

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

T.B.C. : B-FRF-M-BUB

Test Booklet Series

Serial No.

TEST BOOKLET

CIVIL ENGINEERING PAPER—II



Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET **DOES NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
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3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. **DO NOT** write *anything else* on the Test Booklet.
4. This Test Booklet contains **120** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case, you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.
5. You have to mark your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**
THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.
 - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.
 - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
 - (iii) If a question is left blank, i.e. no answer is given by the candidate, there will be **no penalty** for that question.

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1. The absolute pressure at a point 2.5 m below the clear water surface is measured as 125.703 kN/m^2 . If the atmospheric pressure is taken as 101.325 kN/m^2 , the gauge pressure in kN/m^2 at this point would be :
 - (a) 113.514
 - (b) 24.378
 - (c) 45.401
 - (d) 56.757
2. Flow measurements with a Prandtl-Pitot tube showed that the tip readings varied only across the flow while the side-opening readings varied only in the direction of flow. The type of flow is :
 - (a) Uniform irrotational
 - (b) Uniform rotational
 - (c) Non-uniform irrotational
 - (d) Non-uniform rotational
3. An open cylindrical tank 75 cm diameter and 1.5 m high contains water upto 1.2 m depth. If the cylinder is rotated about its vertical axis, what is the maximum angular velocity (in radians per second) that can be attained without spilling any water ?
 - (a) 7.55
 - (b) 8.08
 - (c) 9.15
 - (d) 10.02
4. X-component of velocity in a two-dimensional incompressible flow is given by $u = 2y^2 + 6xy$. If the Y-component of velocity v is zero at $y = 0$, the expression for Y-component of velocity is given by :
 - (a) $v = 3y^2 + f(y)$
 - (b) $v = 3y^2 + f(x)$
 - (c) $v = -3y^2 + f(y)$
 - (d) $v = -3y^2 + f(x)$
5. Consider the following statements :
Euler's equation of motion
 1. can be derived from Navier-Stokes equations.
 2. refers to energy balance.
 3. develops into Bernoulli's equation under appropriate conditions.
 4. is applicable to rotational as well as irrotational flows.
 Which of these statements are correct ?
 - (a) 1, 2, 3 and 4
 - (b) 1 and 2 only
 - (c) 1 and 3 only
 - (d) 3 and 4 only
6. In 1 in 50 model of a spillway, discharge is $3 \text{ m}^3/\text{sec}$. Find the corresponding discharge in the prototype in m^3/sec .
 - (a) 1061
 - (b) 7500
 - (c) 53033
 - (d) 375000

7. For accurate flow measurement in open channels, an arrangement for aeration under the nappe is necessary when the weir used is :
 - (a) Contracted rectangular
 - (b) Suppressed rectangular
 - (c) Submerged contracted rectangular
 - (d) Triangular
8. At a distance of 20 cm from the axis of a whirlpool in an ideal liquid, the velocity is 10 m/s. At a radius of 50 cm, what will be the depression of the free surface of the liquid below that at a very large distance ? (Take $1/g = 0.102 \text{ s}^2/\text{m}$)
 - (a) 0.408 m
 - (b) 0.612 m
 - (c) 0.816 m
 - (d) 1.224 m
9. The average drag coefficient for a laminar boundary layer over a flat plate was obtained as 0.018. If all other factors remain unchanged, and length of the plate is increased by 4 times its original value, this average drag coefficient would change to :
 - (a) 0.0036
 - (b) 0.0056
 - (c) 0.008
 - (d) 0.009
10. A jet of oil of relative density 0.8 and of area 0.02 m^2 issues at 10 m/s. If it strikes normally on a stationary plate, the force exerted on the plate is :
 - (a) 1906 N
 - (b) 15606 N
 - (c) 1600 N
 - (d) 19581 N
11. A wall shear stress of 40 Pa exists in a laminar flow in a 12 cm diameter pipe. At a distance of 2 cm from the wall, what will be the shear stress ?
 - (a) 22.2 Pa
 - (b) 24.0 Pa
 - (c) 26.7 Pa
 - (d) 28.0 Pa
12. A model of a boat is built to a scale of 1/100. It experiences a resistance of 0.10 N when simulating a speed of 5 m/s of the prototype. Water is the fluid in both the cases. Neglecting frictional forces, corresponding resistance in the prototype is :
 - (a) 1000 kN
 - (b) 100 kN
 - (c) 10 kN
 - (d) 1 kN
13. The performance of a hydraulic structure during a flood has been investigated in a 1/25 model based on Froude law of similarity. A flood wave passing through the model in 2 hrs. corresponds to a prototype period of :
 - (a) 50 hr
 - (b) 12.5 hr
 - (c) 10 hr
 - (d) 0.4 hr
14. A 1 : 25 model of a naval ship is towed at a velocity of 1.2 m/s to determine each of the two components of the total drag that may be experienced by the prototype. The wave-making drag of the model is duly estimated to be 0.37 kgf. What would be the wave making drag on the prototype ship ?
 - (a) 1250 kgf
 - (b) 1875 kgf
 - (c) 3750 kgf
 - (d) 4625 kgf

15. A very small spherical particle of sand settles in a column of viscous liquid. If the Reynolds number corresponding to its terminal velocity is 0.25, the drag coefficient of the sand particle is :
- 256
 - 128
 - 96
 - 64
16. A turbine develops 7000 kW power under a head of 25 m at 145 rpm. Calculate the specific speed of turbine and state the type of turbine.
- 485, Pelton
 - 217, Francis
 - 217, Pelton
 - 485, Francis
17. When small sphere falls freely in Stokes range through a water column, which of the following statements are correct ?
- Viscosity, surface tension and gravitational forces act on the sphere.
 - There is no turbulence possible in the wake of the falling sphere.
 - Drag coefficient, $C_d = R/24$, where R is Reynolds number.
 - Proximity of the boundary moderates the drag and lift coefficients.
- 1 and 2
 - 2 and 3
 - 3 and 4
 - 2 and 4
18. The Bernoulli's equation is applicable to :
- Both steady and unsteady flows
 - Real fluids
 - All fluids and flows along a stream tube
 - Steady flow of ideal fluids along a stream tube
19. A river whose discharge is 10^5 cumecs is to be studied by a 1 : 100 scale model in a laboratory. The discharge required in the model is :
- $0.5 \text{ m}^3/\text{s}$
 - $10 \text{ m}^3/\text{s}$
 - $1 \text{ m}^3/\text{s}$
 - $5 \text{ m}^3/\text{s}$
20. A rectangular channel carries a uniform flow with a Froude number of 2.83. The ratio of critical depth to normal depth of this flow is :
- 1.68
 - 2.83
 - 2.00
 - 4.75
21. At the same mean velocity of flow, the ratio of head loss per unit length for a sewer pipe running full to that for the same pipe flowing half-full is :
- 2.0
 - 1.67
 - 1.0
 - 0.67

22. Which of the following equations are used for the derivation of the differential equation for water surface profile in an open channel ?
1. Continuity equation
 2. Energy equation
 3. Momentum equation
- (a) 1, 2 and 3
 - (b) 1 and 3 only
 - (c) 2 and 3 only
 - (d) 1 and 2 only
23. When flow is critical through open channels, which of the following statements are correct ?
1. The specific energy is minimum for a given discharge.
 2. The discharge is maximum for a given specific energy.
 3. The specific force is minimum for a given discharge.
 4. Froude number of the flow is equal to unity.
- (a) 1, 2 and 3 only
 - (b) 1, 2 and 4 only
 - (c) 1, 2, 3 and 4
 - (d) 2, 3 and 4 only
24. Among weirs used in open flow metrology, critical depth of the flow is the relevant criterion in :
- (a) Broad-crested weir
 - (b) Cippoletti weir
 - (c) Parabolic weir
 - (d) Sharp-crested weir
25. The loss of head in a pipe carrying turbulent flow varies :
- (a) Inversely as the square of the velocity of flow
 - (b) Inversely as the square of the diameter of pipe
 - (c) Directly as the square of the velocity of flow
 - (d) Directly as the velocity of flow
26. Consider the following statements regarding laminar flow through a circular pipe :
1. The friction factor is constant.
 2. The friction factor depends upon the pipe roughness.
 3. The friction factor varies inversely with the Reynolds number of flow.
 4. The velocity distribution is parabolic.
- Which of these statements are correct ?
- (a) 1 and 3
 - (b) 3 and 4
 - (c) 2 and 3
 - (d) 2 and 4
27. It is proposed to increase the discharge by 20% in circular pipe carrying oil in laminar regime. If all other factors remain unchanged, power consumption to maintain the modified flow relative to the original flow would increase by :
- (a) 10%
 - (b) 20%
 - (c) 44%
 - (d) 52%

28. In a pipe network :

- (a) The algebraic sum of discharges around each elementary circuit must be zero
- (b) The head at each node must be the same
- (c) The algebraic sum of the drop in piezometric head around each elementary circuit is zero
- (d) The piezometric head loss in each line of each circuit is the same

29. In a pipeline 1920 m long, the velocity of propagation of pressure wave is 960 m/s. Rapid closure of a downstream valve will entail, the maximum time for the closure is :

- (a) 8 s
- (b) 6 s
- (c) 4 s
- (d) 2 s

30. A centrifugal pump delivers a manometric head of 12 m when pumping a liquid of relative density 0.8. If all other factors remain the same but the liquid has a relative density of 1.2, the new manometric head would be :

- (a) 8 m
- (b) 10 m
- (c) 12 m
- (d) 18 m

31. Consider the following statements :

To maximize the Net Positive Suction Head Available for a reciprocating pump, one must :

- 1. Reduce the suction pipe friction loss.
- 2. Increase the ambient pressure at the supply reservoir.
- 3. Increase the pump speed.
- 4. Increase the static suction head.

Which of these statements are correct ?

- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 1 and 4

32. A hydraulic ram utilizes a supply under 4.0 m head, and delivers to an effective head of 20 m above the unit. The ratio of water wasted to the water delivered is 15. The efficiency of the pump, with neglecting frictional losses in the pipes, is :

- (a) 17.5%
- (b) 20.0%
- (c) 28.6%
- (d) 33.3%

33. Which of the following statements are correct ?

- 1. Friction and pressure drag depend upon the shape and position of immersed body.
- 2. If a thin plate is kept parallel to the direction of flow, then the pressure drag is zero.
- 3. If a thin plate is kept perpendicular to the moving fluid, then friction drag is zero.

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

34. In all reaction turbines, for maximum efficiency, the velocity of :
- Swirl at outlet must be zero
 - Flow at entrance must be zero
 - Swirl at entrance must be zero
 - Flow at outlet must be zero
35. A turbine develops 2516 kW at 240 rpm. The torque in the shaft is approximately :
- 400 kN.m
 - 3336 kN.m
 - 1000 kN.m
 - 100 kN.m
36. A Kaplan turbine has a runner of diameter 4.0 m. The diameter of the hub is 1.6 m. If the velocity of flow and the swirl velocity at the inlet side of the blade at the hub are 6.0 m/s and 10.0 m/s, respectively, the flow and swirl velocities at the inlet side of the tip are, respectively :
- 15.0 m/s and 10.0 m/s
 - 6.0 m/s and 25.0 m/s
 - 6.0 m/s and 4.0 m/s
 - 2.5 m/s and 10.0 m/s
37. Which of the following statements are correct ?
- A fine sprinkle of precipitation of small and rather uniform water drops with all drop diameters below 0.10 mm is called as drizzle.
 - The precipitation of liquid water with every drop diameter less than 0.5 mm is known as rain.
 - Precipitation in the form of balls or irregular lumps of ice each over 5 mm in diameter is called hail.
 - Dew is formed directly by condensation on the ground mainly during night when the surface has been cooled by outgoing radiation.
- 1 and 2
 - 2 and 3
 - 3 and 4
 - 1 and 4
38. The double mass curve technique is used :
- To find the average rainfall over a number of years
 - To estimate the missing rainfall data
 - To check the consistency of rain gauge records
 - To find the minimum number of rain gauges required in a basin
39. The theory of synthetic hydrograph based on flood routing techniques is based on the principle that rainfall impulse (net storm rain) is modified by the factors :
- The time of travel of the flow volume in channel and overland flow
 - Storage
 - Both translation and storage
- 1 and 2 only
 - 1, 2 and 3
 - 1 and 3 only
 - 2 and 3 only
40. It is proposed to design a causeway along a village road. The return period for the annual maximum flood of a given magnitude was found to be 5 years. The probability that this flood magnitude will be exceeded at least once during next 2 years is :
- 0.8
 - 0.5
 - 0.45
 - 0.36
41. Wading technique is used :
- To determine velocity of sea waves during Tsunami
 - To determine thickness of canal lining in alluvial soils
 - To measure the volume of dredging material in harbours
 - To determine velocity of flow in shallow streams

42. A mean annual runoff $2 \text{ m}^3/\text{s}$ from a catchment of area 10 km^2 represents an effective rainfall of nearly :
- 530 cm
 - 590 cm
 - 630 cm
 - 658 cm
43. Steep rise in the flow-mass curve during a certain period indicates :
- Very high evaporation losses during that period
 - Flash floods during that period
 - Sudden spurt in irrigation demand during that period
 - Sudden rise in demand for water to meet hydropower generation
44. A rice crop is to be irrigated in a field covering an area of 2400 ha, the duty and base period of rice are given as 860 ha/cumec and 120 days respectively. The volume of water required in the field is nearly :
- 500 ha—m
 - 1400 ha—m
 - 2000 ha—m
 - 2880 ha—m
45. In an irrigation project, in a certain year, 70% and 46% of the culturable command area in Kharif and Rabi, respectively, remained without water and rest of the area got irrigation water. The intensity of irrigation in that year for the project was :
- 116%
 - 84%
 - 42%
 - 58%
46. The gross command area for a distributory is 5000 hectares, 80% of which is culturable irrigable. The intensity of irrigation for Rabi is 50%; and for Kharif is 30%. The average duty at the head of the distributory is 2000 hectares/cumec for Rabi season and 900 hectares/cumec for Kharif season. The discharge required at the head of the distributory from average demand considerations is :
- 1.00 cumecs
 - 1.33 cumecs
 - 2.33 cumecs
 - 3.33 cumecs
47. Due to continuous pumping for 7 hrs from a catchment of 25 ha, having porosity of 30% and specific retention of 10%, groundwater level dropped by 1 m. The corresponding change in storage is :
- 7.5 ha—m
 - 0.75 ha—m
 - 1.87 ha—m
 - 0.187 ha—m
48. As recommended by Sichardt, the radius of influence is :
- Inversely proportional to drawdown
 - Linearly proportional to drawdown
 - Independent of drawdown
 - Proportional to square root of drawdown

49. Consider the following statements :

1. A regime channel will have side slopes of value 0.5 H : 1 V.
2. Lacey's regime formula is applicable to regime channels with sediment concentration more than 5000 ppm.
3. For a Lacey regime channel the Manning roughness coefficient is estimated by Strickler's formula.
4. The mean velocity in a Lacey channel is proportional to $R^{2/3}$ where R = hydraulic radius.

Which of these statements are correct ?

- (a) 1 and 2
- (b) 1 and 4
- (c) 2 and 3
- (d) 3 and 4

50. The minimum size of gravel that will not move in the bed of a wide rectangular channel of depth 0.8 m and longitudinal slope 0.0041 is :

- (a) 11 mm
- (b) 23 mm
- (c) 36 mm
- (d) 57 mm

51. The flip bucket energy dissipator for a spillway is suitable where :

1. The tail water depth is low.
2. The rock on the downstream is fragile and is erodible.
3. The rock on the downstream is good and non-erodible.

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1 and 3 only

52. Consider the following statements :

1. Groynes are constructed projecting from the bank into the river at the bank to be protected from flood.
2. Repelling groyne projects downstream into the river-flow from the point of its origin from the bank.
3. Attracting groyne projects upstream into the river from the point of its origin from the bank.
4. Perpendicular groyne projects normal to the river-flow from the point of its origin from the bank.

Which of these statements are correct ?

- (a) 1 and 4
- (b) 1 and 2
- (c) 2 and 3
- (d) 3 and 4

53. The dissolved oxygen in a water sample is generally estimated by modified Winkler method. The water sample is taken in a 300 ml BOD bottle and the dissolved oxygen is fixed by adding :

- (a) 1 ml of conc. H_2SO_4 followed by addition of 1 ml of $MnSO_4$ reagent and contents mixed thoroughly, thereafter waiting for 5-10 minutes, and then 1 ml of alkali-iodide-azide reagent is added
- (b) 1 ml of alkali-iodide-azide reagent followed by addition of 1 ml of conc. H_2SO_4 and then the contents mixed thoroughly, thereafter waiting for 5-10 minutes, 1 ml of $MnSO_4$ reagent is added
- (c) 1 ml of $MnSO_4$ followed by addition of 1 ml of alkali-iodide-azide reagents and then the contents mixed thoroughly, thereafter waiting for 5-10 minutes and then 1 ml of conc. H_2SO_4 is added
- (d) 1 ml of conc. of H_2SO_4 followed by addition of 1 ml of alkali-iodide-azide reagent and then the contents mixed thoroughly, thereafter waiting for 5-10 minutes and then 1 ml of $MnSO_4$ reagent is added

54. Consider the following statements :

1. Typhoid fever is caused by viral infection.
2. Infectious hepatitis is caused by bacterial infection.
3. Cholera is caused by bacteria.
4. Amoebic dysentery is caused by protozoal infection.

Which of these statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 3 and 4 only
- (d) 2 and 3 only

55. Which of the following statements are the important characteristics of a slow sand filter ?

1. Cleaning of filter is done by scraping and sand removal.
2. Lack of pretreatment.
3. Greater efficiency of bacterial removal as compared to rapid sand filter.
4. Efficient in colour, taste and odour removal.

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 4 only
- (c) 2, 3 and 4 only
- (d) 1, 2 and 3 only

56. Which of the reasons given below favour the use of cast iron pipe for city water supply ?

1. Strong in tension; and pipe of large diameter (up to 6 m) can be made
2. Easy to make joints
3. Durable
4. Corrosion-resistant

- (a) 1, 2, 3 and 4
- (b) 2, 3 and 4 only
- (c) 1, 2 and 4 only
- (d) 1, 3 and 4 only

57. The self-cleansing velocity in a sewer depends on :

1. BOD (soluble)
2. Slope of the sewer
3. Ratio of depth of flow sewage to sewer diameter ratio

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1 and 3 only

58. One sewer has a dia. of 300 mm and another one has a dia. of 600 mm. When both run half-full, what will be the ratio of velocities in the two pipes if the slope of both pipes is the same ?

- (a) 1
- (b) $\frac{1}{2}$
- (c) $\left(\frac{1}{2}\right)^{\frac{2}{3}}$
- (d) $\left(\frac{1}{2}\right)^{\frac{3}{2}}$

59. If the slope of sewer A is 1/100 and that of sewer B is 1/400, the velocity of flow in the two sewers will have a ratio of (size of both the sewers being same) :

- (a) $\frac{1}{2}$
- (b) 1
- (c) $(2)^{\frac{2}{3}}$
- (d) 2

60. What is the correct sequence of the following treatment units employed in a conventional sewage treatment plant ?
1. Screen chamber
 2. Primary settling tank
 3. Trickling filter
 4. Grit chamber
 5. Secondary settling tank
- (a) 5, 4, 2, 3 and 1
(b) 1, 4, 2, 3 and 5
(c) 5, 2, 3, 4 and 1
(d) 1, 4, 3, 2 and 5
61. Which of the following parameters are employed in the design of trickling filter ?
1. Hydraulic loading rate
 2. Organic loading rate
 3. Detention time
 4. Weir loading rate
- (a) 1, 2, 3 and 4
(b) 1 and 2 only
(c) 2 and 3 only
(d) 3 and 4 only
62. In activated sludge process, 1 mld (by volume) of secondary sludge has to be returned to keep the required MLSS concentration in the aeration tank. This sludge has a water content of 99%. If the sludge water content is reduced to 98%, what volume of the sludge will be needed to be recycled ?
- (a) 0.25 mld
(b) 0.5 mld
(c) 0.75 mld
(d) 1.00 mld
63. Consider the following statements :
1. Grease data is a measure of effectiveness of primary settling tanks.
 2. Volatile acid data provide information concerning anaerobic degradation of organic matter.
 3. Total and volatile solids data are indispensable in the design and operation of sludge digestion, vacuum filter and incineration units.
 4. Ammonia and organic nitrogen data are helpful in controlling aerobic treatment costs to a minimum.
- Which of these statements are correct ?
- (a) 1, 2, 3 and 4
(b) 1, 2 and 3 only
(c) 1, 2 and 4 only
(d) 2, 3 and 4 only
64. Consider the following statements in regard to an electrostatic precipitator :
1. Power requirement is small compared to other devices.
 2. Immune to variable particulate loadings and flow rates.
 3. 99+ percent efficiency is obtainable. Very small particles can be collected, wet or dry.
 4. Can handle both gases and mists at high volume of flow.
- Which of these statements are correct ?
- (a) 1, 2, 3 and 4
(b) 1, 3 and 4 only
(c) 1, 2 and 3 only
(d) 2, 3 and 4 only

65. Consider the following statements :

1. Noise pollution can be reduced using double-glass window panes.
2. Glass absorbs the noise.
3. The air trapped in the double-glass system acts as an insulator and reduces the noise.
4. The noise totally reflects back due to the two layers of glass.

Which of these statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 1 and 3 only
- (d) 2 and 4 only

66. Consider the following statements :

1. Sound is a form of mechanical energy from a vibrating substance, transmitted by a cyclic series of compressions and rarefactions of the molecules of the material through which it passes.
2. In a pure tone, the wave pattern of the alternating positive and negative sound pressure is of ideal sinusoidal form with fixed wave length, frequency and amplitude.
3. The speed of transmission of sound is a function of the transmitting medium and its temperature.
4. The audible range of 200 to 25000 Hz is considered normal for young adults.

Which of these statements are correct in respect of sound transmission ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 4 only
- (c) 1, 2 and 3 only
- (d) 2, 3 and 4 only

67. Consider the following statements :

1. Activity is a property typical of clay soils.
2. An activity value of 7 in a clay soil is indicative of the presence of montmorillonite mineral.
3. An activity value of 7 in a clay soil is indicative of the presence of illite mineral.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

68. In a wet soil mass air, occupies one-fourth of its volume and water occupies one-half of its volume. The void ratio of this soil is :

- (a) 1
- (b) 2
- (c) 3
- (d) 4

69. Which one of the following statements is correct ?

- (a) Grain size is the primary criterion for classification of course, as well as fine-grained soil
- (b) Grain size is the primary criterion for classification of coarse-grained soils
- (c) Plasticity curve classifies coarse-grained soils
- (d) Plasticity characteristics relate to classification of coarse-grained soils

70. Consider the following statements :

1. A conspicuous break in the continuity of a grain size distribution curve indicates a mixture of soil from two different layers.
2. A steep grain size distribution curve indicates prevalence of nearly uniform grain size.
3. A flat grain size distribution curve indicates certain range of missing grain sizes.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1 and 2 only

71. Consider the following statements :

1. Swelling is greater and shrinkage is less for clay compacted on the dry-side of optimum.
2. Clays compacted on the dry-side of optimum are characterized by larger strength.
3. An increase in organic content of clay soils causes an increase in optimum moisture content value.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

72. Consider the following statements :

1. Quantity of seepage in each flow channel of a flow-net is independent of the size of field.
2. Drop in head between adjacent equipotential lines of a flow-net is dependent on upstream head.
3. With increase in the length of a flow path, the corresponding exit gradient will decrease.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

73. Consider the following statements :

1. Presence of moisture in sand does not affect the magnitude of friction angle.
2. Moisture introduces capillary effect in a sandy soil leading to apparent increase in angle of internal friction.
3. Moisture introduces capillary effect in a sandy soil leading to development of apparent cohesion.
4. The capillary film is broken by drying or submergence leading to loss in the apparent cohesion.

Which of these statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 2 and 3 only
- (c) 2 and 4 only
- (d) 3 and 4 only

74. Consider the following statements :

1. Cohesion-less soils experience relatively quicker compression under load.
2. Clays compacted dry-of-optimum compress more rapidly.
3. Clays compacted wet-of-optimum consolidate more under low stress range.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

75. Consider the following statements :

1. The maximum possible over-consolidation ratio of normally consolidated soil is unity.
2. The compressibility of a field deposit is slightly greater than that shown by a laboratory sample.
3. In Terzaghi's theory of one-dimensional consolidation, only hydrodynamic lag is considered whereas plastic lag is ignored.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

76. Consider the following statements :

1. Brittle behaviour of soils can be obtained when the soil is heavily over-consolidated clay.
2. Remoulded cohesive clays show a tendency towards progressive failure.
3. Undisturbed sensitive clays show a tendency towards progressive failure.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 3 only
- (c) 1 and 2 only
- (d) 2 and 3 only

77. A concentrated load of 50 kN acts on the surface of ground. The increase in vertical stress directly below the load at a depth of 4 m will be (Value of influence factor is 0.48) :

- (a) 1.5 kN/m²
- (b) 15 kN/m²
- (c) 150 kN/m²
- (d) 0.15 kN/m²

78. Consider the following statements :

1. The bulb of pressure under strip-footing forms in the length-wise direction.
2. The bulb of pressure under a strip-footing forms in the width-wise direction.
3. Contact pressure at the edges of a rigid footing on saturated clay is theoretically infinite.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 2 and 3 only
- (c) 1 and 2 only
- (d) 1 and 3 only

79. Consider the following statements :

1. Undisturbed samples may be obtained with the help of augers.
2. Auger drilling is most effective in clayey soils.
3. Hollow stem augers are sometimes used to drill holes in silty sand.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1 and 3 only

80. A single pile, 50 cm in diameter and 16 m long, is driven in clay having an average unconfined compressive strength of 100 kN/m^2 . The ultimate load carrying capacity of the pile, neglecting end bearing if any, and assuming shear mobilization of 0.75 around the pile, is nearly :

- (a) 840 kN
- (b) 900 kN
- (c) 940 kN
- (d) 1000 kN

81. Consider the following statements :

1. If the soil is not black in colour, it is unlikely to be a swelling soil.
2. The swelling pressure of a fine-grained soil depends on its initial water content and density.
3. The swelling pressure of a fine-grained soil depends on the nature of the pore fluid.

Which of these statements are correct ?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

82. Which one of the following statements is correct ?

- (a) In a retrograde vernier, $(n - 1)$ divisions on the primary scale are divided into n divisions on the vernier scale.
- (b) A double vernier consists of two simple verniers placed end-to-end forming one scale with the zero in the centre.
- (c) In an extended vernier, $(2n + 1)$ primary divisions are divided into n divisions on the vernier.
- (d) In a direct vernier, $(n + 1)$ primary divisions are divided into n equal divisions on the vernier scale.

83. The length of a line measured with a 30 m chain was found to be 734.6 m. It was afterwards found that the chain was 0.05 m too long. The true length of the line was :

- (a) 630.82 m
- (b) 680.82 m
- (c) 735.82 m
- (d) 780.92 m

84. Following offsets were taken from a survey line to a hedge :

Distance (in meters)	0	5	10	15	20	30	40
Offsets (in meters)	3	4	5.5	5	6	4	4.5

The area between survey line and the hedge is (by trapezoidal method) :

- (a) 185.5 m^2
- (b) 187.5 m^2
- (c) 189.5 m^2
- (d) 289.5 m^2

85. The bearing of line AB is 150° and the angle ABC is 124° . Bearing of line BC is :

- (a) 94°
- (b) 98°
- (c) 198°
- (d) 90°

86. The following observations were taken during testing of a dumpy level :

Instrument at	Staff reading on	
	P	Q
P	1.475 m	2.205 m
Q	1.440 m	2.060 m

The collimation error in the instrument was :

- (a) $+0.055$ m
- (b) $+0.005$ m
- (c) -0.055 m
- (d) -0.005 m

87. R.L. of a floor level is 200.490 m. Staff reading on the floor is 1.695 m. Reading on the staff held upside down against the bottom of the roof is 3.305 m. Height of the ceiling is :

- (a) 3.5 m
- (b) 4.0 m
- (c) 5.0 m
- (d) 6.0 m

88. Which of the following terms related to levelling are correctly defined ?

1. Line of collimation Line joining the intersection of the crosshairs to the optical centre of the object glass and its continuation
2. Back-sight First staff reading taken after the level is set up
3. Fore-sight Last staff reading prior to shifting of level, or termination of the process of levelling
4. Height of instrument Height of centre of telescope above the ground where the level is set up

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 4 only
- (c) 1, 2 and 3 only
- (d) 2, 3 and 4 only

89. Two stations P and Q are on the opposite banks of a river. Following observations were taken in reciprocal levelling.

Instrument near	Staff reading at	
	P	Q
P	1.400	3.500
Q	0.600	2.200

R.L. of P is 200.000 m, and then R.L. of Q is nearly :

- (a) 199.3
- (b) 201.7
- (c) 200.0
- (d) 198.2

90. Which of the following set of terms does not relate to operation of a theodolite ?
- Transiting and inverting
 - Face left and face right
 - Right swing and left swing
 - Gauging and sounding
91. Under the Nagpur Road Plan, which of the following are NOT relevant in planning the road development programme in a backward district ?
- Existing agriculture drainage network of drain canals.
 - Existing number of Panchayat unions.
 - Existing length of mud-track roads.
 - Number of villages with population of 10000 and above.
- 1, 2, 3 and 4
 - 1, 2 and 3 only
 - 1, 2 and 4 only
 - 2, 3 and 4 only
92. The earth pressure behind a bridge abutment is :
- Active
 - Passive
 - At rest
 - Constant always and everywhere
93. The purpose of check rail is :
- To aid the flange of the opposite wheel passing through the crossing to steer clear of the nose
 - To avoid derailment per se
 - To help control the running speed
 - To minimize the laying cost of long distances of trades
94. A 45 kg rail on BG tracks in Indian conditions is expected to carry approximate axle loads of :
- 21 t
 - 22 t
 - 23 t
 - 24 t
95. Traffic capacity is the :
- Ability of roadway to accommodate traffic volume in terms of vehicles/hr
 - Number of vehicles occupying a unit length of roadway at a given instant expressed as vehicles/km
 - Capacity of lane to accommodate the vehicles widthwise (across the road)
 - Maximum attainable speed of vehicles
96. For a bituminous carriageway surface having 2% camber and design speed of 100 kmph, Radius beyond which super-elevation is not essential is nearly :
- 1100 m
 - 1500 m
 - 1800 m
 - 2200 m
97. Fish plates are used in rail joints to :
- Maintain the continuity of rails
 - Provide for any expansion or contraction
 - Transfer the load to the ballast
 - Maintain correct alignment
- 1, 2, 3 and 4
 - 1, 2 and 3 only
 - 2, 3 and 4 only
 - 1, 2 and 4 only

98. For a railway track in hilly terrain, the type of gradient provided is :
- Pulling gradient
 - Momentum gradient
 - Helper gradient
 - Minimum gradient
99. A road passes through a cut with impervious strata at a depth of 1.25 m from the sub-grade level. To intercept seepage flow, a longitudinal pipe drain in trench filled with filter material and clay seal is constructed. What will be the required depth of the trench ?
- 2.5 m
 - 1.5 m
 - 1.25 m
 - 0.5 m
100. What is the value of the resultant retardation in m/s^2 when a longitudinal friction coefficient of 0.4 is allowed for stopping the vehicle on road ?
- 0.98
 - 1.95
 - 2.93
 - 3.93
101. The rate of super-elevation for a horizontal curve of radius 500 m in a national highway for a design speed of 100 kmph is :
- 0.04
 - 0.063
 - 0.07
 - 0.70

102. The corrected modulus of sub-grade reaction for standard diameter plate is 6.0 kg/cm^3 . What would be the modulus of sub-grade reaction of the soil when tested with a 30 cm diameter plate ?
- 15 kg/cm^3
 - 25 kg/cm^3
 - 30 kg/cm^3
 - 60 kg/cm^3

Directions :—

Each of the next **EIGHTEEN (18)** items consists of two statements, one labeled as the 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

- Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- Both Statement (I) and Statement (II) are individually true but Statement (II) is **NOT** the correct explanation of Statement (I)
- Statement (I) is true but Statement (II) is false
- Statement (I) is false but Statement (II) is true

103. Statement (I) : As temperature increases, viscosity of air decreases.
- Statement (II) : As temperature increases, activity of the air molecules increases.

104. Statement (I) : Fluid pressure is a scalar quantity.
Statement (II) : Fluid thrust always acts downwards.
105. Statement (I) : The integration of differential form of Euler's equation of motion yields to Bernoulli's equation.
Statement (II) : Euler's equation is based on the assumption of conservation of mass.
106. Statement (I) : A tennis ball with a rough surface can be made to curve more markedly than the one with a smooth surface.
Statement (II) : Circulation is increased in the case of a rough ball.
107. Statement (I) : A rectangular bridge pier experiences lateral force during flood flow.
Statement (II) : The bridge pier sheds vortices alternately from its either side into the wake flow.
108. Statement (I) : Gravity is a determinant in estimating pipe flow magnitudes.
Statement (II) : The term 'g' appears explicitly in Darcy-Weisbach formula for pipe flow resistance.
109. Statement (I) : An economical channel section gives maximum discharge for a given cross-sectional area.
Statement (II) : An economical channel section has smooth surface with reduced friction.
110. Statement (I) : In the case of an open channel flow, for a hydraulically efficient section, the hydraulic radius is equal to 50% of depth of flow in the channel.
Statement (II) : Wetted perimeter is minimum for a hydraulically efficient section of an open channel.
111. Statement (I) : Condensation of water vapour into droplets precedes the precipitation process.
Statement (II) : Formation of precipitation droplets is predicted on the presence of condensation nuclei.

112. Statement (I) : Rapid sand filters consisting of carefully sieved sand on top of a bed of gravel will only filter particles larger than its pore size.
- Statement (II) : In addition to straining, adsorption, continued flocculation and sedimentation in the pore spaces help in particle removal mechanism.
113. Statement (I) : Suspended as well as colloidal particulates are removed from water by addition of 25% alum dosage.
- Statement (II) : The optimum dosage of alum is determined by performing the 'Jar test'.
114. Statement (I) : In a rectangular baffled channel, it is easy to alter the G value.
- Statement (II) : In a rectangular baffled channel, the baffles are rigidly built and so cannot undergo any change.
115. Statement (I) : Plastic media of 25 to 100 mm size are employed in super-rate trickling filters for treatment of wastewater having a very high BOD.
- Statement (II) : Plastic media have high specific surface area, high void space and low weight. Hydraulic loading rate and organic loading rate are 30 to 90 m³/d/m² and 1000 to 2000 g/d/m³ respectively, which are much higher than in stone media trickling filter.
116. Statement (I) : The cross-section of a grit channel is designed for a uniform velocity at all flow rates.
- Statement (II) : A U-type of cross-section maintains a uniform velocity at all flow rates.
117. Statement (I) : Water with heavy algal growths often has pH values as high as 9 to 10.
- Statement (II) : Non-utilization of the bicarbonate ion as a carbon source by algae can result in substantial accumulation of OH ions.

118. Statement (I) : For aerobic composting of refuse, it is mandatory to maintain the C/N ratio between 50 and 60.

Statement (II) : C/N ratio is one of the important factors in composting. It is an important constituent as loss of nitrogen is to be prevented and maximum proportion of the nitrogen in compost is to be preserved.

119. Statement (I) : 'Environment' includes abiotic and biotic parameters.

Statement (II) : Abiotic parameters include algae, bacteria, animals; and biotic parameters are air, water and soil.

120. Statement (I) : The actual payload, particularly in passenger aircraft, is normally less than the maximum structural payload even when the aircraft is completely full.

Statement (II) : There are limitations in the use of space when passengers are carried in an aircraft.

SPACE FOR ROUGH WORK

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