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- 1) The minimum and the maximum eigen values of the matrix  $\begin{pmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{pmatrix}$  are -2 and 6, respectively. What is the other eigen value?
  - a) 5
  - b) 3
  - c) 1
  - d) -1
- 2) The degree of the differential equation  $\frac{d^2x}{dt^2} + 2x^3 = 0$  is
  - a) 0
  - b) 1
  - c) 2
  - d) 3
- 3) The solution for the differential equation  $\frac{dy}{dx} = x^2y$  with the condition that  $y = 1$  at  $x = 0$  is
  - a)  $y = e^{\frac{1}{2x}}$
  - b)  $\ln(y) = \frac{x^3}{3} + 4$
  - c)  $\ln(y) = \frac{x^2}{2}$
  - d)  $y = e^{\frac{x^3}{3}}$
- 4) An axially loaded bar is subjected to a normal stress of 173 MPa. The shear stress in the bar is
  - a) 75 MPa
  - b) 86.5 MPa
  - c) 100 MPa
  - d) 122.3 MPa
- 5) A steel column, pinned at both ends, has a buckling load of 200 kN. If the column is restrained against lateral movement at its mid-height, its buckling load will be
  - a) 200 kN
  - b) 283 kN
  - c) 400 kN
  - d) 800 kN
- 6) The stiffness coefficient  $k_{ij}$  indicates
  - a) force at  $i$  due to a unit deformation at  $j$
  - b) deformation at  $j$  due to a unit force at  $i$
  - c) deformation at  $i$  due to a unit force at  $j$

d) force at  $j$  due to a unit deformation at  $i$

7) For an isotropic material, the relationship between the Young's modulus ( $E$ ), shear modulus ( $\mu$ ) is given by

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

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

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

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

8) A clay soil sample is tested in a triaxial apparatus in consolidated-drained conditions at a cell pressure of  $100 \frac{kN}{m^2}$ . What will be the pore water pressure at a deviator stress of  $40 \frac{kN}{m^2}$

a)  $0 \frac{kN}{m^2}$

b)  $20 \frac{kN}{m^2}$

c)  $40 \frac{kN}{m^2}$

d)  $60 \frac{kN}{m^2}$

9) The number of blows observed in a Standard Penetration Test (STP) for different penetration depths are given as follows:

Penetration of Sampler	Number of Blows
0-150 mm	6
150-300 mm	8
300-450 mm	10

The observed  $N$  value is

a) 8

b) 14

c) 18

d) 24

10) The vertical stress at some depth below the corner of a  $2m \times 3m$  rectangular footing due to a certain load intensity is  $100 \frac{kN}{m^2}$ . What will be the vertical stress in  $\frac{kN}{m^2}$  below the centre of a  $4m \times 6m$  rectangular footing at the same depth and same load intensity?

a) 25

b) 100

c) 200

d) 400

11) There is a free overfall at the end of a long open channel. For a given flow rate, the critical depth is less than the normal depth. What gradually varied flow profile will occur in the channel for this flow rate?

a)  $M_1$

b)  $M_2$

c)  $M_3$

d)  $S_1$

12) The consecutive use of water for a crop during a particular stage of growth is  $2.0$  mm/day. The maximum depth of available water in the root zone is  $60$  mm. Irrigation

is required when the amount of available water is 50 % of the maximum available water in the root zone. Frequency of irrigation should be

- a) 10 days
- b) 15 days
- c) 20 days
- d) 25 days

13) As per the Lacey's method for design of alluvial channels, identify the **TRUE** statement from the following:

- a) Wetted perimeter increases with an increase in design discharge
- b) Hydraulic radius increases with an increase in silt factor
- c) Wetted perimeter decreases with an increase in design discharge
- d) Wetted perimeter increases with an increase in silt factor

14) At two points 1 and 2 in a pipeline the velocities are  $V$  and  $2V$ , respectively. Both the points are at the same elevation. The fluid density is  $\rho$ . The flow can be assumed to be incompressible, inviscid, steady and irrotational. The difference in pressures  $P_1$  and  $P_2$  at points 1 and 2 is

- a)  $0.5\rho V^2$
- b)  $1.5\rho V^2$
- c)  $2\rho V^2$
- d)  $3\rho V^2$

15) The presence of hardness in excess of permissible limit causes

- a) cardio vascular problems
- b) skin discolouration
- c) calcium deficiency
- d) increased laundry expenses

16) The dispersion of pollutants in atmosphere is maximum when

- a) environmental lapse rate is greater than adiabatic lapse rate.
- b) environmental lapse rate is less than adiabatic lapse rate.
- c) environmental lapse rate is equal to adiabatic lapse rate.
- d) maximum mixing depth is equal to zero.

17) The alkalinity and the hardness of a water sample are 250 mg/L and 350 mg/L as  $\text{CaCO}_3$ , respectively. The water has

- a) 350 mg/L carbonate hardness and zero non-carbonate hardness.
- b) 250 mg/L carbonate hardness and zero non-carbonate hardness.
- c) 250 mg/L carbonate hardness and 350 mg/L non-carbonate hardness.
- d) 350 mg/L carbonate hardness and 100 mg/L non-carbonate hardness.