



12. Which of the following statement is TRUE for the relation between discharge velocity and seepage velocity?
- Seepage velocity is always smaller than discharge velocity
  - Seepage velocity can never be smaller than discharge velocity
  - Seepage velocity is equal to the discharge velocity
  - No relation between seepage velocity and discharge velocity can be established.
13. Which of the following statement is TRUE for degree of disturbance of collected soil sample?
- Thinner the sampler wall, lower the degree of disturbance of collected soil sample
  - Thicker the sampler wall, lower the degree of disturbance of collected soil sample
  - Thickness of the sampler wall and the degree of disturbance of collected soil sample are unrelated
  - The degree of disturbance of collected soil sample is proportional to the inner diameter of the sampling tube
14. In an unconsolidated undrained triaxial test, it is observed that an increase in cell pressure from 150 kPas to 250 kPa leads to a pore pressure increase of 80 kPa. It is further observed that, an increase of 50 kPa in deviatoric stress result in an increase of 25 kPa in the pore pressure. The value of Skempton's pore pressure parameter B is:
- 0.5
  - 0.625
  - 0.8
  - 1.0
15. Which of the following statement is NOT correct?
- Loose sand exhibits contractive behavior upon shearing
  - Dense sand when sheared under undrained condition, may lead to generation of negative pore pressure
  - Black cotton soil exhibits expansive behavior
  - Liquefaction is the phenomenon where cohesionless soil near the downstream side of dams or sheet-piles loses its shear strength due to high upward hydraulic gradient
16. In a two-dimensional steady flow field, in a certain region of the x-y plane, the velocity component in the x-direction is given by  $v_x = x^2$  and the density varies as  $\rho = \frac{1}{x}$ . Which of the following is a valid expression for the velocity component in the y-direction,  $v_y$ ?
- $v_y = -x/y$
  - $v_y = x/y$
  - $v_y = -xy$
  - $v_y = xy$
17. For steady incompressible flow through a closed-conduit of uniform cross-section, the direction of flow will always be :
- From higher to lower elevation
  - From higher to lower pressure
  - From higher to lower velocity
  - From higher to lower piezometric head
18. A circular pipe has a diameter of 1m, bed slope of 1 in 1000, and Manning's roughness coefficient equal to 0.01. It may be treated as an open channel flow when it is flowing just full, i.e., the

water level just touches the crest. The discharge in this condition is denoted by  $Q_{full}$ . Similarly, the discharge when the pipe is flowing half-full i.e., with a flow depth of 0.5m, is denoted by  $Q_{half}$ . The ratio  $Q_{full}/Q_{half}$  is:

- 1
  - 2
  - $\sqrt{2}$
  - 4
19. The two columns below show some parameters and their possible values.
- Parameter**  
 P – Gross Command Area  
 Q – Permanent Wilting Point  
 R – Duty of canal water  
 S – Delta of wheat
- Value**  
 I – 100 hectares/cumec  
 II – 6°C  
 III – 1000 hectares  
 IV – 1000 cm  
 V – 40 cm  
 VI – 0.12
- Which of the following options matches the parameters and the values correctly?
- P-I, Q-II, R-III, S-IV
  - P-III, Q-VI, R-I, S-V
  - P-I, Q-V, R-VI, S-II
  - P-III, Q-II, R-V, S-IV
20. Total Kjeldahal Nitrogen (TKN) concentration (mg/L as N) in domestic sewage is the sum of the concentration of :
- Organic and inorganic nitrogen in sewage
  - Organic nitrogen and nitrate in sewage
  - Organic nitrogen and ammonia in sewage
  - Ammonia and nitrate in sewage
21. Solid waste generated from an industry contains only two components, X and Y as shown in the table below

| Component | Composition (% weight) | Density (kg/m <sup>3</sup> ) |
|-----------|------------------------|------------------------------|
| X         | $c_1$                  | $\rho_1$                     |
| Y         | $c_2$                  | $\rho_2$                     |

Assuming  $(c_1 + c_2) = 100$ , the composite density of the solid waste ( ) is given by :

- $\frac{100}{\left(\frac{c_1}{\rho_1} + \frac{c_2}{\rho_2}\right)}$
  - $100 \left(\frac{\rho_1}{c_1} + \frac{\rho_2}{c_2}\right)$
  - $100(c_1\rho_1 + c_2\rho_2)$
  - $100 \left(\frac{\rho_1\rho_2}{c_1\rho_1 + c_2\rho_2}\right)$
22. The penetration value of a bitumen sample tested at 25°C is 80. When this sample is heated to 60°C and tested again, the needle of the penetration test apparatus penetrates the bitumen sample by d mm. The value of d CANNOT be less than \_\_\_\_\_ mm.
- 80
  - 70
  - 20
  - 40

23. Which of the following statements CANNOT be used to describe free flow speed ( $u_f$ ) of a traffic stream?  
 A.  $u_f$  is the speed when flow is negligible  
 B.  $u_f$  is the speed when density is negligible  
 C.  $u_f$  is affected by geometry and surface conditions of the road  
 D.  $u_f$  is the speed at which flow is maximum and density is optimum
24. Which of the following statements is FALSE?  
 A. Plumb line is along the direction of gravity  
 B. Mean Sea Level (MSL) is used as a reference surface for establishing the horizontal control  
 C. Mean Sea Level (MSL) is a simplification of Geoid  
 D. Geoid is an equi-potential surface of gravity
25. In a closed loop traverse of 1 km total length, the closing errors in departure and latitude are 0.3 m and 0.4m, respectively. The relative precision of this traverse will be:  
 A. 1 : 5000                      B. 1 : 4000  
 C. 1 : 3000                      D. 1 : 2000
26. The smallest and largest Eigen values of the following matrix are :

$$\begin{bmatrix} 3 & -2 & 2 \\ 4 & -4 & 6 \\ 2 & -3 & 5 \end{bmatrix}$$

- A. 1.5 and 2.5                      B. 0.5 and 2.5  
 C. 1.0 and 3.0                      D. 1.0 and 2.0
27. The quadratic equation  $x^2 - 4x + 4 = 0$  is to be solved numerically, starting with the initial guess  $x_0 = 3$ . The Newton-Raphson method is applied once to get a new estimate and then the Secant method is applied once using the initial guess and this new estimate. The estimated value of the root after the application of the Secant method is \_\_\_\_\_.  
 A. 2.444                              B. 2.333  
 C. 2.666                              D. None
28. Consider the following differential equation:

$$x(ydx + xdy) \cos \frac{y}{x} = y(xdy - ydx) \sin \frac{y}{x}$$

Which of the following is the solution of the above equation (c is an arbitrary constant)?

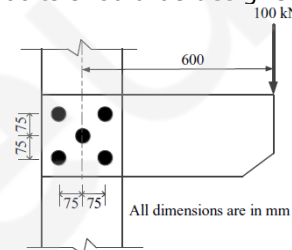
- A.  $\frac{x}{y} \cos \frac{y}{x} = c$                       B.  $\frac{x}{y} \sin \frac{y}{x} = c$   
 C.  $xy \cos \frac{y}{x} = c$                       D.  $xy \sin \frac{y}{x} = c$
29. Consider the following complex function:

$$f(z) = \frac{9}{(z-1)(z+2)^2}$$

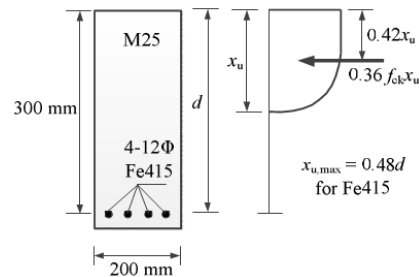
Which of the following is one of the residues of the above function?

- A. -1                                      B. 9/16  
 C. 2                                        D. 9

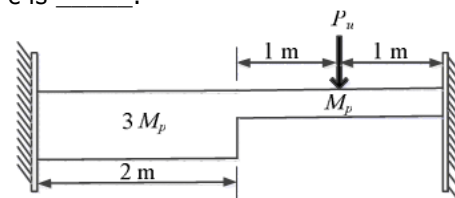
30. The directional derivative of the field  $u(x, y, z) = x^2 - 3yz$  in the direction of the vector  $\hat{i} + \hat{j} + \hat{k}$  and point (2, -1, 4) is \_\_\_\_\_.  
 A. -3.72                              B. -4.72  
 C. -8.72                              D. -5.72
31. The composition of an air-entrained concrete is given below:  
 Water : 184 kg/m<sup>3</sup>  
 Ordinary Portland cement (OPC): 368 kg/m<sup>3</sup>  
 Sand : 606 kg/m<sup>3</sup>  
 Coarse aggregate : 1155 kg/m<sup>3</sup>  
 Assume the specific gravity of OPC, sand and coarse aggregate to be 3.14, 2.67 and 2.74, respectively. The air content is \_\_\_\_\_ litres/m<sup>3</sup>.  
 A. 64                                      B. 59  
 C. 51                                      D. 60
32. A bracket plate connected to a column flange transmits a load of 100 kN as shown in the following figure. The maximum force for which the bolts should be designed is \_\_\_\_\_ kN.



- A. 156.20                              B. 145.20  
 C. 256.20                              D. None
33. Consider the singly reinforced beam section given below (left figure). The stress block parameters for the cross-section from IS: 456 : 2000 are also given below (right figure). The moment of resistance for the given section by the limit state method is \_\_\_\_\_ kN-m.

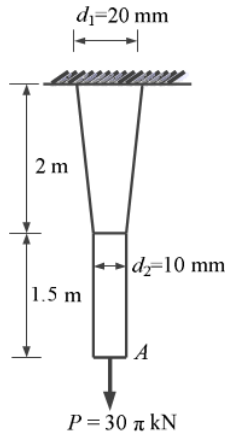


- A. 45.66                              B. 49.44  
 C. 42.82                              D. None
34. For formation of collapse mechanism in the following figure, the minimum value of  $P_u$  is  $cM_p/L$ .  $M_p$  and  $3P_p$  denote the plastic moment capacities of beam sections as shown in this figure. The value of c is \_\_\_\_\_.

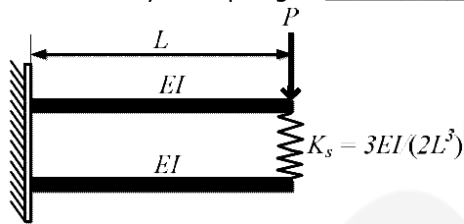


- A. 13.33                              B. 19.33  
 C. 10.33                              D. None

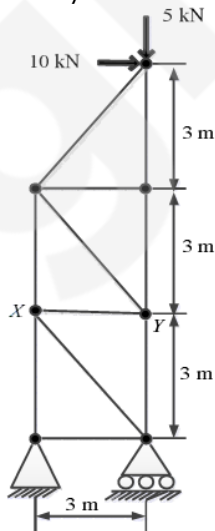
35. A tapered circular rod of diameter varying from 20 mm to 10 mm is connected to another uniform circular rod of diameter 10 mm as shown in the following figure. Both bars are made of same material with the modulus of elasticity,  $E = 2 \times 10^5$  MPa. When subjected to a load  $P = 30 \pi$  kN, the deflection at point A is \_\_\_\_\_ mm.



- A. 15  
B. 18  
C. 10  
D. 13
36. Two beams are connected by a linear spring as shown in the following figure. For a load  $P$  as shown in the figure, the percentage of the applied load  $P$  carried by the spring is \_\_\_\_\_.

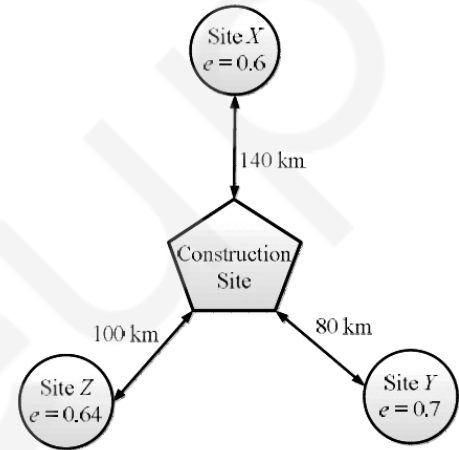


- A. 33.33  
B. 44.44  
C. 66.66  
D. 55.55
37. For the 2D truss with the applied loads shown below, the strain energy in the member XY is \_\_\_\_\_ kN-m. For member XY, assume  $AE = 30$  kN, where  $A$  is cross-section area and  $E$  is the modulus of elasticity.

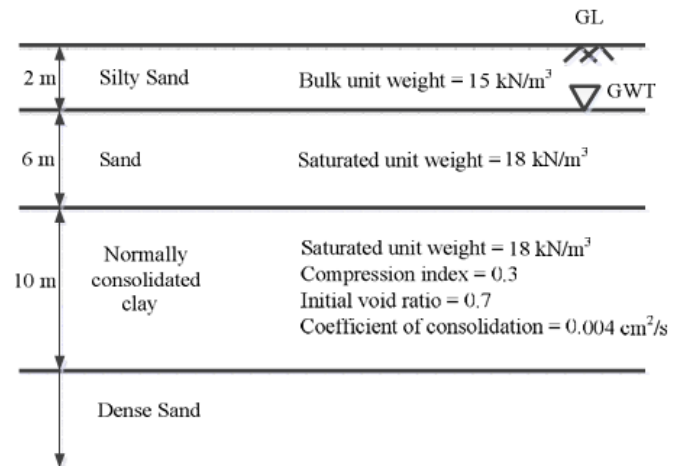


- A. 5  
B. 6  
C. 9  
D. 4

38. An earth embankment is to be constructed with compacted cohesionless soil. The volume of the embankment is  $5000 \text{ m}^3$  and the target dry unit weight is  $16.2 \text{ kN/m}^3$ . Three nearby sites (see figure below) have been identified from where the required soil can be transported to the construction site. The void ratios ( $e$ ) of different sites are shown in the figure. Assume the specific gravity of soil to be 2.7 for all three sites. If the cost of transportation per km is twice the cost of excavation per  $\text{m}^3$  of borrow pits, which site would you choose as the most economic solution? (Use unit weight of water =  $10 \text{ kN/m}^3$ )



- A. Site X  
B. Site Y  
C. Site Z  
D. Any of the sites
39. A water tank is to be constructed on the soil deposit shown in the figure below. A circular footing of diameter 3 m and depth of embedment 1 m has been designed to support the tank. The total vertical load to be taken by the footing is  $1500 \text{ kN}$ . Assume the unit weight of water as  $10 \text{ kN/m}^3$  and the load dispersion pattern as  $2V : 1H$ . The expected settlement of the tank due to primary consolidation of the clay layer is \_\_\_\_\_ mm.



- A. 50.286  
B. 53.236  
C. 63.346  
D. 66.332

40. A 20 m thick clay layer is sandwiched between a silty sand layer and a gravelly sand layer. The layer experiences 30 mm settlement in 2 years.

$$T_v = \begin{cases} \frac{\pi \left( \frac{U}{1000} \right)^2}{4} & \text{for } U \leq 60\% \\ 1.781 - 0.933 \log_{10}(100 - U) & \text{for } U > 60\% \end{cases}$$

Where  $T_v$  is the time factor and  $U$  is the degree consolidation in %.

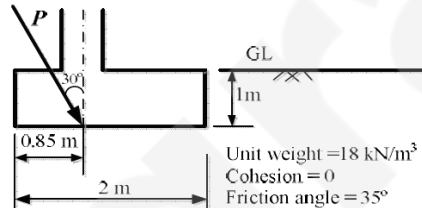
If the coefficient of consolidation of the layer is  $0.003 \text{ cm}^2/\text{s}$ , the deposit will experience a total of 50 mm settlement in the next \_\_\_\_\_ years.

- A. 5.53                      B. 4.43  
C. 6.63                      D. 8.33
41. A non-homogenous soil deposit consists of a silt layer sandwiched between a fine-sand layer at top and a clay layer below. Permeability of the silt layer is 10 times the permeability of the clay layer and one-tenth of the permeability of the sand layer. Thickness of the silt layer is 2 times the thickness of the sand layer and two-third of the thickness of the clay layer. The ratio of equivalent horizontal and equivalent vertical permeability of the deposit is \_\_\_\_\_.

- A. 10.967                      B. 10.968  
C. 10.969                      D. None

42. A square footing (2 m × 2m) is subjected to an inclined point load  $P$  as shown in the figure below. The water table is located well below the base of the footing. Considering one-way eccentricity, the net safe load carrying capacity of the footing for a factor of safety of 3.0 is \_\_\_\_\_ kN.

The following factor may be used:  
Bearing capacity factors:  $N_q = 33.3$ ,  $N = 37.16$ ;  
Shape factor:  $F_{qs} = 1.314$  ; Depth factors :  $F_{qd} = F_d = 1.133$ ; Inclination factors :  $F_{qi} = 0.444$ ,  $F_i = 0.02$



- A. 453                          B. 452  
C. 450                          D. None

43. Two reservoirs are connected through a 930 m long, 0.3 m diameter pipe, which has a gate valve. The pipe entrance is sharp (loss coefficient = 0.5) and the valve is half-open (loss coefficient = 5.5). The head difference between the two reservoirs is 20 m. Assume the friction factor for the pipe as 0.03 and  $g = 10 \text{ m/s}^2$ . The discharge in the pipe accounting for all minor and major losses is \_\_\_\_\_  $\text{m}^3/\text{s}$ . (use  $g = 10 \text{ m/s}^2$ )

- A. 0.1413                      B. 0.4513  
C. 0.1367                      D. None

44. A hydraulic jump is formed in a 2 m wide rectangular channel which is horizontal and frictionless. The post-jump depth and velocity are 0.8 m and 1 m/s, respectively. The pre-jump velocity is \_\_\_\_\_ m/s. (use  $g = 10 \text{ m/s}^2$ ).

- A. 4.94                          B. 5.64  
C. 3.84                          D. None

45. A short reach of a 2 m wide rectangular open channel has its bed level rising in the direction of flow at a slope of 1 in 10000. It carries a discharge of  $4 \text{ m}^3/\text{s}$  and its Manning's roughness coefficient is 0.01. The flow in this reach is gradually varying. At a certain section in this reach, the depth of flow was measured as 0.5 m. The rate of change of the after depth with distance,  $dy/dx$ , at this section is \_\_\_\_\_ (use  $g = 10 \text{ m/s}^2$ ).

- A. 0.0043                      B. 0.0042  
C. 0.0032                      D. None

46. The density force  $F_D$ , on a sphere kept in a uniform flow field depends on the diameter of the sphere,  $D$ ; flow velocity,  $V$ ; fluid density,  $\rho$ ; and dynamic viscosity,  $\mu$ . Which of the following options represents the non-dimensional parameters which could be used to analyze this problem?

- A.  $\frac{F_D}{V_D}$  and  $\frac{\mu}{\rho V D}$                       B.  $\frac{F_D}{\rho V D^2}$  and  $\frac{\rho V D}{\mu}$   
C.  $\frac{F_D}{\rho V^2 D^2}$  and  $\frac{\rho V D}{\mu}$                       D.  $\frac{F_D}{\rho V^3 D^3}$  and  $\frac{\mu}{\rho V D}$

47. In a catchment, there are four rain-gauge stations, P, Q, R, and S. Normal annual precipitation values at these stations are 780 mm, 850 mm, 920 mm, respectively. In the year 2013, stations Q, R, and S, were operative but P was not. Using the normal ratio method, the precipitation at station P for the year 2013 has been established as 860 mm. If the observed precipitation at station Q and R for the year 2013 were 930 mm and 1010 mm, respectively; what was the observed precipitation (in mm) at station S for that year?

- A. 1076.2                      B. 1075.2  
C. 1078.5                      D. 1077.3

48. The 4-hr unit hydrograph for a catchment is given in the table below. What would be the maximum ordinate of the S-curve (in  $\text{m}^4/\text{s}$ ) derive from this hydrograph?

| Time (hr) | Unit hydrograph ordinate ( $\text{m}^3/\text{s}$ ) |
|-----------|--|
| 0         | 0  |
| 2         | 0.6  |
| 4         | 3.1  |
| 6         | 10   |
| 8         | 13   |
| 10        | 9  |
| 12        | 5  |
| 14        | 2  |
| 16        | 0.7  |
| 18        | 0.3  |
| 20        | 0.2  |
| 22        | 0.1  |
| 24        | 0  |

- A. 22                              B. 25  
C. 29                              D. None

