

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. $(\sqrt{14}, \sqrt{46})$
 - b. $(14, 46)$
 - c. $(\sqrt{24}, \sqrt{56})$
 - 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
- $\frac{3\sqrt{2}}{16}$
 - $\frac{16\sqrt{3}}{5}$
 - $\frac{5\sqrt{3}}{16}$
 - $\frac{16\sqrt{2}}{3}$
8. The value of the integral $\int_0^a \int_0^b \int_0^c e^{x+y+z} dz dy dx$ is
- e^{a+b+c}
 - $e^a + e^b + e^c$
 - $(e^a - 1)(e^b - 1)(e^c - 1)$
 - e^{abc}
9. If $\nabla\phi = 2xyz^3 \vec{i} + x^2z^3 \vec{j} + 3x^2yz^2 \vec{k}$, then $\phi(x, y, z) =$
- $\phi = xyz^2 + c$
 - $\phi = x^3yz^2 + c$
 - $\phi = x^2yz^3 + c$
 - $\phi = x^3yz + c$
10. The only function from the following that is analytic is
- $F(z) = \operatorname{Re}(z)$
 - $F(z) = \operatorname{Im}(z)$
 - $F(z) = z$
 - $F(z) = \sin z$
11. The value of m so that $2x - x^2 + my^2$ may be harmonic is
- 0
 - 1
 - 2
 - 3
12. The value of $\int_C \frac{1}{z} dz$, where C is the circle $z = e^{i\theta}$, $0 \leq \theta \leq \pi$ is,
- πi
 - $-\pi i$
 - $2\pi i$
 - 0
13. The Region of convergence of the signal $x(n) = \delta(n - k)$, $k > 0$ is
- $z = \infty$
 - $z = 0$
 - Entire z -plane, except at $z = 0$
 - 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
- 0
 - 4
 - 1/6
 - 4/3
15. Given the inverse Fourier transform of $f(s) = \begin{cases} a - |s|, & |s| \leq a \\ 0, & |s| > a \end{cases}$ 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
- π
 - $\frac{2\pi}{3}$
 - $\frac{\pi}{2}$
 - $\frac{\pi}{4}$
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 is strictly diagonally dominant
 - $|a_{ii}| = 1$
 - $\det(A) \neq 0$
 - $\det(A) > 0$
17. Which of the following formula is used to fit a polynomial for interpolation with equally spaced data?
- Newton's divided difference interpolation formula
 - Lagrange's interpolation formula
 - Newton's forward interpolation formula
 - 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?
- odd
 - two
 - even
 - 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
- 1/5
 - 1/10
 - 1/15
 - 1/20
20. For a Binomial distribution with mean 4 and variance 2, the value of 'n' is
- 2
 - 4
 - 6
 - 8

PART II — BASIC ENGINEERING AND SCIENCES

(Common to all candidates)

(Answer ALL questions)

21. Speed of the processor chip is measured in
- Mbps
 - GHz
 - Bits per second
 - Bytes per second
22. A program that converts Source Code into machine code is called
- Assembler
 - Loader
 - Compiler
 - Converter
23. What is the full form of URL?
- Uniform Resource Locator
 - Unicode Random Locator
 - Unified Real Locator
 - Uniform Read Locator
24. Which of the following can adsorb larger volume of hydrogen gas?
- Finely divided platinum
 - Colloidal solution of palladium
 - Small pieces of palladium
 - A single metal surface of platinum
25. What are the factors that determine an effective collision?
- Collision frequency, threshold energy and proper orientation
 - Translational collision and energy of activation
 - Proper orientation and steric bulk of the molecule
 - Threshold energy and proper orientation
26. Which one of the following flows in the internal circuit of a galvanic cell?
- atoms
 - electrons
 - electricity
 - ions
27. Which one of the following is not a primary fuel?
- petroleum
 - natural gas
 - kerosene
 - coal
28. Which of the following molecules will not display an infrared spectrum?
- CO₂
 - N₂
 - Benzene
 - HCCH
29. Which one of the following behaves like an intrinsic semiconductor, at the absolute zero temperature?
- Superconductor
 - Insulator
 - n-type semiconductor
 - p-type semiconductor
30. The energy gap (eV) at 300K of the material GaAs is
- 0.36
 - 0.85
 - 1.20
 - 1.42

31. Which of the following ceramic materials will be used for spark plug insulator?
- SnO_2
 - $\alpha\text{-Al}_2\text{O}_3$
 - TiN
 - YBaCuO_7
32. In unconventional super-conductivity, the pairing interaction is
- non-phononic
 - phononic
 - photonic
 - non-excitonic
33. What is the magnetic susceptibility of an ideal super conductor?
- 1
 - 1
 - 0
 - infinite
34. The Rayleigh scattering loss, which varies as _____ in a silica fiber.
- λ^0
 - λ^{-2}
 - λ^{-4}
 - 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)?
- $D^2 / 2\lambda$
 - $D^2 / 4\lambda$
 - $2D^2 / \lambda$
 - $4D^2 / \lambda$
36. Which one of the following represents open thermodynamic system?
- Manual ice cream freezer
 - Centrifugal pump
 - Pressure cooker
 - 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:
- 0°C
 - 50°C
 - 100°C
 - 150°C
38. Which of the cross-section of the beam subjected to bending moment is more economical?
- Rectangular cross-section
 - I - cross-section
 - Circular cross-section
 - 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?
- 8.33 s
 - 0.833 s
 - 0.0833 s
 - 1 s
40. What will happen if the frequency of power supply in a pure capacitor is doubled?
- The current will also be doubled
 - The current will reduce to half
 - The current will remain the same
 - 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
- Frenkel defect
 - Schottky defect
 - Dislocation
 - Surface imperfection
42. The nearest neighbor distance in case of BCC structure is
- $\frac{a\sqrt{3}}{2}$
 - $\frac{2a}{\sqrt{3}}$
 - $\frac{a}{\sqrt{2}}$
 - 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
- (122)
 - (121)
 - (211)
 - (212)
44. The crystal structure of the following materials is FCC except
- Aluminum
 - Magnesium
 - Nickel
 - Copper
45. How many number of atoms are present in the unit cell of HCP structure?
- 2
 - 4
 - 6
 - 12
46. Which of the following structures has the highest density of packing?
- Diamond cubic
 - Cesium chloride
 - Body centred cubic
 - Face centred cubic
47. The Fe-Fe bond length is 2.48\AA , the radius of iron atom is
- 0.62\AA
 - 1.24\AA
 - 2.48\AA
 - 3.96\AA
48. The correct order of co-ordination number in BCC, FCC and HCP unit cells is
- 12,8,6
 - 8,12,12
 - 6,8,12
 - 12,6,8
49. The interplanar distance for (100) planes in a rocksalt crystal with $a = 2.814\text{\AA}$ is
- 0.612\AA
 - 1.224\AA
 - 2.814\AA
 - 1.926\AA
50. Choose the wrong statement
- In Laue method monochromatic X-ray beam is used
 - In powder method monochromatic X-ray beam is used
 - In rotating method monochromatic X-ray beam is used
 - 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
- higher
 - lower
 - almost negligible
 - infinite
52. Frank – Reed source is a
- Dislocation multiplier
 - Multiplier of point defects
 - Ionic defects multiplier
 - Multiplier of interstitial defects
53. The degree of freedom when ice, water and water vapour co-exist in equilibrium is
- 1
 - 3
 - 0
 - 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
- 0.78
 - 0.87
 - 0.22
 - 0.27
55. Which one of the following sets of constituents is expected in equilibrium cooling of a hyper-eutectoid steel from austenitic state?
- Cementite and pearlite
 - Ferrite and pearlite
 - Ferrite and bainite
 - Cementite and martensite
56. Which one of the following statements about phase diagram is NOT correct?
- It gives information on transformation rates
 - Relative amount of different phases can be found under given equilibrium conditions
 - It indicates the temperature at which different phases start to melt
 - Solid solubility limits are depicted by it
57. Specify the sequence correctly
- Stress relief, grain growth, recrystallisation
 - Grain growth, recrystallisation, stress relief
 - Grain growth, stress relief, recrystallisation
 - Stress relief, recrystallisation, grain growth
58. The arm chair structure of carbon nanotube is obtained when nanotube axis is
- Parallel to the C – C bond
 - Perpendicular to the C – C bond
 - In any random direction with respect to C – C bond
 - None of the above
59. Which of the following Heat treatment processes is used for softening hardened steel?
- Carburizing
 - Normalizing
 - Annealing
 - Tempering
60. Choose the correct statement
- thermoplastics are either amorphous or crystalline
 - thermoplastics are crystalline
 - thermosetting and thermoplastics polymers are essentially amorphous
 - thermosetting plastics are crystalline

61. What are the trade names of two most common aramid materials?
- silicon carbide, silicon nitride
 - e - glass, aluminium oxide
 - kevlar, nomex
 - zircon, carborundum
62. Conductive polymers are mainly synthesized by
- Free radical polymerization
 - Condensation polymerization
 - Electrochemical polymerization
 - Ionic polymerization
63. Polyvinyl chloride is
- Thermoplastics
 - Thermosetting
 - Elastomers
 - None of the above
64. The carbon content required in steels to produce scissors and knives are
- 0.8% – 0.9% C
 - 0.4% – 0.5% C
 - 0.2% – 0.3% C
 - 1.3% – 1.4% C
65. Martensitic transformations
- Are diffusion controlled
 - Yield two products of different composition
 - Are shear processes
 - Yield a soft product in steels
66. Corrosion resistance of steel is increased by adding
- Chromium to nickel
 - Nickel to molybdenum
 - Aluminum to zinc
 - Tungsten to sulphur
67. What will happen at the accelerating or tertiary creep stage?
- Work hardening is less than recovery
 - Work hardening is greater than recovery
 - Work hardening is equal to recovery
 - None of the above
68. Fatigue failure occurs due to
- Extended constant loading
 - Extended cyclic loading
 - Diffusion of atoms
 - Movement of dislocations
69. Which of the following is known as the Griffith equation?
- $\sigma = (2\gamma E / \pi C)^{1/2}$
 - $\sigma = (\gamma E / \pi C)^{1/2}$
 - $\sigma = (\gamma E / 2\pi C)^{1/2}$
 - $\sigma = (\pi C / \gamma E)^{1/2}$
70. If K and σ be the thermal and electrical conductivities of a metal at temperature T , then
- $\frac{KT}{\sigma} = \text{constant}$
 - $\frac{K\sigma}{T} = \text{constant}$
 - $\frac{\sigma}{KT} = \text{constant}$
 - $\frac{K}{\sigma T} = \text{constant}$
71. The faces in a tetragon are
- 12
 - 4
 - 6
 - 2

72. The lattice constant of a BCC unit cell with atomic radius of 1.24 \AA is
- 1.432
 - 2.864
 - 1.754
 - 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
- 13.5°
 - 18.5°
 - 25°
 - 36.8°
74. Metallic bond is not characterized by
- Opacity
 - Ductility
 - High conductivity
 - Directionality
75. The unit of diffusional flux is
- atoms/m².s
 - atoms/m³.s
 - atoms/m.s²
 - atoms/m.s³
76. The windows of aero plane are made in
- PVC
 - PTFE
 - PMMA
 - PEEK
77. Cermet are examples of
- Ceramic – Metal
 - Ceramic – Ceramic
 - Metal – Metal
 - 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?
- 35 GPa
 - 45 GPa
 - 30 GPa
 - 20 GPa
79. The fracture toughness values of Ceramic Matrix Composites lie between
- 5 and 18 MPa \sqrt{m}
 - 6 and 20 MPa \sqrt{m}
 - 8 and 16 MPa \sqrt{m}
 - 9 and 21 MPa \sqrt{m}
80. Nanostructured materials have crystallites ranging in the size of _____
- 1 – 100 nm
 - 150 – 300 nm
 - 350 – 500 nm
 - 500 – 900 nm
81. Which of the following is not an allotropic form of iron?
- α
 - ρ
 - γ
 - θ
82. The mean grain diameter corresponding to ASTM number of 0.5 is
- 0.33 mm
 - 0.43 mm
 - 0.53 mm
 - 0.63 mm

83. If resistivity is $1.7 \times 10^{-6} \Omega\text{cm}$, area of cross section is $19.6 \times 10^{-8} \text{m}^2$, length is 31.4m, the resistance is found to be
- 1.72 Ω
 - 2.72 Ω
 - 3.72 Ω
 - 4.72 Ω
84. In N Type semiconductor, the Fermi Level
- Is lower than the centre of energy gap
 - Is at the centre of energy gap
 - Is higher than the centre of energy gap
 - 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
- $P = VI \cos\delta$
 - $P = VI \cos\delta$
 - $P = VI \sin\delta$
 - $P = VI \sin\delta$
86. Which of the following is not made of calcium carbonate?
- Calcspars
 - Witherite
 - Marl
 - Chalk
87. Zirconia is present in _____ crystal structure in the mineral baddeleyite.
- Monoclinic
 - Triclinic
 - Tetragonal
 - Cubic
88. _____ is the property of titania.
- Stability against ultraviolet radiation
 - High fracture toughness
 - High modulus of rupture
 - High compressive strength
89. Addition of _____ to alumina increases its toughness.
- Magnesia
 - Silica
 - Chromia
 - Calcia
90. The limiting compositions of $\text{Al}_2\text{O}_3 : \text{SiO}_2$ in mullite solid solution series are _____
- 1:2 and 3:2
 - 2:1 and 3:1
 - 3:2 and 2:1
 - 3:1 and 3:2
91. In flat plate test, concave glazed side refers to _____ in glaze which will lead to _____.
- Tension, peel
 - Tension, craze
 - Compression, peel
 - Compression, craze
92. _____ is not a glass former.
- SiO_2
 - B_2O_3
 - GeO
 - Cr_2O_3

93. Danner process is used to prepare glass _____ continuously.
- Bulb
 - Tube
 - Sheet
 - Fiber
94. Crown glass is a _____ glass.
- Optical
 - Safety
 - Radiation shield
 - Toughened
95. _____ is not a neutral refractory.
- Zircon
 - Chrome
 - Carbon
 - Silicon carbide
96. _____ is used to calculate theoretical weight deposited on the electrode during electrolysis
- Faraday's Law
 - Hess Law
 - De Bragg's Law
 - Stoke's Law
97. What is the major problem with fuel cell?
- Inefficient
 - Produce harmful chemicals
 - Difficult to supply them with fuels
 - Less powerful than gasoline
98. Which one of the following is not a major reason to develop automotive fuel cell technology?
- Efficiency
 - Low capacitance
 - Low or zero emission
 - Local source production
99. Which phase must form on a biomaterial surface to promote bioactive bond?
- Amorphous silica
 - Silanols
 - Amorphous calcium phosphate
 - Hydroxyapatite
100. Which of the following substances is not used as coolant in nuclear reactors?
- Graphite
 - Liquid sodium
 - CO₂
 - Heavy water