NG 24 (GROUP B)

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

17 - MATERIAL SCIENCE & CERAMIC TECHNOLOGY

(Answer ALL questions)

41. A cation vacancy and an anion vacancy in a crystal is called

a. Frenkel defect

b. Schottky defect

c. Dislocation

d. Surface imperfection

42. The nearest neighbor distance in case of BCC structure is

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

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

c. $\frac{a}{\sqrt{2}}$

d. a

43. In a cubic crystal a plane makes intercepts 1,2,2 on the *x*, *y* and z axes respectively.

The Miller indices of that plane is

a. (122)

b. (121)

c. (211)

d. (212)

44. The crystal structure of the following materials is FCC except

a. Aluminum

b. Magnesium

c. Nickel

d. Copper

45. How many number of atoms are present in the unit cell of HCP structure?

a. 2

b. 4

c. 6

d. 12

46. Which of the following structures has the highest density of packing?

a. Diamond cubic

b. Cesium chloride

c. Body centred cubic

d. Face centred cubic

47. The Fe-Fe bond length is 2.48Å, the radius of iron atom is

a. 0.62 Å

b. 1.24 Å

c. 2.48 Å

d. 3.96 Å

48. The correct order of co-ordination number in BCC, FCC and HCP unit cells is

a. 12,8,6

b. 8,12,12

c. 6,8,12

d. 12,6,8

49. The interplanar distance for (100) planes in a rocksalt crystal with a = 2.814Å is

a. 0.612Å

b. 1.224Å

c. 2.814Å

d. 1.926Å

50. Choose the wrong statement

a. In Laue method monochromatic X-ray beam is used

b. In powder method monochromatic X-ray beam is used

c. In rotating method monochromatic X-ray beam is used

d. In Laue method white X-radiation is used

51. In comparison to lattice diffusion, the activation energy for diffusion along surfaces and grain boundaries is

a. higher

b. lower

c. almost negligible

d. infinite

52. Frank – Reed source is a

a. Dislocation multiplier

b. Multiplier of point defects

c. Ionic defects multiplier

d. Multiplier of interstitial defects

53. The degree of freedom when ice, water and water vapour co-exist in equilibrium is

a. 1

b. 3

c. 0

d. –1

54. In a binary system of A and B if a liquid of 30% A is co-existing with a solid of 75% A, for an overall composition of 40% A, the fraction of liquid is given by

a. 0.78

b. 0.87

c. 0.22

d. 0.27

55. Which one of the following sets of constituents is expected in equilibrium cooling of a hyper-eutectoid steel from austenitic state?

a. Cementite and pearlite

b. Ferrite and pearlite

c. Ferrite and bainite

d. Cementite and martensite

56. Which one of the following statements about phase diagram is NOT correct?

a. It gives information on transformation rates

b. Relative amount of different phases can be found under given equilibrium conditions

c. It indicates the temperature at which different phases start to melt

d. Solid solubility limits are depicted by it

57. Specify the sequence correctly

a. Stress relief, grain growth, recrystallisation

b. Grain growth, recrystallisation, stress relief

c. Grain growth, stress relief, recrystallisation

d. Stress relief, recrystallisation, grain growth

58. The arm chair structure of carbon nanotube is obtained when nanotube axis is

a. Parallel to the C – C bond

b. Perpendicular to the C – C bond

c. In any random direction with respect to C – C bond

d. None of the above

59. Which of the following Heat treatment processes is used for softening hardened steel?

a. Carburizing

b. Normalizing

c. Annealing

d. Tempering

60. Choose the correct statement

a. thermoplastics are either amorphous or crystalline

b. thermoplastics are crystalline

c. thermosetting and thermoplastics polymers are essentially amorphous

d. thermosetting plastics are crystalline

61. What are the trade names of two most common aramid materials?

a. silicon carbide, silicon nitride
b. e - glass, aluminium oxide
c. kevlar, nomex
d. zircon, carborundum

62. Conductive polymers are mainly synthesized by

a. Free radical polymerization
b. Condensation polymerization
c. Electrochemical polymerization
d. Ionic polymerization

63. Polyvinyl chloride is

a. Thermoplastics
b. Thermosetting
c. Elastomers
d. None of the above

64. The carbon content required in steels to produce scissors and knives are

a. 0.8% – 0.9% C
b. 0.4% – 0.5% C
c. 0.2% – 0.3% C
d. 1.3% – 1.4% C

65. Martensitic transformations

a. Are diffusion controlled
b. Yield two products of different composition
c. Are shear processes
d. Yield a soft product in steels

66. Corrosion resistance of steel is increased by adding

a. Chromium to nickel
b. Nickel to molybdenum
c. Aluminum to zinc
d. Tungsten to sulphur

67. What will happen at the accelerating or tertiary creep stage?

a. Work hardening is less than recovery
b. Work hardening is greater than recovery
c. Work hardening is equal to recovery
d. None of the above

68. Fatigue failure occurs due to

a. Extended constant loading
b. Extended cyclic loading
c. Diffusion of atoms
d. Movement of dislocations

69. Which of the following is known as the Griffith equation?

a. $\sigma = (2\gamma E / \pi C)^{1/2}$
b. $\sigma = (\gamma E / \pi C)^{1/2}$
c. $\sigma = (\gamma E / 2\pi C)^{1/2}$
d. $\sigma = (\pi C / \gamma E)^{1/2}$

70. If K and σ be the thermal and electrical conductivities of a metal at temperature T, then

a. $\frac{KT}{\sigma}$ = constant
b. $\frac{K\sigma}{T}$ = constant
c. $\frac{\sigma}{KT}$ = constant
d. $\frac{K}{\sigma T}$ = constant

71. The faces in a tetragon are

a. 12
b. 4
c. 6
d. 2

72. The lattice constant of a BCC unit cell with atomic radius of 1.24 A° is

a. 1.432
b. 2.864
c. 1.754
d. 1.432

73. If the first reflection from an FCC crystal has a Bragg angle $\theta = 21.5^{\circ}$, the θ corresponding to second reflection is

a. 13.5°
b. 18.5°
c. 25°
d. 36.8°

74. Metallic bond is not characterized by _____

a. Opacity
b. Ductility
c. High conductivity
d. Directionality

75. The unit of diffusional flux is

a. atoms/m^2.s
b. atoms/m^3.s
c. atoms/m.s^2
d. atoms/m.s^3

76. The windows of aero plane are made in

a. PVC
b. PTFE
c. PMMA
d. PEEK

77. Cermet are examples of

a. Ceramic – Metal
b. Ceramic – Ceramic
c. Metal – Metal
d. Polymer – Metal

78. A continuous and aligned glass fibre reinforced composite consists of 40 vol% of glass fibres having a modulus of elasticity 69 GPa and 60 vol% of a polyester resin that when hardened displays a modulus of elasticity 3.4 GPa. What is the modulus of elasticity in longitudinal direction?

a. 35 GPa
b. 45 GPa
c. 30 GPa
d. 20 GPa

79. The fracture toughness values of Ceramic Matrix Composites lie between

a. 5 and 18 MPa $\sqrt{m}$
b. 6 and 20 MPa $\sqrt{m}$
c. 8 and 16 MPa $\sqrt{m}$
d. 9 and 21 MPa $\sqrt{m}$

80. Nanostructured materials have crystallites ranging in the size of _____

a. 1 – 100 nm
b. 150 – 300 nm
c. 350 – 500 nm
d. 500 – 900 nm

81. Which of the following is not an allotropic form of iron?

a. α
b. ρ
c. γ
d. θ

82. The mean grain diameter corresponding to ASTM number of 0.5 is

a. 0.33 mm
b. 0.43 mm
c. 0.53 mm
d. 0.63 mm

83. If resistivity is 1.7×10^{-6} Ωcm, area of cross section is $19.6\times10^{-8}m^2$, length is 31.4m, the resistance is found to be

a. 1.72 Ω

b. 2.72 Ω

c. 3.72 Ω

d. 4.72 Ω

84. In N Type semiconductor, the Fermi Level

a. Is lower than the centre of energy gap

b. Is at the centre of energy gap

c. Is higher than the centre of energy gap

d. Does not exist

85. The power loss (p) in a dielectric is given by _____ where V is voltage, I is current, δ is loss tangent

a. $P = VI \cos\delta$

b. $P = V/I \cos\delta$

c. $P = VI \sin\delta$

d. $P = V/I \sin\delta$

86. Which of the following is not made of calcium carbonate?

a. Calcspar

b. Witherite

c. Marl

d. Chalk

87. Zirconia is present in _____ crystal structure in the mineral baddeleyite.

a. Monoclinic

b. Triclinic

c. Tetragonal

d. Cubic

88. _____ is the property of titania.

a. Stability against ultraviolet radiation

b. High fracture toughness

c. High modulus of rupture

d. High compressive strength

89. Addition of _____ to alumina increases its toughness.

a. Magnesia

b. Silica

c. Chromia

d. Calcia

90. The limiting compositions of $Al_2O_3 : SiO_2$ in mullite solid solution series are _____

a. 1:2 and 3:2

b. 2:1 and 3:1

c. 3:2 and 2:1

d. 3:1 and 3:2

91. In flat plate test, concave glazed side refers to _____ in glaze which will lead to _____.

a. Tension, peel

b. Tension, craze

c. Compression, peel

d. Compression, craze

92. _____ is not a glass former.

a. SiO_2

b. B_2O_3

c. GeO

d. Cr_2O_3

93. Danner process is used to prepare glass ———— continuously.

a. Bulb

b. Tube

c. Sheet

d. Fiber

94. Crown glass is a ———— glass.

a. Optical

b. Safety

c. Radiation shield

d. Toughened

95. ———— is not a neutral refractory.

a. Zircon

b. Chrome

c. Carbon

d. Silicon carbide

96. ———— is used to calculate theoretical weight deposited on the electrode during electrolysis

a. Faraday's Law

b. Hess Law

c. De Bragg's Law

d. Stoke's Law

97. What is the major problem with fuel cell?

a. Inefficient

b. Produce harmful chemicals

c. Difficult to supply them with fuels

d. Less powerful than gasoline

98. Which one of the following is not a major reason to develop automotive fuel cell technology?

a. Efficiency

b. Low capacitance

c. Low or zero emission

d. Local source production

99. Which phase must form on a biomaterial surface to promote bioactive bond?

a. Amorphous silica

b. Silanols

c. Amorphous calcium phosphate

d. Hydroxyapatite

100. Which of the following substances is not used as coolant in nuclear reactors?

a. Graphite

b. Liquid sodium

c. CO_2

d. Heavy water