ANSWER SHEET											
1	(2)	13	(A)	25	(0.5)	37	(A)	49	(B)	61	(B)
2	(D)	14	(A)	26	(B)	38	(C)	50	(B)	62	(C)
3	(11.9 to 12.1)	15	(A)	27	(C)	39	(900 to 1000)	51	(219900 to 220000)	63	(B)
4	(B)	16	(C)	28	(A)	40	(B)	52	(65 to 68)	64	(C)
5	(A)	17	(C)	29	(6.79)	41	(13 to 14)	53	(D)	65	(D)
6	(B)	18	(A)	30	(D)	42	(C)	54	(A)		
7	(C)	19	(A)	31	(B)	43	(B)	55	(.25 to .27)		
8	(C)	20	(A)	32	(B)	44	(B)	56	(D)		
9	(B)	21	(D)	33	(D)	45	(B)	57	(B)		
10	(A)	22	(0.5)	34	(D)	46	(C)	58	(A)		
11	(C)	23	(4.9 to 5.1)	35	(A)	47	(A)	59	(C)		
12	(D)	24	(14.9 to 15.1)	36	(C)	48	(D)	60	(20 to 25)		

SOLUTION

1. (2)

Total No. of elastic constant for homogeneous and isotropic material is = 4

Of which 2 are independent.

2. (D)

$$\sigma_{max} = \frac{4}{3}\sigma_{avg}$$

3. (11.9 to 12.1)

Deformation of bar due to own $wt = \frac{WL}{2AE} = 6\,mm$

If sub. to direct load equal to wt then $\delta_t = \frac{WL}{AE} = 12\,mm$

4. (B)

5. (A)

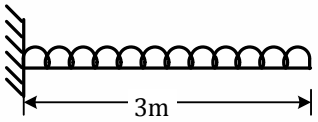
6. (B)

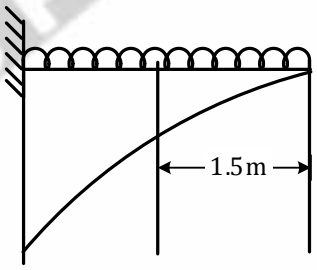
$$\sqrt{\left(\frac{60-120}{2}\right)^2 + 40^2}$$

$$= \sqrt{30^2 + 40^2}$$

$$= 50\,MPa$$

7. (C)





$\Rightarrow$ SF @ mid have

$= 6\,KN$

$w \times 1.5 = 6$

$w = 6 \times \frac{2}{3} = 4\,KN$

8. (C)

$$\sigma = \frac{FA\bar{y}}{Ib}$$

$F = 200\,kgf = 20\,KN$

$A = 5 \times 5 = 25\,cm^2$

$\bar{y} = 2.5\,cm$

$I = \frac{5 \times 10^3}{12} = 416.67$

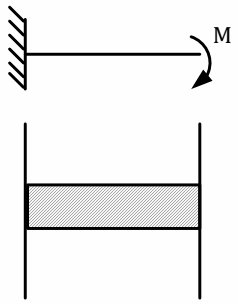
$b = 5cm$

$\Rightarrow \sigma = \frac{2000 \times 25 \times 2.5}{416.67 \times 5}$

$= 60\,kgf/cm^2$

9. (B)

10. (A)



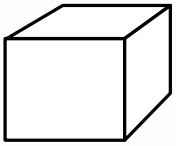
11. (C)

12. (D)

$$\sigma = \frac{45\times10^3}{1500}$$

$$= 30\ N/mm^2$$

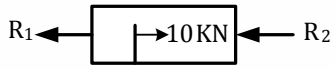
13. (A)



Free to deform hence

No stress

14. (A)



$$R_1 + R_2 = 10\,KN$$

$$R_B = \frac{10\times1}{3} = \frac{10}{3}$$

$$R_A = \frac{20}{3}$$

15. (A)

$$\int_0^{L/3} \frac{P^2 dx}{2AE}$$

$$+\int_{L/3}^{2L/3} \frac{(-P)^2 dx}{2AE}$$

$$+\int_{2L/3}^{L} \frac{(P)^2 dx}{2AE}$$

$$= \frac{P^2}{2AE}\left[\frac{L}{3} + \frac{2L}{3} - \frac{L}{3} + 4\times\left[\frac{L-2L}{3}\right]\right]$$

$$= \frac{P^2}{2AE}\left[\frac{4L+2L}{3} - \frac{81}{3}\right]$$

$$= \frac{P^2L}{2AE}\left[\frac{12+2-8}{3}\right]$$

$$= \frac{P^2L}{2AE}\times\frac{6}{3}$$

$$= \frac{P^2L}{AE}$$

16. (C)

17. (C)

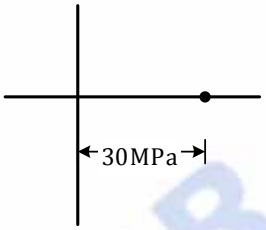
18. (A)

19. (A)

20. (A)

21. (D)

$\sigma_x = 30\,MPa, \sigma_y = 30\,MPa$

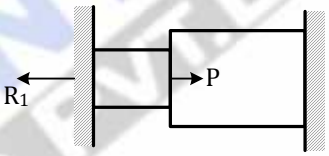


22. (0.5)

23. (4.9 to 5.1)

Maximum torque = 4 KN-m

24. (14.9 to 15.1)



$$R_1 = P$$

$$\frac{P\times1000}{1\times200\times10^5} = 0.75$$

$$\boxed{P = 15\,KN}$$

25. (0.5)

26. (B)

$$\Delta l = \Delta KL + \Delta LM + \Delta MN$$

$$= \frac{100\times500}{25\times200\times10^3} + \frac{(-150)\times800}{2.5\times200\times10^3}$$

$$+ \frac{50\times400}{25\times400\times10^3}$$

$$= -10\,m$$

27. (C)

28. (A)

$$\text{Actual} = \frac{PL}{\frac{\pi}{4}D_1D_2E} = \frac{PL}{\frac{\pi}{4}\times2D_x^2E}$$

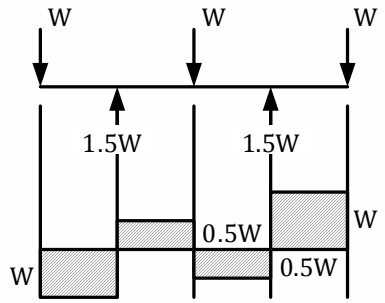
If $D_1 = D_2 = 1.5D$

$$L_1^1 = \frac{PL}{\frac{\pi}{4}\times1.5^2D^2L}$$

$$\%error = \frac{\frac{1}{2} - \frac{1}{1.5^2}}{\frac{1}{2}}$$

$$= 11.11\%$$

29. (6.79)



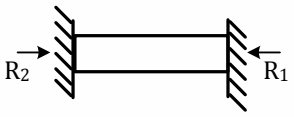
$$\sigma_{max} = W = 10\,KN$$

$$\tau_{max} = \frac{FA\bar{y}}{Ib} = \frac{4}{3}\tau_{avg}$$

$$= \frac{4}{3} \times \frac{10 \times 10^3}{\frac{\pi}{4} \times 50^2}$$

$$\boxed{\tau_{max} = 6.79\,MPa}$$

30. (D)



$20^0 C \text{ to } 60^0 C$

$E = 200 \times 10^3\ MPa$

$\sim = 10^{-5}/^0 C$

$$\frac{R_1 L}{AE} + \sim L\Delta T = 0.2\,mm$$

$$\Rightarrow \quad \frac{\pm \times L}{E} + \sim L\Delta T = 0.2\,mm$$

$$\Rightarrow \quad \frac{\pm \times 2000}{200 \times 10^3} + 10^{-5} \times 2000 \times 40 = 0.2$$

$$\Rightarrow \quad \pm = -60\,MPa$$

$\pm = 60\,MPa$ compressive

31. (B)

$\pm = 50\,MPa$

$$\tau = \frac{16T}{\pi d^3} = \frac{16 \times 10 \times 10^3}{\pi \times \left(100 \times 10^{-3}\right)^3}$$

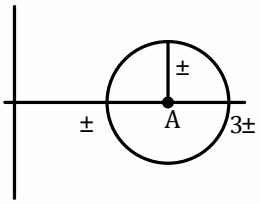
$$\Rightarrow \quad \tau = 50.92\,MPa$$

$$\therefore \text{Principal stress} = \sqrt{\left(\frac{50}{2}\right)^2 + 50.92^2} + \frac{50}{2}$$

$$= 81.726\,MPa$$

32. (B)

$3\pm$ & $\pm$



At A

$$\frac{\text{Normal Stress}}{\text{maximum shear stress}}$$

$$= \frac{2\pm}{\pm} = 2$$

33. (D)

$$\tau_{max} = \frac{80 - (-40)}{2}$$

$$= \frac{120}{2} = 60\,MPa$$

34. (D)

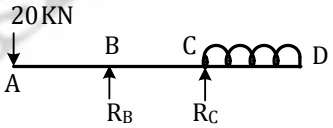
35. (Data Missing)

36. (C)

37. (A)

38. (C)

39. (900 to 1000)



$$R_B + R_C = 100\,KN$$

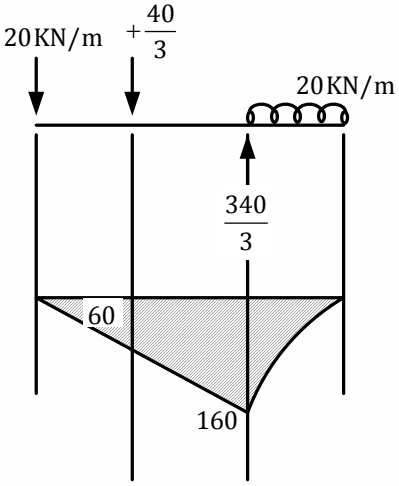
$MB = 0$

$$20 \times 3 + R_C \times 3 = 80 \times 5$$

$$\Rightarrow \quad R_C = \frac{400 - 60}{3} = \frac{340}{3}$$

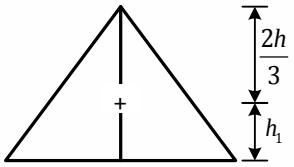
$$R_B = \frac{100 - 340}{3}$$

$$= -\frac{40}{3}$$



$\Rightarrow$ maximum = 160 KN - m

$$\pm = \frac{My}{I}$$



$$= \frac{160 \times (2 \times 0.2)/3}{\frac{0.1 \times 0.2^3}{36}}$$

$$= 960\, MPa$$

40. (B)

$$\sigma_{avg} = \frac{3}{4} \times 64$$

$$= 3 \times 16$$

$$= 48\, KN/m^2$$

$$\therefore \quad \frac{V}{\frac{\pi}{4} \times 0.15^2} = 48 \times 10^3$$

$$\boxed{V = 848.23\, N}$$

$$\pm = \frac{10 \times 10^3}{\frac{\pi}{4} \times 0.03^2}$$

$$= 14.147\, MPa$$

$$\tau = \frac{16T}{\pi d^3}$$

$$= \frac{16 \times 60}{\pi \times 0.03^3}$$

$$= 11.317\, MPa$$

$$\sigma_{max} = \sqrt{\left(\frac{14.147}{2}\right)^2 + 11.317^2}$$

$$= 13.345\, MPa$$

41. (13 to 14)

42. (C)

M_{at} mid point

$$-\left(x + \frac{L}{2}\right) + \left(P + \frac{WL}{2}\right) \times \frac{L}{2}$$

$$- \frac{w\left(\frac{L}{2}\right)^2}{2} = 0$$

$$\Rightarrow \quad \frac{Px - PL}{2} + \frac{PL}{2} + \frac{wL^2}{4} - \frac{wL^2}{8} = 0$$

$$\Rightarrow \quad Px = \frac{wL^2}{8}$$

$$\Rightarrow \quad \boxed{x = \frac{wL^2}{8P}}$$

43. (B)

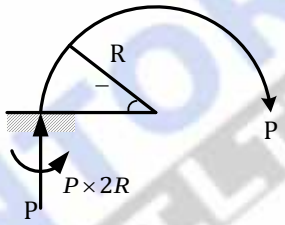
$$\frac{T_1}{\sigma_1} = 20 \quad \Rightarrow \quad \sigma_1 = 0.5$$

$$\frac{T_2}{\sigma_2} = 30 \quad \Rightarrow \quad \sigma_2 = \frac{1}{3}$$

$$\frac{T_3}{\sigma_3} = 60 \quad \Rightarrow \quad \sigma_3 = \frac{1}{6}$$

$$\Rightarrow \quad \sigma_1 + \sigma_2 + \sigma_3 = 1$$

44. (B)



$$M = 2PR - P[R - R\cos\theta]$$

$$= 2PR - PR + PR\cos\theta$$

$$= PR + PR\cos\theta$$

$$\frac{\partial M}{\partial P} = R(1 + \cos\theta)$$

$$\delta_V = \frac{\partial V}{\partial P}$$

$$= \int_0^{\pi} \frac{M \frac{\partial M}{\partial P} R d\theta}{EI}$$

$$= \frac{1}{EI} \int_0^{\pi} \frac{PR(1+\cos\theta).R(1+\cos\theta).Rd\theta}{1}$$

$$= \frac{PR^3}{EI} \int_0^{\pi} [1 + \cos\theta]^2 d\theta$$

$$= \frac{PR^3}{EI} \int_0^{\pi} [1 + \cos^2\theta + 2\cos\theta] d\theta$$

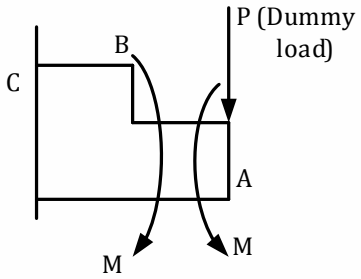
$$= \frac{PR^3}{EI} \left[\pi + \int_0^{\pi} \left(\frac{1 + \cos 2\theta}{2}\right) d\theta + 2[\sin\theta]_0^{\pi}\right]$$

$$= \frac{PR^3}{EI} \left[\pi + \frac{\pi}{2}\right]$$

$$= \frac{3\pi}{2} \frac{PR^3}{EI} = \frac{3\pi PR^3}{2EI}$$

45. (DATA MISSING)

46. (C)



Section AB

$$U_{AB} = \int_0^{L/2} \frac{\left(-P_x + M\right)^2 dx}{2EI}$$

$$U_{BC} = \int_{L/2}^{L} \frac{\left[-Px\right]^2 dx}{2\left(2EI\right)}$$

$$\frac{\partial}{\partial P}\left[U_{AB} + U_{BC}\right] = \int_0^{L/2} \frac{\left(-x\right)M}{EI} dx + 0$$

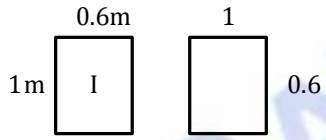
$$= \frac{M}{EI} : \frac{L^2}{2}$$

$$= \frac{ML^2}{2EI}$$

47. (A)

48. (D)

49. (B)



$$Z_1 = \frac{bd^2}{6} = \frac{0.6 \times 1^2}{6}$$

$$Z_2 = \frac{1 \times 0.6^2}{6}$$

$$\frac{I_2}{Z_1} = \frac{0.6^2}{0.6} = 0.6$$

$$\boxed{Z_2 = 0.6\, Z_1}$$

50. (B)

At P

$$\tau = \frac{FA\bar{y}}{Ib}$$

$$\frac{\tau_P}{\tau_Q} = \frac{b_Q}{b_P} = \frac{20}{100}$$

$$\Rightarrow \quad \tau_Q = 12 \times 5 = 60 \text{ MPa}$$

51. (219900 to 220000)

$$d = 1cm, t = 1cm$$

$$P = 1.6\, MPa$$

$$\frac{\Delta V}{V} = \frac{3\varepsilon d}{d}$$

$$= 3\left[\frac{Pd}{4tE} - \frac{\nu Pd}{4tE}\right]$$

$$= \frac{3Pd}{4tE}\left(1 - \nu\right)$$

$$= \frac{3 \times 1.6 \times 1 \times \left(1 - 0.3\right)}{4 \times 0.011 \times 200 \times 10^3}$$

$$= 4.2 \times 10^{-4}$$

$$\Delta V = 4.2 \times 10^{-4} \times \frac{4}{3}\pi \times 0.5^3$$

$$= 2.199 \times 10^{-4}\, m^3$$

$$= 2.2 \times 10^{-4+9}$$

$$= 2.2 \times 10^5\, mm^3$$

52. (65 to 68)

$$\sigma_x = 30, \sigma_y = 60, \tau_{xy} = 15$$

$$\sigma_z = -10$$

$$\sigma_1 = \frac{90}{2} \pm \sqrt{15^2 + 15^2}$$

$$= 66.21\, MPa$$

$$\sigma_2 = 23.786\, MPa$$

$$\sigma_3 = -10\, MPa$$

$$\sigma_{max} = 66.21\, MPa$$

53. (D)

$$D = 100\, mm, \quad L = 1000\, mm$$

$$\tau_{max} = 60\, N/mm^2$$

$$\tau = \frac{16T}{\pi d^3}$$

$$\Rightarrow \quad T = \frac{60 \times 10^6 \times \pi \times 0.1^3}{16}$$

$$T = 11.78\, KN - m$$

Now

If hole in drilled then

$$d_1 = 100\, mm, d_2 = 50\, mm$$

$$\tau = \frac{T\left(\frac{d_1}{2}\right)}{\frac{\pi}{32}\left(d_1^4 - d_2^4\right)}$$

$$\Rightarrow \quad \tau = \frac{16Td_1}{\pi\left(d_1^4 - d_2^4\right)}$$

$$\Rightarrow \quad \frac{60 \times 10^6 \times \pi \times \left[0.1^4 - 0.05^4\right]}{16 \times 0.1}$$

$$T_2 = 11.044\, KN - m$$

$$\frac{T_2}{T_1}=\frac{110044}{11.78}$$

$$\boxed{T_2=0.93T_1}$$

$$T_1-T_2=(1-0.93)T_1$$

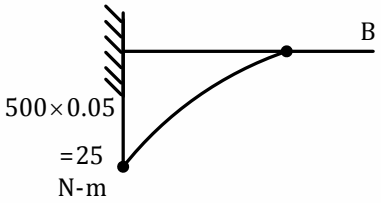
$$=0.07T_1$$

54. (A)

$$\text{¢}_c=\frac{DL^3}{3EI}$$

$$M_A=2PL$$

55. (.25 to 27)



$$\Rightarrow\quad \text{¢}_B=\frac{\frac{1}{3}\times 25\times 0.05}{200}\times\left[0.05+\frac{3}{4}\times 0.05\right]$$

$$\boxed{\text{¢}_B=0.18\,mm}$$

56. (D)
57. (B)
58. (A)
59. (C)
60. (20 to 25)
61. (B)
62. (C)
63. (B)
64. (C)
65. (D)