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 $°\rho$, the boiling and freezing points of water at one atmosphere are $100°\ \rho$ and $300°\rho$ respectively. Correlate this scale with the Centigrade scale. The reading of $0°\rho$ 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

07 - AERONAUTICAL AND AEROSPACE ENGINEERING

(Answer ALL questions)

41. The ratio of modulus of rigidity to bulk modulus for a Poisson's ratio of 0.25 would be
    a. 2/3
    b. 2/5
    c. 3/5
    d. 1

42. The stress due to suddenly applied load is ———— compared to that of the gradually applied load?
    a. Half
    b. Same
    c. 3 times
    d. 2 times

43. In a short column with eccentric loading, the neutral axis
    a. passes through the centroid of the section.
    b. passes through the point of application of load.
    c. passes through the shear center of the section.
    d. does not pass through the centroid of the section.

44. A rectangular section beam subjected a bending moment M varying along its length is required to develop same maximum bending stress at any cross section. If the depth of the section is constant, then its width will vary as
    a. M
    b. $M^{1/2}$
    c. M^2
    d. 1/M

45. The deflection of the free end of a cantilever beam subjected to a concentrated load at its mid span is given by
    a. $PL^3/3EI$
    b. $PL^3/8EI$
    c. $PL^3/24EI$
    d. $5PL^3/48EI$

46. If two shafts of same length, one of which is hollow, transmit equal torque and have equal maximum shear stress, then they should have equal
    a. polar moment of inertia
    b. polar modulus of section
    c. diameter
    d. angle of twist

47. A closely coiled helical spring has a stiffness of 8N/mm. If it extends by 5 mm , the energy absorbed is
    a. 0
    b. 50 N mm
    c. 100 N mm
    d. 10 N mm

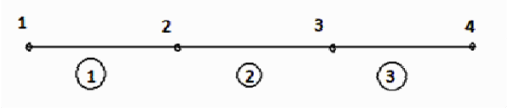
48. Modified Tsai-Hill theory
    a. distinguishes between tensile and compressive strength
    b. gives the mode of failure
    c. does not relate the different strength parameters
    d. relates only tensile and shear strength

49. If a laminate consists of pairs of layers with identical thickness and elastic properties, but with orientation of $+\theta$ and $-\theta$ with respect to the laminate reference axis, then the laminate is called as
    a. angle ply laminate
    b. symmetric Angle ply laminate
    c. quasi isotropic laminate
    d. balanced laminate

50. The Shear stresses in the fiber and matrix are 200GPa and 20GPa respectively. If the fiber volume fraction is 70%, then the longitudinal compressive strength of the lamina is
    a. 112 GPa
    b. 64.8 GPa
    c. 146 GPa
    d. 292 GPa

51. The function $y = A(1 - \cos(2\pi x)/L)$ is an allowed approximate function for a
    a. fixed-fixed beam
    b. cantilever beam
    c. simply-supported beam
    d. propped cantilever beam

52. Which of the following statements is NOT true of a 1-D problem represented using 2-node line elements as indicated?



    a. this could represent a finite element model of a bar under axial loading
    b. size of global stiffness matrix is 4×4
    c. size of global force vector is 4×1
    d. size of global stiffness matrix is 8×8

53. Which of the following assumptions / statements is NOT true about the Euler-Bernoulli beam theory?
    a. cross-sections which are normal and plane to the longitudinal axis before bending remain normal and plane to it after bending deformation
    b. shear deformations are small
    c. rotations are small
    d. the Euler-Bernoulli beam has a lower stiffness than compared to the Timoshenko beam

54. The shape functions indicated here are for a
$N_1 = L_1(2L_1 - 1),\ N_2 = 4L_1 L_2$
$N_3 = L_2(2L_2 - 1),\ N_4 = 4L_2 L_3$
$N_5 = L_3(2L_3 - 1), N_6 = 4L_3 L_1$
    a. constant strain triangle, in area coordinates
    b. linear strain triangle, in area coordinates
    c. 4-node quadrilateral element
    d. 8-node brick element

55. Axisymmetric problems involving axisymmetric loading and solids of revolution can be conveniently formulated with the following element type.
    a. 1-D line element
    b. 2-D plane stress element
    c. 8-node brick element
    d. higher order element

56. Which of the following statements is true about Finite Element Analysis (FEA)?
    a. Residue obtained equals zero
    b. The solution is exact.
    c. The solution is exact at the boundaries.
    d. It is an analytical technique.

57. Consider an equal-leg angle section cantilever beam subject to a vertical shearing load at the tip where the line of action of the applied vertical force passes through the centroid. This beam will experience
    a. symmetrical bending with twist
    b. symmetrical bending without twist
    c. unsymmetrical bending and twisting
    d. unsymmetrical bending

58. The shear centre position of a thin-walled symmetrical channel section will lie
    a. on the centroid
    b. very close to the centroid
    c. between the centroid and the web mid-point
    d. away from the web, on the line of symmetry

59. Shear flow has the same units as
    a. shear stress
    b. force
    c. force per unit length
    d. torque per unit length

60. AB = 40 cm while BC = 30 cm. Areas A and C are equal to 8 cm^2 while areas B and D are 6 cm^2. The given section is subject to M_x = 100 kNm and M_y = 40 kNm. Find an expression for the bending stress. Assume that the webs are ineffective in bending.
    a. $\sigma = -0.191x + 1.551y$
    b. $\sigma = 0.191x + 2.268y$
    c. $\sigma = 2.268x + 1.675y$
    d. $\sigma = -0.872x + 1.675y$

61. The physical principle used for the derivation of momentum equation is
    a. First law of thermodynamics
    b. Second law of thermodynamics
    c. Newtons second law
    d. Law of conservation of mass

62. Potential function for three dimensional doublet of strength μ is

a. $\frac{\mu}{4\pi}\frac{\cos\theta}{r^2}$

b. $-\frac{\mu}{4\pi}\frac{\cos\theta}{r^2}$

c. $\frac{\mu}{4\pi}\frac{\sin\theta}{r^2}$

d. $-\frac{\mu}{4\pi}\frac{\sin\theta}{r^2}$

63. The lifting flow over circular cylinder is obtained by the combination of
a. Uniform flow +sink + vortex
b. Uniform flow + doublet + vortex
c. Uniform flow + source
d. Uniform flow + sink + source

64. Which of the following is usually measured as the angle between the line of 25% chord and a perpendicular to the root chord?
a. Anhedral angle
b. Dihedral angle
c. Sideslip angle
d. sweep angle

65. Winglets are used to reduce
a. Pressure drag
b. Wave drag
c. Induced drag
d. Trim drag

66. When a nozzle is said to be over expanded?
a. Pressure at exit is less than the backpressure
b. Pressure at exit is higher than the backpressure
c. Pressure at exit is equal to backpressure
d. Pressure at exit is equal to zero

67. For a flow a Prandtl-Meyer expansion wave is
a. Mach Number remains constant
b. Entropy remains constant
c. Density remains constant
d. Temperature remains constant

68. Which of the following is a barotropic flow?
a. Density depends only on the temperature
b. Density independent of pressure
c. Density depends only on the pressure
d. Density independent of temperature

69. The shadowgraph flow visualization technique depends on
a. the variation of the value of density in the flow
b. the first derivative of density with respect to spatial coordinate
c. the second derivative of density with respect to spatial coordinate
d. the third derivative of density with respect to spatial coordinate

70. Flow separation is due to
a. Adverse pressure gradient
b. Negative pressure gradient
c. Density gradient
d. Velocity gradient

71. The semi-span of a rectangular wing of plan form area 8.4 m^2 is 3.5 m. The aspect ratio of the wing is
a. 1.458
b. 8.53
c. 3.85
d. 1.2

72. What is the center pressure if the lift coefficient and lift curve slope of an aerofoil of percentage camber 0.6 are 1.02 and 2, respectively?
a. 0.2685
b. 0.6852
c. 0.8526
d. 0.6825

73. Consider an infinitely thin flat plate at an angle of attack of 5^o in a Mach 2.3 flow. Pressure is 101 kPa. The lift coefficient as per shock expansion theory is
a. 0.1735
b. 0.3735
c. 0.6735
d. 0.8735

74. Aerodynamic center is defined as point on the airfoil at which
a. moments are independent of angle attack
b. moments are zero
c. moments are dependent of aspect ratio
d. moments are independent of chord

75. What is the Coefficient of pressure, where velocity at surface of the cylinder is equal to free stream velocity?
    a. 1
    b. 0
    c. infinity
    d. maximum

76. Which of the following states that the time rate of change of circulation around a closed curve consisting of the same fluid elements is zero?
    a. KuttaJoukowski's theorem
    b. Kelvin's circulation theorem
    c. Helmholtz theorem
    d. Blasius theorem

77. For calorically perfect gas, specific heats C_p and C_v are
    a. constant
    b. function of temperature
    c. function of pressure
    d. function of density

78. The free stream Mach number for which the entire flow around the body is subsonic is called
    a. Critical Mach number
    b. Lower critical Mach number
    c. Upper critical Mach number
    d. Supercritical Mach number

79. When airfoil thickness decreases, the critical Mach number
    a. increases
    b. decreases
    c. constant
    d. infinity

80. What is the purpose of supercritical airfoil?
    a. to increase the value of drag divergence Mach number
    b. to decrease the value of drag divergence Mach number
    c. to increase the value of critical divergence Mach number
    d. to decrease the value of critical divergence Mach number

81. A turbojet powered aircraft is suitable for which of the following type of applications?
    a. low speed and heavy load applications.
    b. high speed and heavy load applications.
    c. high speed and high altitude applications.
    d. low speed and high altitude applications.

82. For which of these applications is the turbo shaft engine most suited?
    a. Low-speed fixed-wing aircraft
    b. Helicopters
    c. High altitude reconnaissance aircraft
    d. High-speed combat aircraft

83. In the subcritical operation mode of a supersonic inlet, shock strands
    a. at some distance away from the inlet
    b. at the lip of inlet
    c. inside the inlet
    d. at the entry of combustion chamber

84. Ram efficiency is defined as
    a. Real local temperature rise/ ideal temperature rise
    b. Actual rise in static pressure/ ideal rise in static pressure
    c. Actual total temperature rise/ ideal total temperature rise
    d. Real total pressure rise/ ideal total pressure rise

85. The combustion in a gas turbine is a
    a. Isochoric process
    b. Isobaric process
    c. Isothermal process
    d. Partially isobaric and partially isochoric process

86. What is the purpose of a fuel injection system in the combustor?
    a. to accelerate the flow in the combustor.
    b. to increase the stagnation pressure of the fuel-air mixture.
    c. to ignite the fuel-air mixture.
    d. to convert the bulk fuel into tiny droplets.

87. The critical mass flow rate through a converging-diverging nozzle
    a. is inversely proportional to stagnation speed of sound
    b. is directly proportional to stagnation speed of sound
    c. is directly proportional to stagnation temperature
    d. is inversely proportional to stagnation pressure

88. For a given rotational speed of a rotor of an axial flow compressor, as the fan tip radius increases, the centrifugal stress on the fan blade
    a. Increases
    b. Decreases
    c. remains constant
    d. first increases and then decreases

89. Pressure gradient in the flow direction
    a. is adverse in axial flow compressor
    b. is negative in axial flow compressor
    c. is positive in axial flow turbine
    d. is adverse in the front stages of compressor and later becomes zero

90. If there is no change in static enthalpy and static pressure across a rotor, then the turbo-machine is called
    a. reaction machine
    b. impulse machine
    c. 50% reaction machine
    d. free vortex machine

91. In a turbojet engine, thrust specific fuel consumption _____ with increasing compressor pressure ratio and _____ with increasing turbine inlet temperature (within range of operation).
    a. decreases, increases
    b. decreases, decreases
    c. increases, increases
    d. increases, decreases

92. Characteristic velocity of a rocket engine is equal to
    a. twice the discharge coefficient
    b. square root of discharge coefficient
    c. inverse of discharge coefficient
    d. thrust of the rocket divided by initial mass of rocket

93. Specific impulse of a rocket
    a. is proportional to combustion chamber temperature
    b. is inversely proportional to square root of molecular weight of combustion products
    c. is proportional to molecular weight of combustion products
    d. is proportional to square root of molecular weight of combustion products

94. The concept of erosive burning in solid propellant rocket operation pertains to
    a. erosion of propellant grain due to ageing
    b. decreased burning rate of propellant grain due to melting of propellant
    c. increased burning rate of propellant grain due to high velocity cross flow gases
    d. increased burning rate of propellant grain due to rocket motion

95. Which one of the following is not an example of an adapted nozzle?
    a. Expansion-Deflection nozzle
    b. Plug nozzle
    c. Spike nozzle
    d. Bell nozzle

96. The laminar flame speed in a combustion chamber of a jet engine is
    a. inversely proportional to square root of thermal diffusivity of reactant mixture
    b. proportional to thermal diffusivity of reactant mixture
    c. inversely proportional to the temperature of reactant mixture
    d. proportional to viscosity of reactant mixture

97. For isentropic flows the value of work-done factor for a turbo machine (ψ) will be
    a. $\Psi = 0$
    b. $\Psi = 1$
    c. $\Psi > 1$
    d. $\Psi < 1$

98. Which of these analyses needs a stretched grid?
    a. Transient flow over a flat plate
    b. Incompressible flow over a flat plate
    c. Viscous flow over a flat plate
    d. Subsonic flow over a flat plate

99. Numerical panel methods are applicable for
    a. steady, incompressible and inviscid flows only
    b. unsteady, incompressible and inviscid flows
    c. steady, compressible and inviscid flows
    d. unsteady, compressible and inviscid flows

100. Which type of grids is the best for flow over an airfoil?
    a. Stretched grids
    b. Adaptive grids
    c. Boundary-fitted grids
    d. Elliptic grids