these

**Q.60** A composite bar is made of steel and aluminium strips, with $A_a = 3A_s$, where $A_a$ and $A_s$ are areas of cross-section of aluminium and steel bars, respectively $E_s/E_a = 3$. Due to an external load, if the stress developed in the aluminium is 30 MPa, then what is the stress developed in the steel bar?
(a) 10 MPa (b) 30 MPa
(c) 90 MPa (d) None of these

**Q.61** A copper bar of area of cross-section 200 mm$^2$ is encased in a steel tube of area of cross-section 400 mm$^2$. Due to an external load, the stress in copper bar is 10 MPa and load on composite bar is $P$. What is the load shared by the steel bar? $\frac{E_s}{E_{cu}} = 2$
(a) 0.5 $P$ (b) 0.6 $P$
(c) 0.8 $P$ (d) None of these

**Q.62** A bimetallic strip is made of two metals with equal areas of cross-section. Due to temperature change, the stress developed in one strip is –40 N/mm$^2$. What is the stress developed in another component of the composite bar?
(a) –40 N/mm$^2$ (b) 20 N/mm$^2$
(c) 40 N/mm$^2$ (d) –20 N/mm$^2$

**Q.63** Three strips of same area of cross-section share a load of 5.5 kN. If their Young's modulus are in the ratio of $E_1 = 2E_2 = 3E_3$, then what is the load, shared by the strip with Young's modulus $E_1$

(a) 3 kN (b) 3.5 kN
(c) 2.5 kN (d) 2 kN

**Q.64** A steel rail track is laid by joining 30 m long rails end to end. At 30°C there is no stress in the rails. At 50°C, what will be the stress in the rails if $\alpha = 11 \times 10^{-6}$/°C and $E = 2 \times 10^5$ N/mm$^2$

(a) 88 MPa (b) 44 MPa
(c) 22 MPa (d) 11 MPa

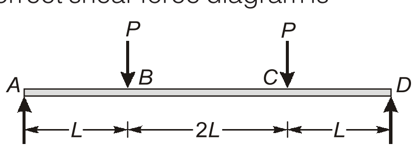
**Q.65** True stress $\sigma$ is related with conventional stress $\sigma_0$ as

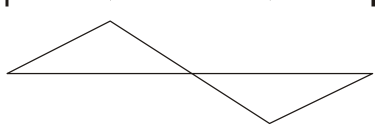
(a) $\frac{\sigma}{\sigma_0} = (1+\epsilon)^2$ (b) $\frac{\sigma}{\sigma_0} = \frac{1}{(1+\epsilon)^2}$

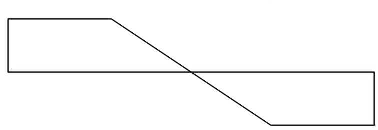
(c) $\frac{\sigma}{\sigma_0} = \frac{1}{1+\epsilon}$ (d) $\frac{\sigma}{\sigma_0} = 1+\epsilon$

## 2. Shear Force and Bending Moment

**Q.66** For the loaded beam shown in the figure, the correct shear force diagram is



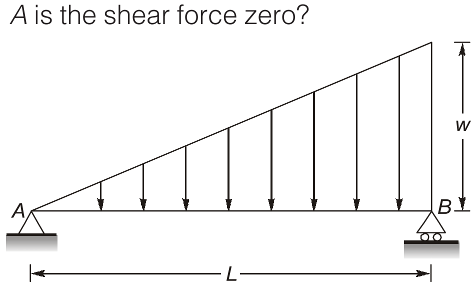

(a)


(b)


(c)


(d)

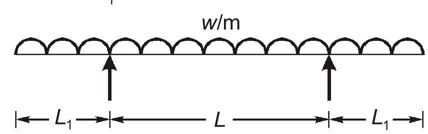

**Q.67** For the simply supported beam, shown in the figure below at what distance from the support *A* is the shear force zero?




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

(c) $\frac{L}{2}$ (d) $\frac{L}{\sqrt{3}}$

**Q.68** For the beam shown in the given figure, the maximum positive bending moment is equal to the maximum negative bending moment. The value of $L_1$ is




(a) $\frac{L}{\sqrt{2}}$ (b) $\frac{L}{\sqrt{3}}$

(c) $\frac{L}{2}$ (d) $\frac{L}{2\sqrt{2}}$

**Q.69** The maximum bending moment due to a moving load on a fixed ended beam occurs

(a) at a support
(b) always at the mid span
(c) under the load only
(d) None of the above

**Q.70** If a beam is subjected to a constant bending moment along its length then the shear force will

(a) also have a constant value every where along its length
(b) be zero at all sections along the beam
(c) be maximum at the centre and zero at the ends
(d) be maximum at the ends and zero at the centre

**Q.71** 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

## Answers Strength of Materials

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (b) | 2. | (a) | 3. | (c) | 4. | (c) | 5. | (b) | 6. | (d) | 7. | (a) | 8. | (d) |
| 9. | (d) | 10. | (b) | 11. | (c) | 12. | (a) | 13. | (b) | 14. | (c) | 15. | (b) | 16. | (b) |
| 17. | (c) | 18. | (b) | 19. | (b) | 20. | (c) | 21. | (a) | 22. | (a) | 23. | (c) | 24. | (a) |
| 25. | (c) | 26. | (d) | 27. | (b) | 28. | (d) | 29. | (a) | 30. | (b) | 31. | (b) | 32. | (c) |
| 33. | (b) | 34. | (b) | 35. | (c) | 36. | (d) | 37. | (b) | 38. | (d) | 39. | (b) | 40. | (b) |
| 41. | (a) | 42. | (c) | 43. | (d) | 44. | (d) | 45. | (c) | 46. | (b) | 47. | (c) | 48. | (a) |
| 49. | (d) | 50. | (d) | 51. | (b) | 52. | (b) | 53. | (c) | 54. | (b) | 55. | (c) | 56. | (b) |
| 57. | (a) | 58. | (c) | 59. | (a) | 60. | (b) | 61. | (c) | 62. | (c) | 63. | (a) | 64. | (b) |
| 65. | (c) | 66. | (c) | 67. | (d) | 68. | (d) | 69. | (a) | 70. | (b) | 71. | (c) | 72. | (b) |
| 73. | (d) | 74. | (d) | 75. | (c) | 76. | (a) | 77. | (c) | 78. | (d) | 79. | (a) | 80. | (b) |
| 81. | (c) | 82. | (d) | 83. | (d) | 84. | (c) | 85. | (a) | 86. | (c) | 87. | (a) | 88. | (c) |
| 89. | (a) | 90. | (c) | 91. | (d) | 92. | (a) | 93. | (b) | 94. | (b) | 95. | (d) | 96. | (b) |
| 97. | (a) | 98. | (c) | 99. | (c) | 100. | (a) | 101. | (b) | 102. | (d) | 103. | (a) | 104. | (d) |
| 105. | (d) | 106. | (a) | 107. | (b) | 108. | (c & b) | 109. | (b) | 110. | (a) | 111. | (c) | 112. | (a) |
| 113. | (c) | 114. | (b) | 115. | (c) | 116. | (c) | 117. | (a) | 118. | (c) | 119. | (d) | 120. | (b) |
| 121. | (d) | 122. | (b) | 123. | (d) | 124. | (a) | 125. | (c) | 126. | (b) | 127. | (b) | 128. | (b) |
| 129. | (c) | 130. | (a) | 131. | (d) | 132. | (a) | 133. | (c) | 134. | (a) | 135. | (b) | 136. | (d) |
| 137. | (c) | 138. | (b) | 139. | (b) | 140. | (b) | 141. | (c) | 142. | (c) | 143. | (b) | 144. | (a) |
| 145. | (d) | 146. | (a) | 147. | (d) | 148. | (b) | 149. | (b) | 150. | (b) | 151. | (b) | 152. | (b) |
| 153. | (b) | 154. | (c) | 155. | (b) | 156. | (c) | 157. | (a) | 158. | (b) | 159. | (d) | 160. | (b) |
| 161. | (c) | 162. | (d) | 163. | (b) | 164. | (a) | 165. | (c) | 166. | (b) | 167. | (c) | 168. | (c) |
| 169. | (a) | 170. | (b) | 171. | (a) | 172. | (a) | 173. | (c) | 174. | (a) | 175. | (c) | 176. | (c) |
| 177. | (d) | 178. | (d) | 179. | (d) | 180. | (b) | 181. | (c) | 182. | (c) | 183. | (a) | 184. | (d) |
| 185. | (d) | 186. | (c) | 187. | (c) | 188. | (c) | 189. | (a) | 190. | (c) | 191. | (c) | 192. | (a) |
| 193. | (a) | 194. | (a) | 195. | (c) | 196. | (d) | 197. | (d) | 198. | (a) | 199. | (c) | 200. | (c) |
| 201. | (a) | 202. | (d) | 203. | (d) | 204. | (d) | 205. | (d) | 206. | (b) | 207. | (c) | 208. | (d) |
| 209. | (a) | 210. | (c) | 211. | (c) | 212. | (b) | 213. | (d) | 214. | (c) | 215. | (b) | 216. | (d) |
| 217. | (b) | 218. | (b) | 219. | (a) | 220. | (b) | 221. | (c) | 222. | (b) | 223. | (c) | 224. | (a) |
| 225. | (c) | 226. | (a) | 227. | (d) | 228. | (a) | 229. | (b) | 230. | (d) | 231. | (c) | 232. | (b) |
| 233. | (c) | 234. | (d) | 235. | (d) | 236. | (c) | 237. | (a) | 238. | (c) | 239. | (b) | 240. | (d) |
| 241. | (a) | 242. | (d) | 243. | (c) | 244. | (a) | 245. | (c) | 246. | (d) | 247. | (c) | 248. | (a) |
| 249. | (c) | 250. | (a) | 251. | (d) | 252. | (c) | 253. | (b) | 254. | (c) | 255. | (a) | 256. | (b) |
| 257. | (a) | 258. | (b) | 259. | (c) | 260. | (a) | 261. | (c) | 262. | (d) | 263. | (d) | 264. | (a) |
| 265. | (d) | 266. | (c) | 267. | (d) | 268. | (b) | 269. | (a) | 270. | (b) | | | | |

**Explanations** **Strength of Materials**

**2. (a)**

$$\text{Nominal stress} = \frac{\text{Load}}{\text{Original area}} = \frac{P}{A}$$

$$\text{Actual stress} = \frac{\text{Load}}{\text{Actual area}} = \frac{P}{A}$$

Actual area at instant of loading does not remain constant and decreases with increases in elongation actual stress is also called true stress.

**3. (c)**

The temperature at which the creep becomes an important consideration is called HOMOLOGOUS TEMPERATURE and this temperature is nearly half of the melting point temperature.

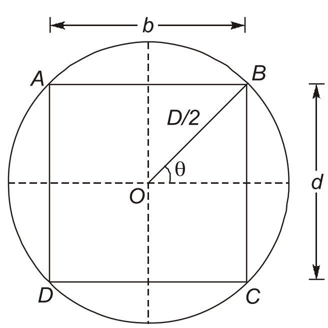
**5. (b)**

$$\bar{\varepsilon} = \log_n\left(\frac{l}{l_0}\right) = \ln 2 = 0.693$$

**10. (b)**

$AB = b = D\cos\theta,\ BC = d = D\sin\theta$

$$z = \frac{bd^2}{6} = \frac{D^3\cos\theta.\sin^2\theta}{6}$$




For $z$ to be maximum, $\dfrac{dz}{d\theta} = 0$

$$\frac{D^3}{6}[\cos\theta.2\sin\theta\cos\theta - \sin^3\theta] = 0$$

or $\quad 2\cos^2\theta - \sin^2\theta = 0$

$$\tan\theta = \sqrt{2}, \sin\theta = \sqrt{\frac{2}{3}}, \cos\theta = \frac{1}{\sqrt{3}},$$

$$\frac{b}{d} = \cot\theta = \frac{1}{\sqrt{2}} = 0.707$$

**14. (c)**

Since the bar is free to expand, no stresses will be developed in the bar.

**19. (b)**

$$G = \frac{E}{2(1+\mu)} = \frac{1.25\times10^5}{2(1+0.34)} = 0.4664 \times 10^5 \text{ MPa}$$

**25. (c)**

$l = 100$ mm, $d = 50$ mm,

$E = 2 \times 10^5$ N/mm$^2$, $\alpha = 12 \times 10^{-6}$/°C

$$\delta l = \alpha l \Delta T, \varepsilon = \frac{\delta l}{l}, \sigma = E_\epsilon = E\alpha$$

$= 2 \times 10^5 \times 12 \times 10^{-6} \times 100 = 240$ N/mm$^2$

**29. (a)**

$$E = 2G(1+\mu) \quad \text{or} \quad \frac{E}{G} = 2 \times 1.5 = 3$$

**30. (b)**

$$G = \frac{E}{2(1+\mu)}$$

or, $\quad 1 + \mu = \dfrac{120}{2\times50} = 1.2$

$\therefore \quad \mu = 0.2$

**31. (b)**

$$\sigma = E\propto T = -200 \times 10^3 \times 10^{-3} \times 30$$
$$= -6000 \text{ N/mm}^2$$

**33. (b)**

There are two independent elastic constants $E$ and $G$ for an isotropic linear elastic material.

**34. (b)**

$$\delta_{taper} = 4Pl/(\pi d_1 d_2 E)$$
$$\delta_{uniform} = 4Pl/(pd^2 E)$$
$$\therefore \quad d = \sqrt{d_1 d_2}$$

**36. (d)**

$$E = 2G(1+\mu) = 2 \times 100(1 + 0.25)$$
$$= 250 \text{ GPa}$$

**37. (b)**

For hydrostatic state stress = 0

$$\sigma_x = \sigma_y = \sigma_z = 0$$

$$\sigma = \left(\frac{1}{E}\right)[\sigma - 2\nu\sigma] = \sigma\frac{(1-2\mu)}{E} = \sigma T$$

$$\sigma = \frac{E\alpha T}{1-2\mu}$$

**38. (d)**

Toughness is the total area under the stress-strain curve upto fracture.

**40. (b)**

Coefficient of expansion of copper is more than that of steel. Hence, copper will develop compressive stress.

**41. (a)**

Change in volume, $\delta V = 3\alpha$ cm$^3$.

**42. (c)**

$E = 3K(1 - 2\nu)$. For $\nu$ = 0.30 to 0.34 $E \approx$ K.

**43. (d)**

Strength of steel increases with carbon content, but Young's modulus remains constant.

**44. (d)**

Weight of the bar, $W = \left(\frac{\pi}{4}\right) D^2 L_r$

$$dL = \frac{WL}{2AE} = \frac{L^2}{2E}$$

**46. (b)**

Proof resilience,

$$u_{max} = \frac{\sigma_y^2}{2E} = \frac{400^2}{2 \times 2 \times 10^5} = 0.4 \text{ N/mm}^2$$

**48. (a)**

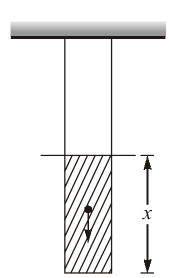
Unit volume change = Volumetric strain

$$= e_x + e_y + e_z$$

**49. (d)**

While emptying a tank wall of the vessel moves towards filled liquid which is analogous to passive case while during filling the tank wall of the vessel (tank) moves away from the liquid which is homologous to active case.

**52. (b)**




$$\sigma_x = \frac{W_x}{A} = \frac{\gamma\, A \cdot x}{A} = \gamma . x$$

If dimensions are doubled then,

$$\sigma_x' = \gamma . nx$$

$$\therefore\ \sigma_x' = \sigma = n.1$$

**53. (c)**

$$E_v = 0.44\, E_l$$

Let the axial tensile stress = $\sigma_x$

$$\therefore\quad \in_x = \frac{\sigma_x}{E}$$

$$\in_y = -\mu \frac{\sigma_x}{E}$$

$$\in_z = -\mu \frac{\sigma_x}{E}$$

$\therefore$ Volumetric strain,

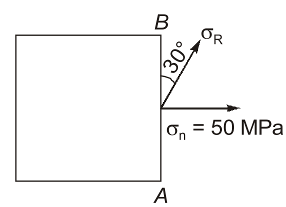
$$\in_v = \in_x + \in_y + \in_z = \frac{\sigma_x}{E}(1 - 2\mu)$$

$$\therefore\quad \frac{\sigma_x}{E}(1 - 2\mu) = 0.44 \times \frac{\sigma_x}{E}$$

$$\therefore\quad 1 - 2\mu = 0.44$$

$$\Rightarrow\quad \mu = 0.28$$

**54. (b)**




Let the plane be $AB$,

$$\therefore\quad \tan(90 - 30) = \frac{\tau}{50}$$

$\therefore$ Shear stress $\tau = 50 \tan 60° = 86.6$ MPa

**55. (c)**

$$\sigma_n = \frac{P}{a^2}\sin^2\theta = \frac{P}{a^2}\sin^2 45° = \frac{P}{2a^2}$$

**57. (a)**

$$K = \frac{\text{Stress}}{\text{Volumetric strain}}$$

$$\therefore\quad 190 \times 10^3 = \frac{90}{\in_v}$$

$$\Rightarrow\quad \in_v = \frac{90}{190} \times 10^{-3}$$

$\therefore$ Change in volume of the ball

$$\Delta v = \in_v V = \left(\frac{90}{190} \times 10^{-3} \times 1000 \times 10^3\right) \text{mm}^3$$

$$= 473 \text{ mm}^3$$

**60. (c)**

The strain in both the bars will be same,

$$\therefore\quad \frac{P_s}{A_s E_s} = \frac{P_a}{A_a E_a}$$

$$\Rightarrow \quad \frac{P_s}{A_s 3E_a} = \frac{P_a}{3A_s E_a}$$

$$\Rightarrow \quad P_s = P_a$$

$$P_s = \frac{P_s}{A_s}$$

$$P_A = \frac{P_A}{A_a} = \frac{P_s}{3A_s} = 30\,\text{MPa}$$

$$\therefore \quad P_s = 3P_A = 90\text{ MPa}$$

**63. (a)**

$$E_1 = 2E_2 = 3E_3$$

$$\therefore \quad P_1 = 2P_2 = 3P_3$$

$$\therefore \quad P_1 + \frac{P_1}{2} + \frac{P_1}{3} = 5.5$$

$$\Rightarrow \quad P_1 = 3\text{ kN}$$

**64. (b)**

The stress in the rails will be developed due to the expansion which is prevented.

$\therefore$ Expansion = $\alpha L(50 - 30)$

Prevented = $(11 \times 10^{-6} \times 30 \times 10^3 \times 20)$ mm

= 6.6 mm

$$\therefore \quad \text{Stress} = \frac{6.6}{30 \times 10^3} \times 2 \times 10^5$$

$$= 44\text{ N/mm}^2$$

**66. (c)**

The shear force in the span *BC* will be zero. The shear force in the span *AB* and *CD* will be of opposite sign.

**67. (d)**

Reaction $R_A$ at $A = \frac{wL}{2} \times \frac{1}{3} = \frac{wL}{6}$

Let the point of zero shear force occur at section *X-X* from left support *A*

$\therefore$ Shear force at *X-X*

$$S_{xx} = \frac{wL}{6} - \left(\frac{wx}{L}\right) \times \frac{x}{2}$$

$\therefore$ For zero shear force we have,

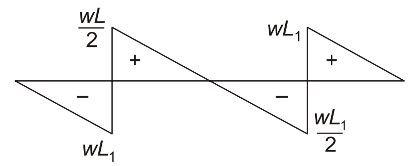
$$\frac{wL}{6} = \frac{wx^2}{2L}$$

$$\Rightarrow \quad x^2 = \frac{L^2}{3} \text{ or } x = \frac{L}{\sqrt{3}}$$

**68. (d)**

The BM can be found from the area of SFD.

The shear force diagram is




Maximum negative, bending moment,

$$M_1 = \frac{wL_1^2}{2}$$

Maximum positive, bending moment,

$$M_2 = \frac{wL^2}{8} - \frac{wL_1^2}{2}$$

$$\text{For} \quad M_1 = M_2$$

$$L_1 = \frac{L}{2\sqrt{2}}$$

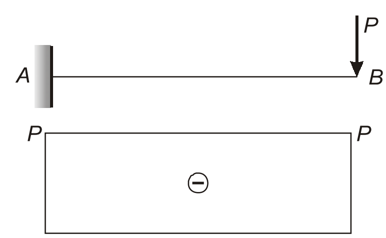
**70. (b)**

If M is constant then,

$$\text{S.F} = 0, \text{ as}$$

$$\text{S.F} = \frac{dM}{dx}$$

**71. (c)**

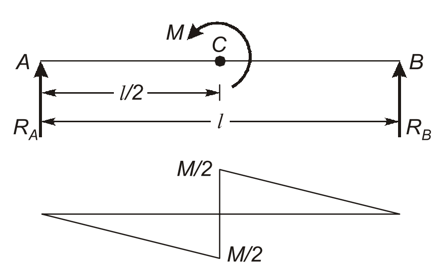



**SFD**

**73. (d)**

$$R_A \times l = M$$

$$R_A = \frac{M}{l}$$




Span *AC* :

$$M_x = \frac{M}{l}x$$

$$M_C = \frac{M}{2} - M = -\frac{M}{2}$$