BPSC
Lecturer

Previous Year Paper
(Civil Engineering)
2022

1. If

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix} A = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

then the order of matrix A is

(A) 2×2

(B) 2×3

(C) 3×2

(D) 3×3

2. If I is an identity matrix of order m, then it is a multiplicative identity for every matrix of order

(A) $n \times n$

(B) $m \times n$

(C) $n \times m$

(D) $m \times m$

3. The characteristic roots of the matrix

$$\begin{pmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$$

are

(A) 2, 2, 2

(B) 2, 2, 8

(C) −2, 2, 8

(D) −2, 2, −8

4. Find the eigenvector for value of $\lambda = 1$ for the given matrix

$$A = \begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$$

(A) [0 −1]

(B) [1 −1]

(C) [−1 −1]

(D) [1 0]

5. The system of linear equations $x + y + z = 6$, $x + 2y + 3z = 14$ and $2x + 5y + \lambda z = \mu$ (λ and μ are reals) is consistent if

(A) $\lambda = \mu$

(B) $\lambda = 8,\ \mu \neq 36$

(C) $\lambda = 8,\ \mu = 36$

(D) None of the above

6. The point of discontinuity of the function $f(x) = \sin x / x$ when $x \neq 0$ and $f(0) = 0$ is when x is equal to

(A) 1

(B) −1

(C) 0

(D) $\pi / 2$

7. If the function

$$f(x) = x(x+3)e^{-x/2}$$

for $x \in [-3, 0]$ and $f'(c) = 0$, then

(A) $c = 3$

(B) $c = -2$

(C) $c = 3$ and $c = -2$

(D) $c = \infty$

8. The minimum value of

$$f(x) = (x^3 + x + 2)/x$$

for positive value of x is

(A) 2

(B) 3

(C) 4

(D) 0

9. The directional derivative of

$$F(x, y, z) = x^2yz + 4xz^2$$

at the point $(1, -2, -1)$ in the direction $2\hat{i} - \hat{j} - 2\hat{k}$ is

(A) 37/3

(B) 29/3

(C) 22/2

(D) 0

10. The divergence of the vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ is given by

(A) $x + y + z$

(B) $\hat{i} + \hat{j} + \hat{k}$

(C) 0

(D) 3

11. The solution of the differential equation $dy/dx = e^{x-2y}$ is

(A) $e^{2y} - e^x + c$

(B) $(1/2)e^y + e^{2x} + c$

(C) $(1/2)e^{2y} - e^x + c$

(D) $2e^{2y} - e^x + c$

12. The solution of the differential equation

$$d^2y/dx^2 + 6\,dy/dx + 9y = e^{2x}$$

is

(A) $y = (a + bx)e^{-3x} + (1/25)e^{2x}$

(B) $y = (a + bx)e^{3x} + 25$

(C) $y = 1/25$

(D) $y = (a + bx)e^{-3x}$

13. The solution of the differential equation

$$3x^2\,d^2y/dx^2 + x\,dy/dx - 8y = 0$$

is

(A) $ax + bx^{-4/3}$

(B) $ax^{-4/3} + bx$

(C) $ax^2 + bx^{-4/3}$

(D) $ax + bx^{-4}$

14. The particular integral of the differential equation

$$(2x+1)^2 d^2y/dx^2 - 2(2x+1)\,dy/dx - 12y = 6x$$

is

(A) $-(6x - 1)/16$

(B) $-(6x + 1)/16$

(C) $(6x + 1)/16$

(D) $(6x - 1)/16$

15. The solution to the initial value problem $d^2y/dx^2 + 4y = 0$; $y(0) = 0$, $(dy/dx) = 1$ at $x = 0$ is

(A) $(1/2)\sin x$

(B) $(1/2)\sin 2x$

(C) $(1/2)\cos 2x$

(D) $\cos 2x + \sin 2x$

16. If the function $f(x)$ is even, then which of the following is zero in the Fourier expansion?

(A) a_n

(B) b_n

(C) a_0

(D) Nothing is zero

17. Which of the following is the solution to the partial differential equation?

$$\frac{\partial^2 u}{\partial x^2} = 9\frac{\partial^2 u}{\partial y^2}$$

(A) $\cos(3x - y)$

(B) $x^2 + y^2$

(C) $\sin(3x - 3y)$

(D) $e^{-3\pi x}\sin(\pi y)$

18. The suitable solution of the one-dimensional wave equation is

(A) $y(x, t) = (C_1 e^{px} + C_2 e^{-px})$
$(C_3 \cos \lambda at + C_4 \sin \lambda at)$

(B) $y(x, t) = (C_1 e^{\lambda x} + C_2 e^{-\lambda x})$
$(C_3 e^{\lambda ct} + C_4 e^{-\lambda ct})$

(C) $y(x, t) = (C_1 \cos \lambda x + C_2 \sin \lambda x)$
$(C_3 \cos \lambda at + C_4 \sin \lambda at)$

(D) $y(x, t) = (C_1 x + C_2)(C_3 t + C_4)$

19. Find the Laplace equation value of the following potential field

$$V = x^2 - y^2 + z^2$$

(A) 0

(B) 2

(C) 4

(D) 6

20. The general solution of the one-dimensional diffusion equation is

(A) $y(x, t) = C_1 e^{-k2t}$
$(C_2 \cos kx + C_3 \sin kx)$

(B) $y(x, t) = C_1 e^{k2t}$
$(C_2 \cos kx + C_3 \sin kx)$

(C) $y(x, t) = C_1 \cos(k^2 t)$
$(C_2 \cos kx + C_3 \sin kx)$

(D) $y(x, t) = C_1 \sin(k^2 t)$
$(C_2 \cos kx + C_3 \sin kx)$

21. The mean and median of this set of numbers 4, 6, 7, 9, 2000000 are respectively

(A) 1000000, 5·2

(B) 400005·2, 7

(C) 7, 400005·2

(D) None of the above

22. The mean and variance of the Poisson distribution are

(A) in a constant ratio

(B) equal

(C) unequal

(D) zero

23. The probability of drawing an ace or a spade or both from a deck of cards is

(A) 1/4

(B) 1/3

(C) 4/13

(D) 13/51

24. A random variable X has the following probability function :

$X = x$	$P(X = x)$
1	k
2	$2k$
3	$2k$
4	$3k$
5	k^2
6	$2k^2$
7	$7k^2 + k$

The value of k is

(A) -1

(B) $1/10$

(C) 1

(D) $2/10$

25. If one regression coefficient is greater than one, then the other will be

(A) more than one

(B) equal to one

(C) less than one

(D) equal to minus one

26. Newton-Gregory forward interpolation formula can be used

(A) only for equally spaced intervals

(B) only for unequally spaced intervals

(C) for both equally and unequally spaced intervals

(D) for unequally intervals

27. The value of Y at $X = 2$ by using the Lagrange interpolation method using the following data

X	0	1	3	4
Y	5	6	50	105

is

(A) 219/6

(B) 54

(C) 19

(D) 55·67

28. The first derivative of the function at the point $x = 1{\cdot}5$ from the following data

X	1·5	2	2·5	3	3·5	4
Y	3·375	7·0	13·625	24	38·875	59

is

(A) 9

(B) –4·5

(C) 4·75

(D) 4·25

29. The highest order of polynomial integrand for which Simpson's 1/3rd rule of integration is exact is

(A) first

(B) second

(C) third

(D) fourth

30. Consider an ordinary differential equation $dy/dx = x - y$, with initial condition $y = 1$ when $x = 0$. The first approximation of $y(0{\cdot}2)$ is

(A) 0·8200

(B) 0·9386

(C) 0·9372

(D) 0·7456

[P.T.O.

31. The terms P/Y, $V^2/2g$ and z used in the Bernoulli's equations are

(A) pressure head, velocity head and potential head respectively

(B) static head, kinetic head and datum head respectively

(C) Both of the above

(D) None of the above

32. In a real fluid flow towards the direction of flow, for a varied flow, the specific energy

(A) always decreases

(B) always increases

(C) may increase or decrease

(D) None of the above

33. A tank 21 m high stands on a trolley and in full of water. It has an orifice of area $1\,cm^2$ at 1 m from the bottom of the tank. If the orifice is suddenly opened, what will be the propelling force F on the trolley? (Coefficient of discharge of orifice C is 0·6 and acceleration due to gravity g is 10)

(A) $F = 14{\cdot}4$ N

(B) $F = 24$ N

(C) $F = 1{\cdot}440$ kN

(D) None of the above

34. The coefficient C of Chezy's formula has dimensions

(A) Dimensionless

(B) $L^{1/2} T^{-1}$

(C) $L T^{-2}$

(D) $(L T^{-1})^{1/2}$

35. Pick the correct statement.

(A) Centre of pressure is always below the centroid of the area.

(B) As depth increases the centre of pressure shifts towards centroid of the plane surface.

(C) Both of the above are correct

(D) None of the above is correct

36. The stream function in a 2-D flow is $\psi = 2xy$. The velocity potential ϕ will be

(A) $x^2 - y^2 + c$

(B) $x^2 + y^2 + c$

(C) Cannot be determined

(D) 0

37. The curing period required for OPC is _____ PPC.

(A) greater than

(B) less than

(C) equal to

(D) not related to

38. About 80% of the mass of atmosphere is contained in the

(A) troposphere

(B) stratosphere

(C) mesosphere

(D) thermosphere

39. The infrared portion of EMR lies between

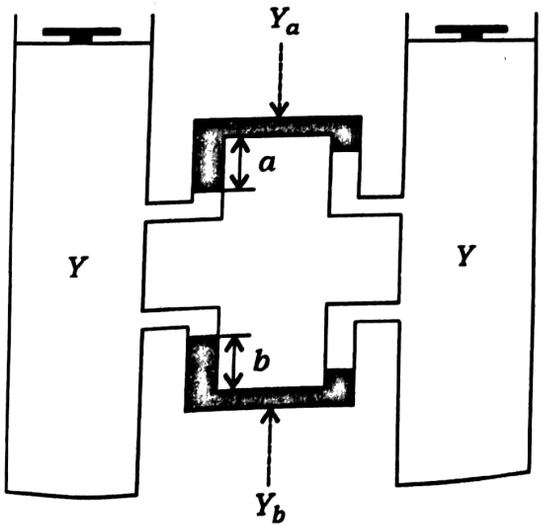
(A) 0·4 μm to 0·7 μm

(B) 0·7 μm to 1·3 μm

(C) 0·7 μm to 14 μm

(D) 1 mm to 1 m

40. In the setup shown below, if $Y_a < Y_b$, then the value of Y will be



(A) $(aY_a + bY_b)/(a+b)$

(B) $(aY_b - bY_a)/(b-a)$

(C) $(bY_b + aY_a)/(b-a)$

(D) $(aY_b - bY_a + cY)/(b-a+c)$

41. As per IS 800 : 2007, physical properties of structural steel irrespective of its grade may be taken as

1. coefficient of thermal expansion $\alpha = 12 \times 10^6 /°C$
2. unit mass of steel $\rho = 7850\ kg/m^3$
3. modulus of elasticity $E = 2{\cdot}0 \times 10^5\ N/mm^2$ (MPa)
4. Poisson ratio $\mu = 0{\cdot}3$
5. modulus of rigidity $G = 0{\cdot}769 \times 10^5\ N/mm^2$ (MPa)

Choose the correct option from the codes given below.

(A) Only 1, 3 and 5 are correct

(B) Only 2, 3, 4 and 5 are correct

(C) All of the above are correct

(D) None of the above is correct

42. As per IS 800 : 2007, the maximum value of effective slenderness ratios for a tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces is

(A) 180

(B) 350

(C) 400

(D) No limit

43. The height displacement on a vertical photograph

(A) increases as the horizontal distance increases from the principal point

(B) increases as the ground elevation decreases

(C) decreases as the flying height decreases

(D) All of the above

44. Which of the following is ***not*** the element of visual image interpretation?

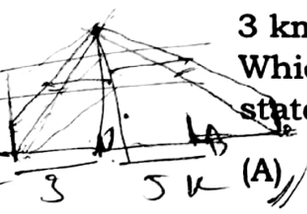
(A) Texture

(B) Shape

(C) Distance

(D) Association

45. *A* and *B* are two towers of equal height diametrically opposite on either side of the nadir point, at 3 km and 5 km distances. Which one of the following statements is correct?



(A) Height displacement of *A* will be less than that of *B*.

(B) Height displacement of *B* will be less than that of *A*.

(C) Height displacements of *A* and *B* are equal.

(D) Height displacements of *A* and *B* will be towards each other.

46. Accidental errors

(A) do not follow any definite mathematical law

(B) can be removed by applying corrections to the observed values

(C) are generally large

(D) are also known as cumulating errors

47. Living vegetation appears _____ on false-color IR images.

(A) white (B) black

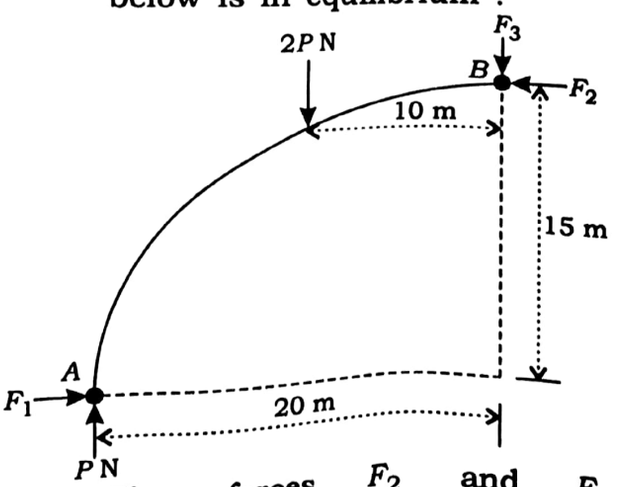
(C) blue (D) red

48. The minimum number of control points required for geo-referencing the image with error estimation is

(A) 2 (B) 3

(C) 4 (D) 5

49. A coplanar system of forces *P* and 2*P* (in newton) as shown below is in equilibrium :



The forces F_2 and F_3 respectively are

(A) 0, *P* (upward)

(B) 0, *P* (downward)

(C) *P* (leftward), *P* (upward)

(D) Forces cannot be computed

50. Based on IS code recommendations, the effective flange width of T-beam is

(A) $b_f = (l_0 / 12) + b_w + 3D_f$

(B) $b_f = (l_0 / 6) + b_w + 6D_f$

(C) $b_f = (l_0 / 6) + b_w + 3D_f$

(D) $b_f = (l_0 / 12) + b_w + 6D_f$

51. The bond failure in RCC structure between concrete and steel is

(A) failure of adhesion between concrete and reinforcement bar

(B) longitudinal splitting of concrete around reinforcement bar

(C) crushing of concrete between ribs of deformed bar

(D) All of the above

52. For the development of full strength in stirrups, the development length shall be bent satisfying the following criteria :

1. The ends of the stirrups shall be bent through an angle of at least 90 degree around a bar of at least its own diameter and continued beyond the end of the curve for a length of at least 8 times the diameter of the bar.

2. The ends of the bar shall be bent through an angle of 135 degree around a bar of at least its own diameter and continued beyond the end of the curve for a length of at least 6 times the bar diameter.

3. The ends of the bar shall be bent through an angle of 180 degree around a bar of at least its own diameter and continued beyond the end of the curve for a length of at least four times the bar diameter.

Choose the correct option from the codes given below.

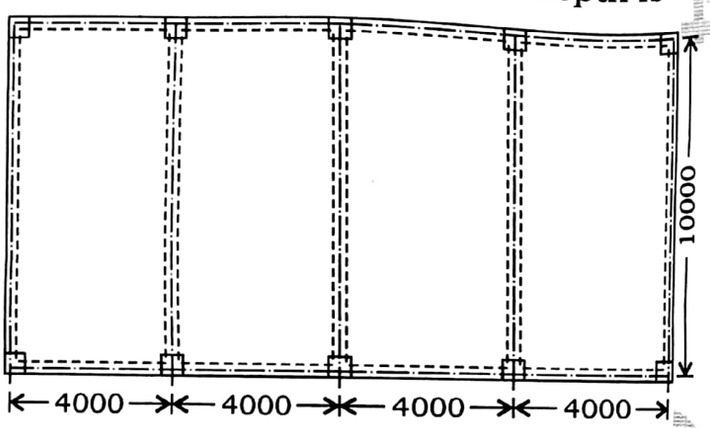
(A) Only 1 and 2 are correct

(B) Only 2 and 3 are correct

(C) All of the above are correct

(D) None of the above is correct

53. A continuous one-way slab, as shown in the figure below, is subjected to a live load of 4 kN/m^2 and surface finish of 1 kN/m^2. Grade of concrete is M20 and steel of grade is Fe415. The diameter provided for the bar is 10 mm and $m_{ft} = 1{\cdot}25$. If the effective thickness of the slab is 140, the overall depth is



(A) 140 mm

(B) 160 mm

(C) 220 mm

(D) None of the above

54. A beam is of square section of side b. If the permissible bending stress is f, the ratio of moment of resistance of a beam of square cross-section when placed with its two sides horizontal to the moment of resistance with its diagonal horizontal, is

(A) $\sqrt{2}$

(B) f/b

(C) b/f

(D) $1/\sqrt{2}$

55. A rectangular channel and a triangular channel have same depth of flow, same top width and same average velocity. If Froude number for triangular channel is $\sqrt{2}$, then Froude number for rectangular channel is

(A) $\sqrt{2}$ (B) $1/\sqrt{2}$

(C) 1 (D) $1/\sqrt{3}$

56. The unit hydrograph theory constitutes which one of the following basic assumptions?

(A) Linear response and time variance

(B) Non-linear response and time variance

(C) Non-linear response and non-linear time variance

(D) Time invariance and linear response

57. The porosity of a certain sample of sand was 50%. The specific gravity of the particles is 2·70. Estimate the critical hydraulic gradient.

(A) 0·57 (B) 0·85

(C) 1·33 (D) 0·75

58. Which of the following is the correct hydrometer reading equation?

(A) $R = Rh' + Cm \pm CL - Cd$

(B) $R = Rh' + Cm + CL - Cd$

(C) $R = Cm \pm Rm - Cd + CL$

(D) $R = Rh + Cm \pm Cd + CL$

59. 50 g of minus 75 micron, oven-dried soil was used in a hydrometer analysis. The corrected hydrometer reading after 2 minutes in a 1000 cc soil suspension was 25·0. The effective depth H_e for RH of 25 is 12·13 cm. Taking specific gravity of solids as 2·75 and viscosity of water as 0·01 poise, calculate the coordinates of the point of the grain-size curve.

(A) (0·033 mm, 78·6%)

(B) (0·1 mm, 90%)

(C) (0·5 mm, 82%)

(D) (0·001 mm, 14%)

60. In a specific gravity test, the mass of density bottle is 0·040 kg; mass of density bottle + dry soil is 0·485 kg; mass of density bottle + dry soil + water is 0·946 kg; mass of density bottle + water is 0·674 kg. The specific gravity found is

(A) 2·57

(B) 2·62

(C) 2·67

(D) 2·72

61. The coefficient of permeability of fine sand is 0·012 cm/sec at a void ratio of 0·57. Estimate the increased permeability using the Kozeny-Carman formula of this same sand when its void ratio has increased to 0·72.

(A) 0·1 cm/sec

(B) 0·08 cm/sec

(C) 0·2 cm/sec

(D) 0·022 cm/sec

62. Given the following parameters of a clay layer :

$m_v = 1 \times 10^{-4}\ m^2/kN$

$c_v = 0{\cdot}4\ m^2/month$

$Y_w = 10\ kN/m^3$

The clay layer is double drained and is 8 m thick. What is the ultimate settlement of the clay under an excess load of 100 kN/m^2?

(A) 0·08 m

(B) 0·032 m

(C) 0·2 m

(D) 0·32 m

63. Group—I enlists *in-situ* field tests carried out for soil exploration, while Group—II provides a list of parameters for sub-soil strength characterization. Match the type of tests with the characterization parameters :

Group—I	*Group—II*
P. Pressuremeter Test (PMT)	1. Menard's modulus (E_m)
Q. Static Cone Penetration Test (SCPT)	2. Number of blows (N)
R. Standard Penetration Test (SPT)	3. Skin resistance (f_c)
S. Vane Shear Test (VST)	4. Undrained cohesion (c_u)

Choose the correct answer from the options given below.

(A) P 1, Q 3, R 2, S 4

(B) P 1, Q 2, R 3, S 4

(C) P 2, Q 3, R 4, S 1

(D) P 4, Q 1, R 2, S 3

64. For a partially saturated soil, Δu the increase in pore water pressure, when no drainage is permitted, is expressed as (where A and B are Skempton's pore pressure parameters and $\Delta\sigma_1$ and $\Delta\sigma_3$ are major and minor principal stress increments)

(A) $\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$

(B) $\Delta u = A[\Delta\sigma_3 + B(\Delta\sigma_1 - \Delta\sigma_3)]$

(C) $\Delta u = \Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)$

(D) $\Delta u = \Delta\sigma_3 + B(\Delta\sigma_1 - \Delta\sigma_3)$

65. A clay layer 5 m thick in field takes 300 days to attain 50% consolidation with condition of double drainage. If the same clay layer is underlain by hard rock, then the time taken to attain 50% consolidation will be

(A) 300 days

(B) 600 days

(C) 1200 days

(D) None of the above

66. The action of negative skin friction on the pile is to

(A) increase the ultimate load on the pile

(B) reduce the allowable load on the pile

(C) maintain the working load on the pile

(D) reduce the settlement of the pile

67. A square footing is required to carry a net load of 1200 kN. Determine the size of the footing if the depth of foundation is 2 m and tolerable settlement is 40 mm. The soil is sandy with N value 13. Water table is at very deep.

(A) ~ 1·3 m × 1·3 m

(B) ~ 1·52 m × 1·52 m

(C) ~ 2·5 m × 2·5 m

(D) ~ 1·9 m × 1·9 m

68. A 450 mm wide, square in section concrete pile, 15 m long, is driven in a deep deposit of uniform clay. The laboratory unconfined compression tests on undisturbed samples indicate an average q_u value of 75 kN/m^2. Calculate the ultimate load capacity of the pile (take, $N_c = 9$; $\alpha = 0{\cdot}8$).

(A) 787 kN

(B) 878 kN

(C) 487 kN

(D) 687 kN

69. In transition curves up to 9°

(A) the radius decreases as the length increases

(B) the radius decreases as the length decreases

(C) the rate of change of radius is constant

(D) None of the above

70. If the following are present in water, the hardness cannot be removed by simple boiling :

1. Sulphates
2. Chlorides
3. Nitrates of calcium
4. Nitrates of magnesium
5. Carbonates of calcium

Choose the correct option from the codes given below.

(A) 1, 2 and 5 are correct

(B) 1, 2, 3 and 4 are correct

(C) All of the above are correct

(D) None of the above is correct

71. As per IRC/37-1970 for the CBR method of design, the CBR tests should be performed on

(A) remoulded soils in the laboratory

(B) in-site tests

(C) Both of the above

(D) None of the above

72. The average normal flow of traffic on cross-roads *A* and *B* during design period are 250 pcu and 400 pcu per hour, the saturations flow values on these roads are estimated as 1000 pcu and 1250 pcu per hour respectively. The all-red time required for pedestrian crossing is 2 sec. The calculated green period for roads *A* and *B* are 22·5 sec and 29 sec respectively. The amber time provided is 2 sec each for clearance. The total cycle time (in sec) is

(A) 65·5

(B) 63·5

(C) 67·5

(D) 55·5

73. Softening point test is usually determined by

(A) Pensky-Martens closed-cup test

(B) ring and ball test

(C) All of the above

(D) None of the above

74. For finding the optimum bitumen content of a mix, following data were observed :

- The optimum bitumen content corresponding to maximum values of stability is 5·4 percent.
- The optimum bitumen content corresponding to unit weight is 6·0 percent.
- The bitumen content corresponding to 4% air voids in total mix is 5·7.

The optimum bitumen content for the mix design is

(A) 5·4

(B) 6·0

(C) 5·7

(D) None of the above

75. Water-borne diseases are caused by

(A) bacterial infection

(B) viral infection

(C) protozoal infection

(D) All of the above

76. Service connection consists of

(A) ferrule, stopcock and gooseneck

(B) ferrule, check valve and gooseneck

(C) stopcock, meter and sluice valve

(D) sluice valve, check valve and meter

77. The formation for BOD assimilation in a stream should include

(A) BOD rate constant

(B) sedimentation of organic matter

(C) BOD rate constant and sedimentation of organic matter

(D) pathogenic bacterial delay coefficient

78. The maximum deflection of simply supported beam occurs at zero

(A) bending moment location

(B) shear force location

(C) slope location

(D) shear force location and also zero bending moment location

79. Disinfection of water results in

(A) removal of turbidity

(B) removal of hardness

(C) killing of disease bacteria

(D) complete sterilization

80. Activated carbon is used for

(A) disinfection

(B) removing hardness

(C) removing odours

(D) removing corrosiveness