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PRODUCTION AND INDUSTRIAL ENGINEERING

Objective Practice Sets

General Engineering : Volume II

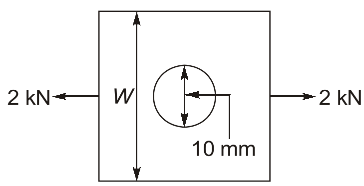
Applied Mechanics

MADE EASY PUBLICATIONS

II VOLUME

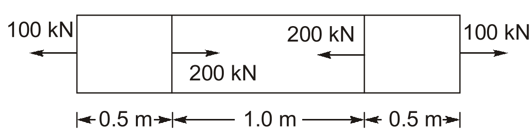
Applied Mechanics

Q.1 If permissible stress in plates of thickness 2 mm of joint through a pin as shown in the figure is 200 MPa, then the width *w* will be



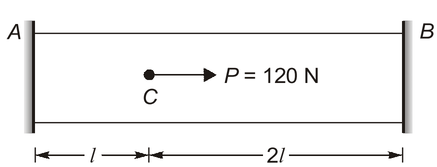
(a) 15 mm (b) 20 mm
(c) 18 mm (d) 25 mm

Q.2 A slender bar of 100 mm^2 cross-section is subjected to loading as shown in the figure below. If the modulus of elasticity is taken as 200×10^9 Pa, then the elongation produced in the bar will be



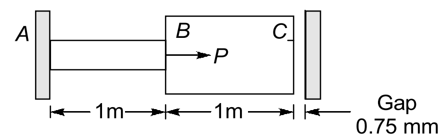
(a) 10 mm (b) 5 mm
(c) 1 mm (d) Nil

Q.3 A straight bar is fixed at edges *A* and *B*. Its elastic modulus is *E* and cross-section is *A*. There is a load *P* = 120 N acting at *C*. The reactions at the ends are



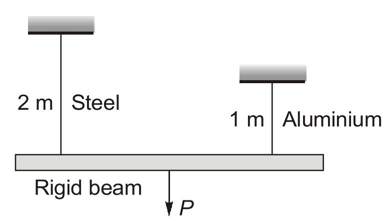
(a) 60 N at *A*, 60 N at *B*
(b) 30 N at *A*, 90 N at *B*
(c) 40 N at *A*, 80 N at *B*
(d) 80 N at *A*, 40 N at *B*

Q.4 In the arrangement as shown in the figure, the stepped steel bar *ABC* is loaded by a load *P*. The material has Young's modulus *E* = 200 GPa and the two portions *AB* and *BC* have area of cross section 1 cm^2 and 2 cm^2 respectively. The magnitude of load *P* required to fill up the gap of 0.75 mm is



(a) 10 kN (b) 15 kN
(c) 20 kN (d) 25 kN

Q.5 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-sectional areas 100 mm^2 and 200 mm^2, and Young's modulus of 200 GPa and 100 GPa, respectively. A load *P* is applied as shown in the figure below :



If the rigid beam is to remain horizontal, then
(a) the force *P* must be applied at the centre of the beam
(b) the force on the steel rod should be twice the force on the aluminium rod
(c) the force on the aluminium rod should be twice the force on the steel-rod
(d) the forces on both the rods should be equal

Q.6 A copper rod of 2 cm diameter is completely encased in a steel tube of inner diameter 2 cm and outer diameter 4 cm. Under an axial load, the stress in the steel tube is 100 N/mm^2.
If $E_s = 2E_c$, then the stress in the copper rod is
(a) 50 N/mm^2 (b) 33.33 N/mm^2
(c) 100 N/mm^2 (d) 300 N/mm^2

Q.7 The resilience of steel can be found by integrating stress-strain curve up to the

(a) ultimate fracture point
(b) upper yield point
(c) lower yield point
(d) elastic point

Q.8 The relationship between the Lame's constant λ, Young's modulus E and the Poisson's ratio μ 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) $\lambda = \dfrac{E\mu}{(1-\mu)}$

Q.9 Which one of the following is correct in respect of Poisson's ratio (m) limits for an isotropic elastic solid?

(a) $-\infty \le \mu \le \infty$ (b) $\dfrac{1}{4} \le \mu \le \dfrac{1}{3}$

(c) $-1 \le \mu \le \dfrac{1}{2}$ (d) $-\dfrac{1}{2} \le \mu \le \dfrac{1}{2}$

Q.10 What is the relationship between elastic constants E, G and K?

(a) $E = \dfrac{KG}{9K+G}$ (b) $E = \dfrac{9KG}{K+G}$

(c) $E = \dfrac{9KG}{K+3G}$ (d) $E = \dfrac{9KG}{3K+G}$

Q.11 A copper rod 400 mm long is pulled in tension to a length of 401.2 mm by applying a tensile stress of 330 MPa. If the deformation is entirely elastic, the Young's modulus of copper is

(a) 110 GPa (b) 110 MPa
(c) 11 GPa (d) 11 MPa

Q.12 The modulus of rigidity and the bulk modulus of a material are found as 70 GPa and 150 GPa respectively. Then

1. Elasticity modulus is 200 GPa
2. Poisson's ratio is 0.22
3. Elasticity modulus is 182 GPa
4. Poisson's ratio is 0.3

Which of the above statement are correct?

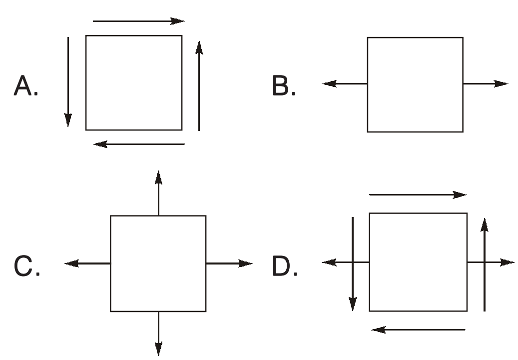
(a) 1 and 2 (b) 1 and 4
(c) 2 and 3 (d) 3 and 4

Q.13 An isotropic elastic material is characterized by:

(a) two independent moduli of elasticity along two mutually perpendicular directions
(b) two independent moduli of elasticity along two mutually perpendicular directions and Poisson's ratio
(c) a modulus of elasticity, a modulus of rigidity and Poisson's ratio
(d) any two out of a modulus of elasticity, a modulus of rigidity and Poisson's ratio

Q.14 Match **List-I** (State of stress) with **List-II** (Kind of loading) and select the correct answer using the codes given below the lists:

List-I



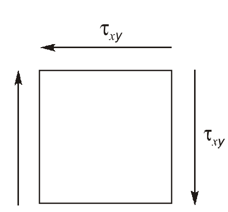
List-II

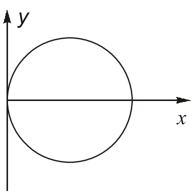
1. Combined bending and torsion of circular shaft.
2. Torsion of circular shaft.
3. Thin cylinder subjected to internal pressure.
4. Tie bar subjected to tensile force.

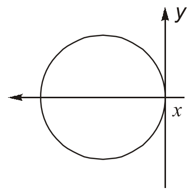
Codes:

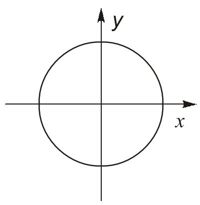
	A	B	C	D
(a)	1	2	3	4
(b)	2	3	4	1
(c)	2	4	3	1
(d)	3	4	1	2

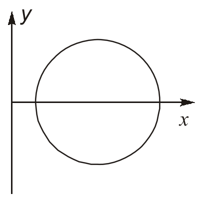
Q.15 State of stress at a point in a strained body is shown in figure. Which one of the figure given below represents correctly the Mohr's circle for the state of stress?



(a) 

(b) 

(c) 

(d) 

Q.16 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 $\gamma_{xy} = 0$

Q.17 Normal stresses of equal magnitude σ, but of opposite signs, act at a point of a strained material in perpendicular direction. What is the magnitude of the stress on a plane inclined at 45° to the applied stresses?

(a) 2σ (b) σ/2
(c) σ/4 (d) Zero

Q.18 In a strained material, normal stresses on two mutually perpendicular planes are σ_x and σ_y (both alike) accompanied by a shear stress τ_{xy}. One of the principal stresses will be zero, only if

(a) $\tau_{xy} = \dfrac{\sigma_x \times \sigma_y}{2}$ (b) $\tau_{xy} = \sigma_x \times \sigma_y$

(c) $\tau_{xy} = \sqrt{\sigma_x \times \sigma_y}$ (d) $\tau_{xy} = \sqrt{\sigma^2{}_x + \sigma^2{}_y}$

Q.19 The principal stresses at a point in two-dimensional stress system are σ_1 and σ_2 and corresponding principal strains are ε_1 and ε_2. If E and μ denote Young's modulus and Poisson's ratio, respectively, then which one of the following is correct?

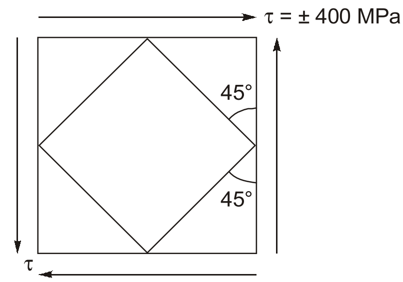
(a) $\sigma = E\,\varepsilon_1$

(b) $\sigma = \dfrac{E}{1-\mu^2}[\varepsilon_1 + \mu\,\varepsilon_2]$

(c) $\sigma = \dfrac{E}{1-\mu^2}[\varepsilon_1 - \mu\,\varepsilon_2]$

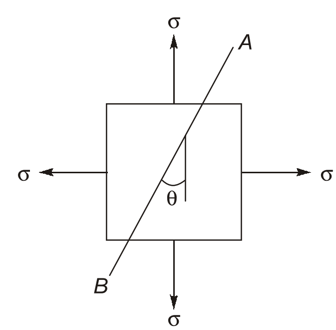
(d) $\sigma = E(\varepsilon_1 - \mu\varepsilon_2)$

Q.20 What are the normal and shear stresses on the 45° planes shown?



(a) $\sigma_1 = -\sigma_2 = 400$ MPa and $\tau = 0$
(b) $\sigma_1 = \sigma_2 = 400$ MPa and $\tau = 0$
(c) $\sigma_1 = \sigma_2 = -400$ MPa and $\tau = 0$
(d) $\sigma_1 = \sigma_2 = \tau = \pm 200$ MPa

Q.21 A point in two-dimensional stress state, is subjected to biaxial stress as shown in the below figure. The shear stress acting on the plane AB is



(a) Zero (b) σ
(c) $\sigma \cos^2\theta$ (d) $\sigma \sin\theta . \cos\theta$

Q.22 The state of plane stress at a point in a loaded member is given by :

$$\sigma_x = +800 \text{ MPa}$$
$$\sigma_y = +200 \text{ MPa}$$
$$\tau_{xy} = \pm 400 \text{ MPa}$$

The maximum principal stress and maximum shear stress are given by :

(a) $\sigma_{max} = 800$ MPa and $\tau_{max} = 400$ MPa
(b) $\sigma_{max} = 800$ MPa and $\tau_{max} = 500$ MPa
(c) $\sigma_{max} = 1000$ MPa and $\tau_{max} = 500$ MPa
(d) $\sigma_{max} = 1000$ MPa and $\tau_{max} = 400$ MPa

Q.23 The state of stress at a point in a body is given by $\sigma_x = 100$ MPa and $\sigma_y = 200$ MPa. One of the principal stresses $\sigma_1 = 250$ MPa. The magnitudes of the other principal stress and the shearing stress τ_{xy} are respectively

Answers Applied Mechanics

1. (a)	2. (d)	3. (d)	4. (b)	5. (c)	6. (a)	7. (d)
8. (a)	9. (b)	10. (d)	11. (a)	12. (d)	13. (d)	14. (c)
15. (c)	16. (b)	17. (d)	18. (c)	19. (b)	20. (a)	21. (a)
22. (c)	23. (c)	24. (a)	25. (c)	26. (d)	27. (b)	28. (c)
29. (c)	30. (c)	31. (c)	32. (a)	33. (c)	34. (b)	35. (c)
36. (b)	37. (b)	38. (b)	39. (d)	40. (a)	41. (b)	42. (a)
43. (a)	44. (d)	45. (b)	46. (d)	47. (d)	48. (c)	49. (c)
50. (c)	51. (c)	52. (c)	53. (b)	54. (c)	55. (a)	56. (a)
57. (c)	58. (d)	59. (0.85)	60. (c)	61. (c)	62. (d)	63. (b)
64. (c)	65. (a)	66. (a)	67. (c)	68. (d)	69. (c)	70. (b)
71. (c)	72. (b)	73. (b)	74. (c)	75. (b)	76. (d)	77. (b)
78. (b)	79. (d)	80. (d)	81. (c)	82. (c)	83. (b)	84. (a)
85. (a)	86. (c)	87. (d)	88. (a)	89. (c)	90. (73.63)	91. (b)
92. (b)	93. (c)	94. (c)	95. (c)	96. (b)	97. (a)	98. (a)
99. (b)	100. (c)	101. (b)	102. (a)	103. (a)	104. (b)	105. (d)
106. (a)	107. (c)	108. (b)	109. (16.667)	110. (32.48)	111. (b)	112. (b)
113. (b)	114. (33.075)	115. (–0.64174)	116. (0.234375)	117. (52.02)	118. (190.8)	119. (14.5)
120. (76.95)	121. (d)	122. (c)	123. (c)	124. (150)	125. (2.778)	126. (264.6)
127. (a)	128. (b)	129. (d)	130. (d)	131. (1.9285)	132. (b)	133. (d)
134. (a)	135. (d)	136. (–180)	137. (d)	138. (c)	139. (200.1708)	140. (c)
141. (b)	142. (a)	143. (d)	144. (0.04321)	145. (10.667)	146. (c)	147. (57.83)
148. (1.25)	149. (a)	150. (2.515)	151. (d)	152. (a)	153. (a)	154. (a)
155. (b)	156. (b)	157. (a)	158. (c)	159. (a)	160. (c)	161. (a)
162. (6)	163. (1.28)	164. (0)	165. (b)	166. (a)	167. (a)	168. (480)
169. (40)	170. (266.67)	171. (d)	172. (893.33)	173. (1845.89)	174. (5.6655)	175. (133.33)
176. (75)	177. (–4.732)	178. (b)	179. (b)	180. (a)	181. (1)	182. (367.87)
183. (20)	184. (b)	185. (a)	186. (d)	187. (d)	188. (b)	189. (56.6)
190. (b)	191. (d)	192. (a)	193. (d)	194. (c)	195. (b)	196. (c)
197. (b)	198. (2.75)	199. (a)	200. (0.3)	201. (633.93)	202. (642.3)	203. (1.60)

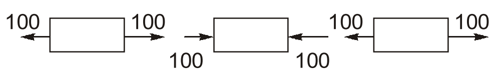
Explanations Applied Mechanics

1. (a)

$$A \times \sigma = F$$
$$(W - 10) \times 2 \times 200 = 2000$$
$$\therefore \quad W - 10 = 5$$
$$\therefore \quad W = 15 \text{ mm}$$

2. (d)

F.B.D.



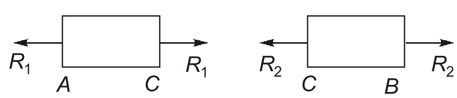
Total elongation, $\delta = \dfrac{PL}{AE}$

$$= \frac{1}{AE}(100 \times 0.5 - 100 \times 1 + 100 \times 0.5) = 0$$

3. (d)

$$R_A = 120 \times (BC/AB) = 80 \text{ N/mm}^2$$
$$R_B = 120 \times AC/AB = 40 \text{ N/mm}^2.$$

Free body diagrams,



$$R_1 - R_2 = 120 \quad \text{...(i)}$$

and $$(\delta l)_1 + (\delta l)_2 = 0$$

$$\frac{R_1 \times l}{A \times E} + \frac{R_2 \times 2l}{A \times E} = 0$$

$$\therefore \quad R_1 = -2R_2 \quad \text{...(ii)}$$

From Equation (i) and (ii), we get

$$R_2 = -40 \text{ N}$$

$R_2 = 40$ N (opposite direction to our assumption) and $R_1 = 80$ N.

4. (b)

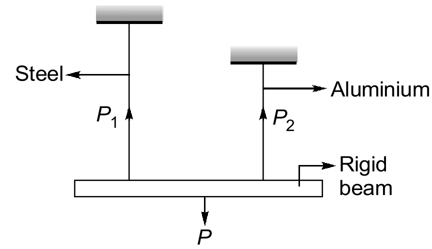
If BC is not touching the fixed end then there will be no stress in BC portion, So no force in BC section.

$$\frac{PL}{AE} = \delta l$$

$$\frac{P \times 1000}{(10)^2 \times 200 \times 10^3} = 0.75$$

$$P = 15 \text{ kN}$$

5. (c)



If the rigid beam is to remain horizontal

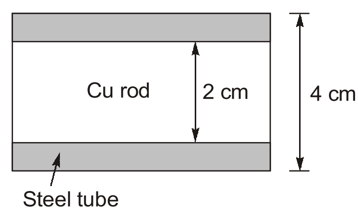
$$(\delta_L)_1 = (\delta_L)_2$$

$$\frac{P_1 L_1}{A_1 E_1} = \frac{P_2 L_2}{A_2 E_2}$$

$$\frac{P_1 \times 2000}{100 \times 200 \times 10^3} = \frac{P_2 \times (1000)}{200 \times 100 \times 10^3}$$

$$P_2 = 2P_1 \text{ [i.e. } P_{Al} = 2\, P_{steel}]$$

6. (a)



Given:

$$\sigma_s = 100 \text{ MPa}$$
$$E_s = 2E_C$$
$$\delta_s = \delta_c$$

$$\frac{P_s L_s}{A_s E_s} = \frac{P_c L_c}{A_c E_c}$$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c} \qquad [\because L_s = L_c]$$

$$\sigma_c = \frac{\sigma_s}{E_s} \times E_c$$

$$\sigma_c = \frac{\sigma_s}{2}$$

$$\sigma_c = \frac{100}{2} = 50 \text{ MPa}$$

7. (d)

The resilience of steel can be found by integrating stress-strain curve upto elastic point.