PRACTICE EXAM 15 : FE CIVIL SIMULATION (110 QUESTIONS)

110 questions. Recommended time: 5 hours 20 minutes..

1. A 100 N force acts at 30° above the horizontal. What are its horizontal and vertical components?

A. Fx = 50 N, Fy = 86.6 N

B. Fx = 100 N, Fy = 0 N

C. Fx = 86.6 N, Fy = 50 N

D. Fx = 70.7 N, Fy = 70.7 N

2. A 3 m wide rectangular channel carries water 1.2 m deep at 1.5 m/s. What is the discharge?

A. 4.5 m^3/s

B. 5.4 m^3/s

C. 3.6 m^3/s

D. 1.5 m^3/s

3. A project's cost performance index (CPI) is 0.80. This indicates the project is:

A. Under budget by 20%

B. Exactly on budget

C. Ahead of schedule

D. Over budget, earning $0.80 of value per $1 spent

4. A simply supported beam of span 10 m carries a uniform load of 6 kN/m. What is each support reaction?

A. 60 kN

B. 15 kN

C. 30 kN

D. 6 kN

5. A field soil reaches 92% of the standard Proctor maximum dry density, but the specification requires 95%. The field result:

A. Exceeds the requirement

B. Exactly meets the requirement

C. Cannot be evaluated

D. Fails the requirement and needs more compaction

6. A 120 m line runs due south (azimuth 180°). What are its latitude and departure?

A. −120 m latitude, 0 m departure

B. +120 m latitude, 0 m departure

C. 0 m latitude, +120 m departure

D. −60 m latitude, −60 m departure

7. A steel tension member has a net area of 1,200 mm² and an ultimate strength of 400 MPa. Using Fu·An, what is its nominal rupture capacity?

A. 120 kN

B. 240 kN

C. 480 kN

D. 960 kN

8. A simply supported beam of span 4 m carries a central point load of 24 kN. Using PL/4, what is the maximum bending moment?

A. 12 kN·m

B. 24 kN·m

C. 48 kN·m

D. 96 kN·m

9. What is the dot product of the vectors (2, 3) and (4, 1)?

A. 14

B. 5

C. 24

D. 11

10. The head-loss term in the pipe-flow energy equation primarily represents:

A. Energy gained from the pump

B. The elevation difference only

C. The velocity increase

D. Energy dissipated by friction and fittings

11. A roadway segment has a capacity of 2,000 veh/hr and carries 1,400 veh/hr. What is its reserve capacity?

A. 1,400 veh/hr

B. 600 veh/hr

C. 0.70 veh/hr

D. 3,400 veh/hr

12. A submerged object floats in equilibrium, neither rising nor sinking. Its average density equals the:

A. Density of the surrounding fluid

B. Twice the fluid density

C. Half the fluid density

D. Zero

13. Two angles of a triangle in a triangulation network are 65° and 75°. What is the third angle?

A. 140°

B. 40°

C. 65°

D. 50°

14. A town of 5,000 people uses 300 L per person per day. What is the daily water demand?

A. 150 m^3/day

B. 1,500 m^3/day

C. 15,000 m^3/day

D. 500 m^3/day

15. What is $(2 + 3i) + (4 - i)$, where i is the imaginary unit?

A. $6 + 2i$

B. $6 - 2i$

C. $5 + 2i$

D. 2 + 4i

16. The shear force at any section of a beam equals the:

A. Total load on the beam

B. Bending moment at that section

C. Reaction at the nearer support always

D. Slope (derivative) of the bending moment diagram

17. An engineer's design will be used by the public. The engineer's foremost responsibility is to ensure the design is:

A. Safe for public health and welfare

B. The cheapest possible

C. Aesthetically pleasing above all

D. Completed before the deadline regardless of safety

18. The principal cause of corrosion of reinforcing steel in concrete is:

A. Excessive compressive load

B. High cement content

C. Rapid curing

D. Penetration of chlorides and moisture to the steel

19. A 2 m bar of area 250 mm^2 and modulus 200 GPa carries 50 kN. Using $\delta = PL/AE$, what is its elongation?

A. 2 mm

B. 1 mm

C. 4 mm

D. 0.5 mm

20. A fully saturated soil has a void ratio of 0.5 and Gs = 2.7. Using w = Se/Gs, what is its water content?

A. 18.5%

B. 5.4%

C. 50%

D. 27%

21. A high-strength bolt is tightened to develop a clamping force that resists slip through:

A. Welding the plates together

B. Adhesive bonding

C. Magnetic attraction

D. Friction between the connected surfaces

22. An engineer accepts a commission from a supplier for specifying that supplier's product without disclosing it. This is:

A. Standard and acceptable practice

B. An undisclosed conflict of interest and unethical

C. Required by the supplier's contract

D. A form of professional development

23. What is the solution set of the inequality $2x - 4 > 0$?

A. $x > 2$

B. $x < 2$

C. $x > 4$

D. $x < -2$

24. A 400 N weight hangs from two cables, each at 45° from the horizontal ceiling. What is the tension in each cable?

A. 283 N

B. 400 N

C. 200 N

D. 566 N

25. Lateral ties around the longitudinal bars of a reinforced concrete column primarily:

A. Increase the column's height

B. Carry the floor's shear

C. Prevent the longitudinal bars from buckling outward

D. Replace the concrete cover

26. The aggregate in concrete typically occupies what fraction of the total volume?

A. About 5%

B. About 20%

C. About 60–75%

D. About 95%

27. A truss has 13 members, 8 joints, and 3 reactions. Applying $m + r = 2j$, the truss is:

A. Unstable

B. Indeterminate to the first degree

C. Indeterminate to the second degree

D. Statically determinate

28. Beam deflection under a given load is reduced most effectively by increasing the:

A. Moment of inertia of the cross-section

B. Length of the span

C. Magnitude of the load

D. Width of the supports

29. The correction that reduces a measured distance to its equivalent at the reference ellipsoid is the:

A. Temperature correction

B. Sea-level (elevation) reduction

C. Tension correction

D. Sag correction

30. Type I portland cement is best described as:

A. A rapid-hardening, high-early-strength cement

B. A sulfate-resisting cement

C. A general-purpose (ordinary) cement

D. A low-heat cement for mass concrete

31. The friction factor read from the Moody diagram depends on the Reynolds number and the:

A. Fluid temperature only

B. Pipe length

C. Flow direction

D. Relative roughness of the pipe wall

32. A 200 m^3 tank is filled at 0.05 m^3/s. How long does it take to fill?

A. 10 minutes

B. 40 minutes

C. 66.7 minutes

D. 4,000 minutes

33. A 5 kg object is acted on by a net force of 15 N. What is its acceleration?

A. 75 m/s^2

B. 3 m/s^2

C. 0.33 m/s^2

D. 10 m/s^2

34. A material's Poisson's ratio relates axial strain to:

A. Lateral (transverse) strain

B. Shear stress

C. Temperature change

D. Density

35. A car traveling at 30 m/s rounds a curve of radius 90 m. What is its centripetal acceleration?

A. 3 m/s^2

B. 10 m/s^2

C. 0.33 m/s^2

D. 30 m/s^2

36. A clay's liquidity index exceeds 1.0. This indicates the natural water content is:

A. Below the plastic limit

B. Equal to the plastic limit

C. Above the liquid limit, making it very soft

D. Equal to zero

37. The external distance E of a horizontal curve increases as the:

A. Radius increases

B. Deflection angle decreases

C. Deflection angle increases (sharper curve)

D. Tangent length decreases

38. A 1,000 kg car at 15 m/s strikes a stationary 1,500 kg car and they stick together. What is the common velocity?

A. 15 m/s

B. 6 m/s

C. 9 m/s

D. 3 m/s

39. What is the median of the data set 3, 7, 8, 12, 15, 20?

A. 8

B. 10

C. 12

D. 11

40. $4,000 is invested for 3 years at 10% compounded annually. What is the future value?

A. $4,400

B. $5,200

C. $4,000

D. $5,324

41. What is the derivative of sin(x)?

A. −cos(x)

B. −sin(x)

C. tan(x)

D. cos(x)

42. A movement gets 36 s of effective green in a 90 s cycle with a saturation flow of 1,800 veh/hr. What is its capacity?

A. 1,800 veh/hr

B. 450 veh/hr

C. 720 veh/hr

D. 2,250 veh/hr

43. A circular shaft has maximum shear stress $\tau = 16T/(\pi d^3)$. If the diameter is doubled, the stress becomes:

A. Doubled

B. Halved

C. One-eighth of the original

D. Quadrupled

44. The maximum pressure under a retaining wall base must not exceed the:

A. Allowable soil bearing capacity

B. Active earth pressure

C. Passive earth pressure

D. Weight of the backfill

45. A 4 km^2 catchment produces a peak runoff of 8 m^3/s. What is the peak runoff per unit area?

A. 32 m^3/s per km^2

B. 2 m^3/s per km^2

C. 0.5 m^3/s per km^2

D. 12 m^3/s per km^2

46. For a simply supported beam under uniform load, the bending moment is zero at:

A. The midspan

B. The quarter points

C. The point of maximum shear

D. Both supports (the ends)

47. A soil classified as GW in the USCS is a:

A. High-plasticity clay

B. Poorly graded sand

C. Low-plasticity silt

D. Well-graded gravel

48. A bulldozer pushes 8 m^3 per cycle and completes 30 cycles per hour. What is its hourly production?

A. 38 m^3/hr

B. 240 m^3/hr

C. 3.75 m^3/hr

D. 480 m^3/hr

49. For $f(x) = 2x^2 - 3x + 1$, what is $f(0)$?

A. 0

B. 1

C. 2

D. −3

50. An error in the reference azimuth controlling a survey causes:

A. Only vertical errors

B. Errors in distance measurement only

C. No effect on the survey

D. A systematic rotation of the entire traverse

51. A footing is placed below the frost depth primarily to prevent:

A. Excessive bearing capacity

B. Settlement from consolidation

C. Sliding of the footing

D. Heave from freezing and thawing of the soil

52. A batch plant produces 12 m^3 every 15 minutes. What is its hourly production?

A. 3 m^3/hr

B. 48 m^3/hr

C. 180 m^3/hr

D. 12 m^3/hr

53. The jam density of a traffic stream is the density at which:

A. Flow is at its maximum

B. Vehicles are stopped bumper-to-bumper and speed is zero

C. Free-flow speed occurs

D. Density is zero

54. A project's net present value is positive at the minimum attractive rate of return. The project is:

A. Economically acceptable

B. Always rejected

C. Exactly at breakeven

D. Indeterminate without the payback period

55. Schedule float on a construction project belongs to:

A. Only the contractor in all cases

B. The project, shared per the contract terms

C. Only the owner always

D. The bonding company

56. Disinfection by-products in drinking water form when chlorine reacts with:

A. Dissolved oxygen

B. Calcium carbonate

C. Natural organic matter

D. Suspended sand

57. Prestressing steel is used in concrete to:

A. Eliminate the need for concrete

B. Increase the concrete's weight

C. Reduce the steel's strength requirement

D. Introduce compression that offsets tensile stresses

58. Entering an incorrect prism constant in a total station causes a:

A. Random angular error

B. Vertical refraction error

C. Tilt of the instrument

D. Systematic error in every measured distance

59. A piezometer tube attached to a pressurized pipe measures the:

A. Velocity head only

B. Pressure head at that point

C. Total energy head

D. Elevation head only

60. An asset's salvage value is the:

A. Original purchase price

B. Annual depreciation amount

C. Estimated value at the end of its useful life

D. Total interest paid

61. Compared with a simply supported beam of the same span and uniform load, a fixed-end beam's maximum midspan moment is:

A. Larger

B. Smaller

C. Identical

D. Zero

62. A machine generates $3,000 net annually for 6 years. At 8% with (P/A, 8%, 6) = 4.6229, what is the present worth of these benefits?

A. $18,000

B. $13,869

C. $4,623

D. $6,000

63. A beam's maximum deflection under a given load is inversely proportional to:

A. The span cubed

B. The applied load

C. The span length

D. The flexural rigidity EI

64. A vertical sag curve is designed primarily to provide adequate:

A. Drainage at the low point only

B. Superelevation

C. Passing opportunities

D. Headlight sight distance at night

65. The compass (Bowditch) rule balances a traverse by distributing closure error in proportion to each course's:

A. Length

B. Bearing only

C. Number of setups

D. Interior angle

66. Roadway capacity is reduced by all of the following EXCEPT:

A. Narrow lane widths

B. Heavy truck percentages

C. Frequent access points

D. A higher free-flow speed on a clear, wide road

67. A beam section's neutral axis passes through its:

A. Top fiber

B. Centroid

C. Bottom fiber

D. Support point

68. For a body in equilibrium under a system of forces, the vector sum of all forces must be:

A. Zero

B. Equal to the largest force

C. Equal to the sum of magnitudes

D. Maximum

69. Compared with a gradually applied load of the same magnitude, a sudden (impact) load produces a stress that is:

A. Smaller

B. The same

C. Larger

D. Zero

70. A distributed load varies linearly from 0 to 9 kN/m over a 6 m beam. What is the total resultant force?

A. 27 kN

B. 54 kN

C. 9 kN

D. 13.5 kN

71. A road carries 1,200 veh/hr per lane with 2 lanes per direction. What is the directional flow?

A. 2,400 veh/hr

B. 600 veh/hr

C. 1,200 veh/hr

D. 4,800 veh/hr

72. The moment of a force about a point is zero when the force's line of action:

A. Is perpendicular to the position vector

B. Passes through that point

C. Is horizontal

D. Equals the weight

73. A soil's coefficient of consolidation cv governs the:

A. Magnitude of settlement

B. Shear strength

C. Rate (time) of consolidation settlement

D. Bearing capacity

74. What is the limit of $(x^2 - 4)/(x - 2)$ as x approaches 2?

A. 4

B. 0

C. 2

D. Undefined

75. A compact steel section can reach its full plastic moment without:

A. Carrying any load

B. Any deflection

C. Tension yielding

D. Local buckling of the flanges or web

76. A pay item measured "per linear meter" most appropriately applies to:

A. Concrete volume

B. Excavation by area

C. Pipe or curb installation

D. Reinforcing steel by weight

77. A laboratory constant-head permeability test is best suited to:

A. Fine clays only

B. Organic soils only

C. Frozen soils

D. Coarse, highly permeable soils

78. A 0.5 kg ball hits the ground at 8 m/s. What is its kinetic energy at impact?

A. 32 J

B. 16 J

C. 4 J

D. 8 J

79. An engineer discovers a completed structure has a defect that endangers occupants. The first ethical duty is to:

A. Notify the responsible parties so the danger can be addressed

B. Wait for an inspection to find it

C. Keep silent to avoid liability

D. Resign quietly without telling anyone

80. The wetted perimeter of a trapezoidal channel includes the bottom and the:

A. Free water surface

B. Air above the water

C. Top width only

D. Two sloping sides in contact with water

81. A column carries an axial load applied with a small eccentricity. This produces:

A. Pure axial stress only

B. Combined axial and bending stress

C. Pure bending only

D. Pure torsion

82. A pump operates at the intersection of its characteristic curve and the:

A. System (resistance) curve

B. Atmospheric pressure line

C. Reynolds number axis

D. Pipe diameter scale

83. A mass on a spring oscillates with period $T = 2\pi\sqrt{(m/k)}$. Increasing the mass will:

A. Increase the period

B. Decrease the period

C. Not affect the period

D. Make the period zero

84. A pavement's serviceability index measures its:

A. Construction cost

B. Soil bearing capacity

C. Functional ride quality and condition

D. Drainage slope only

85. A soil has a porosity of 0.40. Using $e = n/(1 - n)$, what is its void ratio?

A. 0.667

B. 0.40

C. 1.50

D. 0.286

86. A 60 N and an 80 N force act at a point with 90° between them. What is the resultant magnitude?

A. 100 N

B. 140 N

C. 20 N

D. 70 N

87. The specific energy of open-channel flow is the sum of the flow depth and the:

A. Channel slope

B. Bed elevation

C. Manning's n

D. Velocity head

88. A simply supported beam's maximum moment under uniform load occurs at midspan because that is where the:

A. Shear force crosses zero

B. Reaction is largest

C. Deflection is zero

D. Load intensity is greatest

89. An engineer is asked to sign off on a project using a method outside their experience. The engineer should:

A. Sign off to appear competent

B. Sign off and learn the method later

C. Gain the necessary competence or involve a qualified expert before signing

D. Refuse all future work permanently

90. A fluid's absolute (dynamic) viscosity has SI units of:

A. m^2/s

B. $Pa \cdot s$

C. kg/m^3

D. N/m^2

91. A slope in cohesionless sand is stable as long as the slope angle is less than the soil's:

A. Cohesion value

B. Liquid limit

C. Angle of internal friction (angle of repose)

D. Plasticity index

92. A rainfall intensity of 50 mm/hr converts to how many m/s?

A. 50 m/s

B. 1.39×10^{-5} m/s

C. 0.05 m/s

D. 1.39×10^{-3} m/s

93. A construction inspector verifies that delivered concrete matches the:

A. Contractor's profit estimate

B. Owner's financing schedule

C. Approved mix design and specifications

D. Architect's color preference

94. A streamline in steady flow is a line that is everywhere:

A. Tangent to the velocity vector

B. Perpendicular to the flow

C. Of constant pressure

D. Of constant elevation

95. A flow is supercritical when its Froude number is:

A. Less than 1

B. Equal to 0

C. Greater than 1

D. Equal to 0.5

96. The compressive strength of concrete is most commonly tested using a:

A. Tensile coupon

B. Charpy impact specimen

C. Beam in three-point bending

D. Standard cylinder loaded to failure

97. A moment connection in a steel frame is designed to transfer:

A. Axial force only

B. Shear force only

C. Both moment and shear

D. Neither moment nor force

98. Two reservoirs are joined by a pipe. Flow occurs from the reservoir with the higher:

A. Temperature

B. Pipe roughness

C. Cross-sectional area

D. Total energy (water surface) elevation

99. What is the sum of the series $2 + 4 + 6 + 8 + 10$?

A. 30

B. 20

C. 40

D. 25

100. A cantilever beam's maximum deflection occurs at:

A. The fixed support

B. The free end

C. The midspan

D. The quarter point

101. When estimating a project, an engineer should base the cost on:

A. The figure most likely to win the bid regardless of accuracy

B. The client's desired number

C. Honest, realistic quantities and prices

D. A deliberate underestimate to secure the job

102. A four-leg intersection with stop signs on all approaches is an:

A. Uncontrolled intersection

B. Signalized intersection

C. All-way stop-controlled intersection

D. Grade-separated interchange

103. A cash flow occurring at the end of every year indefinitely, valued at A/i, is a:

A. Single payment

B. Gradient series

C. Finite annuity

D. Perpetuity

104. What is the probability of two consecutive heads in two fair coin tosses?

A. 0.50

B. 1.0

C. 0.25

D. 0.125

105. A daily construction report typically records:

A. The contractor's bank balance

B. The engineer's salary

C. Weather, labor, equipment, and work performed

D. Future stock prices

106. To compare cash flows across years despite inflation, analysts often convert them to:

A. Constant (real) dollars

B. Foreign currency

C. The highest nominal value

D. Gross domestic product

107. A structure used temporarily to hold back soil and water during excavation is a:

A. Cofferdam or sheet-pile shoring

B. Permanent gravity wall

C. Finished basement slab

D. Roof truss

108. A soil's effective stress increases when:

A. The water table rises

B. Pore pressure increases

C. The soil becomes saturated

D. The water table is lowered (drained)

109. A spiral (transition) curve in a horizontal alignment is used to:

A. Eliminate the need for superelevation

B. Increase the design speed indefinitely

C. Gradually introduce curvature and superelevation

D. Replace the vertical curve

110. For steady incompressible flow in a pipe of varying diameter, the mass flow rate is:

A. Greatest at the widest section

B. Constant at every section

C. Greatest at the narrowest section

D. Zero at the narrowest section

PRACTICE EXAM 15 — ANSWER KEY AND EXPLANATIONS

1. C — Fx = 100 cos 30° = 86.6 N; Fy = 100 sin 30° = 50 N. The cosine resolves the force horizontally and the sine vertically. The horizontal component is larger at this shallow angle.

2. B — Q = A·V = (3 × 1.2) × 1.5 = 3.6 × 1.5 = 5.4 m³/s. Discharge is the flow area times the mean velocity. Continuity governs this relationship.

3. D — A CPI of 0.80 means only $0.80 of value is earned per $1 spent, so the project is over budget. CPI is the ratio of earned value to actual cost. Values below 1.0 indicate cost overrun.

4. C — Each reaction = wL/2 = 6 × 10/2 = 30 kN. A symmetric uniform load splits equally between the two supports. Each carries half the total.

5. D — At 92% of the required 95% relative compaction, the soil fails the specification and needs further compaction. The Proctor maximum is the benchmark for field acceptance. Additional passes raise the density.

6. A — A due-south course has latitude = −L = −120 m and zero departure. The bearing points entirely south, so there is no east-west component. The negative sign denotes the southerly direction.

7. C — Rupture capacity = Fu·An = $400\times10^{6} \times 1{,}200\times10^{-6}$ = 480,000 N = 480 kN. Rupture is checked on the reduced net section. It is one of the two tension limit states.

8. B — Mmax = PL/4 = 24 × 4/4 = 24 kN·m at midspan. A central point load on a simple span gives this standard result. Each reaction is P/2.

9. D — Dot product = (2)(4) + (3)(1) = 8 + 3 = 11. The dot product multiplies corresponding components and sums them. It yields a scalar.

10. D — The head-loss term represents energy dissipated by friction and fittings. It accounts for the irreversible energy lost as the fluid moves. Pump head is a separate gain term.

11. B — Reserve capacity = capacity − demand = 2,000 − 1,400 = 600 veh/hr. It is the spare flow the facility can still carry. The road operates below capacity.

12. A — A neutrally buoyant submerged object has an average density equal to the surrounding fluid's. The buoyant force then exactly balances the weight. It neither rises nor sinks.

13. B — Third angle = 180° − 65° − 75° = 40°. The interior angles of a triangle sum to 180°. Subtracting the two known angles gives the third.

14. B — Demand = 5,000 × 300 = 1,500,000 L/day = 1,500 m³/day. Per-capita demand times population gives the total. Dividing by 1,000 converts liters to cubic meters.

15. A — $(2 + 3i) + (4 - i) = (2 + 4) + (3 - 1)i = 6 + 2i$. Real parts add and imaginary parts add separately. The result combines both.

16. D — Shear force equals the slope (derivative) of the bending moment diagram. This relationship comes from beam statics. Where shear is zero, the moment is at an extremum.

17. A — An engineer's foremost responsibility is to ensure the design is safe for public health and welfare. This duty is paramount in every code of ethics. Cost, aesthetics, and schedule are subordinate.

18. D — Corrosion of reinforcing steel is caused chiefly by chlorides and moisture penetrating to the steel. These break down the protective passive layer. Adequate cover and low permeability resist it.

19. A — $\delta = PL/AE = 50{,}000 \times 2/(250\times10^{-6} \times 200\times10^{9}) = 100{,}000/5\times10^{7} = 0.002$ m = 2 mm. Elongation grows with load and length and falls with stiffness. The bar behaves elastically.

20. A — For full saturation, $w = Se/Gs = (1.0 \times 0.5)/2.7 = 0.185 = 18.5\%$. At S = 100% the voids are filled with water. The water mass relates to the solids through this expression.

21. D — A high-strength bolt develops a clamping force that resists slip through friction between the connected surfaces. The pretension grips the plates together. This is the basis of slip-critical connections.

22. B — Accepting an undisclosed commission for specifying a product is a conflict of interest and unethical. It can bias the engineer's professional judgment. Disclosure or refusal is required.

23. A — Solving $2x - 4 > 0$ gives $2x > 4$, so $x > 2$. Adding 4 and dividing by 2 isolates x. The inequality direction is preserved.

24. A — Two cables at 45° share the load: $2T \sin 45° = 400$, so $T = 400/(2 \times 0.707) = 283$ N. Vertical equilibrium splits the weight between the symmetric cables. The sine sets each vertical component.

25. C — Lateral ties confine the longitudinal bars and prevent them from buckling outward under compression. They also confine the core concrete. This maintains the column's capacity.

26. C — Aggregate typically occupies about 60–75% of concrete's total volume. It forms the bulk, bound together by cement paste. This high fraction reduces cost and shrinkage.

27. D — Applying $m + r = 2j$: $13 + 3 = 16 = 2(8)$, so the truss is statically determinate. Members plus reactions exactly match the joint equations. No redundancy exists.

28. A — Deflection is reduced most effectively by increasing the moment of inertia of the cross-section. Deflection is inversely proportional to I. A deeper section is far stiffer.

29. B — The sea-level (elevation) reduction adjusts a measured distance to its equivalent at the reference ellipsoid. It accounts for measuring above the datum. Higher elevations require larger corrections.

30. C — Type I portland cement is the general-purpose (ordinary) cement. It suits most ordinary construction. Other types address sulfate resistance, high early strength, or low heat.

31. D — The Moody-diagram friction factor depends on the Reynolds number and the relative roughness of the pipe wall. These two parameters fix the factor in turbulent flow. Roughness matters more at high Reynolds numbers.

32. C — Time = volume/rate = 200/0.05 = 4,000 s = 66.7 minutes. Dividing the volume by the fill rate gives the time. The result converts to about 67 minutes.

33. B — $a = F/m = 15/5 = 3$ m/s². Newton's second law relates net force, mass, and acceleration. The result is in meters per second squared.

34. A — Poisson's ratio relates axial strain to the resulting lateral (transverse) strain. It quantifies how a material contracts sideways when stretched. It is dimensionless.

35. B — Centripetal acceleration = $v^2/r = 30^2/90 = 900/90 = 10$ m/s². It points toward the center of the curve. Speed squared drives the value.

36. C — A liquidity index above 1.0 means the natural water content exceeds the liquid limit, making the clay very soft and near-liquid. Such soils have very low strength. The index locates the water content between the Atterberg limits.

37. C — The external distance E increases as the deflection angle increases (a sharper curve). A larger central angle pushes the curve farther from the intersection point. E measures that offset.

38. B — Common velocity = $(1{,}000 \times 15)/(1{,}000 + 1{,}500) = 15{,}000/2{,}500 = 6$ m/s. The inelastic collision conserves momentum into the combined mass. Kinetic energy is not conserved.

39. B — Median = average of the two middle values = $(8 + 12)/2 = 10$. With six ordered values, the median lies between the third and fourth. Their average is the median.

40. D — $F = 4{,}000 \times 1.10^3 = 4{,}000 \times 1.331 = \$5{,}324$. Compound interest applies the growth factor each year. Interest earns interest over three years.

41. D — The derivative of sin(x) is cos(x). This is a fundamental result of calculus. It follows from the limit definition of the derivative.

42. C — Capacity = saturation flow × (g/C) = 1,800 × (36/90) = 1,800 × 0.4 = 720 veh/hr. The movement receives green only 40% of the cycle. Effective green scales the capacity.

43. C — Since $\tau \propto 1/d^3$, doubling the diameter divides the stress by $2^3 = 8$. The torsional stress falls sharply with larger diameter. A bigger shaft is far stronger in torsion.

44. A — The maximum base pressure of a retaining wall must not exceed the allowable soil bearing capacity. This guards against bearing failure beneath the footing. It is one of the wall's stability checks.

45. B — Unit-area runoff = 8/4 = 2 m^3/s per km^2. Dividing the peak flow by the catchment area normalizes it. It allows comparison between watersheds.

46. D — For a uniformly loaded simple beam, the bending moment is zero at both supports (the ends). The moment builds from zero at each reaction to a midspan maximum. The ends are simply supported with no applied moment.

47. D — A GW classification denotes a well-graded gravel. G is gravel and W is well-graded. It has a broad, continuous range of particle sizes.

48. B — Production = volume per cycle × cycles per hour = 8 × 30 = 240 m^3/hr. Multiplying the cycle volume by the cycle rate gives hourly output. This is a basic productivity calculation.

49. B — $f(0) = 2(0)^2 - 3(0) + 1 = 1$. Substituting x = 0 leaves only the constant term. The value is one.

50. D — An error in the controlling reference azimuth rotates the entire traverse systematically. All directions shift by the same angular error. The shape is preserved but its orientation is wrong.

51. D — A footing placed below the frost depth avoids heave from freezing and thawing of the soil. Frost action lifts shallow footings and damages structures. Founding below the frost line prevents it.

52. B — Production = 12 m^3 × (60/15) = 12 × 4 = 48 m^3/hr. Four 15-minute batches occur per hour. Their volumes sum to the hourly output.

53. B — Jam density is the density at which vehicles are stopped bumper-to-bumper and speed is zero. It is the maximum possible density. Flow is also zero at this condition.

54. A — A positive net present value at the MARR means the project is economically acceptable. The discounted benefits exceed the discounted costs. The investment meets the return threshold.

55. B — Schedule float generally belongs to the project and is shared according to the contract terms. It is not automatically owned by one party. Contract language governs its use.

56. C — Disinfection by-products form when chlorine reacts with natural organic matter in the water. The reaction creates compounds such as trihalomethanes. Removing organics before chlorination limits them.

57. D — Prestressing introduces compression into concrete that offsets later tensile stresses. This lets the concrete resist loads that would otherwise crack it. It exploits concrete's compressive strength.

58. D — An incorrect prism constant causes a systematic error in every distance the total station measures. The constant offsets the electronic distance reading. The same error repeats on each measurement.

59. B — A piezometer tube measures the pressure head at its point of attachment. The water rises to a height equal to the local pressure head. It does not include velocity head.

60. C — Salvage value is the asset's estimated worth at the end of its useful life. It reduces the depreciable base. It is recovered when the asset is retired.

61. B — A fixed-end beam's maximum midspan moment ($wL^2/24$) is smaller than a simple beam's ($wL^2/8$). The end fixity develops negative moments that relieve the midspan. Continuity makes fixed-end beams more efficient.

62. B — PW = A(P/A) = 3,000 × 4.6229 = $13,869. The uniform-series present-worth factor discounts six annual benefits to today. The result is less than the undiscounted total.

63. D — Beam deflection is inversely proportional to the flexural rigidity EI. A stiffer or deeper beam deflects less under the same load. Increasing E or I reduces deformation.

64. D — A sag vertical curve is designed primarily for adequate headlight sight distance at night. The driver must see far enough by headlight to stop. This controls the curve length.

65. A — The compass (Bowditch) rule distributes closure error in proportion to each course's length. Longer courses receive larger corrections. It assumes errors accumulate with distance.

66. D — Capacity is reduced by narrow lanes, heavy trucks, and frequent access points, but not by a higher free-flow speed on a clear, wide road. A higher free-flow speed reflects favorable conditions. The other factors all lower capacity.

67. B — A beam's neutral axis passes through the centroid of the cross-section. For symmetric bending, the centroid carries zero bending stress. Stress increases linearly away from it.

68. A — For equilibrium, the vector sum of all forces must be zero. No net force means no acceleration. This is a condition of static equilibrium.

69. C — A sudden (impact) load produces a larger stress than a gradually applied load of the same magnitude. The dynamic effect can double the static stress for sudden application. Impact must be accounted for in design.

70. A — Total load = ½ × base × peak = ½ × 6 × 9 = 27 kN. The resultant equals the area under the triangular load diagram. It acts at the triangle's centroid.

71. A — Directional flow = 1,200 × 2 = 2,400 veh/hr. Two lanes each carrying 1,200 veh/hr sum in one direction. The lane flows add.

72. B — The moment of a force about a point is zero when the force's line of action passes through that point. The moment arm is then zero. No turning effect results.

73. C — The coefficient of consolidation cv governs the rate (time) of consolidation settlement. It does not set the magnitude, which depends on the compression index. A higher cv means faster settlement.

74. A — Factoring $(x^2 - 4)/(x - 2) = (x + 2)$, which approaches 4 as $x \to 2$. The removable discontinuity cancels. The simplified form gives a finite limit.

75. D — A compact section reaches its full plastic moment without local buckling of the flanges or web. Compactness limits the width-to-thickness ratios. This ensures the section yields fully before buckling.

76. C — A "per linear meter" pay item applies to pipe or curb installation. These are measured along their length. Concrete is by volume and steel by weight.

77. D — A constant-head permeability test is best suited to coarse, highly permeable soils. Their rapid flow gives a steady, measurable head. Fine soils require a falling-head test.

78. B — $KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.5 \times 8^2 = \frac{1}{2} \times 0.5 \times 64 = 16$ J. Kinetic energy varies with the square of velocity. The mass scales it linearly.

79. A — The engineer's first ethical duty is to notify the responsible parties so the danger can be addressed. Public safety requires prompt action. Silence or delay would be a serious violation.

80. D — A trapezoidal channel's wetted perimeter includes the bottom and the two sloping sides in contact with water. The free surface is excluded. The perimeter sets the hydraulic radius.

81. B — An eccentric axial load produces combined axial and bending stress. The eccentricity creates a bending moment in addition to the direct stress. The two effects superimpose.

82. A — A pump operates where its characteristic curve intersects the system (resistance) curve. That point sets the operating flow and head. Changing system resistance shifts the operating point.

83. A — Since $T = 2\pi\sqrt{(m/k)}$, increasing the mass increases the period. A heavier mass oscillates more slowly. The period grows with the square root of mass.

84. C — A pavement's serviceability index measures its functional ride quality and condition. It rates how well the pavement serves traffic. It declines as the pavement deteriorates.

85. A — $e = n/(1 - n) = 0.40/0.60 = 0.667$. This converts porosity (voids to total) into void ratio (voids to solids). The void ratio exceeds the porosity.

86. A — Resultant $= \sqrt{(60^2 + 80^2)} = \sqrt{(3{,}600 + 6{,}400)} = \sqrt{10{,}000} = 100$ N. Perpendicular forces combine by the Pythagorean theorem. This is a 3-4-5 relationship scaled by twenty.

87. D — Specific energy is the sum of the flow depth and the velocity head. It expresses energy relative to the channel bottom. It is central to open-channel analysis.

88. A — The maximum moment occurs where the shear force crosses zero, which for a uniform load is at midspan. The moment is the integral of the shear. Its peak is at the zero-shear point.

89. C — The engineer should gain the necessary competence or involve a qualified expert before signing. Engineers must practice only within their competence. Signing off on unfamiliar work risks public safety.

90. B — Dynamic viscosity has SI units of pascal-seconds (Pa·s). It relates shear stress to the velocity gradient. Kinematic viscosity instead has units of m^2/s.

91. C — A cohesionless sand slope is stable while the slope angle stays below the angle of internal friction (angle of repose). Beyond that angle the particles slide. Cohesion does not contribute in clean sand.

92. B — 50 mm/hr = 0.050 m/3,600 s = 1.39×10^{-5} m/s. Converting requires changing both length and time units. The result is a very small velocity.

93. C — The inspector verifies that delivered concrete matches the approved mix design and specifications. This ensures the strength and durability assumed in design. Quality control protects the structure.

94. A — A streamline is everywhere tangent to the velocity vector. No flow crosses a streamline. It traces the path of fluid particles in steady flow.

95. C — A flow is supercritical when its Froude number is greater than 1. Inertial forces then dominate gravity, producing rapid, shallow flow. Below 1 the flow is subcritical.

96. D — Concrete compressive strength is most commonly tested with a standard cylinder loaded to failure. The cylinder is cured and crushed at 28 days. The peak load divided by area gives f′c.

97. C — A moment connection transfers both moment and shear between members. It maintains the angle between connected members under load. This gives the frame rigidity.

98. D — Flow occurs from the reservoir with the higher total energy (water surface) elevation. Water moves from higher to lower energy. The elevation difference drives the flow.

99. A — Sum = 2 + 4 + 6 + 8 + 10 = 30. Adding the five even terms gives the total. The arithmetic series sums to thirty.

100. B — A cantilever beam's maximum deflection occurs at the free end. The fixed end has zero slope and deflection. Deflection accumulates toward the unsupported tip.

101. C — A project estimate should be based on honest, realistic quantities and prices. Estimates must reflect genuine expected costs. Deliberate under- or over-estimating is unethical.

102. C — A four-leg intersection with stop signs on every approach is an all-way stop-controlled intersection. All drivers must stop and proceed in turn. It differs from two-way stop control.

103. D — A cash flow occurring at the end of every year forever, valued at A/i, is a perpetuity. It has no end date. Its present worth is the payment divided by the interest rate.

104. C — P(two heads) = 0.5 × 0.5 = 0.25. Independent tosses multiply their probabilities. There is a one-in-four chance.

105. C — A daily construction report records weather, labor, equipment, and work performed. It documents site progress and conditions. It is a key project record.

106. A — To compare cash flows across years despite inflation, analysts convert them to constant (real) dollars. This removes the effect of changing purchasing power. Real dollars allow a fair comparison.

107. A — A cofferdam or sheet-pile shoring temporarily holds back soil and water during excavation. It creates a dry, stable work area. It is removed once permanent construction is complete.

108. D — Lowering (draining) the water table reduces pore pressure, which increases the effective stress. Effective stress is total stress minus pore pressure. Removing water shifts load to the soil skeleton.

109. C — A spiral transition curve gradually introduces curvature and superelevation between a tangent and a circular curve. It provides a smooth, comfortable change in lateral acceleration. This improves safety at speed.

110. B — For steady incompressible flow in a pipe of varying diameter, the mass flow rate is constant at every section. Conservation of mass requires equal mass flow throughout. Velocity changes inversely with area to maintain it.