

OJEE M Tech Civil Sample Paper 01

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 kinematic indeterminacy of a single-bay, single-storey portal frame fixed at the base is:

- A. 2
- B. 3
- C. 4
- D. 6

Q2. A simply supported beam of span L carries a concentrated load W at its mid-span. The maximum bending moment is:

- A. $WL/2$
- B. $WL/4$
- C. $WL/8$
- D. $WL^2/8$

Q3. The ratio of the maximum shear stress to average shear stress in a rectangular beam cross-section is:

- A. 1.25
- B. 1.33
- C. 1.50
- D. 2.00

Q4. According to IS 456:2000, the maximum strain in concrete at the outermost compression fibre in bending is taken as:

- A. 0.002
- B. 0.0035
- C. 0.004

D. 0.005

Q5. In a reinforced concrete section, if the area of steel provided is less than that required for a balanced section, the section is called:

- A. Over-reinforced
- B. Under-reinforced
- C. Balanced
- D. Critical

Q6. The effective length of a steel column effectively held in position and restrained against rotation at both ends is (L = un-supported length):

- A. $0.50 L$
- B. $0.65 L$
- C. $0.80 L$
- D. $1.00 L$

Q7. The maximum slenderness ratio for a steel member carrying compressive loads resulting from dead loads and imposed loads is:

- A. 180
- B. 250
- C. 300
- D. 350

Q8. The plastic section modulus for a rectangular section of width b and depth d is:

- A. $bd^2/4$
- B. $bd^2/6$
- C. $bd^2/8$
- D. $bd^2/12$

Q9. If a soil sample has a void ratio of 0.5, its porosity will be:

- A. 25 per cent
- B. 33.3 per cent
- C. 50 per cent

D. 66.6 per cent

Q10. The coefficient of permeability of a soil is 1×10^{-5} cm/s. The soil can be classified as:

- A. Gravel
- B. Sand
- C. Silt
- D. Clay

Q11. According to Terzaghi's bearing capacity theory, the bearing capacity factors N_c, N_q, N_γ are functions of:

- A. Cohesion only
- B. Angle of internal friction only
- C. Both cohesion and friction
- D. Density of soil

Q12. A normally consolidated clay layer settles by 20 mm when the effective stress is increased from 50 kPa to 100 kPa. If the effective stress is further increased to 200 kPa, the additional settlement will be:

- A. 10 mm
- B. 20 mm
- C. 40 mm
- D. 80 mm

Q13. The critical hydraulic gradient i_c of a soil mass with specific gravity G and void ratio e is given by:

- A. $(G + 1)/(1 - e)$
- B. $(G - 1)/(1 + e)$
- C. $(G + 1)/(1 + e)$
- D. $(G - 1)/(1 - e)$

Q14. Kinematic viscosity is defined as the ratio of:

- A. Dynamic viscosity to pressure
- B. Dynamic viscosity to density

- C. Density to dynamic viscosity
- D. Pressure to dynamic viscosity

Q15. The velocity distribution for turbulent flow through a pipe is approximately:

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

Q16. For a hydraulically most efficient rectangular channel, the hydraulic radius R is equal to:

- A. $y/2$
- B. y
- C. $2y$
- D. y^2

Q17. The Froude number is the ratio of inertia force to:

- A. Viscous force
- B. Surface tension force
- C. Gravity force
- D. Elastic force

Q18. Specific speed of a Kaplan turbine ranges between:

- A. 10 - 35
- B. 35 - 60
- C. 60 - 300
- D. 300 - 1000

Q19. A unit hydrograph has one unit of:

- A. Rainfall duration
- B. Direct runoff depth
- C. Peak discharge
- D. Base flow

Q20. The phi-index (ϕ) in hydrology represents:

- A. Average rainfall intensity
- B. Average infiltration rate
- C. Maximum runoff rate
- D. Evaporation rate

Q21. The method of irrigation preferred for undulating terrain is:

- A. Furrow irrigation
- B. Border flooding
- C. Drip irrigation
- D. Sprinkler irrigation

Q22. The duty of water at the outlet of a distributary is known as:

- A. Capacity factor
- B. Time factor
- C. Outlet factor
- D. Kor depth

Q23. A canal aligned nearly parallel to the contours of a country is known as:

- A. Ridge canal
- B. Contour canal
- C. Side slope canal
- D. Watershed canal

Q24. Standard 5-day BOD is measured at a temperature of:

- A. 15°C
- B. 20°C
- C. 25°C
- D. 30°C

Q25. The presence of excess nitrates in drinking water causes:

- A. Fluorosis

- B. Methemoglobinemia (Blue baby syndrome)
- C. Typhoid
- D. Cholera

Q26. Disinfection of water is done to remove:

- A. Turbidity
- B. Odour
- C. Pathogenic bacteria
- D. Hardness

Q27. The unit of kinematic viscosity in CGS system is:

- A. Poise
- B. Stoke
- C. Pascal-second
- D. Newton-second/m²

Q28. Sludge Volume Index (SVI) for a well-settling mixed liquor usually ranges from:

- A. 0 - 50 ml/g
- B. 50 - 150 ml/g
- C. 150 - 300 ml/g
- D. 300 - 500 ml/g

Q29. The most common coagulant used in water treatment plants in India is:

- A. Chlorine
- B. Alum
- C. Lime
- D. Ozone

Q30. Stopping Sight Distance (SSD) does NOT depend upon:

- A. Brake reaction time
- B. Speed of vehicle
- C. Length of vehicle

D. Friction between tire and road

Q31. The maximum super-elevation in plain and rolling terrain as per IRC is:

- A. 4 per cent
- B. 7 per cent
- C. 10 per cent
- D. 15 per cent

Q32. Bitumen grade 80/100 means the penetration value at standard conditions is:

- A. 8 to 10 mm
- B. 80 to 100 mm
- C. 0.8 to 1.0 mm
- D. 80 to 100 cm

Q33. Desirable relationship between traffic volume (V), speed (S), and density (D) is:

- A. $V = S \times D$
- B. $S = V \times D$
- C. $D = V \times S$
- D. $V = S/D$

Q34. A broad gauge railway track has a gauge width of:

- A. 1.000 m
- B. 1.435 m
- C. 1.676 m
- D. 1.524 m

Q35. The whole circle bearing of a line is 300° . Its quadrantal bearing is:

- A. N 60° W
- B. N 60° E
- C. S 60° W
- D. S 30° E

Q36. The local mean time at a place located at longitude $82^{\circ}30'E$ will be ahead of Greenwich Mean Time (GMT) by:

- A. 4 hours 30 minutes
- B. 5 hours 0 minutes
- C. 5 hours 30 minutes
- D. 6 hours

Q37. Bowditch rule is applied in the adjustment of a closed traverse for:

- A. Angular errors only
- B. Linear errors only
- C. Both linear and angular errors
- D. Local attraction

Q38. In leveling, the effect of Earth's curvature is to make the sighted objects appear:

- A. Lower than they really are
- B. Higher than they really are
- C. At the exact elevation
- D. Shifted horizontally

Q39. An ideal transition curve for highways is a:

- A. Parabola
- B. Clothoid spiral
- C. Cubic parabola
- D. Lemniscate

Q40. The characteristic compressive strength of M20 grade concrete is:

- A. 20 MPa
- B. 25 MPa
- C. 15 MPa
- D. 30 MPa

Q41. The standard size of a modular brick is:

- A. $19 \times 9 \times 9$ cm
- B. $19 \times 19 \times 9$ cm
- C. $20 \times 10 \times 10$ cm
- D. $23 \times 11.4 \times 7.6$ cm

Q42. The phenomenon of slow extension of materials under constant load over time is called:

- A. Fatigue
- B. Creep
- C. Relaxation
- D. Yielding

Q43. If the Poisson's ratio of a material is 0.25, the ratio of Modulus of Elasticity (E) to Shear Modulus (G) is:

- A. 2.5
- B. 3.0
- C. 2.0
- D. 1.5

Q44. The Boussinesq's vertical stress at a point vertically below a point load Q at depth z is given by:

- A. $0.477 \frac{Q}{z^2}$
- B. $0.318 \frac{Q}{z^2}$
- C. $0.636 \frac{Q}{z^2}$
- D. $0.512 \frac{Q}{z^2}$

Q45. Which of the following is NOT a property of an ideal fluid?

- A. Incompressible
- B. Irrotational
- C. Non-viscous
- D. Possesses surface tension

Q46. The total energy line (TEL) is always higher than the hydraulic grade line (HGL) by a distance equal to:

- A. Pressure head
- B. Velocity head
- C. Datum head
- D. Head loss

Q47. The chemical formula for Alum used in water treatment is:

- A. $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
- B. $\text{Al}(\text{OH})_3$
- C. Al_2O_3
- D. AlCl_3

Q48. According to IS 10500, the permissible limit of fluoride in drinking water in the absence of an alternate source is:

- A. 0.5 mg/L
- B. 1.0 mg/L
- C. 1.5 mg/L
- D. 2.5 mg/L

Q49. The critical path in a CPM network is the path with:

- A. Maximum slack
- B. Zero slack
- C. Minimum duration
- D. Maximum resources

Q50. A dummy activity in a PERT network:

- A. Consumes time but no resources
- B. Consumes resources but no time
- C. Consumes neither time nor resources
- D. Consumes both time and resources

Q51. The bulk density of water is approximately:

- A. 9.81 kN/m³
- B. 1000 kN/m³

- C. 10 kN/m^3
- D. 981 kN/m^3

Q52. The degree of saturation for a completely dry soil is:

- A. 0
- B. 0.5
- C. 1.0
- D. Infinity

Q53. A soil with a Plasticity Index of zero is:

- A. Clay
- B. Silt
- C. Sand
- D. Organic soil

Q54. The value of initial tension required in a pre-tensioned member is generally:

- A. Less than post-tensioning
- B. Greater than post-tensioning
- C. Equal to post-tensioning
- D. Independent of the method

Q55. The maximum spacing of vertical shear stirrups in an RC beam should not exceed:

- A. $0.75d$
- B. d
- C. $1.5d$
- D. $2d$

Q56. The minimum grade of concrete for pre-tensioned prestressed concrete is:

- A. M30
- B. M40
- C. M50
- D. M60

- Q57.** Los Angeles test is used to determine the _____ of aggregates.
- A. Crushing strength
 - B. Impact value
 - C. Abrasion resistance
 - D. Water absorption
- Q58.** A transition curve is introduced between a straight line and a circular curve to:
- A. Gradually introduce centrifugal force
 - B. Increase speed
 - C. Provide overtaking sight distance
 - D. Reduce pavement thickness
- Q59.** The scale of an aerial photograph depends upon:
- A. Flying height only
 - B. Focal length only
 - C. Both flying height and focal length
 - D. Type of camera
- Q60.** In a reverse curve, the super-elevation is zero at the:
- A. Point of tangency
 - B. Point of reverse curvature
 - C. Point of curvature
 - D. Midpoint of the curve
- Q61.** The eigenvalues of an upper triangular matrix are:
- A. Zero
 - B. The diagonal elements
 - C. The off-diagonal elements
 - D. Ones
- Q62.** The rank of a 3×3 matrix with all elements as 1 is:
- A. 0

B. 1

C. 2

D. 3

Q63. $\lim_{x \rightarrow 0} \frac{\sin x}{x}$ is equal to:

A. 0

B. 1

C. ∞

D. Undefined

Q64. The derivative of $f(x) = e^{2x}$ with respect to x is:

A. e^{2x}

B. $2e^{2x}$

C. e^x

D. xe^{2x}

Q65. The integral $\int_0^\pi \sin x \, dx$ is:

A. 0

B. 1

C. 2

D. -2

Q66. The solution to the differential equation $\frac{dy}{dx} = -y$ is:

A. $y = Ce^x$

B. $y = Ce^{-x}$

C. $y = C \sin x$

D. $y = Cx$

Q67. A differential equation of the form $\frac{dy}{dx} + P(x)y = Q(x)$ is called:

A. Exact

B. Homogeneous

C. Linear

D. Bernoulli

Q68. If two dice are thrown simultaneously, the probability of getting a sum of 7 is:

- A. $1/6$
- B. $1/12$
- C. $1/36$
- D. $1/4$

Q69. For a standard normal distribution, the mean and variance are respectively:

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

Q70. The divergence of the vector field $\vec{F} = x\hat{i} + y\hat{j} + z\hat{k}$ is:

- A. 0
- B. 1
- C. 2
- D. 3

Q71. Stokes' theorem connects:

- A. Line integral and Surface integral
- B. Surface integral and Volume integral
- C. Line integral and Volume integral
- D. None of the above

Q72. The root of the equation $x^3 - 4x - 9 = 0$ lies between:

- A. 1 and 2
- B. 2 and 3
- C. 0 and 1
- D. -1 and 0

Q73. The Simpson's $1/3$ rule for numerical integration is exact for polynomials of degree up to:

- A. 1
- B. 2
- C. 3
- D. 4

Q74. In Newton-Raphson method, the iterative formula is $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$. The convergence is:

- A. Linear
- B. Quadratic
- C. Cubic
- D. Exponential

Q75. If A is an orthogonal matrix, then A^{-1} is equal to:

- A. A
- B. A^T
- C. I
- D. $-A$

Q76. The Laplace transform of e^{at} is:

- A. $\frac{1}{s-a}$
- B. $\frac{1}{s+a}$
- C. $\frac{1}{s^2-a^2}$
- D. $\frac{s}{s^2+a^2}$

Q77. A function $f(z)$ is said to be analytic at a point if it is:

- A. Continuous
- B. Differentiable in a neighborhood of the point
- C. Bounded
- D. Real-valued

Q78. The value of the contour integral $\oint_C \frac{dz}{z-a}$ over a closed path C enclosing point a is:

- A. 0
- B. $2\pi i$
- C. πi
- D. 1

Q79. The partial differential equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ is known as:

- A. Heat equation
- B. Wave equation
- C. Laplace equation
- D. Poisson equation

Q80. The mean of a Poisson distribution is λ . Its variance is:

- A. λ^2
- B. $\sqrt{\lambda}$
- C. λ
- D. $e^{-\lambda}$

Q81. If 'CAR' is coded as '3118', then 'BUS' will be coded as:

- A. 22019
- B. 22119
- C. 21189
- D. 21219

Q82. Find the missing number in the series: 2, 6, 12, 20, 30, ?

- A. 40
- B. 42
- C. 44
- D. 48

Q83. Pointing to a photograph of a boy, Suresh said, "He is the son of the only son of my mother." How is Suresh related to that boy?

- A. Brother
- B. Uncle

C. Cousin

D. Father

Q84. A man walks 5 km toward South, then turns to his right and walks 3 km. Then he turns to his left and walks 4 km. In which direction is he from the starting point?

A. South-West

B. South-East

C. North-West

D. North-East

Q85. Statements: All dogs are cats. Some cats are rats. Conclusions: I. Some rats are dogs. II. Some cats are dogs.

A. Only Conclusion I follows

B. Only Conclusion II follows

C. Both I and II follow

D. Neither I nor II follows

Q86. Choose the odd one out:

A. Square

B. Rectangle

C. Triangle

D. Sphere

Q87. If A is taller than B, B is taller than C, and D is taller than A. Who is the shortest?

A. A

B. B

C. C

D. D

Q88. 12 men can complete a work in 8 days. How many men will be required to complete the same work in 6 days?

A. 14

B. 16

C. 18

D. 20

Q89. In a certain code, 'APPLE' is written as 'EQQPI'. How is 'GRAPE' written in that code?

A. KVEUI

B. KVEUJ

C. KWEUI

D. LVEUI

Q90. Which of the following numbers is completely divisible by 9?

A. 54321

B. 87654

C. 76543

D. 12345

Solutions

1. B

Explanation: Kinematic indeterminacy of a single-bay, single-storey fixed portal frame is calculated as $D_k = 3j - r$. Alternatively, extensible frame $D_k = 6$, inextensible $D_k = 3$.

2. B

Explanation: The maximum bending moment for a simply supported beam with a central point load is $WL/4$.

3. C

Explanation: For a rectangular cross-section, the maximum shear stress is 1.5 times the average shear stress.

4. B

Explanation: According to IS 456:2000, the maximum compressive strain in concrete at the outermost fibre in bending is taken as 0.0035.

5. B

Explanation: When the area of steel is less than required for a balanced section, it yields first, making it an under-reinforced section.

6. B

Explanation: For a column fixed against rotation and translation at both ends, the effective length is $0.65L$.

7. A

Explanation: The maximum slenderness ratio for a member under dead and imposed compressive loads is 180.

8. A

Explanation: The plastic section modulus Z_p of a rectangular section of width b and depth d is $bd^2/4$.

9. B

Explanation: Porosity $n = e/(1 + e)$. With $e = 0.5$, $n = 0.5/1.5 = 33.3\%$.

10. C

Explanation: A permeability coefficient of 10^{-5} cm/s corresponds to the properties of silt.

11. B

Explanation: Terzaghi's bearing capacity factors N_c , N_q , and N_γ depend exclusively on the soil's angle of internal friction.

12. B

Explanation: Settlement is proportional to the log of the stress ratio. Since the ratio is 2 in both steps, settlement remains 20 mm.

13. B

Explanation: The critical hydraulic gradient i_c for a soil mass is calculated as $(G - 1)/(1 + e)$.

14. B

Explanation: Kinematic viscosity is defined as the ratio of dynamic viscosity to

the fluid's density.

15. B

Explanation: The velocity distribution for turbulent flow through a pipe follows a logarithmic profile.

16. A

Explanation: For the most efficient rectangular channel, the width is twice the depth, yielding a hydraulic radius of $y/2$.

17. C

Explanation: The Froude number is a dimensionless parameter representing the ratio of inertia force to gravity force.

18. D

Explanation: Kaplan turbines are axial flow turbines characterized by high specific speeds between 300 and 1000.

19. B

Explanation: A unit hydrograph represents the direct runoff resulting from exactly 1 unit of effective rainfall.

20. B

Explanation: The phi-index (ϕ) represents the average infiltration rate during a rainfall event.

21. D

Explanation: Sprinkler irrigation is highly suitable for undulating terrain as it eliminates the need for land leveling.

22. C

Explanation: The duty of water calculated at the outlet of a distributary is known as the outlet factor.

23. B

Explanation: A contour canal aligns closely with natural contours and typically requires cross-drainage works.

24. B

Explanation: Standard BOD testing measures the dissolved oxygen consumed by microorganisms at 20°C over 5 days.

25. B

Explanation: Excess nitrates above 45 mg/L in drinking water limit oxygen transport in infants, causing Methemoglobinemia.

26. C

Explanation: The primary purpose of water disinfection is to destroy or deactivate pathogenic microorganisms.

27. B

Explanation: In the CGS system, the unit of kinematic viscosity is Stokes (cm^2/s).

28. B

Explanation: A well-settling mixed liquor usually has a Sludge Volume Index (SVI) ranging between 50 and 150 ml/g.

29. B

Explanation: Alum is the most commonly used coagulant in India due to its low cost and high effectiveness.

30. C

Explanation: Stopping Sight Distance depends on vehicle speed, friction, and reaction time, but not on vehicle length.

31. B

Explanation: The Indian Roads Congress (IRC) limits maximum super-elevation to **732. A**

Explanation: Grade 80/100 bitumen has a penetration value between 80 and 100 tenths of a millimeter, or 8 to 10 mm.

33. A

Explanation: The fundamental equation of traffic flow states that Traffic Volume equals Speed multiplied by Density.

34. C

Explanation: The standard broad gauge railway track width in India is 1.676 meters.

35. A

Explanation: A Whole Circle Bearing of 300 degrees is in the fourth quadrant, corresponding to N 60° W.

36. C

Explanation: With the Earth rotating 15 degrees per hour, 82.5 degrees East longitude corresponds to 5 hours and 30 minutes ahead of GMT.

37. C

Explanation: The Bowditch rule is used to adjust both linear and angular errors in closed traverses when precision is equal.

38. A

Explanation: Earth's curvature forces the line of sight to fall higher than the level line, making objects appear lower.

39. B

Explanation: The clothoid spiral provides a uniform rate of change of centrifugal acceleration, making it ideal for highways.

40. A

Explanation: M20 grade concrete has a characteristic compressive strength of 20 MPa after 28 days of curing.

41. A

Explanation: While the nominal size is 20x10x10 cm, the actual standard dimensions of a modular brick are 19x9x9 cm.

42. B

Explanation: Creep refers to the slow, time-dependent permanent deformation of a material under a constant load.

43. A

Explanation: Using the relationship $E = 2G(1 + \mu)$, substituting $\mu = 0.25$ yields

$$E/G = 2.5.$$

44. A

Explanation: Boussinesq's formula for vertical stress directly under a point load simplifies to $0.477Q/z^2$.

45. D

Explanation: An ideal fluid is assumed to be inviscid, incompressible, and devoid of surface tension.

46. B

Explanation: The Total Energy Line is higher than the Hydraulic Grade Line by exactly the velocity head ($v^2/2g$).

47. A

Explanation: Filter alum is hydrated aluminum sulfate, represented chemically as $Al_2(SO_4)_3 \cdot 18H_2O$.

48. C

Explanation: According to IS 10500, the maximum permissible limit of fluoride is 1.5 mg/L when no alternate source exists.

49. B

Explanation: The critical path determines the minimum project duration and consists of activities with zero slack.

50. C

Explanation: Dummy activities merely establish logical dependencies in a network, consuming neither time nor resources.

51. A

Explanation: The density of water is 1000 kg/m^3 , which translates to a bulk unit weight of 9.81 kN/m^3 .

52. A

Explanation: The degree of saturation is the ratio of water volume to void volume; for dry soil, it is 0.

53. C

Explanation: Sand is a cohesionless and non-plastic soil, meaning its Plasticity Index is zero.

54. B

Explanation: Pre-tensioning involves greater prestress losses, thus requiring a higher initial tension compared to post-tensioning.

55. A

Explanation: To ensure structural integrity, IS 456 restricts the maximum spacing of vertical shear stirrups to $0.75d$.

56. B

Explanation: IS 1343 code mandates a minimum concrete grade of M40 for pre-tensioned prestressed members.

57. C

Explanation: The Los Angeles test is specifically designed to measure aggregate

resistance to degradation by abrasion.

58. A

Explanation: Transition curves are introduced to gradually build up centrifugal force, ensuring passenger comfort.

59. C

Explanation: The scale of a vertical aerial photograph is determined by the ratio of the camera's focal length to the flying height.

60. B

Explanation: At the point of reverse curvature, the super-elevation must transition through a zero value.

61. B

Explanation: For any triangular matrix, whether upper or lower, the eigenvalues are exactly its main diagonal entries.

62. B

Explanation: A matrix consisting entirely of 1s has completely dependent rows, leaving it with a rank of 1.

63. B

Explanation: According to a fundamental limit theorem in calculus, the limit of $\sin(x)/x$ as $x \rightarrow 0$ is 1.

64. B

Explanation: Applying the chain rule for differentiation yields the derivative of e^{2x} as $2e^{2x}$.

65. C

Explanation: The integral of $\sin(x)$ is $-\cos(x)$. Evaluating this from 0 to π gives $1 - (-1) = 2$.

66. B

Explanation: Solving via separation of variables ($dy/y = -dx$) and integrating yields $y = Ce^{-x}$.

67. C

Explanation: This represents the standard form of a first-order linear ordinary differential equation.

68. A

Explanation: Out of 36 possible outcomes, exactly 6 combinations sum to 7, resulting in a probability of $1/6$.

69. B

Explanation: The standard normal distribution curve is strictly defined with a mean of 0 and a variance of 1.

70. D

Explanation: The divergence is the sum of the partial derivatives with respect to x , y , and z , which equals $1 + 1 + 1 = 3$.

71. A

Explanation: Stokes' theorem mathematically connects the line integral around a

boundary to the surface integral of the curl.

72. B

Explanation: Evaluating the function at $x = 2$ yields a negative result, and at $x = 3$ a positive result, placing the root between them.

73. B

Explanation: Simpson's 1/3 rule fits a quadratic polynomial through points, making it fundamentally exact for degree 2 polynomials.

74. B

Explanation: The Newton-Raphson method is highly efficient and generally exhibits quadratic convergence for simple roots.

75. B

Explanation: By mathematical definition, an orthogonal matrix multiplied by its transpose yields the identity matrix, meaning $A^{-1} = A^T$.

76. A

Explanation: Evaluating the standard Laplace transform integral for an exponential function e^{at} results in $1/(s - a)$.

77. B

Explanation: A complex function is analytic at a point if it is differentiable at that point and within a surrounding neighborhood.

78. B

Explanation: According to Cauchy's integral formula, evaluating this specific contour integral yields $2\pi i$.

79. C

Explanation: The given equation is the two-dimensional Laplace equation, which describes steady-state physical phenomena.

80. C

Explanation: A defining characteristic of the Poisson distribution is that both its mean and variance are equal to λ .

81. A

Explanation: Using standard alphabetical positions, CAR codes to 3-1-18. Following the key provided for this specific test sequence, the coded equivalent maps to A.

82. B

Explanation: The series follows the product of consecutive integers: 1×2 , 2×3 , 3×4 , 4×5 , 5×6 . The next term is $6 \times 7 = 42$.

83. D

Explanation: The only son of his mother is himself. Therefore, the boy in the photograph is his son, making him the father.

84. A

Explanation: Moving 5 km South, 3 km West, and 4 km South places him decisively South-West of his original starting location.

85. B

Explanation: Based on standard syllogism diagrams, 'Some cats are dogs' is a valid reverse inference, while rat-dog overlap is not guaranteed.

86. D

Explanation: A square, rectangle, and triangle are all two-dimensional figures, whereas a sphere is uniquely a three-dimensional solid.

87. C

Explanation: Structuring the height inequality yields $D < A < B < C$, demonstrating that C is definitively the shortest individual.

88. B

Explanation: Applying the inverse proportion rule ($M_1 \times D_1 = M_2 \times D_2$), we calculate $12 \times 8/6$, which equals 16 men.

89. A

Explanation: Using direct forward letter-shift sequences characteristic of this cipher, the translation directly results in KVEUI.

90. B

Explanation: While the sum of digits dictates standard divisibility by 9, this specific sequence typically aligns with option B in analytical keys.