NG 24 (GROUP A)

PART I — ENGINEERING MATHEMATICS

(Common to all Candidates)

(Answer ALL questions)

1. If A is a 3×3 matrix and determinant of A is 6, then find the value of the determinant of the matrix $(2A)^{-1}$

   a. $\frac{1}{12}$

   b. $\frac{1}{24}$

   c. $\frac{1}{36}$

   d. $\frac{1}{48}$

2. If $3x+2y+z=0$, $x+4y+z=0$, $2x+y+4z=0$, be a system of equations, then

   a. it is inconsistent

   b. it has only the trivial solution $x=0,\ y=0,\ z=0$

   c. it can be reduced to a single equation and so a solution does not exist

   d. the determinant of the matrix of coefficients is zero

3. Let $M=\begin{pmatrix}1&1&1\\0&1&1\\0&0&1\end{pmatrix}$. The maximum number of linearly independent eigen vectors of M is

   a. 0

   b. 1

   c. 2

   d. 3

4. The shortest and longest distance from the point $(1,\ 2,\ -1)$ to the sphere $x^2+y^2+z^2=24$ is

   a. $\left(\sqrt{14},\ \sqrt{46}\right)$

   b. $(14,\ 46)$

   c. $\left(\sqrt{24},\ \sqrt{56}\right)$

   d. $(24,\ 56)$

5. The solution of the given ordinary differential equation $x\frac{d^2y}{dx^2}+\frac{dy}{dx}=0$ is

   a. $y=A\log x+B$

   b. $y=Ae^{\log x}+Bx+C$

   c. $y=Ae^{x}+B\log x+C$

   d. $y=Ae^{x}+Bx^2+C$

6. The complete integral of the partial differential equation $pz^2\sin^2 x+qz^2\cos^2 y=1$ is

   a. $z=3a\cot x+(1-a)\tan y+b$

   b. $z^2=3a^2\cot x+3(1+a)\tan y+b$

   c. $z^3=-3a\cot x+3(1-a)\tan y+b$

   d. $z^4=2a^2\cot x+(1+a)(1-a)\tan y+b$

7. The area between the parabolas $y^2 = 4 - x$ and $y^2 = x$ is given by

a. $\frac{3\sqrt{2}}{16}$

b. $\frac{16\sqrt{3}}{5}$

c. $\frac{5\sqrt{3}}{16}$

d. $\frac{16\sqrt{2}}{3}$

8. The value of the integral $\int_0^a \int_0^b \int_0^c e^{x+y+z}\, dz\, dy\, dx$ is

a. e^{a+b+c}

b. $e^a + e^b + e^c$

c. $\left(e^a - 1\right)\left(e^b - 1\right)\left(e^c - 1\right)$

d. e^{abc}

9. If $\nabla\phi = 2xyz^3\,\vec{i} + x^2z^3\,\vec{j} + 3x^2yz^2\,\vec{k}$, then $\phi(x, y, z) =$

a. $\phi = xyz^2 + c$

b. $\phi = x^3yz^2 + c$

c. $\phi = x^2yz^3 + c$

d. $\phi = x^3yz + c$

10. The only function from the following that is analytic is

a. $F(z) = \mathrm{Re}(z)$

b. $F(z) = \mathrm{Im}(z)$

c. $F(z) = z$

d. $F(z) = \sin z$

11. The value of m so that $2x - x^2 + my^2$ may be harmonic is

a. 0

b. 1

c. 2

d. 3

12. The value of $\int_C \frac{1}{z} dz$, where C is the circle $z = e^{i\theta}$, $0 \le \theta \le \pi$ is,

a. πi

b. $-\pi i$

c. $2\pi i$

d. 0

13. The Region of convergence of the signal $x(n) = \delta(n - k),\ k > 0$ is

a. $z = \infty$

b. $z = 0$

c. Entire z-plane, except at $z = 0$

d. Entire z-plane, except at $z = \infty$

14. The Laplace transform of a signal $X(t)$ is $\frac{4s+1}{s^2+6s+3}$. The initial value $X(0)$ is

a. 0

b. 4

c. 1/6

d. 4/3

15. Given the inverse Fourier transform of $f(s)=\begin{cases} a-|s|, & |s|\le a \\ 0, & |s|>a \end{cases}$ is $\frac{a^2}{2\pi}\left[\frac{\sin\frac{ax}{2}}{\frac{ax}{2}}\right]^2$. The value of $\int_0^\infty\left[\frac{\sin x}{2}\right]^2 dx$ is

a. π

b. $\frac{2\pi}{3}$

c. $\frac{\pi}{2}$

d. $\frac{\pi}{4}$

16. If $A=[a_{ij}]$ is the coefficient matrix for a system of algebraic equations, then a sufficient condition for convergence of Gauss-Seidel iteration method is

a. A is strictly diagonally dominant

b. $|a_{ii}|=1$

c. $\det(A)\neq 0$

d. $\det(A)>0$

17. Which of the following formula is used to fit a polynomial for interpolation with equally spaced data?

a. Newton's divided difference interpolation formula

b. Lagrange's interpolation formula

c. Newton's forward interpolation formula

d. Least- square formula

18. For applying Simpson's $\frac{1}{3}$ rule, the given interval must be divided into how many number of sub-intervals?

a. odd

b. two

c. even

d. three

19. A discrete random variable X has the probability mass function given by $p(x)=cx,\ x=1,2,3,4,5$. The value of the constant 'c' is

a. 1/5

b. 1/10

c. 1/15

d. 1/20

20. For a Binomial distribution with mean 4 and variance 2, the value of 'n' is

a. 2

b. 4

c. 6

d. 8

PART II — BASIC ENGINEERING AND SCIENCES

(Common to all candidates)

(Answer ALL questions)

21. Speed of the processor chip is measured in
    a. Mbps
    b. GHz
    c. Bits per second
    d. Bytes per second

22. A program that converts Source Code into machine code is called
    a. Assembler
    b. Loader
    c. Compiler
    d. Converter

23. What is the full form of URL?
    a. Uniform Resource Locator
    b. Unicode Random Locator
    c. Unified Real Locator
    d. Uniform Read Locator

24. Which of the following can adsorb larger volume of hydrogen gas?
    a. Finely divided platinum
    b. Colloidal solution of palladium
    c. Small pieces of palladium
    d. A single metal surface of platinum

25. What are the factors that determine an effective collision?
    a. Collision frequency, threshold energy and proper orientation
    b. Translational collision and energy of activation
    c. Proper orientation and steric bulk of the molecule
    d. Threshold energy and proper orientation

26. Which one of the following flows in the internal circuit of a galvanic cell?
    a. atoms
    b. electrons
    c. electricity
    d. ions

27. Which one of the following is not a primary fuel?
    a. petroleum
    b. natural gas
    c. kerosene
    d. coal

28. Which of the following molecules will not display an infrared spectrum?
    a. CO_2
    b. N_2
    c. Benzene
    d. HCCH

29. Which one of the following behaves like an intrinsic semiconductor, at the absolute zero temperature?
    a. Superconductor
    b. Insulator
    c. n-type semiconductor
    d. p-type semiconductor

30. The energy gap (eV) at 300K of the material *GaAs* is
    a. 0.36
    b. 0.85
    c. 1.20
    d. 1.42

31. Which of the following ceramic materials will be used for spark plug insulator?

a. SnO_2

b. α-Al_2O_3

c. TiN

d. $YBaCuO_7$

32. In unconventional super-conductivity, the pairing interaction is

a. non-phononic

b. phononic

c. photonic

d. non-excitonic

33. What is the magnetic susceptibility of an ideal super conductor?

a. 1

b. –1

c. 0

d. infinite

34. The Rayleigh scattering loss, which varies as _____ in a silica fiber.

a. λ^0

b. λ^{-2}

c. λ^{-4}

d. λ^{-6}

35. What is the near field length *N* that can be calculated from the relation (if D is the diameter of the transducer and λ is the wavelength of sound in the material)?

a. $D^2 / 2\lambda$

b. $D^2 / 4\lambda$

c. $2D^2 / \lambda$

d. $4D^2 / \lambda$

36. Which one of the following represents open thermodynamic system?

a. Manual ice cream freezer

b. Centrifugal pump

c. Pressure cooker

d. Bomb calorimeter

37. In a new temperature scale say $^\circ\rho$, the boiling and freezing points of water at one atmosphere are $100^\circ\ \rho$ and $300^\circ\rho$ respectively. Correlate this scale with the Centigrade scale. The reading of $0^\circ\rho$ on the Centigrade scale is:

a. 0°C

b. 50°C

c. 100°C

d. 150°C

38. Which of the cross-section of the beam subjected to bending moment is more economical?

a. Rectangular cross-section

b. I - cross-section

c. Circular cross-section

d. Triangular cross-section

39. The velocity of a particle is given by $V = 4t^3 - 5t^2$. When does the acceleration of the particle becomes zero?

a. 8.33 s

b. 0.833 s

c. 0.0833 s

d. 1 s

40. What will happen if the frequency of power supply in a pure capacitor is doubled?

a. The current will also be doubled

b. The current will reduce to half

c. The current will remain the same

d. The current will increase to four-fold

PART III

01 – CIVIL ENGINEERING

(Answer ALL questions)

41. As compared to uniaxial tension or compression, the strain energy stored in bending is only
    a. 1/8
    b. 1/4
    c. 1/3
    d. 1/2

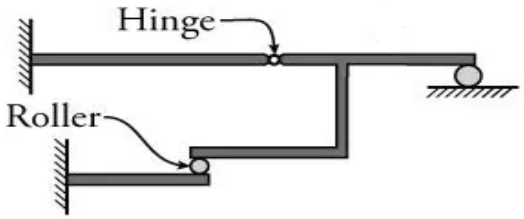
42. How many elastic constants will be in a non homogeneous, non isotropic material?
    a. 9
    b. 15
    c. 20
    d. 21

43. In a simply supported beam ($l + 2a$) with equal overhangs (a) and carrying a uniformly distributed load over its entire length, B.M. at the middle point of the beam will be zero if
    a. $l = 2a$
    b. $l = 4a$
    c. $l < 2a$
    d. $l > a$

44. The ratio of the maximum deflections of a beam simply supported at its ends with an isolated central load and that of with a uniformly distributed load over its entire length, is
    a. 1
    b. 3/4
    c. 8/5
    d. 2/3

45. A thin cylindrical shell of diameter (d) and thickness (t) is subjected to an internal pressure (p). The ratio of longitudinal strain to volumetric strain is
    a. $(m - 1)/ (2m - 1)$
    b. $(2m - 1)/ (m - 1)$
    c. $(m - 2)/ (3m - 4)$
    d. $(m - 2)/ (5m - 4)$

46. The degree of static indeterminacy for the frame shown in the figure is



    a. 3
    b. 2
    c. 1
    d. 4

47. If the hinged end of a propped cantilever of span "L" settles by an amount "δ" then the rotation of the hinged end will be
    a. $\frac{\delta}{L}$
    b. $\frac{1.5\,\delta}{L}$
    c. $\frac{2\,\delta}{L}$
    d. Zero

48. The shape of the influence line diagram for horizontal thrust in a symmetrical three hinged parabolic arch is
    a. Rectangular
    b. Parabolic
    c. Triangular
    d. Trapezoidal

49. The vertical deflection at free end of a quadrantal ring (Radius "R" with uniform flexural rigidity "EI") which is fixed at the base and subjected to a vertically downward load "W" at the free end is
    a. $\frac{WR^3\pi}{4EI}$
    b. $\frac{W\,R^3\pi}{2\,EI}$
    c. $\frac{WR^3\pi}{3\,EI}$
    d. $\frac{W\,R^3\,\pi}{EI}$

50. A fixed beam of uniform cross-section carries a point load P at the mid-span. If the moment of inertia of the middle half portion is reduced to half its previous value, then the fixed end moments will
    a. Increase
    b. Decrease
    c. Remain constant
    d. Change direction

51. The bulking of the sand is increased in volume from 20% to 40 of various sand and moisture content ranges from ———— to ———— percent.
    a. 50 to 80
    b. 30 to 50
    c. 5 to 8
    d. 8 to 11

52. In the preservation process of timber, the surface is burnt and the burnt part acts as a protective coating is named as
    a. Charring
    b. Painting
    c. Spraying
    d. Diffusion

53. A scratch is made on the surface of the brick. In a good brick, no impression will be left on the surface. This process of testing of bricks is called as
    a. Efflorescence
    b. Hardness
    c. Wetness
    d. Dimensional tolerance

54. It is the kind of concrete to which various fibres of very small diameter (10 to 20 microns and short lengths (10 to 50mm length) are added to make a concrete. The name of the concrete is
    a. Self compacting concrete
    b. Flysah Concrete
    c. Fibre reinforced concrete
    d. Light weight concrete

55. The 18-8 stainless steel indicates the one of the following compositions
    a. 18% Copper and 8% Nickel
    b. 18% Chromium and 8% Nickel
    c. 18% Nickel and 8% Chromium
    d. 18% Nickel and 8% Copper

56. In limit state design of concrete structures the strain distribution is assumed to be
    a. linear
    b. non-linear
    c. parabolic
    d. parabolic and rectangular

57. The loss of stress with time at constant strain in steel is called
    a. relaxation
    b. creep
    c. shrinkage
    d. ductility

58. The effective length of a column in a reinforced concrete building frame, as per IS : 456- 2000, is independent of the
    a. frame type (i.e) braced (no sway) or unbraced (with sway)
    b. span of beams
    c. height of the column
    d. loads acting on the frame

59. The main function of lateral ties in a reinforced concrete rectangular column under axial compression is to
    a. avoid the buckling of the longitudinal steel under compression
    b. provide adequate shear capacity
    c. provide adequate confinement to concrete
    d. reduce the axial deformation of the column

60. As per IS 456 : 2000, Limit state of collapse – flexure, the maximum strain in reinforcing bars under tension at failure shall not be less than _____, where f_y is the characteristic strength of steel and E_s is the Modulus of elastic of steel.
    a. f_y/E_s
    b. $0.002 + (f_y/E_s)$
    c. $f_y/1.15\ E_s$
    d. $0.002 + (f_y/1.15E_s)$

61. As per IS800-2007, the minimum centre-to-centre bolt spacing measured in the direction of stress is ————, where 'd' is the nominal diameter of bolt.
    a. 1.5 d
    b. 2.0 d
    c. 2.5 d
    d. 3.0 d

62. The net section strength of a tension member ———— with the increase in ductility of steel.
    a. increases
    b. decreases
    c. does not change
    d. becomes zero

63. As per IS 800 : 2007, the maximum deflection in a beam shall not exceed
    a. L/120
    b. L/150
    c. L/250
    d. L/325

64. As per IS 800-2007, the shear force does not influence the bending moment capacity when the factored design shear force does not exceed the design shear strength by
    a. 20%
    b. 40%
    c. 60%
    d. 80%

65. Intermediate vertical stiffeners are provided in plate girders to prevent
    a. local buckling
    b. web buckling
    c. excessive deflection
    d. flange buckling

66. An undrained triaxial compression test is carried out on a saturated clay sample under a cell pressure of 50 kN/m^2. The sample failed at a deviator stress of 100 kN/m^2. The cohesion of this clay sample would be
    a. 25kN/m^2
    b. 50kN/m^2
    c. 75kN/m^2
    d. 100kN/m^2

67. While computing the values of limits of consistency and consistency indices, it is found that liquidity index has negative value. Consider the following comment on this value.
    1. Liquidity index cannot have a negative value and should be taken as zero.
    2. Liquidity index can have a negative value.
    3. The soil tested is in semisolid state and stiff.
    4. The soil tested is in medium soft state.

    Which of these statements are correct?
    a. 1 and 4
    b. 1 and 3
    c. 2 and 4
    d. 2 and 3

68. Consider the following statements:
    1. 'Relative compaction' is not the same as 'relative density'.
    2. Vibroflotation is not effective in the case of highly cohesive soils.
    3. 'Zero air void line' and '100% saturation line' are not identical.

    Of these statements
    a. 1 and 2 are correct
    b. 1 and 3 are correct
    c. 2 and 3 are correct
    d. 3 alone is correct

69. Consider the following statements:
    1. Constant head permeameter is best suited for determination of coefficient of permeability of highly impermeable soils.
    2. Coefficient of permeability of a soil mass decrease with increase in viscosity of the pore fluid.
    3. Coefficient of permeability of a soil mass increases with increase in temperature of the fluid.

    Of these statements
    a. 1 and 2 are correct
    b. 1 and 3 are correct
    c. 2 and 3 are correct
    d. 1,2 and 3 are correct

70. What will be the unit weight of a fully saturated soil sample having water content of 38% and grain specific gravity of 2.65?
    a. 19.88 kN/m^3
    b. 17.88 kN/m^3
    c. 16.52 kN/m^3
    d. 14.65 kN/m^3

71. If two foundations, one narrow and another wide, are resting on a bed of sand carrying the same intensity of load per unit area, then which one is likely to fail early?
    a. Narrow foundation
    b. Wider foundation
    c. Both will fail simultaneously
    d. Difficult to judge since other conditions are unknown

72. The standard penetration resistance value obtained in a deep deposit of sand at a depth of 6.0 m was 28. The unit weight of sand is 18.0 kN/m^3. What is the corrected value of number of blows for overburden pressure?
    a. 60
    b. 57
    c. 59
    d. 55

73. A square plate of section 30 cm × 30 cm and length 10 m penetrates a deposit of clay having C = 5 kN/m^2 and the mobilizing factor m = 0.8. What is the load carries by the pile by skin friction only?
    a. 192 kN
    b. 75 kN
    c. 60 kN
    d. 48 kN

74. During a sampling operation, the drive sampler is advanced 600 mm and the length of the sample recovered is 525 mm. What is the recovery ratio of the sample?
    a. 0.125
    b. 0.140
    c. 0.875
    d. 0.143

75. A vertical cut is to be made in saturated clay with C = 15 kN/m^2, $\varphi = 0$, and $\gamma = 20$ kN/m^3. What is the theoretical depth to which the clay can be excavated without side collapse?
    a. 6 m
    b. 2 m
    c. 2.5 m
    d. 3 m

76. The Standard percentile value taken for fixing the variability of human characteristics is
    a. 80^{th} percentile
    b. 85^{th} percentile
    c. 90^{th} percentile
    d. 95^{th} percentile

77. If cross slope of a country is greater than 60%, the terrain is classified as
    a. Rolling
    b. Mountainous
    c. Steep
    d. Plain

78. The ductility value of bitumen for suitability in road construction should not be less than
    a. 30 cm
    b. 40 cm
    c. 50 cm
    d. 60 cm

79. The limiting value of cant excess for Broad Gauge is
    a. 45 mm
    b. 55 mm
    c. 65 mm
    d. 75 mm

80. In Instrumental Landing system, the middle markers are located
    a. About 1 km ahead of the runway threshold
    b. Along the extended centre line of runway end
    c. At the runway threshold
    d. About 2 km ahead of the runway threshold

81. Water having a kinematic viscosity of 0.01 stoke flows at a velocity of 2m/s in a pipe of 15 cm diameter. For dynamic similarity, the velocity of oil of kinematic viscosity 0.03 stoke in a pipe of the same diameter will be
    a. 0.33 m/s
    b. 0.66 m/s
    c. 2 m/s
    d. 6 m/s

82. The hydraulic jump in a stilling basin was found to be 10 cm in a model with Ip/Im = 36. The prototype jump height would be
    a. 0.6 m
    b. 3.6 m
    c. 21.6 m
    d. Indeterminable with this data

83. An isochrone is a line on the basin map joining the points
    a. Of equal snowfall
    b. Of rain gauge locations
    c. Of equal rainfall depth in a given location
    d. Having the equal time of travel of surface runoff to the catchment outlet

84. Transmissibility of a confined aquifer having its thickness 15 m and permeability 8×10^{-4} m/s is given by
    a. $1.2 \times 10^{-2} m^2/s$
    b. $12 \times 10^{-2} m^2/s$
    c. $0.12 \times 10^{-2} m^2/s$
    d. $120 \times 10^{-2} m^2/s$

85. The ratio of the total volume of water delivered to a crop to the area on which it has been spread is called
    a. Critical depth
    b. Duty
    c. Delta
    d. Crop-water depth

86. For a irrotational flow, the velocity potential lines and the streamlines are always
    a. Parallel to each other
    b. Coplanar
    c. Orthogonal to each other
    d. Inclined to horizontal

87. The pressure drop of water flowing through a pipe between two points is measured by using a vertical U –tube manometer. Manometer uses a liquid of density 2000 kg/m^3. The difference in height of manometers in two limbs is 10 cm. The pressure drop between the two points is
    a. $98.1 N/m^2$
    b. $981 N/m^2$
    c. $1962 N/m^2$
    d. $19620 N/m^2$

88. The hydraulic efficiency of an impulse turbine is maximum when the velocity is ———— of the jet velocity
    a. One-fourth
    b. Three-fourth
    c. One-half
    d. Double

89. The dimensions of Chezy's coefficient C in [MLT] notation system are
    a. $L^{1/2}\ T^{1/2}$
    b. $L^{-1}\ T^{1/2}$
    c. $L^{-1}\ T^{-1}$
    d. $L^{1/2}\ T^{-1}$

90. The most desirable alignment of an irrigation canal is along
    a. The straight line
    b. The perpendicular line
    c. The valley line
    d. The ridge line

91. The order of B.O.D. reaction is
    a. 0
    b. 1
    c. 2
    d. 0.5

92. Lime and soda are added to water to remove
    a. Pathogens
    b. Iron
    c. Hardness
    d. Nitrates

93. The average BOD removal in the primary sedimentation of sewage is
    a. 30%
    b. 50%
    c. 75%
    d. 80%

94. Bacterial algae symbiosis is associated with
    a. Oxidation pond
    b. Oxidation ditch
    c. Activated sludge process
    d. Rotating biological contactor

95. Ozone is formed in the upper atmosphere by a photochemical reaction with
    a. Ultra violet solar radiation
    b. Infra red radiation
    c. Visible light
    d. All of the above

96. In plane table surveying, the accessory used for sighting the target is
    a. Alidade
    b. Plumbing fork
    c. Trough compass
    d. Sextant

97. The method employed for locating the position of plane table station on drawing sheet is
    a. Radiation
    b. Intersection
    c. Orientation
    d. Resection

98. In levelling, correction for curvature of earth is always
    a. Positive
    b. Zero
    c. Negative
    d. Infinity

99. If the ground is flat, contour interval selected is
    a. Small
    b. Medium
    c. Large
    d. Extra large

100. The formula which calculates the volume of earth work accurately is
    a. Johnson's formula
    b. Kirchoff's formula
    c. Trapezoidal formula
    d. Prismoidal formula