

OJEE M Tech Civil Sample Paper 02

A) Mode and Time: The exam is a Computer Based Test (CBT) lasting 120 minutes.

B) Total Questions: The exam contains 90 questions.

C) Marking Scheme & Rules:

- +4 for correct answers and -1 for incorrect responses.

Q1. The method of consistent deformations is an example of a:

- A. Force method
- B. Displacement method
- C. Relaxation method
- D. Kinematic method

Q2. The maximum deflection of a cantilever beam of length L carrying a uniformly distributed load w over its entire length is:

- A. $wL^4/4EI$
- B. $wL^3/6EI$
- C. $wL^4/8EI$
- D. $wL^4/12EI$

Q3. The shear center of a thin-walled semi-circular channel section of radius R lies at a distance of from the center of the semi-circle.

- A. R/π
- B. $2R/\pi$
- C. $3R/\pi$
- D. $4R/\pi$

Q4. In a fixed beam of span L subjected to a central concentrated load W , the fixed end moment is:

- A. $WL/4$
- B. $WL/8$
- C. $WL/12$
- D. $WL/16$

Q5. The estimated flexural strength (modulus of rupture) of M25 grade concrete as per IS 456 is:

- A. 2.5 MPa
- B. 3.5 MPa
- C. 4.5 MPa
- D. 5.0 MPa

Q6. As per IS 456, the minimum percentage of longitudinal reinforcement in an RCC column is:

- A. 0.12 per cent
- B. 0.15 per cent
- C. 0.8 per cent
- D. 1.0 per cent

Q7. The effective throat thickness of a standard fillet weld with an angle between fusion faces of 90° is equal to:

- A. $0.50 \times \text{size of weld}$
- B. $0.70 \times \text{size of weld}$
- C. $0.85 \times \text{size of weld}$
- D. $1.0 \times \text{size of weld}$

Q8. The shape factor of a standard solid circular section is:

- A. 1.12
- B. 1.50
- C. 1.70
- D. 2.00

Q9. A soil has a bulk density of 20 kN/m^3 and a water content of 25 per cent. Its dry density is:

- A. 15 kN/m^3
- B. 16 kN/m^3
- C. 18 kN/m^3
- D. 25 kN/m^3

Q10. The toughness index of a soil is defined as the ratio of:

- A. Plasticity index to flow index
- B. Flow index to plasticity index
- C. Liquidity index to plasticity index
- D. Consistency index to flow index

Q11. Quick sand condition occurs when the effective stress in a cohesionless soil becomes:

- A. Equal to total stress
- B. Greater than atmospheric pressure
- C. Zero
- D. Infinite

Q12. The coefficient of consolidation is used primarily for calculating the:

- A. Total settlement
- B. Rate of settlement
- C. Bearing capacity
- D. Pre-consolidation pressure

Q13. The active earth pressure coefficient (K_a) for a soil with an angle of internal friction of 30° is:

- A. $1/2$
- B. $1/3$
- C. $2/3$
- D. 3

Q14. A fluid whose apparent viscosity increases with the rate of deformation is known as:

- A. Pseudoplastic fluid
- B. Dilatant fluid
- C. Bingham plastic
- D. Newtonian fluid

Q15. Bernoulli's equation is derived assuming the fluid flow to be:

- A. Viscous and compressible
- B. Inviscid and incompressible
- C. Inviscid and compressible
- D. Viscous and incompressible

Q16. The thickness of a laminar boundary layer over a flat plate at a distance x from the leading edge varies as:

- A. $x^{1/2}$
- B. $x^{4/5}$
- C. $x^{1/5}$
- D. $x^{-1/2}$

Q17. A hydraulic jump occurs when the flow changes from:

- A. Sub-critical to super-critical
- B. Super-critical to sub-critical
- C. Laminar to turbulent
- D. Turbulent to laminar

Q18. The specific speed of a centrifugal pump is given by the expression:

- A. $N\sqrt{Q}/H^{3/4}$
- B. $N\sqrt{P}/H^{5/4}$
- C. $N\sqrt{Q}/H^{5/4}$
- D. $N\sqrt{P}/H^{3/4}$

Q19. An isohyet is a line joining points of equal:

- A. Elevation
- B. Evaporation
- C. Rainfall depth
- D. Infiltration rate

Q20. The time required by rain water to reach the outlet of a drainage basin from the farthest point is called:

- A. Lag time

- B. Time of concentration
- C. Base time
- D. Recession time

Q21. The ratio of the quantity of water stored in the root zone of crops to the quantity of water actually delivered to the field is:

- A. Water application efficiency
- B. Water conveyance efficiency
- C. Water use efficiency
- D. Water distribution efficiency

Q22. In a gravity dam, the major overturning force is caused by:

- A. Uplift pressure
- B. Water pressure
- C. Silt pressure
- D. Earthquake force

Q23. An Ogee spillway is designed to have a profile matching the:

- A. Upper nappe of a free-falling jet
- B. Lower nappe of a free-falling jet
- C. Shape of a hydraulic jump
- D. Parabolic trajectory of a projectile

Q24. Temporary hardness in water is primarily caused by the presence of:

- A. Chlorides of Calcium
- B. Sulfates of Magnesium
- C. Carbonates and Bicarbonates of Calcium and Magnesium
- D. Nitrates of Sodium

Q25. The indicator organism commonly used to test for fecal contamination in water is:

- A. Salmonella typhi
- B. Vibrio cholerae
- C. Escherichia coli (E. coli)

D. Entamoeba histolytica

Q26. Which of the following is a secondary air pollutant?

A. Carbon monoxide

B. Sulfur dioxide

C. Ozone

D. Particulate matter

Q27. The method of solid waste disposal that operates on the principle of aerobic decomposition is:

A. Incineration

B. Sanitary landfilling

C. Composting

D. Pyrolysis

Q28. If two noise sources produce 80 dB and 80 dB simultaneously, the combined noise level is approximately:

A. 80 dB

B. 83 dB

C. 86 dB

D. 160 dB

Q29. The ruling design speed on a National Highway in plain terrain as per IRC is:

A. 80 kmph

B. 100 kmph

C. 120 kmph

D. 65 kmph

Q30. The shift of a transition curve is given by:

A. $L^2/24R$

B. $L^2/12R$

C. $L/24R^2$

D. $L/12R^2$

Q31. The function of a prime coat in a flexible pavement is to:

- A. Provide a wearing surface
- B. Bond the base course and the new binder course
- C. Plug the capillary voids in a porous underlying layer
- D. Increase the structural capacity of the pavement

Q32. Webster's method is used for the design of:

- A. Flexible pavements
- B. Traffic signal timings
- C. Superelevation
- D. Runway lengths

Q33. The coning of wheels in railways is done at a slope of:

- A. 1 in 10
- B. 1 in 20
- C. 1 in 30
- D. 1 in 40

Q34. Basic runway length requires correction for:

- A. Elevation, temperature, and gradient
- B. Elevation, wind, and temperature
- C. Temperature, wind, and humidity
- D. Gradient, wind, and payload

Q35. The magnetic bearing of a line is 45° . If the magnetic declination is 5° East, the true bearing is:

- A. 40°
- B. 45°
- C. 50°
- D. 55°

Q36. The first reading taken on a level staff after setting up the instrument is known as:

- A. Foresight
- B. Backsight
- C. Intermediate sight
- D. Benchmark

Q37. In a theodolite, the condition where the line of sight is not perpendicular to the horizontal axis is known as:

- A. Index error
- B. Collimation error
- C. Centering error
- D. Trunnion axis error

Q38. Relief displacement on a vertical aerial photograph is radial from the:

- A. Principal point
- B. Nadir point
- C. Isocenter
- D. Focal point

Q39. The Global Positioning System (GPS) consists of a minimum of how many operational satellites?

- A. 12
- B. 18
- C. 24
- D. 32

Q40. In a PERT network, the expected time for an activity is given by:

- A. $(t_o + 4t_m + t_p)/6$
- B. $(t_o + 2t_m + t_p)/4$
- C. $(t_o + t_m + t_p)/3$
- D. $(t_o + 4t_m - t_p)/6$

Q41. The amount of time by which an activity can be delayed without affecting the early start of its succeeding activities is called:

- A. Total float
- B. Free float
- C. Independent float
- D. Interfering float

Q42. The type of brick masonry bond where alternate courses consist of all headers and all stretchers is:

- A. English bond
- B. Flemish bond
- C. Stretcher bond
- D. Header bond

Q43. The compound of Portland cement that reacts earliest with water and is responsible for flash setting is:

- A. Tricalcium silicate (C3S)
- B. Dicalcium silicate (C2S)
- C. Tricalcium aluminate (C3A)
- D. Tetracalcium aluminoferrite (C4AF)

Q44. The Poisson's ratio for structural steel is typically in the range of:

- A. 0.10 to 0.15
- B. 0.15 to 0.20
- C. 0.25 to 0.33
- D. 0.40 to 0.50

Q45. On a principal plane, the shear stress is:

- A. Maximum
- B. Minimum
- C. Zero
- D. Equal to normal stress

Q46. The point of contraflexure is the point where:

- A. Shear force changes sign

- B. Bending moment changes sign
- C. Deflection is maximum
- D. Slope is zero

Q47. In a post-tensioned prestressed concrete member, the loss of prestress due to elastic shortening of concrete occurs:

- A. Only if wires are tensioned simultaneously
- B. Only if wires are tensioned sequentially
- C. Irrespective of the tensioning sequence
- D. Never occurs in post-tensioning

Q48. The minimum cover to the main reinforcement in a reinforced concrete column should not be less than:

- A. 15 mm
- B. 25 mm
- C. 40 mm
- D. 50 mm

Q49. Stiffeners are provided in a plate girder primarily to:

- A. Increase moment carrying capacity
- B. Prevent buckling of the web
- C. Increase shear capacity of the flanges
- D. Connect the web to the flange

Q50. Standard Proctor test is used to determine the:

- A. Permeability of soil
- B. Bearing capacity of soil
- C. Maximum dry density and optimum moisture content
- D. Shear strength parameters

Q51. In a flow net, the discharge q per unit length is given by (k = permeability, H = head loss, N_f = number of flow channels, N_d = number of equipotential drops):

- A. $kH \cdot (N_d/N_f)$

- B. $kH \cdot (N_f/N_d)$
- C. $k \cdot (H/N_f \cdot N_d)$
- D. $H \cdot (k \cdot N_d/N_f)$

Q52. An undrained triaxial test is suitable for simulating:

- A. Long-term stability of a clay slope
- B. Short-term stability of a clay foundation
- C. Steady seepage conditions
- D. Permeability of granular soils

Q53. Negative skin friction on a pile foundation:

- A. Increases its load-carrying capacity
- B. Reduces its load-carrying capacity
- C. Has no effect on load-carrying capacity
- D. Acts upwards

Q54. The friction factor f for a smooth pipe in turbulent flow depends on:

- A. Reynolds number only
- B. Relative roughness only
- C. Both Reynolds number and relative roughness
- D. Froude number

Q55. For a given discharge in an open channel, the specific energy is minimum at:

- A. Normal depth
- B. Critical depth
- C. Conjugate depth
- D. Alternate depth

Q56. The standard pan coefficient for a Class A evaporation pan is approximately:

- A. 0.5
- B. 0.7
- C. 0.9

D. 1.2

Q57. The operational trouble in a trickling filter where the filter media gets clogged by excessive biomass growth is called:

- A. Bulking
- B. Ponding
- C. Sloughing
- D. Foaming

Q58. According to IRC, the minimum passing sight distance is approximately equal to:

- A. Stopping sight distance
- B. Twice the stopping sight distance
- C. Thrice the stopping sight distance
- D. Overtaking sight distance

Q59. Passenger Car Unit (PCU) is a unit used to measure:

- A. Vehicle speed
- B. Road capacity and traffic volume
- C. Pavement thickness
- D. Axle load

Q60. In remote sensing, the spectral band typically used for monitoring vegetation health is:

- A. Ultraviolet
- B. Blue
- C. Near-infrared
- D. Thermal infrared

Q61. The determinant of an orthogonal matrix is always:

- A. 0
- B. 1
- C. -1
- D. ± 1

Q62. If λ is an eigenvalue of a non-singular matrix A , then the eigenvalue of A^{-1} is:

- A. λ
- B. $-\lambda$
- C. $1/\lambda$
- D. $1 - \lambda$

Q63. The function $f(x) = x^3 - 3x$ has a local minimum at x equals:

- A. -1
- B. 0
- C. 1
- D. 3

Q64. The value of the integral $\int_0^1 x e^x dx$ is:

- A. 1
- B. e
- C. $e - 1$
- D. $e + 1$

Q65. The order and degree of the differential equation $\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^3 = x$ are respectively:

- A. 2 and 1
- B. 1 and 3
- C. 2 and 3
- D. 1 and 1

Q66. The integrating factor of the differential equation $\frac{dy}{dx} + y \cot x = \cos x$ is:

- A. $\sin x$
- B. $\cos x$
- C. $\tan x$
- D. $e^{\sin x}$

Q67. The Laplace transform of $\sin(\omega t)$ is:

- A. $\frac{s}{s^2 + \omega^2}$

B. $\frac{\omega}{s^2 + \omega^2}$

C. $\frac{s}{s^2 - \omega^2}$

D. $\frac{\omega}{s^2 - \omega^2}$

Q68. If a fair coin is tossed 3 times, the probability of getting exactly 2 heads is:

A. $1/8$

B. $3/8$

C. $1/2$

D. $5/8$

Q69. In Bayes' theorem, $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$, the term $P(A|B)$ is known as the:

A. Prior probability

B. Posterior probability

C. Likelihood

D. Evidence

Q70. The directional derivative of a scalar function $\phi(x, y, z)$ is maximum in the direction of:

A. $\nabla\phi$

B. $\nabla \times \nabla\phi$

C. The x -axis

D. The zero vector

Q71. The divergence of the curl of any smooth vector field is always:

A. 1

B. -1

C. 0

D. The vector itself

Q72. The residue of the complex function $f(z) = \frac{1}{(z-2)^2}$ at the pole $z = 2$ is:

A. 0

B. 1

C. 2

D. ∞

Q73. The Cauchy-Riemann equations for a complex function $f(z) = u(x, y) + iv(x, y)$ are:

A. $u_x = v_y$ and $u_y = v_x$

B. $u_x = -v_y$ and $u_y = v_x$

C. $u_x = v_y$ and $u_y = -v_x$

D. $u_x = -v_y$ and $u_y = -v_x$

Q74. Using the Trapezoidal rule with one interval, the integral $\int_0^2 x^2 dx$ is approximated as:

A. 2

B. 4

C. $8/3$

D. 8

Q75. The Fourth-order Runge-Kutta (RK4) method has a global truncation error of the order of:

A. $O(h^2)$

B. $O(h^3)$

C. $O(h^4)$

D. $O(h^5)$

Q76. If A is a singular matrix, then its inverse:

A. Is a diagonal matrix

B. Is an identity matrix

C. Is a zero matrix

D. Does not exist

Q77. The Maclaurin series expansion of $\cos(x)$ contains only:

A. Odd powers of x

B. Even powers of x

C. Both even and odd powers

D. Exponential terms

Q78. The Fourier series of an odd periodic function contains:

- A. Only sine terms
- B. Only cosine terms
- C. Both sine and cosine terms
- D. A constant term and cosine terms

Q79. The partial differential equation $u_{xx} - c^2 u_{yy} = 0$ is classified as:

- A. Elliptic
- B. Parabolic
- C. Hyperbolic
- D. Linear

Q80. If the variance of a binomial distribution is 2 and the mean is 4, then the probability of success p is:

- A. 0.2
- B. 0.5
- C. 0.6
- D. 0.8

Q81. Pointing to a woman, a man says, "Her mother is the only daughter of my mother-in-law." How is the man related to the woman?

- A. Uncle
- B. Brother
- C. Father
- D. Husband

Q82. Look at this series: 7, 10, 8, 11, 9, 12, ... What number should come next?

- A. 7
- B. 10
- C. 12
- D. 13

Q83. A person starts from his house and travels 8 km towards the North. Then he turns right and travels 6 km. What is the shortest distance from his house to his current position?

- A. 10 km
- B. 14 km
- C. 12 km
- D. 8 km

Q84. If in a certain language, 'MACHINE' is coded as '19-7-9-14-15-20-11', how will 'DANGER' be coded in the same language?

- A. 10-7-20-13-11-24
- B. 11-7-20-16-11-24
- C. 13-7-20-9-11-25
- D. 10-7-20-14-11-24

Q85. Statements: All cups are glasses. Some glasses are bowls. Conclusions: I. Some bowls are cups. II. No bowl is a cup.

- A. Only Conclusion I follows
- B. Only Conclusion II follows
- C. Either Conclusion I or II follows
- D. Neither I nor II follows

Q86. Five friends A, B, C, D, and E are sitting in a row facing South. A is to the immediate right of B. C is between D and E. B is to the immediate left of D. Who is sitting in the middle?

- A. B
- B. C
- C. D
- D. E

Q87. The angle between the minute hand and the hour hand of a clock when the time is 8:30 is:

- A. 80°
- B. 75°

- C. 60°
- D. 105°

Q88. If January 1, 2024, was a Monday, what day of the week will be January 1, 2025?

- A. Tuesday
- B. Wednesday
- C. Thursday
- D. Friday

Q89. Choose the odd one out:

- A. Aluminium
- B. Iron
- C. Brass
- D. Copper

Q90. Which of the following diagrams indicates the best relation between Travelers, Train, and Bus?

- A. Two disjoint circles inside a larger circle
- B. Three overlapping circles
- C. One circle partially overlapping with two disjoint circles
- D. Three disjoint circles

Solutions

1. A

Explanation: The method of consistent deformations uses compatibility conditions to find redundant forces, making it a force method.

2. C

Explanation: For a cantilever with a UDL over its entire span, the maximum deflection at the free end is $wL^4/8EI$.

3. D

Explanation: The shear center for a thin-walled semi-circular section is located at $4R/\pi$ from the center of the arc.

4. B

Explanation: The fixed end moments for a fixed beam with a central point load are $WL/8$ at both supports.

5. B

Explanation: As per IS 456, flexural strength $f_{cr} = 0.7\sqrt{f_{ck}}$. For M25, $0.7\sqrt{25} = 3.5$ MPa.

6. C

Explanation: IS 456 stipulates that the minimum longitudinal reinforcement in a column should be 0.87. **B**

Explanation: For a 90 fillet weld, the effective throat thickness is 0.707 times weld size.

8. C

Explanation: The shape factor is the ratio of plastic modulus to elastic modulus; for a solid circular section, it is $16/3\pi \approx 1.70$.

9. B

Explanation: Dry density $h_{od} = h_o/(1 + w) = 20/(1 + 0.25) = 16$ kN/m.

10. A

Explanation: The toughness index (I_t) is the ratio of the plasticity index (I_p) to the flow index (I_f).

11. C

Explanation: Quick sand is a hydraulic condition where upward seepage pressure equals the submerged weight of the soil, making effective stress zero.

12. B

Explanation: The coefficient of consolidation (c_v) governs the rate at which primary consolidation settlement occurs.

13. B

Explanation: For $\phi = 30^\circ$, $K_a = (1 - \sin 30)/(1 + \sin 30) = 0.5/1.5 = 1/3$.

14. B

Explanation: A dilatant fluid exhibits an increase in apparent viscosity with an increased rate of shear deformation.

15. B

Explanation: Bernoulli's equation assumes steady, irrotational, inviscid, and in-

compressible flow.

16. A

Explanation: The thickness of a laminar boundary layer over a flat plate is proportional to $x^{1/2}$.

17. B

Explanation: A hydraulic jump is an abrupt transition from a super-critical to a sub-critical flow condition.

18. A

Explanation: For pumps, specific speed $N_s = N\sqrt{Q}/H^{3/4}$.

19. C

Explanation: Isohyets are lines on a map connecting points that receive equal amounts of rainfall.

20. B

Explanation: Time of concentration is the time needed for water to flow from the most remote point in a watershed to the outlet.

21. A

Explanation: Water application efficiency measures the water effectively stored in the root zone.

22. B

Explanation: Horizontal hydrostatic water pressure from the reservoir is the primary force attempting to overturn a gravity dam.

23. B

Explanation: An Ogee spillway is designed to match the lower nappe of a ventilated free-falling water jet.

24. C

Explanation: Temporary hardness is caused by carbonates/bicarbonates of Ca and Mg, removable by boiling.

25. C

Explanation: E. coli is used globally as an indicator organism of recent fecal contamination.

26. C

Explanation: Ozone forms when primary pollutants react in the atmosphere, making it a secondary pollutant.

27. C

Explanation: Composting is a biological process where organic waste decomposes under aerobic conditions.

28. B

Explanation: Adding two equal noise levels (L) results in an increase of 3 dB; $80 + 80 = 83$ dB.

29. B

Explanation: The ruling design speed for National Highways in plain terrain is generally 100 kmph.

30. A

Explanation: The shift of a transition curve is derived mathematically as $L^2/24R$.

31. C

Explanation: A prime coat is applied to an absorbent surface to plug capillary voids and promote bonding.

32. B

Explanation: Webster's rational method uses traffic volume and saturation flow to calculate optimum cycle length and signal timings.

33. B

Explanation: Coning of wheels at 1 in 20 helps keep the train centered and assists in negotiating curves.

34. A

Explanation: Basic runway lengths are corrected for elevation, temperature, and longitudinal gradient.

35. C

Explanation: True Bearing = Magnetic Bearing + East Declination = $45 + 5 = 50^\circ$.

36. B

Explanation: The backsight (BS) is the first staff reading on a known elevation after setting up.

37. B

Explanation: Collimation error occurs when the line of sight is not strictly perpendicular to the horizontal axis.

38. B

Explanation: In a vertical aerial photograph, relief displacement radiates from the nadir point.

39. C

Explanation: GPS nominally consists of a constellation of 24 operational satellites.

40. A

Explanation: Expected time $t_e = (t_o + 4t_m + t_p)/6$.

41. B

Explanation: Free float is the float used without delaying the early start of any successor activity.

42. A

Explanation: English bond consists of alternating courses of stretchers and headers.

43. C

Explanation: Tricalcium aluminate (C3A) hydrates very rapidly, causing the initial flash set.

44. C

Explanation: Poisson's ratio for structural steel is typically 0.25 to 0.33.

45. C

Explanation: Principal planes are subjected to normal stress only; shear stress is zero.

46. B

Explanation: The point of contraflexure is where the bending moment changes sign.

47. B

Explanation: If tensioned sequentially, elastic shortening causes loss; simultaneous tensioning avoids this.

48. C

Explanation: IS 456 recommends a minimum cover of 40 mm for longitudinal bars in columns.

49. B

Explanation: Stiffeners are used in plate girders to prevent buckling of the thin web.

50. C

Explanation: Standard Proctor test determines maximum dry density and optimum moisture content.

51. B

Explanation: Flow per unit length through a flow net is $q = k \cdot H \cdot (N_f/N_d)$.

52. B

Explanation: Undrained tests simulate fast loading conditions typical of short-term stability in clays.

53. B

Explanation: Negative skin friction exerts a downward drag, reducing net load-carrying capacity.

54. C

Explanation: Friction factor in turbulent flow depends on both relative roughness and Reynolds number.

55. B

Explanation: Specific energy reaches its minimum exactly at critical depth.

56. B

Explanation: The standard pan coefficient for a Class A pan is typically 0.7.

57. B

Explanation: Ponding occurs when filter media voids are plugged with excessive biomass.

58. B

Explanation: Intermediate Sight Distance (ISD) is equal to twice the Stopping Sight Distance (SSD).

59. B

Explanation: PCU converts mixed traffic into equivalent passenger cars to evaluate road capacity.

60. C

Explanation: Healthy vegetation strongly reflects NIR energy, making it ideal for vegetation monitoring.

61. D

Explanation: For an orthogonal matrix A ,

62. C

Explanation: If $Ax = \lambda x$, then $A^{-1}x = (1/\lambda)x$.

63. C

Explanation: Set $f'(x) = 3x^2 - 3 = 0 \Rightarrow x = \pm 1$. $f''(1) = 6 > 0$ (min).

64. A

Explanation: Integration by parts: $[xe^x - e^x]_0^1 = (e - e) - (0 - 1) = 1$.

65. A

Explanation: Highest derivative is order 2, exponent is 1 (degree 1).

66. A

Explanation: $IF = e^{\int \cot x dx} = e^{\ln(\sin x)} = \sin x$.

67. B

Explanation: $\mathcal{L}\{\sin(\omega t)\} = \omega/(s^2 + \omega^2)$.

68. B

Explanation: $C(3, 2) \times (0.5)^3 = 3 \times 0.125 = 0.375 = 3/8$.

69. B

Explanation: $P(A$

70. A

Explanation: Directional derivative is maximized in the direction of the gradient

71. C

Explanation: Divergence of the curl (

72. A

Explanation: Residue of $1/(z-a)^n$ for $n > 1$ at $z = a$ is 0.

73. C

Explanation: Cauchy-Riemann: $u_x = v_y$ and $u_y = -v_x$.

74. B

Explanation: Area = $(h/2)[f(0) + f(2)] = (2/2)[0 + 4] = 4$.

75. C

Explanation: RK4 global error is $O(h^4)$.

76. D

Explanation: Singular matrix (

77. B

Explanation: $\cos(x)$ is even; Maclaurin series has only even powers.

78. A

Explanation: Fourier series of an odd function contains only sine terms.

79. C

Explanation: For $u_{xx} - c^2 u_{yy} = 0$, $B^2 - 4AC = 0 - 4(1)(-c^2) = 4c^2 > 0$ (hyper-

bolic).

80. B

Explanation: Mean $np = 4$, Var $npq = 2 \Rightarrow q = 0.5, p = 0.5$.

81. C

Explanation: Mother-in-law's only daughter = wife. Wife's child = child. Man is father.

82. B

Explanation: Series 1: 7, 8, 9... Series 2: 10, 11, 12. Next is 10.

83. A

Explanation: Hypotenuse = $\sqrt{8^2 + 6^2} = 10$ km.

84. A

Explanation: Shift +6: D=4+6=10, A=1+6=7, N=14+6=20, G=7+6=13, E=5+6=11, R=18+6=24.

85. C

Explanation: Cups are glasses, some glasses are bowls. Bowls/cups overlap indeterminate; I/II are complementary.

86. C

Explanation: Order E, C, D, B, A. D is middle.

87. B

88. B

Explanation: 2024 is leap year (2 odd days). Monday + 2 = Wednesday.

89. C

Explanation: Brass is an alloy; others are metals.

90. C

Explanation: Train and bus are distinct. Travelers use both. Matches one overlapping two disjoint circles.