ANSWER KEY

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

SOLUTIONS

1. **(B)** **2.** **(B)** **3.** **(A)**

4. **(C)** **5.** **(B)** **6.** **(D)**

7. **(A)** **8.** **(C)** **9.** **(D)**

10. **(A)** **11.** **(A)** **12.** **(D)**

13. **(A)** **14.** **(B)** **15.** **(D)**

16. **(C)** **17.** **(C)**

18. **(C)**

$$S=s_f+\frac{xhf_g}{T}=2.3C_W\log\left(\frac{T}{273}\right)+\frac{.85\times 2110}{T}$$

19. **(D)** **20.** **(C)** **21.** **(A)**

22. **(D)** **23.** **(C)**

24. **(A)**

Equation of circle is $(x-a)^2+y^2=r^2$

Differentiating w.r.t. x

$$2(x-a)+2y\frac{dy}{dx}=0 \quad y\frac{dy}{dx}=-(x-a)$$

Squaring

$$y^2\left(\frac{dy}{dx}\right)^2=(x-a)^2=r^2-y^2$$

$$\Rightarrow y^2\left\{1+\left(\frac{dy}{dx}\right)^2\right\}=r^2$$

25. **(C)**

26. **(B)**

$$P.I.\Rightarrow\frac{1}{D^2+DD'}\sin(x+y)$$

$$\Rightarrow\frac{1}{-1-1}\sin(x+y)=\frac{-1}{2}\sin(x+y)$$

27. **(C)**

$D^2+2DD'+D'^2=0$ (Auxiliary equation)

$$(D+D')^2=0$$

$D=-D'$ repeated rots

C.F. $\Rightarrow \phi_1(y-x)+x\phi_2(y-x)$

28. **(D)**

$xys=1$

$$xy\frac{\partial^2 z}{\partial x\partial y}=1$$

$$\frac{\partial}{\partial x}\left(\frac{\partial z}{\partial y}\right)=\frac{1}{xy}$$

Integrating w.r.t x keeping y constant we get,

$$\frac{\partial z}{\partial y}=\frac{1}{y}\log x+g(y)$$

Again integrating w.r.t. y keeping x constant.

$$z=\log x.\log y+f(x)+F(y)$$

$$F(y)=\int g(y)\,dy$$

29. **(B)**

A.E. is $D^2+3D+2=0$

$D=-2,-1$

C.F is $c_1e^{-2t}+c_2e^{-t}$

30. **(A)**

A.E. is

$$D^2+10D+25=0\Rightarrow(D+5)^2=0$$

$D=-5,-5$

C.F. is $(c_1+c_2t)e^{-5t}$

31. **(B)**

$$\tau_{max}=1.5\times\tau_{avg}$$

32. **(B)**

$$\frac{w\ell^2}{2} = \frac{P \times \ell}{2 \times 4} \Rightarrow P = 4w\ell$$

33. **(D)**

34. **(C)**

$$\sigma = \frac{Pd}{4t} \Rightarrow t = 37.5mm$$

35. **(C)**

$$\frac{(S.E)_A}{(SE)_B} = \frac{\frac{1}{2}P_A\delta_A}{\frac{1}{2}P_B\delta_B},$$

$$\frac{\sigma_A \times A_A}{\sigma_B A_B} \times \frac{\sigma_A \times L_A}{E} \times \frac{E}{\sigma_B \times L_B},$$

$$\frac{A_A L_A}{A_B L_B} = \frac{D^2 \times L}{D^2 \times L} \times 2 = 0.5$$

36. **(B)**

37. **(B)**

$$\frac{z_1}{z_2} = \sqrt{2}$$

$$\frac{(\sigma_2)_2}{(\sigma_2)_1} = \frac{\left(\frac{M}{2}\right)_2}{\left(\frac{M}{2}\right)_1} = \frac{z_1}{z_2} = \sqrt{2}, (\sigma_b)_2 = 100\sqrt{2}$$

38. **(A)**

$$T_s = 16T/\pi d^3$$

$$= \frac{16 \times 100 \times 10^3}{\pi (50)^3} = 4.07MPa$$

39. **(C)**

40. **(B)**

41. **(B)**

42. **(B)**

Deflecting due to $P = \frac{Pl^3}{3EI}$,

Deflection due to $M = -\frac{ML^2}{2EI}$,

Total deflection $= \frac{Pl^3}{3EI} - \frac{ML^2}{2EI}$

43. **(A)**

$$\sigma_\theta = \frac{pD}{4tE}(1 - 2\mu) = 0.016875mm$$

44. **(C)**

45. **(A)**

The beam and loading is symmetric, so the bending moment will be maximum at the centre.

Hence, SF = 0

46. **(B)** **&** **47.** **(D)**

$$P_1 + P_3 + P_4 = P_2 + P_5$$

$$P_4 = 65KN$$

F.B.D. of portion CD is

Stress $= \frac{5 \times 10^3}{12.5 \times 10^{-4}}$,

$$\delta_{BC} = \frac{P \times 50 \times 10^{-2}}{200 \times 10^9 \times 15 \times 10^{-4}},$$

$$P = -20 \times 10^3 N$$

48. **(D)**

slope at free end $= \frac{W\ell_1^2}{2EI}$

49. **(D)**

$$P_1 + P_2 = 200 \times 10^3$$

Since slope is same, it implies that load at free end is not producing any deflection or slope.

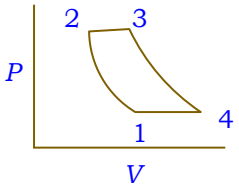
50. **(D)** **&** **51.** **(A)**

$$T_3 = 2179K$$

$$S_2 - S_1 = 2.3\left[C_P \log\frac{T_2}{T_1} + (C_P - C_V)\log\frac{P_1}{P_2}\right]$$

52. **(B)** **&** **53.** **(C)**

For maximum work output



$$T_p = \left(\frac{T_{max}}{T_{min}}\right)^{\frac{\gamma}{2(\gamma-1)}} = \left(\frac{1100}{300}\right)^{\frac{1.4}{2(1.4-1)}} = 9.71$$

$T_{max} = T_3, T_{min} = T_1$

Heat addition in Brayton cycle

$= C_p(T_3 - T_2)$

$\frac{T_2}{T_1} = (r_p)^{\frac{7T}{y}}, T_2 = 300 \times 1.914 = 574.4$

$\therefore$ Heat addition = 1.005 (1100 – 594.4) = 523.3 kJ/kg.

54. **(A)**

$$h_f(\text{in pipe}) = \frac{0.033 \times 5 \times 10^3 \times v^2}{2 \times 9.8 \times 0.6} = 14.03v^2$$

D_p = pipe dia = 100 x 6mm = 0.6m

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If inlet velocity is v1 then $\frac{\pi}{4}D_1^2 v = \frac{\pi}{4}d^2 v_1$

$d_1 = 100mm$,

$\Rightarrow$ v = $0.0278v_1$

Total head = $\frac{v_1^2}{2g} + h_f +$ head cost in nozzle

$$500 = \frac{v_1^2}{2g} + 14.03 \times 0.0278^2 v_1^2 + \frac{v_1^2}{2g}\left(1/c_v{}^2 - 1\right)$$

$$\Rightarrow v_1 = 87.67m/s$$

flow rate is $\frac{\pi}{4}d^2 v_1 = 0.68m^2/s$

55. (D)

$v_{r_1} = v_1 - u = 45.6m/s \qquad u = 0.48, v_1 = 42.08$

$v_{w_1} = v_1 = 87.67m/s \; v_{w_1} = v_{r_1}\cos\phi - u$

$= v_r \times 0.85\cos(180 - 170^0) - v = -3.9m/s$

Shaft power is PQ u$\left(v_{w_1} + v_{w_1}\right) \times 0.92 = 2.157Mw$

56. (A)

57. (B)

58. (B)

A synagogue is a place of worship while the other three are all places related to death.

59. (B)

60. (D)

A dart is a small type of spear while a gun is a small type of canon

61. (D)

Let N be the number of days Nikhil takes to complete the job working alone and A be the number of days Ajnkit takes to finish the job working alone. Thus we have, 1/N = 1/24. Now, if Nikhil worked twice as efficiently, he will take N/2 days to complete the job alone and if Ankit works 1/3 rd as efficiently, he will take 3A days to finish the same job alone , Thus we can say that 1/(N/2) + 1/3A = 1/18 Solving we get 2/3N = 1/18 – 1/72 => 5/3N = 3/72 = > N = 40 days

Alternate Method:

LCM of 24 and 18 is 72. So let us assume the total work to be 72 units If rate of working for Nikhil is n units /day and rate of working for Ankit is a units/day, we can say that n + a = 72/24 = 3 (Total rate of working = Total work/Total time taken).

Also, 2n + a/3 = 72/28 = 4. Solving both equations, we get n = 9/5 units/day. Thus the time taken by Nikhil to finish the job alone = 72/(9/5) = 40 days,

62. (D)

Sum of n terms = $n^2 + 3n$. Sum of (n-1) terms = $(n-1)^2 + 3(n-1) = n^2 + n - 2$

Now, we know, n^{th} term = Sum of n terms – Sum of (n-1) terms, Therefore, n^{th} in this case = $n^2 + 3n - (n^2 + n - 2) = 2n + 2$. Therefore, 5^{th} terms is 2x5+2= 12

63. (C)

64. (D)

The net movement of the monkey = 2 steps in 4 seconds ie 1 step for every 2 second In our bid to solve question quickly, we may tend to directly multiply 21 steps by 2 seconds and arrive at 42 seconds. But consider this – after the monkey reaches the 18^{th} step, he has to climb another 3 steps to reach 21 which he will do in the next 3 second (the fact that he slips another step after reaching the 21^{st} is of no concern to us). Therefore total time taken by the monkey is 18 x 2 + 3 = 39 seconds.

65. (D)

Since we do not know that total number of students graduating from all the IITs put together, we cannot find the percentage of students who did not get placed and hence the data is insufficient

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