



భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Advt. No. IITH/2023/NF/15

Question Paper Code:

Application Number of the Candidate

Name of the Post: Junior Technician – Civil Engineering (Geotechnical Engineering)
Pay Level: 03

Date & Time of the Exam: 11.12.2023

Duration: 02 hr. 00 min

Scheme of the Exam:

Topic	Number of Questions	Marks
Engineering Mathematics (Common for JT in Geotechnical and Structural Engineering and will be used as a tie breaker for the selection)	10	10
Geotechnical Engineering	50	50
Transportation Engineering	10	10
Structural Engineering	10	10
Hydraulic and Water Resources Engineering	10	10
Environmental Engineering	10	10
Total	100	100

Instructions to fill the responses in the OMR answer sheet:

1. Candidate must write his/her **application number** in the designated box on the top of OMR answer sheet.
2. Candidates must write the post code and Question paper code in the designated boxes on the top of OMR answer sheet.
3. Candidates must sign in the box provided in the OMR answer sheet.
4. Each answer sheet must be signed by the invigilator in the space printed in the OMR answer sheet.
5. Only one response to be selected & marked. In case more than one response is marked for a single question or no response is marked for a question, no marks will be awarded for that question.
6. Partially filled circles shall not be considered as responses.
7. Erasing or changing of answer is not allowed.
8. No negative marking
9. Candidate must use Blue/Black ball point pen to fill his/her responses.
10. Rough work should not be done on the OMR answer sheet.
11. Candidates can use the designated page(s) of the question booklet for the purpose of rough work.

Engineering Mathematics

1. Find the determinant of the matrix:
$$\begin{bmatrix} 3 & 1 & 2 \\ 2 & 4 & 5 \\ 1 & 6 & 4 \end{bmatrix}$$

- a. 42
- b. 36
- c. 28
- d. 14

2. Evaluate the limit:
$$\lim_{x \rightarrow 0} \frac{\sin(3x)}{x}$$

- a. 1
- b. 2
- c. 3
- d. Does not exist

3. Let 'x' be a continuous variable defined over the interval $(-\infty, \infty)$, and $f(x) = e^{-x-e^{-x}}$.

The integral $g(x) = \int f(x) dx$ is equal to

- a. e^{-x}
- b. $e^{-e^{-x}}$
- c. e^{-e^x}
- d. e^{-x}

4. Given the matrices $J = \begin{pmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 6 \end{pmatrix}$ and $K = \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}$, the product $K^T JK$ is

- a. 20
- b. 24
- c. 22
- d. 23

5. The sum of Eigen values of the matrix, [M] is...? where $[M] = \begin{pmatrix} 215 & 650 & 795 \\ 655 & 150 & 835 \\ 485 & 355 & 550 \end{pmatrix}$

- a. 915
- b. 1355
- c. 1640
- d. 2180

6. If $y = 5x^2 + 3$, then the tangent at $x = 0, y = 3$
- passes through $x = 0, y = 0$
 - has a slope of +1
 - is parallel to the x-axis
 - has a slope of -1
7. A two-faced fair coin has its faces designated as head (H) and tail (T). This coin is tossed three times in succession to record the following outcomes: H, H, H. If the coin is tossed one more time, the probability (up to one decimal place) of obtaining H again, given the previous realizations of H, H and H, would be:
- 1 to 0.5
 - 1 to 1
 - 0.5 to 0.5
 - 0.5 to 1
8. Solve the first-order linear ODE: $\frac{dy}{dx} + 2y = 4$
- $y = Ce^{2x} + 2$
 - $y = Ce^{2x} - 2$
 - $y = Ce^{-2x} + 2$
 - $y = -Ce^{-2x} + 2$
9. Apply the Newton-Raphson method to find the root of $g(x) = e^x - 4x$ with initial guess of $x_0 = 1.0$. The next iteration will yield:
- 1.0
 - 1.5
 - 2.0
 - 2.5
10. The number of parameters in the univariate exponential and gaussian distributions, respectively are:
- 2 and 2
 - 1 and 2
 - 2 and 1
 - 1 and 1

Geotechnical Engineering

11. In a compaction test, with an increase in compactive effort:
 - a. The compaction curve is shifted to the left and higher
 - b. Maximum dry density increases but OMC decreases
 - c. Both maximum dry density and OMC increases
 - d. Both (a) and (b) are correct

12. The number of blows required for compacting each layer of soil in a compaction test is:
 - a. 16
 - b. 25
 - c. 36
 - d. 45

13. Clay particles on the wet side of optimum moisture content exhibit
 - a. Single-grained structure
 - b. Dispersed structure
 - c. Honeycomb structure
 - d. Flocculent structure

14. Relative compaction is
 - a. Similar to relative density
 - b. A compaction process
 - c. Dry density obtained in the field
 - d. A ratio of γ_d of field to the $\gamma_{d \max}$ of lab

15. Which of the following is true?
 - a. seepage velocity is always smaller than the discharge velocity
 - b. seepage velocity can never be smaller than discharge velocity
 - c. seepage velocity equals to the discharge velocity
 - d. none of the above

16. What is the Net Ultimate Bearing Capacity of a foundation?
 - a. Ultimate Bearing Capacity/Factor of Safety
 - b. (Ultimate Bearing Capacity/Factor of Safety) – Overburden Pressure
 - c. Ultimate Bearing Capacity – Overburden Pressure
 - d. Ultimate Bearing Capacity – Factor of Safety

17. The effect of cohesion on a soil is to:
 - a. Reduce both active and passive earth pressure intensities.
 - b. Increase both active and passive earth pressure intensities.
 - c. Increase active earth pressure intensity but to decrease passive earth pressure intensity
 - d. None of the above

18. The major principal stress in an element of cohesionless soil within the backfill of a retaining wall is:
 - a. horizontal if the soil is in an active state of plastic equilibrium
 - b. horizontal if the soil is in a passive state of plastic equilibrium
 - c. Inclined at 45° to the vertical plane
 - d. None of the above

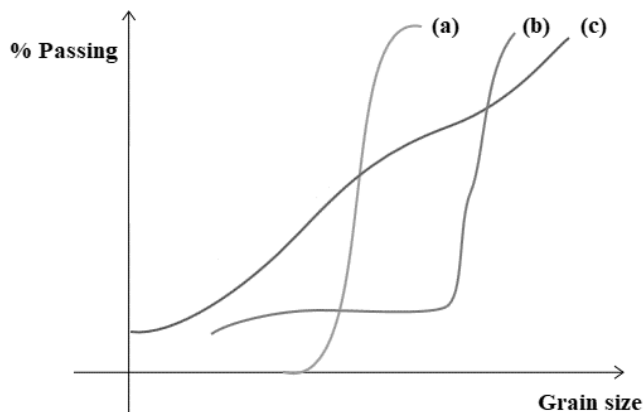
19. If the load-carrying capacity of a pile in sand is denoted as Q and that of a group of N identical piles as by Q_g , then the ratio of Q_g/Q will:
- be equal to 1 irrespective of width of the group
 - be equal to N irrespective of width of the group
 - decrease as the width of the group increases
 - increase as the width of the group increases
20. The ultimate load-carrying capacity of a pile socketed in a bedrock depends on:
- Skin friction resistance
 - End bearing resistance in rock
 - Length of the pile embedment
- Choose the correct answer:
- (i) and (ii)
 - (ii) and (iii)
 - (i) and (iii)
 - (iii)
21. A soil has a dry unit weight of 17 kN/m^3 and a water content of 20%. What will be its bulk unit weight?
- 19.3 kN/m^3
 - 20.4 kN/m^3
 - 22.6 kN/m^3
 - 24.4 kN/m^3
22. _____ index is used to find settlement of soils.
- Expansion
 - Compression
 - Recompression
 - Reloading
23. What will be the porosity of a soil sample with a void ratio of 0.35?
- 19.5%
 - 25.9%
 - 30.65%
 - 40.6%
24. Sedimentation technique in grain size analysis is more suited for characterising:
- Soil particles smaller than 0.075 mm
 - Any soil particles larger than 0.075 mm
 - Soil particles between 0.075 mm – 0.425 mm
 - Any soil particles larger than 0.425 mm
25. As per Indian Standard Soil Classification system, the grain size of Fine Sand particles ranges in:
- 0.002 mm - 0.075 mm
 - 0.075 mm - 0.425 mm
 - 0.425 mm - 02.00 mm
 - 02.00 mm - 04.75 mm

26. With water content unchanged, _____ is the measure of loss of strength with remoulding.
- Compressibility
 - Sensitivity
 - Stability
 - Thixotropy

27. Well-graded soils are composed of:
- soil particles from a wide range of sizes and shapes
 - soil particles in the same range of sizes and shapes
 - excess or deficiency of specific particle sizes and shapes
 - none of the above

28. Please select the correct statement:
- Gap-graded soils are preferred for construction in comparison with Well-graded soils
 - Well-graded soils have more voids in comparison with Uniformly-graded soils
 - Uniformly-graded soils are preferred for construction in comparison with Well-graded soils
 - Well-graded soils are preferred for construction in comparison with Uniformly-graded soils

29. In the following Grain Size Distribution curve,



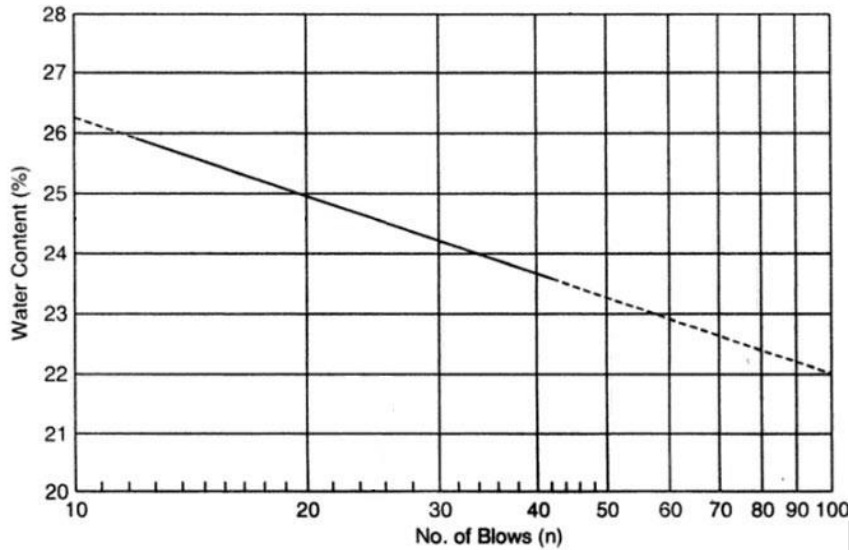
- Curve (a), (b), and (c) represent:

- Well-graded, Gap-graded, and Uniformly-graded soils, respectively
 - Well-graded, Uniformly-graded, and Gap-graded soils, respectively
 - Uniformly-graded, Gap-graded, and Well-graded soils, respectively
 - Uniformly-graded, Well-graded, and Gap-graded soils, respectively
30. In particle size distribution, D_{60} means that:
- 60% of soil particles are larger than this size
 - 60% of soil particles are finer than this size
 - 60% of the soil is well-graded
 - 60% of the soil is uniformly-graded

31. Coefficient of uniformity (C_u) is calculated as:
- D_{60} / D_{10}
 - D_{10} / D_{60}
 - D_{30} / D_{60}
 - D_{60} / D_{30}

32. For a single-sized soil, the Coefficient of uniformity (C_u) and Coefficient of Curvature (C_c) are:
- Both equal to 0.5
 - Both equal to 1
 - $C_u = 0.5 * C_c$
 - $C_c = 0.5 * C_u$
33. The water content of soil is calculated as:
- Weight of water / Bulk weight of soil
 - Bulk weight of soil / Weight of water
 - Weight of water / Dry weight of soil
 - Dry weight of soil / Weight of water
34. Liquid limit testing of soil is performed on soil passing the sieve size:
- 0.002 mm
 - 0.075 mm
 - 0.425 mm
 - 0.600 mm
35. Maximum thickness of soil sample in the Casagrande's apparatus for testing Liquid limit is:
- 1 mm
 - 5 mm
 - 10 mm
 - 15 mm
36. ASTM grooving tool is used in Liquid limit tests for:
- Fine-grained soils
 - Coarse-grained soils
 - Weathered rock fragments
 - All types of soils
37. In the Liquid limit test, blows are given at the rate of 2 blows/sec until the two halves of the soil cake join by _____ in the groove by the flowing of the soil:
- 4 mm
 - 8 mm
 - 12 mm
 - 16 mm
38. Soil threads start crumbling when rolled into a diameter of _____ at the Plastic Limit of the soil.
- 3 mm
 - 5 mm
 - 7 mm
 - 10 mm
39. Plasticity index of a soil is calculated as the difference of:
- Shrinkage limit – Plastic limit
 - Plastic limit – Shrinkage limit
 - Liquid limit – Plastic limit
 - Plastic limit – Liquid limit

40. The following Flow Curve was obtained during the Liquid limit testing of a soil sample.



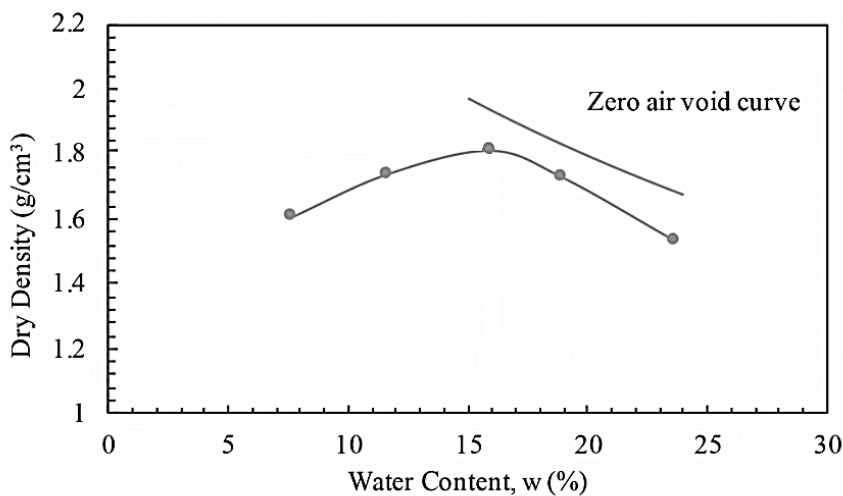
The Liquid limit of the soil is:

- a. 24.5%
- b. 25.0 %
- c. 26.0 %
- d. 26.2 %

41. Heavy-weight compaction test is also known as:

- a. Standard Proctor compaction test
- b. Simplified Proctor compaction test
- c. Modified Proctor compaction test
- d. Extended Proctor compaction test

42. After the Standard Proctor Test, the following Compaction Curve was obtained for a given soil.

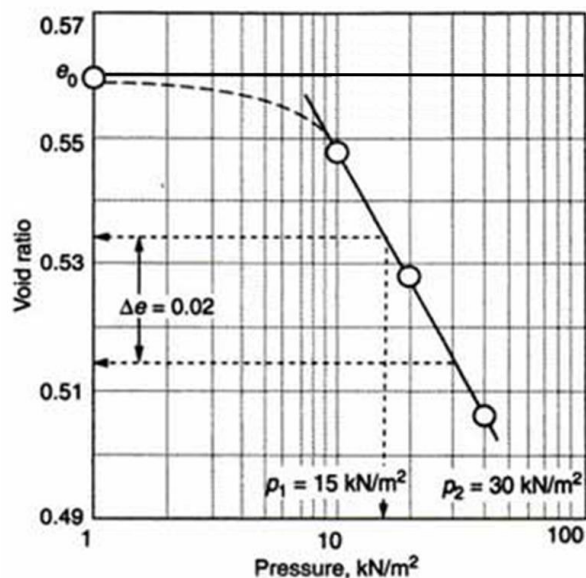


The Optimum Moisture Content (OMC) of the soil is:

- a. 12 %
- b. 16 %
- c. 19 %
- d. 24 %

43. Compaction of soil in the Standard Proctor test mould is performed in:
- 3 layers of soil using a 2.6 kg rammer from a drop height of 310 mm
 - 5 layers of soil using a 2.6 kg rammer from a drop height of 310 mm
 - 5 layers of soil using a 4.9 kg rammer from a drop height of 310 mm
 - 5 layers of soil using a 4.9 kg rammer from a drop height of 450 mm
44. A compaction mould of size 2250 cm³ is used instead of the mould with a volume of 1000 cm³, when the percentage (%) of soil retained on the 4.75 mm sieve is:
- Less than 10%
 - In between 10-20%
 - Greater than 20%
 - Irrespective of the % of soil retained on the 4.75 mm sieve
45. Constant Head Permeability test is suitable for finding the permeability of:
- Cohesive soils
 - Cohesionless soils
 - Organic soils
 - Expansive soils
46. Before beginning the Permeability tests, the soil specimen in the permeameter should be:
- Unsaturated
 - Partially saturated
 - Fully saturated
 - Filled with air
47. The unit of coefficient of permeability is _____
- cm
 - s
 - cm/s
 - cm/s²
48. In general, the permeability of Silty soils is:
- More than Clays, but less than Sands
 - More than both Sands and Clays
 - Less than both Gravels and Sands
 - both (a) and (c) are correct
49. Consolidation tests can be performed on:
- Undisturbed soil specimens
 - Remoulded soil specimens
 - Fissured rock samples
 - Both (a) and (b)
50. Primary consolidation is assumed to be achieved in a soil sample under a given load intensity:
- 1 hour after application of the load
 - 4 hours after application of the load
 - 12 hours after application of the load
 - 24 hours after application of the load

51. Coefficient of consolidation (C_v) can be calculated using:
- Logarithm of time fitting method
 - Root mean square of time fitting method
 - Square root of time fitting method
 - Both (a) and (c)
52. Time corresponding to 90% consolidation is used for calculating the coefficient of consolidation in:
- Logarithm of time fitting method
 - Root mean square of time fitting method
 - Square root of time fitting method
 - Both (a) and (b)
53. Time corresponding to 50% consolidation is used for calculating the coefficient of consolidation in:
- Logarithm of time fitting method
 - Root mean square of time fitting method
 - Square root of time fitting method
 - Both (b) and (c)
54. The following e -log p curve was obtained after carrying out a Consolidation test on a soil sample. The Compression index (C_c) of the soil is estimated to be:

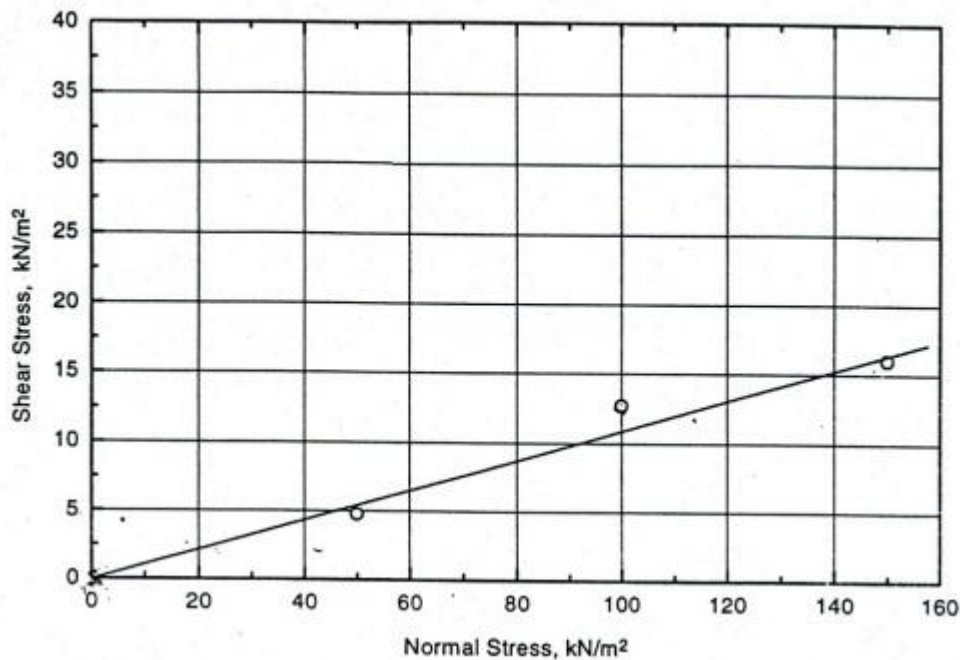


- 0.017
 - 0.066
 - 15.051
 - 58.804
55. In the Direct Shear test, the soil specimen fails through:
- the weakest failure plane within the specimen
 - a predetermined failure plane
 - a plane identified only after the test is complete
 - a random plane of failure

56. As the Normal Stress on the soil specimen is increased in the Direct Shear test, the Shear Stress at failure:
- Decreases
 - Increases
 - Remains constant
 - May either decrease or increase

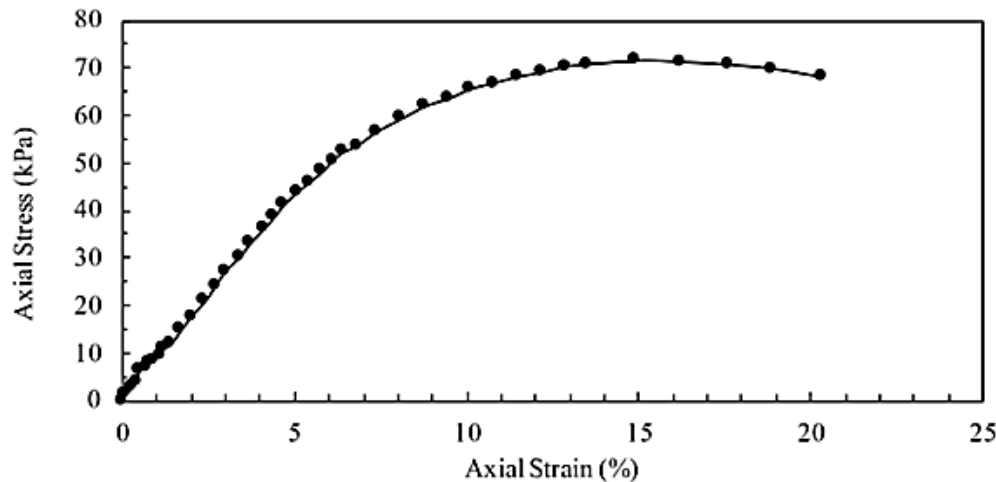
57. The plot between Normal Stress and Shear Stress in the Direct Shear test gives the value of:
- Compressibility
 - Cohesion
 - Angle of internal friction
 - Both (b) and (c)

58. From the graph below obtained after carrying out Direct Shear Test on a soil sample, the Cohesion of the soil is estimated to be:



- 0 kN/m²
 - 5 kN/m²
 - 13 kN/m²
 - 16 kN/m²
59. In the Direct Shear test, Area Correction (A_{corr}) is applied for calculating the shear stress at failure, because the cross-sectional area of the specimen in shear:
- Decreases with horizontal displacement of half-box
 - Increases with horizontal displacement of half-box
 - Remains constant with horizontal displacement of half-box
 - Any of the above statements can be true

60. The plot below shows the variation of Axial stress Vs. Axial strain recorded during a UCS test.



The undrained cohesion of the soil is estimated to be:

- a. 0 kPa
- b. 35 kPa
- c. 70 kPa
- d. 140 kPa

Transportation Engineering

61. The maximum thickness of expansion joint in rigid pavements is

- a. 0
- b. 25 mm
- c. 50 mm
- d. 100 mm

62. The overtaking time required for a vehicle with design speed 50 kmph and overtaking acceleration 1.25 m/sec^2 to overtake a vehicle moving at a speed 30 kmph, is

- a. 5.41 seconds
- b. 6.12 seconds
- c. 25.48 seconds
- d. 30.32 seconds

63. According to Indian Road Congress, the width of the carriageway is

- a. 3.75 m for single lane
- b. 7.0 m for two lanes without raised kerbs
- c. 7.5 m for two lanes with raised kerbs
- d. All the above are correct

64. The vertical alignment of a highway includes:

- a. Highway lighting
- b. Design of valley curves and gradients
- c. Sight distance and traffic intersection
- d. Widening of pavements

65. Which of the following is the maximum density desirable in highway embankments?
- Maximum moisture density
 - Maximum dry density
 - Submerged density
 - Saturated density
66. The design of horizontal and vertical alignments, superelevation, and gradient is worst affected by _____
- Speed of vehicle
 - Length of vehicle
 - Width of vehicle
 - Height of vehicle
67. In general, the drainage layer in a pavement is _____
- Surface course
 - Wearing course
 - Sub-base
 - Subgrade
68. What is the minimum load safety factor used for rigid pavements?
- 1
 - 1.1
 - 1.5
 - 1.7
69. Which one below is not a critical load position in a rigid pavement design?
- Interior
 - Corner
 - Edge
 - Center
70. The coefficient of lateral friction as recommended by IRC is _____
- 0.15
 - 0.30
 - 0.35
 - 0.40

Structural Engineering

71. In static equilibrium, the sum of the forces acting on an object is equal to:
- Zero
 - The mass of the object
 - The acceleration of the object
 - The velocity of the object
72. The point where the entire weight of an object can be considered to act is called the:
- Center of gravity
 - Center of mass
 - Centroid
 - Equilibrium point

73. What is the condition for an object to be in translational equilibrium?
- The sum of the forces is zero, and the sum of the torques is zero.
 - The sum of the forces is zero.
 - The sum of the torques is zero.
 - The sum of the forces and the sum of the torques are nonzero.
74. Which of the following is a scalar quantity?
- Force
 - Velocity
 - Acceleration
 - Mass
75. Which method is commonly used to analyze determinate structures?
- Matrix method
 - Moment distribution method
 - Slope-deflection method
 - Force method
76. What is the primary difference between determinate and indeterminate structures?
- Determinate structures have fixed supports, while indeterminate structures have hinged supports.
 - Determinate structures can be analyzed using static equilibrium equations alone, while indeterminate structures require additional equations.
 - Determinate structures are statically unstable, while indeterminate structures are stable.
 - Determinate structures are always statically determinate, while indeterminate structures are always statically indeterminate.
77. The bending moment at a section of a beam is maximum where the shear force:
- Changes sign
 - Reaches its maximum value
 - Is zero
 - Is minimum
78. Which type of support allows rotation but not translation?
- Roller support
 - Fixed support
 - Hinged support
 - Sliding support
79. Which method is commonly used for analyzing continuous beams and frames?
- Slope-deflection method
 - Moment distribution method
 - Finite element method
 - Force method

80. What is the primary purpose of structural analysis in civil engineering?
- Estimating construction costs
 - Designing aesthetically pleasing structures
 - Predicting the behavior of structures under loads
 - Controlling construction schedules

Hydraulic and Water Resources Engineering

81. Which of the following is not a component of the hydrological cycle?
- Evaporation
 - Precipitation
 - Desalination
 - Transpiration
82. The unit of measurement for precipitation is:
- Inches
 - Degrees Celsius
 - Cubic meters per second
 - Watts per square meter
83. What is the purpose of a hydrograph in hydrology?
- To measure river depth
 - To analyze groundwater quality
 - To depict the variation of streamflow over time
 - To estimate evaporation rates
84. The term "infiltration" in hydrology refers to:
- The movement of water across the land surface
 - The downward movement of water into the soil
 - The evaporation of water from vegetation
 - The transport of sediment by flowing water
85. What is the purpose of a hydraulic jump in an open channel?
- To increase flow velocity
 - To decrease flow velocity
 - To measure flow rate
 - To control sediment transport
86. Which of the following is a characteristic of laminar flow in pipes?
- Chaotic and irregular flow patterns
 - Smooth and orderly flow layers
 - High turbulence and eddies
 - Rapid changes in velocity

87. The Manning's roughness coefficient is used to represent:
- Pipe diameter
 - Channel slope
 - Channel roughness
 - Flow velocity
88. The concept of "critical depth" is related to:
- Pipe flow
 - Open channel flow
 - Water hammer
 - Hydraulic jump
89. Which of the following is a fundamental equation used in open channel hydraulics?
- Bernoulli's equation
 - Darcy's law
 - Manning's equation
 - Poisson's equation
90. The concept of the "time of concentration" in hydrology refers to:
- The time it takes for a reservoir to fill up
 - The time it takes for precipitation to reach the river channel
 - The duration of a rainfall event
 - The time it takes for a river to reach its maximum flow after a storm

Environmental Engineering

91. SO₂ and CO adversely affect
- oxygen carrying capacity of blood and functioning respectively
 - functioning of the respiratory system and brain respectively
 - functioning of the respiratory system and oxygen carrying capacity of blood respectively
 - functioning of air passages and chest respectively
92. Total Kjeldahl Nitrogen (TKN) concentration (mg/L as N) is the sum of the concentrations of:
- organic and inorganic nitrogen
 - organic nitrogen and nitrate
 - organic nitrogen and ammonia
 - ammonia and nitrate
93. Which of the following units you won't need to treat hard ground water?
- Aeration
 - Coagulation
 - Filtration
 - Softening

94. The 5-day BOD of a wastewater sample is obtained as 190 mg/l (with $k = 0.01 \text{ h}^{-1}$). The ultimate oxygen demand (mg/l) of the sample will be
- 3800
 - 475
 - 271
 - 190
95. A sample of mixed solid waste was analyzed in laboratory, and it was observed to contain 21% moisture and 5% ash, with a total energy content of 14740 KJ/kg. What is the energy content on an ash-free dry basis.
- 19919 KJ/kg
 - 18658 KJ/kg
 - 17215 KJ/kg
 - None of the above
96. Theoretically, the range of friction factor (f) possible for laminar flow condition in closed pipes is:
- 0.032 to ∞
 - 0 to 1
 - 0 to 0.064
 - 0.064 to 1
97. Identify the correct statement with regard to flow through a siphon
- Hydraulic gradient line increases upto the ridge (top) point and then decreases
 - Total energy line increases upto the ridge (top) point and then decreases
 - The portion between inlet and ridge (top) point acts like a suction pipe
 - Bernoulli and momentum equations are required to solve for heads and flows
98. Which of the following gradually varied flow (GVF) profiles does NOT exist:
- H_2, C_1, A_2
 - H_1, C_2, A_1
 - H_3, C_1, A_3
 - H_1, C_3, A_1
99. In comparison to 4-hr unit hydrograph, an 8-hr unit hydrograph has:
- Increased peak and decreased base time
 - Decreased peak and increased base time
 - Decreased peak and base time
 - Increased peak and base time
100. The microbial quality of treated piped water supplies is monitored by
- Microscopic examination
 - Plate count of heterotrophic bacteria
 - Coliform MPN test
 - Identification of all pathogens

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