Board Exam Desk

Civil Engineering Reviewer

BS Civil Engineering | CELE | 120 original questions

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Practice mathematics and surveying, hydraulics and geotechnics, and structural design problems.

Practice questions

Structural Engineering and Construction

1. A simply supported beam carries a point load at midspan. How much vertical force does each support carry?

A. One quarter of the load
B. The full load
C. Half the load
D. Zero

2. A 10 kN force acts perpendicular to a 2 m lever arm. What is its moment about the pivot?

A. 5 kN·m
B. 10 kN·m
C. 12 kN·m
D. 20 kN·m

3. A 6 m simply supported beam carries a uniform load of 4 kN/m over its entire span. What is each vertical reaction?

A. 6 kN
B. 12 kN
C. 18 kN
D. 24 kN

4. What moment can an ideal pin support transmit to a planar beam?

A. A fixed moment
B. A clockwise moment only
C. No reaction moment
D. A moment equal to the total load

5. Where is the resultant of a uniformly distributed load over a straight segment applied?

A. At the midpoint of the loaded segment
B. At the left end
C. At the right end
D. At the nearest support

6. A 12 kN point load acts 2 m from the left support of a 6 m simply supported beam. What is the right support reaction?

A. 2 kN
B. 4 kN
C. 6 kN
D. 8 kN

7. A force’s line of action passes through the point about which moments are calculated. What is its moment about that point?

A. Equal to the force
B. Twice the force
C. Zero
D. Dependent only on mass

8. Which condition must be satisfied for a planar rigid body to be in static equilibrium?

A. Only the vertical forces sum to zero
B. Only the horizontal forces sum to zero
C. Only the moments sum to zero
D. Horizontal forces, vertical forces, and moments each sum to zero

89. A symmetrical triangular truss spans 8 m between a pin and a roller, with its apex 3 m above the supports. A 60 kN vertical load acts at the apex. What is the force in the horizontal bottom chord?

A. 50 kN compression
B. 40 kN tension
C. 30 kN tension
D. 80 kN tension

90. A 4 m cantilever carries a uniform load of 6 kN/m over its full length plus a 10 kN point load at the free end. What is the maximum bending moment at the fixed support?

A. 64 kN·m
B. 136 kN·m
C. 88 kN·m
D. 58 kN·m

91. A simply supported beam spans 8 m and carries a uniform load of 15 kN/m. What is the maximum bending moment?

A. 240 kN·m
B. 60 kN·m
C. 120 kN·m
D. 480 kN·m

92. A beam is supported at its left end and at a point 6 m to the right, then overhangs 2 m beyond the right support. A 20 kN downward load acts at the tip of the overhang. What is the reaction at the left support?

A. 6.67 kN upward
B. 6.67 kN downward
C. 26.67 kN upward
D. 20.00 kN downward

93. A 25 mm diameter steel rod carries an axial tensile load of 60 kN. What is the normal stress in the rod?

A. 122.2 MPa
B. 30.6 MPa
C. 763.9 MPa
D. 96.0 MPa

94. A steel bar 3 m long with a cross-sectional area of 500 mm² carries an axial tension of 80 kN. With E = 200 GPa, what is its elongation?

A. 0.24 mm
B. 4.80 mm
C. 1.20 mm
D. 2.40 mm

95. A steel rail is fully restrained between rigid supports and its temperature rises by 40°C. With α = 11.7 × 10■■ /°C and E = 200 GPa, what thermal stress develops?

A. 93.6 MPa tension
B. 93.6 MPa compression
C. 46.8 MPa compression
D. 9.36 MPa compression

96. A rectangular timber beam 200 mm wide and 400 mm deep is subjected to a bending moment of 80 kN·m. What is the maximum flexural stress?

A. 30.0 MPa
B. 7.5 MPa
C. 60.0 MPa
D. 15.0 MPa

97. A rectangular beam section 250 mm wide and 500 mm deep carries a vertical shear of 120 kN. What is the maximum shear stress?

A. 1.44 MPa
B. 0.96 MPa
C. 2.88 MPa
D. 1.92 MPa

98. A T-section has a flange 300 mm wide by 50 mm thick on top of a web 50 mm wide by 250 mm deep. How far is the centroid from the top of the flange?

A. 150.00 mm
B. 206.82 mm
C. 93.18 mm
D. 100.00 mm

99. A solid circular shaft 60 mm in diameter transmits a torque of 2.5 kN·m. What is the maximum shear stress?

A. 117.89 MPa
B. 471.57 MPa
C. 29.47 MPa
D. 58.95 MPa

100. A shaft transmits 50 kW at 300 rpm. What torque does it carry?

A. 166.7 N·m
B. 26.5 N·m
C. 10,000.0 N·m
D. 1,591.5 N·m

101. A pin-ended steel column is 4 m long with a minimum moment of inertia of 8 × 10■ mm■ and E = 200 GPa. What is its Euler critical buckling load?

A. 987.0 kN
B. 246.7 kN
C. 3,947.8 kN
D. 1,973.9 kN

102. A cylindrical steel tank 1.5 m in diameter with 10 mm thick walls holds gas at an internal pressure of 1.2 MPa. What is the hoop (circumferential) stress?

A. 45 MPa
B. 180 MPa
C. 60 MPa
D. 90 MPa

103. A simply supported steel beam spans 6 m and carries a uniform load of 12 kN/m. With E = 200 GPa and I = 120 × 10■ mm■, what is the maximum deflection?

A. 81.00 mm
B. 1.69 mm
C. 0.14 mm
D. 8.44 mm

104. A 3 m cantilever carries a 15 kN point load at its free end. With E = 200 GPa and I = 60 × 10■ mm■, what is the deflection at the free end?

A. 4.22 mm
B. 0.70 mm
C. 11.25 mm
D. 16.88 mm

105. In NSCP 2015 strength design, what is the stress-block factor β■ for concrete with f'c = 35 MPa?

A. 0.80
B. 0.85
C. 0.75
D. 0.65

106. A singly reinforced rectangular beam has b = 300 mm, d = 500 mm, As = 1,800 mm², f'c = 28 MPa and fy = 415 MPa. Assuming the steel yields, what is the nominal moment capacity Mn?

A. 334.4 kN·m
B. 373.5 kN·m
C. 301.0 kN·m
D. 295.3 kN·m

107. Using Ec = 4,700√f'c for normal-weight concrete, what is the modulus of elasticity of concrete with f'c = 28 MPa?

A. 131,600 MPa
B. 24.87 MPa
C. 24,870 MPa
D. 3,281 MPa

108. Using fr = 0.62λ√f'c with λ = 1.0, what is the modulus of rupture of concrete with f'c = 25 MPa?

A. 15.50 MPa
B. 2.50 MPa
C. 1.55 MPa
D. 3.10 MPa

109. A floor beam carries a service dead load of 20 kN/m and a service live load of 12 kN/m. Considering only the combinations 1.4D and 1.2D + 1.6L, what is the governing factored load?

A. 28.0 kN/m
B. 32.0 kN/m
C. 43.2 kN/m
D. 48.0 kN/m

110. A steel plate tension member has a gross area of 2,400 mm² and Fy = 248 MPa. Using LRFD with ϕ = 0.90, what is its design strength for tensile yielding on the gross section?

A. 595.20 kN
B. 446.40 kN
C. 535.68 kN
D. 356.41 kN

111. What is the balanced steel ratio ρb for a rectangular beam with f'c = 21 MPa and fy = 275 MPa? Use ρb = 0.85β■(f'c/fy)[600/(600 + fy)].

A. 0.0378
B. 0.0445
C. 0.0284
D. 0.0552

112. For a beam with f'c = 28 MPa and fy = 415 MPa, which governs the minimum flexural steel ratio: 0.25√f'c/fy or 1.4/fy, and what is its value?

A. 0.25√f'c/fy = 0.00319
B. 1.4/fy = 0.00337
C. 1.4/fy = 0.00319
D. 0.25√f'c/fy = 0.00337

113. A building has 12 isolated footings, each 1.5 m × 1.5 m in plan and 0.40 m thick. What total volume of concrete is needed for the footings?

A. 0.90 m³
B. 10.80 m³
C. 27.00 m³
D. 7.20 m³

114. A wall 12 m long and 3 m high is built of 400 mm × 200 mm concrete hollow blocks. Neglecting openings and waste, how many blocks are needed?

A. 900 pieces
B. 450 pieces
C. 360 pieces
D. 540 pieces

115. Taking the density of steel as 7,850 kg/m³, what is the mass of 120 m of 16 mm diameter reinforcing bars?

A. 757.6 kg
B. 189.4 kg
C. 18.9 kg
D. 118.4 kg

116. A contractor must haul 300 m³ of bank-measured soil that swells 25% when excavated. Using trucks with an 8 m³ loose capacity, how many truck trips are required?

A. 38
B. 30
C. 47
D. 45

117. A project has activities A (4 days, no predecessor), B (6 days, after A), C (5 days, after A) and D (3 days, after both B and C). What is the minimum project duration?

A. 13 days
B. 12 days
C. 18 days
D. 9 days

118. What property of fresh concrete does the slump test primarily measure?

A. Consistency or workability
B. Compressive strength
C. Air content
D. Setting time

119. At a point in a stressed body, σx = 80 MPa (tension), σy = 20 MPa (compression) and τxy = 40 MPa. What is the maximum principal stress?

A. 64.03 MPa
B. 94.03 MPa
C. 120.00 MPa
D. –34.03 MPa

120. In a beam, the slope of the bending moment diagram at any section is equal to:

A. The load intensity at that section
B. The deflection at that section
C. The area of the load diagram up to that section
D. The shear force at that section

Mathematics, Surveying and Transportation Engineering

9. The two roots of $2x^2 - 7x + k = 0$ differ by 2.5. What is the value of k?

A. 1.5
B. 6
C. 4.5
D. 3

10. An arithmetic progression has a first term of 7 and a fifteenth term of 63. What is the sum of its first 15 terms?

A. 490
B. 1,050
C. 525
D. 560

11. An infinite geometric series has a first term of 12 and a sum of 30. What is its common ratio?

A. 0.6
B. 0.4
C. 0.5
D. 2.5

12. From a point on level ground 45 m from the base of a vertical tower, the angle of elevation of the top is 38°. How tall is the tower?

A. 27.70 m
B. 57.60 m
C. 35.16 m
D. 35.46 m

13. Two sides of a triangle measure 8 m and 11 m and the angle between them is 70°. How long is the third side?

A. 13.60 m
B. 15.66 m
C. 11.17 m
D. 12.45 m

14. A triangular lot has sides of 7 m, 9 m and 12 m. What is its area?

A. 31.30 m^2
B. 42.00 m^2
C. 22.14 m^2
D. 27.00 m^2

15. What is the perpendicular distance from the point (3, –2) to the line 4x – 3y + 7 = 0?

A. 25
B. 1.4
C. 3.4
D. 5

16. What is the radius of the circle $x^2 + y^2 – 6x + 8y – 11 = 0$?

A. 5
B. 6
C. $\sqrt{11}$
D. 4

17. What is the length of the latus rectum of the parabola $y^2 = 20x$?

A. 5
B. 20
C. 10
D. 40

18. What is the eccentricity of the ellipse $9x^2 + 25y^2 = 225$?

A. 0.60
B. 1.25
C. 0.36
D. 0.80

19. A farmer has 240 m of fencing to enclose a rectangular area along a straight river; no fence is needed on the river side. What is the largest area that can be enclosed?

A. 3,600 m^2
B. 6,400 m^2
C. 14,400 m^2
D. 7,200 m^2

20. What is the area of the region bounded by the curves $y = x^2$ and $y = 4x$?

A. 32.00 square units
B. 10.67 square units
C. 21.33 square units
D. 5.33 square units

21. The radius of a spherical balloon increases at 2 cm/s. How fast is its volume increasing when the radius is 15 cm?

A. 14,137 cm^3/s
B. 2,827 cm^3/s
C. 5,655 cm^3/s
D. 377 cm^3/s

22. Evaluate the limit of sin(3x)/(5x) as x approaches 0.

A. 3/5
B. 0
C. 5/3
D. 1

23. Two fair dice are rolled once. What is the probability that the sum of the faces is 8?

A. 1/6
B. 5/36
C. 1/9
D. 7/36

24. Five percent of the bolts from a supplier are defective. In a random sample of 10 bolts, what is the probability that exactly one is defective?

A. 0.0315
B. 0.5987
C. 0.0500
D. 0.3151

25. A 4-member committee is to be formed from 7 engineers and 5 architects. How many committees contain exactly 2 architects?

A. 495
B. 31
C. 420
D. 210

26. PHP 150,000 is deposited at 8% interest compounded quarterly. How much is in the account after 5 years?

A. PHP 220,399.21
B. PHP 210,000.00
C. PHP 222,892.11
D. PHP 165,612.12

27. What is the effective annual interest rate corresponding to a nominal rate of 12% compounded monthly?

A. 12.00%
B. 12.55%
C. 12.68%
D. 13.00%

28. What is the present worth of PHP 20,000 received at the end of each year for 10 years if money is worth 6% per year?

A. PHP 147,201.74
B. PHP 200,000.00
C. PHP 263,615.90
D. PHP 111,678.96

29. Equipment costs PHP 2,400,000, has a salvage value of PHP 300,000 and a life of 12 years. Using straight-line depreciation, what is its book value at the end of year 5?

A. PHP 1,400,000
B. PHP 875,000
C. PHP 1,650,000
D. PHP 1,525,000

30. A bridge costs PHP 8,000,000 to build and PHP 120,000 per year to maintain, indefinitely. At 6% interest, what is its capitalized cost?

A. PHP 8,120,000
B. PHP 10,000,000
C. PHP 2,000,000
D. PHP 8,720,000

31. A precast plant has fixed costs of PHP 360,000 per month. Each unit sells for PHP 250 and has a variable cost of PHP 160. How many units per month must be sold to break even?

A. 1,440
B. 2,250
C. 1,000
D. 4,000

32. A 30 m steel tape is found to be 0.012 m too long. A distance measured with it is recorded as 425.60 m. What is the true distance?

A. 425.770 m
B. 425.430 m
C. 425.612 m
D. 425.588 m

33. A steel tape standardized at 20°C (α = 11.6 × 10■■ /°C) is used at 34°C to measure a line recorded as 680.000 m. What is the corrected length?

A. 680.110 m
B. 679.890 m
C. 680.268 m
D. 680.158 m

34. From BM-1 (elevation 85.320 m), a backsight of 2.105 m is taken, then a foresight of 0.874 m on TP-1. From TP-1, a backsight of 1.660 m and a foresight of 3.215 m on point A are taken. What is the elevation of A?

A. 84.996 m
B. 85.644 m
C. 88.211 m
D. 84.210 m

35. A stadia rod intercept of 1.50 m is read with a transit having a stadia interval factor of 100 and negligible instrument constant. The line of sight is inclined at 8°. What is the horizontal distance?

A. 147.09 m
B. 150.00 m
C. 148.54 m
D. 20.67 m

36. A traverse line has a bearing of N 35°20' E and a length of 240.00 m. What is its departure?

A. 195.79 m
B. 138.34 m
C. 138.80 m
D. 170.14 m

37. A closed traverse with a perimeter of 1,200 m has a sum of latitudes of +0.36 m and a sum of departures of −0.48 m. What is its relative precision?

A. 1/2,500
B. 1/2,000
C. 1/1,429
D. 1/3,333

38. A triangular parcel has corners at coordinates (0, 0), (120, 40) and (30, 90), in meters. What is its area?

A. 4,800 m²
B. 9,600 m²
C. 6,000 m²
D. 5,400 m²

39. Using hcr = 0.0675K² (hcr in m, K in km), what is the combined correction for curvature and refraction for a sight of 3 km?

A. 0.608 m
B. 0.203 m
C. 0.707 m
D. 0.068 m

40. A simple circular curve has a radius of 300 m and a central angle of 40°. What is the length of the curve?

A. 109.19 m
B. 205.21 m
C. 104.72 m
D. 209.44 m

41. For a simple curve of radius 300 m and intersection angle 40°, what is the tangent distance from PC to PI?

A. 251.73 m
B. 109.19 m
C. 104.72 m
D. 19.25 m

42. A symmetrical vertical summit curve 200 m long connects a +3% grade to a −2% grade. How far from the PC is the highest point of the curve?

A. 100 m
B. 80 m
C. 120 m
D. 150 m

43. A car travels at 80 km/h on a level road. With a perception-reaction time of 2.5 s and a coefficient of friction of 0.35, what is the stopping sight distance? Use g = 9.81 m/s².

A. 71.9 m
B. 127.5 m
C. 55.6 m
D. 199.4 m

44. A horizontal curve of radius 350 m is designed for 90 km/h with a side friction factor of 0.12. What superelevation rate is required? Use g = 9.81 m/s².

A. 0.062
B. 0.182
C. 0.302
D. 0.074

45. Under the Greenshields model, a highway has a free-flow speed of 90 km/h and a jam density of 150 veh/km. What is its maximum flow?

A. 13,500 veh/h
B. 6,750 veh/h
C. 3,375 veh/h
D. 2,250 veh/h

46. Three vehicles traverse a 1.0 km section in 50 s, 60 s and 75 s. What is the space mean speed?

A. 60.00 km/h
B. 16.22 km/h
C. 58.38 km/h
D. 72.00 km/h

47. An approach carries 1,800 vehicles in the peak hour, and the highest 15-minute count within that hour is 520 vehicles. What is the peak hour factor?

A. 1.156
B. 0.289
C. 0.865
D. 1.000

48. An intersection recorded 18 accidents in 3 years. The total entering volume averages 24,000 vehicles per day. What is the accident rate per million entering vehicles?

A. 2.055
B. 0.685
C. 0.228
D. 0.833

Hydraulics and Geotechnical Engineering

49. What is the gauge pressure at a depth of 6 m in an open tank of oil with a specific gravity of 0.85?

A. 50.03 kPa
B. 58.86 kPa
C. 69.25 kPa
D. 151.36 kPa

50. A flow net under a concrete dam has 4 flow channels and 12 equipotential drops. The head loss across the dam is 8 m and k = 2 × 10■■ m/s. What is the seepage per meter length of dam?

A. 48.00 × 10■■ m³/s
B. 16.00 × 10■■ m³/s
C. 0.67 × 10■■ m³/s
D. 5.33 × 10■■ m³/s

51. A mercury (SG 13.6) differential manometer connected between two points at the same elevation in a water pipe shows a deflection of 250 mm. What is the pressure difference between the points?

A. 33.35 kPa
B. 35.81 kPa
C. 30.90 kPa
D. 3.09 kPa

52. A vertical rectangular gate 2 m wide and 3 m high has its top edge 1.5 m below the water surface. What is the total hydrostatic force on the gate?

A. 88.29 kN
B. 176.58 kN
C. 264.87 kN
D. 58.86 kN

53. A vertical rectangular sluice gate 1.5 m wide and 2 m high has its top edge 1 m below the free water surface. How far below the surface is the center of pressure?

A. 2.167 m
B. 2.000 m
C. 2.333 m
D. 3.000 m

54. A solid wooden cube 0.6 m on each side has a specific gravity of 0.72 and floats in seawater (SG 1.03). How deep is it submerged?

A. 0.419 m
B. 0.432 m
C. 0.445 m
D. 0.181 m

55. A stone weighs 480 N in air and 300 N when fully submerged in water. What is its specific gravity?

A. 2.67
B. 1.60
C. 1.67
D. 0.63

56. Water flows at 1.2 m/s in a 300 mm pipe that reduces to 150 mm diameter. What is the velocity in the smaller pipe?

A. 2.40 m/s
B. 0.30 m/s
C. 9.60 m/s
D. 4.80 m/s

57. A 50 mm sharp-edged orifice with a discharge coefficient of 0.62 discharges under a constant head of 4 m. What is the flow rate?

A. 17.39 L/s
B. 7.63 L/s
C. 43.14 L/s
D. 10.78 L/s

58. Water flows at 1.5 m/s through a 500 m long, 300 mm diameter pipe with a Darcy friction factor of 0.02. What is the head loss due to friction?

A. 7.65 m
B. 3.82 m
C. 2.55 m
D. 1.15 m

59. Water (ν = 1.0 × 10■■ m²/s) flows at 0.8 m/s in a 50 mm pipe. What is the Reynolds number and flow regime?

A. 4,000, transitional
B. 40,000, laminar
C. 1,600, laminar
D. 40,000, turbulent

60. A rectangular concrete channel 3 m wide carries water 1.2 m deep on a slope of 0.001, with Manning's n = 0.015. What is the discharge?

A. 8.57 m³/s
B. 1.61 m³/s
C. 6.20 m³/s
D. 5.79 m³/s

61. A rectangular channel 4 m wide carries 12 m³/s. What is the critical depth?

A. 2.448 m
B. 0.917 m
C. 0.972 m
D. 0.553 m

62. Water flows at 3 m/s in a wide rectangular channel at a depth of 0.5 m. What is the Froude number and the flow state?

A. 1.35, supercritical
B. 1.35, subcritical
C. 1.83, supercritical
D. 0.74, subcritical

63. A hydraulic jump forms in a wide rectangular channel where the upstream depth is 0.4 m and velocity is 6 m/s. What is the depth just after the jump?

A. 1.21 m
B. 0.80 m
C. 3.05 m
D. 1.53 m

64. For the most efficient (best hydraulic) rectangular open-channel section of flow depth y, what is the hydraulic radius?

A. y
B. 2y
C. y/2
D. y/4

65. Using the rational method Q = CiA/360 (Q in m³/s, i in mm/h, A in hectares), what is the peak runoff from a 40 ha catchment with C = 0.6 and a design rainfall intensity of 75 mm/h?

A. 8.33 m³/s
B. 5.00 m³/s
C. 3.00 m³/s
D. 1,800 m³/s

66. A pump delivers 80 L/s of water against a total dynamic head of 45 m. If its efficiency is 78%, what input power is required?

A. 35.32 kW
B. 45.28 kW
C. 27.55 kW
D. 4.62 kW

67. Two pipes connected in parallel join the same two junctions. Which statement is true for steady flow?

A. The flow rate is the same in each pipe
B. The head loss is the same in each pipe
C. The velocity is the same in each pipe
D. The total head loss is the sum of the individual losses

68. How high will water (σ = 0.0728 N/m, contact angle 0°) rise in a clean glass tube of 1.5 mm inside diameter?

A. 9.9 mm
B. 39.6 mm
C. 19.8 mm
D. 2.0 mm

69. Water has a bulk modulus of 2.2 GPa. By what percentage does its volume decrease when the pressure is raised by 15 MPa?

A. 0.682%
B. 6.82%
C. 0.0682%
D. 1.364%

70. A soil has a void ratio of 0.65, specific gravity of solids 2.70 and water content of 18%. What is its degree of saturation?

A. 74.8%
B. 4.3%
C. 48.6%
D. 133.7%

71. A soil has Gs = 2.70 and a void ratio of 0.65. What is its dry unit weight?

A. 16.05 kN/m³
B. 40.75 kN/m³
C. 19.92 kN/m³
D. 26.49 kN/m³

72. A sand has a void ratio of 0.80. What is its porosity?

A. 0.800
B. 0.556
C. 0.444
D. 4.000

73. A clay has Gs = 2.68 and a void ratio of 0.72. What is its saturated unit weight?

A. 15.29 kN/m³
B. 19.39 kN/m³
C. 9.58 kN/m³
D. 12.26 kN/m³

74. A core sample with a volume of 950 cm³ has a mass of 1.85 kg and a water content of 15%. What is its dry unit weight?

A. 19.10 kN/m³
B. 16.24 kN/m³
C. 21.97 kN/m³
D. 16.61 kN/m³

75. A sand deposit has e_max = 0.90, e_min = 0.45 and an in-situ void ratio of 0.62. What is its relative density?

A. 37.8%
B. 62.2%
C. 68.9%
D. 31.1%

76. A clay has a liquid limit of 48%, a plastic limit of 22% and a natural water content of 30%. What is its liquidity index?

A. 0.69
B. 0.17
C. 1.36
D. 0.31

77. Under the Unified Soil Classification System, a soil with 70% passing the No. 200 sieve, a liquid limit of 62 and a plasticity index that plots above the A-line is classified as:

A. MH
B. CH
C. CL
D. SC

78. In a constant-head permeability test, 360 cm³ of water passes through a sample 15 cm long with a cross-sectional area of 80 cm² in 120 s under a head of 40 cm. What is the coefficient of permeability?

A. 0.1000 cm/s
B. 0.0141 cm/s
C. 0.0375 cm/s
D. 0.0281 cm/s

79. A falling-head test uses a standpipe of area 1.2 cm² on a sample 12 cm long with area 40 cm². The head drops from 60 cm to 35 cm in 300 s. What is the coefficient of permeability?

A. 2.81 × 10■■ cm/s
B. 6.47 × 10■■ cm/s
C. 20.57 × 10■■ cm/s
D. 5.00 × 10■■ cm/s

80. The water table is 2 m below the ground surface. The soil above it has γ = 17 kN/m³ and the soil below has γsat = 19.5 kN/m³. What is the vertical effective stress at a depth of 7 m?

A. 131.50 kPa
B. 67.83 kPa
C. 82.45 kPa
D. 62.83 kPa

81. A 4 m thick normally consolidated clay layer has Cc = 0.32, e■ = 1.10 and an initial effective stress at mid-depth of 80 kPa. A building adds 60 kPa at mid-depth. What is the primary consolidation settlement?

A. 283 mm
B. 76 mm
C. 148 mm
D. 341 mm

82. A 6 m clay layer drains at both top and bottom and has cv = 2.5 m²/yr. Taking Tv = 0.197 for 50% consolidation, how long does it take to reach 50% consolidation?

A. 2.84 years
B. 0.47 years
C. 0.24 years
D. 0.71 years

83. A soil has cohesion c = 15 kPa and friction angle ϕ = 28°. What is its shear strength on a plane where the effective normal stress is 120 kPa?

A. 63.81 kPa
B. 78.81 kPa
C. 71.34 kPa
D. 240.69 kPa

84. An unconfined compression test on a saturated clay gives an unconfined compressive strength of 96 kPa. What is its undrained shear strength?

A. 48 kPa
B. 96 kPa
C. 192 kPa
D. 24 kPa

85. A drained triaxial test on a clean sand (c = 0) uses a cell pressure of 100 kPa, and failure occurs at a deviator stress of 200 kPa. What is the friction angle?

A. 45°
B. 19.5°
C. 36.9°
D. 30°

86. A 6 m smooth vertical retaining wall holds back level dry sand with γ = 18 kN/m³ and ϕ = 30°. What is the total Rankine active thrust per meter of wall?

A. 324 kN/m
B. 216 kN/m
C. 36 kN/m
D. 108 kN/m

87. What is the Rankine passive earth pressure coefficient for a cohesionless soil with ϕ = 34°?

A. 3.537
B. 0.283
C. 26.466
D. 1.881

88. A long strip footing rests 1.5 m deep in saturated clay with cu = 40 kPa ($\phi = 0$) and $\gamma = 18$ kN/m³. Using Terzaghi's factors for $\phi = 0$ (Nc = 5.7, Nq = 1, N$\gamma = 0$), what is the ultimate bearing capacity?

A. 228 kPa
B. 85 kPa
C. 255 kPa
D. 282 kPa

Answer key

Civil Engineering

1. C. Half the load

The reactions are equal by symmetry and together balance the point load.

2. D. 20 kN·m

The moment magnitude is the force multiplied by the perpendicular distance, giving 20 kN·m.

3. B. 12 kN

The total load is 24 kN. Symmetry splits it into two 12 kN reactions.

4. C. No reaction moment

An ideal pin restrains translation and allows rotation, so it does not supply a reaction moment.

5. A. At the midpoint of the loaded segment

The equivalent force acts at the centroid of the rectangular load diagram.

6. B. 4 kN

Taking moments about the left support gives right reaction × 6 = 12 × 2, or 4 kN.

7. C. Zero

The perpendicular lever arm is zero, so the moment is zero.

8. D. Horizontal forces, vertical forces, and moments each sum to zero

Planar equilibrium requires zero net force in both directions and zero net moment.

9. D. 3

Sum of roots = 3.5 and difference = 2.5 give roots 3 and 0.5; product = k/2 = 1.5, so k = 3.

10. C. 525

S = n(a■ + a■)/2 = 15(7 + 63)/2 = 525.

11. A. 0.6

S = a/(1 – r), so 30 = 12/(1 – r) and r = 1 – 12/30 = 0.6.

12. C. 35.16 m

Height = 45 tan 38° = 35.16 m.

13. C. 11.17 m

$c^2 = 8^2 + 11^2 – 2(8)(11)\cos 70° = 124.80$, so c = 11.17 m.

14. A. 31.30 m²

Heron's formula: s = 14, A = √[14(7)(5)(2)] = 31.30 m².

15. D. 5

$d = |4(3) – 3(–2) + 7|/\sqrt{(4^2 + 3^2)} = 25/5 = 5$.

16. B. 6

Completing squares: $(x – 3)^2 + (y + 4)^2 = 11 + 9 + 16 = 36$, so r = 6.

17. B. 20

$y^2 = 4ax$ with 4a = 20, so a = 5 and the latus rectum = 4a = 20.

18. D. 0.80

$x^2/25 + y^2/9 = 1$ gives a = 5, b = 3, c = √(25 – 9) = 4, so e = c/a = 0.80.

19. D. 7,200 m²

A = x(240 – 2x); dA/dx = 240 – 4x = 0 gives x = 60 m, so A = 60 × 120 = 7,200 m².

20. B. 10.67 square units

The curves meet at x = 0 and x = 4; A = ∫■■ (4x – x²) dx = 32 – 64/3 = 10.67.

21. C. 5,655 cm³/s

dV/dt = 4πr² dr/dt = 4π(15²)(2) = 1800π ≈ 5,655 cm³/s.

22. A. 3/5

Since sin(3x)/(3x) → 1, the limit equals 3/5.

23. B. 5/36

Favorable outcomes are (2,6), (3,5), (4,4), (5,3), (6,2): 5 of 36.

24. D. 0.3151

P = C(10,1)(0.05)(0.95)■ = 0.3151.

25. D. 210

C(7,2) × C(5,2) = 21 × 10 = 210.

26. C. PHP 222,892.11

F = P(1 + i)■ = 150,000(1.02)²■ = PHP 222,892.11.

27. C. 12.68%

$i_{eff} = (1 + 0.12/12)^{12} – 1 = 12.68\%$.

28. A. PHP 147,201.74

P = A[1 – (1 + i)■■]/i = 20,000(1 – 1.06■¹■)/0.06 = PHP 147,201.74.

29. D. PHP 1,525,000

Annual depreciation = (2,400,000 – 300,000)/12 = 175,000; BV■ = 2,400,000 – 5(175,000) = PHP 1,525,000.

30. B. PHP 10,000,000

Capitalized cost = first cost + A/i = 8,000,000 + 120,000/0.06 = PHP 10,000,000.

31. D. 4,000

Break-even quantity = fixed cost/(price – variable cost) = 360,000/90 = 4,000 units.

32. A. 425.770 m

True length = recorded × (actual tape length/nominal) = 425.60 × 30.012/30 = 425.770 m.

33. A. 680.110 m

C = αL(T – Ts) = 11.6 × 10■■ × 680 × 14 = 0.110 m, added because the tape expands: 680.110 m.

34. A. 84.996 m

Elev A = 85.320 + ΣBS – ΣFS = 85.320 + 3.765 – 4.089 = 84.996 m.

35. A. 147.09 m

H = Ks cos²θ = 100(1.50)cos²8° = 147.09 m.

36. C. 138.80 m

Departure = L sin β = 240 sin 35°20' = +138.80 m (east).

37. B. 1/2,000

Linear error of closure = $\sqrt{(0.36^2 + 0.48^2)} = 0.60$ m; precision = 0.60/1,200 = 1/2,000.

38. A. 4,800 m²

By the coordinate (shoelace) method, A = ½|120(90) – 30(40)| = ½(9,600) = 4,800 m².

39. A. 0.608 m

hcr = $0.0675(3^2) = 0.6075 \approx 0.608$ m.

40. D. 209.44 m

Lc = πRI/180° = π(300)(40)/180 = 209.44 m.

41. B. 109.19 m

T = R tan(I/2) = 300 tan 20° = 109.19 m.

42. C. 120 m

x = g■L/(g■ – g■) = 3(200)/[3 – (–2)] = 120 m.

43. B. 127.5 m

SSD = $vt + v^2/(2gf) = 22.22(2.5) + 22.22^2/(2 \times 9.81 \times 0.35) = 127.5$ m.

44. A. 0.062

e + f = $v^2/(gR) = 25^2/(9.81 \times 350) = 0.182$, so e = 0.182 – 0.12 = 0.062.

45. C. 3,375 veh/h

q_max = v_f k_j/4 = 90(150)/4 = 3,375 veh/h.

46. C. 58.38 km/h

SMS = total distance/total time = 3,000 m/185 s = 16.22 m/s = 58.38 km/h (the time mean speed would be 60 km/h).

47. C. 0.865

PHF = V/(4 × V■■) = 1,800/(4 × 520) = 0.865.

48. B. 0.685

R = A × 10■/(ADT × 365 × years) = 18 × 10■/(24,000 × 365 × 3) = 0.685.

49. A. 50.03 kPa

p = γh = 0.85(9.81)(6) = 50.03 kPa.

50. D. 5.33 × 10■■ m³/s

q = kH(Nf/Nd) = (2 × 10■■)(8)(4/12) = 5.33 × 10■■ m³/s per meter.

51. C. 30.90 kPa

Δp = (SGm – SGw)γw h = (13.6 – 1)(9.81)(0.25) = 30.90 kPa.

52. B. 176.58 kN

F = γ h_c A = 9.81(1.5 + 1.5)(2 × 3) = 176.58 kN.

53. A. 2.167 m

y_p = h_c + I/(A h_c) = 2 + (1.5 × 2^3/12)/(3 × 2) = 2.167 m.

54. A. 0.419 m

Weight = buoyancy: 0.72(0.6) = 1.03D, so D = 0.419 m.

55. A. 2.67

Buoyant force = 480 – 300 = 180 N, so SG = W/(W – W_sub) = 480/180 = 2.67.

56. D. 4.80 m/s

A■V■ = A■V■, so V■ = 1.2(300/150)² = 4.80 m/s.

57. D. 10.78 L/s

Q = Cd A √(2gh) = 0.62(π/4)(0.05²)√(2 × 9.81 × 4) = 10.78 L/s.

58. B. 3.82 m

hf = f(L/D)(v²/2g) = 0.02(500/0.3)(1.5²/19.62) = 3.82 m.

59. D. 40,000, turbulent

Re = vD/ν = 0.8(0.05)/10■■ = 40,000, well above about 4,000, so the flow is turbulent.

60. D. 5.79 m³/s

R = 3.6/5.4 = 0.667 m; V = (1/n)R^(2/3)S^(1/2) = 1.609 m/s; Q = AV = 5.79 m³/s.

61. C. 0.972 m

q = 12/4 = 3 m²/s; yc = (q²/g)^(1/3) = (9/9.81)^(1/3) = 0.972 m.

62. A. 1.35, supercritical

Fr = v/√(gy) = 3/√(9.81 × 0.5) = 1.35 > 1, so the flow is supercritical.

63. D. 1.53 m

Fr■ = 6/√(9.81 × 0.4) = 3.029; y■ = (y■/2)[√(1 + 8Fr■²) – 1] = 1.53 m.

64. C. y/2

The best rectangular section has b = 2y, so R = 2y²/(4y) = y/2.

65. B. 5.00 m³/s

Q = 0.6(75)(40)/360 = 5.00 m³/s.

66. B. 45.28 kW

P = γQH/η = 9.81(0.08)(45)/0.78 = 45.28 kW.

67. B. The head loss is the same in each pipe

Both branches share the same upstream and downstream energy levels, so their head losses are equal while the flows add up.

68. C. 19.8 mm

h = 4σ cos θ/(γd) = 4(0.0728)/(9,810 × 0.0015) = 19.8 mm.

69. A. 0.682%

ΔV/V = Δp/K = 15/2,200 = 0.00682 = 0.682%.

70. A. 74.8%

S = wGs/e = 0.18(2.70)/0.65 = 74.8%.

71. A. 16.05 kN/m³

γd = Gsγw/(1 + e) = 2.70(9.81)/1.65 = 16.05 kN/m³.

72. C. 0.444

n = e/(1 + e) = 0.80/1.80 = 0.444.

73. B. 19.39 kN/m³

$\gamma sat = (Gs + e)\gamma w/(1 + e) = (2.68 + 0.72)(9.81)/1.72 = 19.39$ kN/m³.

74. D. 16.61 kN/m³

$\gamma = 1.85(9.81)/0.00095 = 19.10$ kN/m³; $\gamma d = \gamma/(1 + w) = 16.61$ kN/m³.

75. B. 62.2%

$Dr = (e_{max} – e)/(e_{max} – e_{min}) = (0.90 – 0.62)/(0.90 – 0.45) = 62.2\%$.

76. D. 0.31

PI = 48 – 22 = 26; LI = (w – PL)/PI = (30 – 22)/26 = 0.31.

77. B. CH

More than 50% fines makes it fine-grained; LL ≥ 50 and plotting above the A-line gives high-plasticity clay, CH.

78. B. 0.0141 cm/s

k = QL/(Aht) = 360(15)/(80 × 40 × 120) = 0.0141 cm/s.

79. B. 6.47 × 10■■ cm/s

k = (aL/At) ln(h■/h■) = [1.2(12)/(40 × 300)] ln(60/35) = 6.47 × 10■■ cm/s.

80. C. 82.45 kPa

σ' = 17(2) + (19.5 – 9.81)(5) = 34 + 48.45 = 82.45 kPa.

81. C. 148 mm

S = [CcH/(1 + e■)] log(σf/σ■) = [0.32(4)/2.10] log(140/80) = 0.148 m.

82. D. 0.71 years

Hdr = 6/2 = 3 m; t = Tv Hdr²/cv = 0.197(9)/2.5 = 0.71 years.

83. B. 78.81 kPa

$\tau = c + \sigma' \tan \phi = 15 + 120 \tan 28° = 78.81$ kPa.

84. A. 48 kPa

For a saturated clay ($\phi = 0$), cu = qu/2 = 96/2 = 48 kPa.

85. D. 30°

σ■ = 300 kPa, σ■ = 100 kPa; $\sin \phi = (\sigma■ – \sigma■)/(\sigma■ + \sigma■) = 200/400 = 0.5$, so $\phi = 30°$.

86. D. 108 kN/m

Ka = (1 – sin 30°)/(1 + sin 30°) = 1/3; Pa = ½KaγH² = ½(1/3)(18)(36) = 108 kN/m.

87. A. 3.537

$Kp = \tan^2(45° + \phi/2) = \tan^2 62° = 3.537$.

88. C. 255 kPa

qu = cNc + γDf Nq = 40(5.7) + 18(1.5)(1) = 228 + 27 = 255 kPa.

89. B. 40 kN tension

Each reaction is 30 kN. At a support joint, the rafter (slope 3:4, length 5) carries 30(5/3) = 50 kN compression, whose horizontal part 50(4/5) = 40 kN is balanced by the chord in tension.

90. C. 88 kN·m

M = wL²/2 + PL = 6(4²)/2 + 10(4) = 48 + 40 = 88 kN·m.

91. C. 120 kN·m

$M_{max} = wL^2/8 = 15(8^2)/8 = 120$ kN·m at midspan.

92. B. 6.67 kN downward

Moments about the right support: $R_L(6) = -20(2)$, so $R_L = -6.67$ kN, i.e., 6.67 kN acting downward.

93. A. 122.2 MPa

$\sigma = P/A = 60{,}000/[\pi(25^2)/4] = 122.2$ MPa.

94. D. 2.40 mm

$\delta = PL/(AE) = 80{,}000(3{,}000)/(500 \times 200{,}000) = 2.40$ mm.

95. B. 93.6 MPa compression

$\sigma = E\alpha\Delta T = 200{,}000(11.7 \times 10\blacksquare\blacksquare)(40) = 93.6$ MPa, compressive because expansion is prevented.

96. D. 15.0 MPa

$S = bh^2/6 = 200(400^2)/6 = 5.333 \times 10\blacksquare$ mm³; $f = M/S = 80 \times 10\blacksquare/5.333 \times 10\blacksquare = 15.0$ MPa.

97. A. 1.44 MPa

$\tau_{max} = 1.5V/A = 1.5(120{,}000)/(250 \times 500) = 1.44$ MPa, at the neutral axis.

98. C. 93.18 mm

$\blacksquare = \Sigma Ay/\Sigma A = [15{,}000(25) + 12{,}500(175)]/27{,}500 = 93.18$ mm.

99. D. 58.95 MPa

$\tau = 16T/(\pi d^3) = 16(2.5 \times 10\blacksquare)/(\pi \times 60^3) = 58.95$ MPa.

100. D. 1,591.5 N·m

$T = P/\omega = 50{,}000/(2\pi \times 300/60) = 1591.5$ N·m.

101. A. 987.0 kN

$P_{cr} = \pi^2 EI/(KL)^2 = \pi^2(200{,}000)(8 \times 10\blacksquare)/4{,}000^2 = 987.0$ kN.

102. D. 90 MPa

$\sigma_h = pD/(2t) = 1.2(1{,}500)/(2 \times 10) = 90$ MPa.

103. D. 8.44 mm

$\delta = 5wL\blacksquare/(384EI) = 5(12)(6{,}000\blacksquare)/(384 \times 200{,}000 \times 120 \times 10\blacksquare) = 8.44$ mm.

104. C. 11.25 mm

$\delta = PL^3/(3EI) = 15{,}000(3{,}000^3)/(3 \times 200{,}000 \times 60 \times 10\blacksquare) = 11.25$ mm.

105. A. 0.80

$\beta\blacksquare = 0.85 - 0.05(f'c - 28)/7 = 0.85 - 0.05 = 0.80$ for $28 < f'c < 55$ MPa.

106. A. 334.4 kN·m

$a = Asfy/(0.85f'c\ b) = 747{,}000/7{,}140 = 104.6$ mm; $Mn = Asfy(d - a/2) = 747{,}000(447.7) = 334.4$ kN·m.

107. C. 24,870 MPa

$Ec = 4{,}700\sqrt{28} = 24{,}870$ MPa ≈ 24.9 GPa.

108. D. 3.10 MPa

$fr = 0.62(1.0)\sqrt{25} = 0.62(5) = 3.10$ MPa.

109. C. 43.2 kN/m

$1.4D = 28.0$ kN/m; $1.2(20) + 1.6(12) = 24 + 19.2 = 43.2$ kN/m, which governs.

110. C. 535.68 kN

$\phi Pn = \phi FyAg = 0.90(248)(2{,}400) = 535.68$ kN.

111. A. 0.0378

With $\beta\blacksquare = 0.85$, $\rho b = 0.85(0.85)(21/275)(600/875) = 0.0378$.

112. B. 1.4/fy = 0.00337

$0.25\sqrt{28}/415 = 0.00319$ and $1.4/415 = 0.00337$; the larger value, 0.00337, governs.

113. B. 10.80 m³

$V = 12(1.5 \times 1.5 \times 0.40) = 12(0.90) = 10.80$ m³.

114. B. 450 pieces

Each block face covers $0.40 \times 0.20 = 0.08$ m², i.e., 12.5 blocks/m²; 36 m² × 12.5 = 450 pieces.

115. B. 189.4 kg

Mass per meter = $(\pi/4)(0.016^2)(7{,}850) = 1.578$ kg/m; total = 189.4 kg.

116. C. 47

Loose volume = 300(1.25) = 375 m³; 375/8 = 46.9, rounded up to 47 trips.

117. A. 13 days

Path A-B-D = 4 + 6 + 3 = 13 days and A-C-D = 12 days; the critical path A-B-D gives 13 days.

118. A. Consistency or workability

The slump cone test gauges the consistency of fresh concrete, an indicator of its workability.

119. B. 94.03 MPa

Center = (80 – 20)/2 = 30 MPa, radius = $\sqrt{(50^2 + 40^2)} = 64.03$ MPa; $\sigma\blacksquare = 30 + 64.03 = 94.03$ MPa.

120. D. The shear force at that section

From equilibrium of a beam element, $dM/dx = V$; it is the slope of the shear diagram that equals the load intensity.

Topics to review

- Free-body diagrams and support reactions
- Structural analysis and design
- Hydraulics, geotechnics and surveying
- Construction materials and quantity estimates

Online question banks and study resources

Civil Engineering - Pass Harbor (Question bank)

Engineering Statics - Engineering Statics (Open textbook)

Engineering Mechanics: Statics - UPEI Robertson Library Pressbooks (Open textbook)

Official PRC board information

Current PRC exam programs

Independent study material prepared by Board Exam Desk.