

## NG 24 (GROUP B)

### PART I — ENGINEERING MATHEMATICS

(Common to all Candidates)

(Answer ALL questions)

1. If  $A$  is a  $3 \times 3$  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,
- $\pi i$
  - $-\pi i$
  - $2\pi i$
  - 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
- $\pi$
  - $\frac{2\pi}{3}$
  - $\frac{\pi}{2}$
  - $\frac{\pi}{4}$
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?
- CO<sub>2</sub>
  - N<sub>2</sub>
  - 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

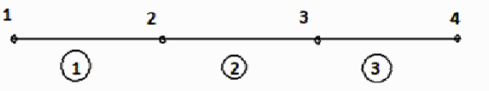
31. Which of the following ceramic materials will be used for spark plug insulator?
- $\text{SnO}_2$
  - $\alpha\text{-Al}_2\text{O}_3$
  - TiN
  - $\text{YBaCuO}_7$
32. In unconventional super-conductivity, the pairing interaction is
- non-phononic
  - phononic
  - photonic
  - non-excitonic
33. What 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.
- $\lambda^0$
  - $\lambda^{-2}$
  - $\lambda^{-4}$
  - $\lambda^{-6}$
35. What is the near field length  $N$  that can be calculated from the relation (if  $D$  is the diameter of the transducer and  $\lambda$  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:
- $0^\circ\text{C}$
  - $50^\circ\text{C}$
  - $100^\circ\text{C}$
  - $150^\circ\text{C}$
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

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
- $2/3$
  - $2/5$
  - $3/5$
  - 1
42. The stress due to suddenly applied load is \_\_\_\_\_ compared to that of the gradually applied load?
- Half
  - Same
  - 3 times
  - 2 times
43. In a short column with eccentric loading, the neutral axis
- passes through the centroid of the section.
  - passes through the point of application of load.
  - passes through the shear center of the section.
  - 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
- $M$
  - $M^{1/2}$
  - $M^2$
  - $1/M$
45. The deflection of the free end of a cantilever beam subjected to a concentrated load at its mid span is given by
- $PL^3/3EI$
  - $PL^3/8EI$
  - $PL^3/24EI$
  - $5PL^3/48EI$
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
- polar moment of inertia
  - polar modulus of section
  - diameter
  - angle of twist
47. A closely coiled helical spring has a stiffness of  $8N/mm$ . If it extends by  $5\text{ mm}$ , the energy absorbed is
- 0
  - $50\text{ N mm}$
  - $100\text{ N mm}$
  - $10\text{ N mm}$
48. Modified Tsai-Hill theory
- distinguishes between tensile and compressive strength
  - gives the mode of failure
  - does not relate the different strength parameters
  - 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
- angle ply laminate
  - symmetric Angle ply laminate
  - quasi isotropic laminate
  - balanced laminate
50. The Shear stresses in the fiber and matrix are  $200\text{GPa}$  and  $20\text{GPa}$  respectively. If the fiber volume fraction is  $70\%$ , then the longitudinal compressive strength of the lamina is
- $112\text{ GPa}$
  - $64.8\text{ GPa}$
  - $146\text{ GPa}$
  - $292\text{ GPa}$

51. The function  $y = A(1 - \cos(2\pi x)/L)$  is an allowed approximate function for a
- fixed-fixed beam
  - cantilever beam
  - simply-supported beam
  - 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?
- 
53. Which of the following assumptions / statements is NOT true about the Euler-Bernoulli beam theory?
- cross-sections which are normal and plane to the longitudinal axis before bending remain normal and plane to it after bending deformation
  - shear deformations are small
  - rotations are small
  - the Euler-Bernoulli beam has a lower stiffness than compared to the Timoshenko beam
54. The shape functions indicated here are for a
- $$N_1 = L_1(2L_1 - 1), N_2 = 4L_1 L_2$$
- $$N_3 = L_2(2L_2 - 1), N_4 = 4L_2 L_3$$
- $$N_5 = L_3(2L_3 - 1), N_6 = 4L_3 L_1$$
- constant strain triangle, in area coordinates
  - linear strain triangle, in area coordinates
  - 4-node quadrilateral element
  - 8-node brick element
55. Axisymmetric problems involving axisymmetric loading and solids of revolution can be conveniently formulated with the following element type.
- 1-D line element
  - 2-D plane stress element
  - 8-node brick element
  - higher order element
56. Which of the following statements is true about Finite Element Analysis (FEA)?
- Residue obtained equals zero
  - The solution is exact.
  - The solution is exact at the boundaries.
  - 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
- symmetrical bending with twist
  - symmetrical bending without twist
  - unsymmetrical bending and twisting
  - unsymmetrical bending
58. The shear centre position of a thin-walled symmetrical channel section will lie
- on the centroid
  - very close to the centroid
  - between the centroid and the web mid-point
  - away from the web, on the line of symmetry
59. Shear flow has the same units as
- shear stress
  - force
  - force per unit length
  - torque per unit length
60.  $AB = 40$  cm while  $BC = 30$  cm. Areas A and C are equal to  $8$  cm<sup>2</sup> while areas B and D are  $6$  cm<sup>2</sup>. 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.
- $\sigma = -0.191x + 1.551y$
  - $\sigma = 0.191x + 2.268y$
  - $\sigma = 2.268x + 1.675y$
  - $\sigma = -0.872x + 1.675y$
61. The physical principle used for the derivation of momentum equation is
- First law of thermodynamics
  - Second law of thermodynamics
  - Newtons second law
  - Law of conservation of mass

62. Potential function for three dimensional doublet of strength  $\mu$  is
- $\frac{\mu \cos \theta}{4\pi r^2}$
  - $-\frac{\mu \cos \theta}{4\pi r^2}$
  - $\frac{\mu \sin \theta}{4\pi r^2}$
  - $-\frac{\mu \sin \theta}{4\pi r^2}$
63. The lifting flow over circular cylinder is obtained by the combination of
- Uniform flow + sink + vortex
  - Uniform flow + doublet + vortex
  - Uniform flow + source
  - 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?
- Anhedral angle
  - Dihedral angle
  - Sideslip angle
  - sweep angle
65. Winglets are used to reduce
- Pressure drag
  - Wave drag
  - Induced drag
  - Trim drag
66. When a nozzle is said to be over expanded?
- Pressure at exit is less than the backpressure
  - Pressure at exit is higher than the backpressure
  - Pressure at exit is equal to backpressure
  - Pressure at exit is equal to zero
67. For a flow a Prandtl-Meyer expansion wave is
- Mach Number remains constant
  - Entropy remains constant
  - Density remains constant
  - Temperature remains constant
68. Which of the following is a barotropic flow?
- Density depends only on the temperature
  - Density independent of pressure
  - Density depends only on the pressure
  - Density independent of temperature
69. The shadowgraph flow visualization technique depends on
- the variation of the value of density in the flow
  - the first derivative of density with respect to spatial coordinate
  - the second derivative of density with respect to spatial coordinate
  - the third derivative of density with respect to spatial coordinate
70. Flow separation is due to
- Adverse pressure gradient
  - Negative pressure gradient
  - Density gradient
  - Velocity gradient
71. The semi-span of a rectangular wing of plan form area 8.4 m<sup>2</sup> is 3.5 m. The aspect ratio of the wing is
- 1.458
  - 8.53
  - 3.85
  - 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?
- 0.2685
  - 0.6852
  - 0.8526
  - 0.6825
73. Consider an infinitely thin flat plate at an angle of attack of 5° in a Mach 2.3 flow. Pressure is 101 kPa. The lift coefficient as per shock expansion theory is
- 0.1735
  - 0.3735
  - 0.6735
  - 0.8735
74. Aerodynamic center is defined as point on the airfoil at which
- moments are independent of angle attack
  - moments are zero
  - moments are dependent of aspect ratio
  - 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?
- 1
  - 0
  - infinity
  - 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?
- KuttaJoukowski's theorem
  - Kelvin's circulation theorem
  - Helmholtz theorem
  - Blasius theorem
77. For calorically perfect gas, specific heats  $C_p$  and  $C_v$  are
- constant
  - function of temperature
  - function of pressure
  - function of density
78. The free stream Mach number for which the entire flow around the body is subsonic is called
- Critical Mach number
  - Lower critical Mach number
  - Upper critical Mach number
  - Supercritical Mach number
79. When airfoil thickness decreases, the critical Mach number
- increases
  - decreases
  - constant
  - infinity
80. What is the purpose of supercritical airfoil?
- to increase the value of drag divergence Mach number
  - to decrease the value of drag divergence Mach number
  - to increase the value of critical divergence Mach number
  - to decrease the value of critical divergence Mach number
81. A turbojet powered aircraft is suitable for which of the following type of applications?
- low speed and heavy load applications.
  - high speed and heavy load applications.
  - high speed and high altitude applications.
  - low speed and high altitude applications.
82. For which of these applications is the turbo shaft engine most suited?
- Low-speed fixed-wing aircraft
  - Helicopters
  - High altitude reconnaissance aircraft
  - High-speed combat aircraft
83. In the subcritical operation mode of a supersonic inlet, shock strands
- at some distance away from the inlet
  - at the lip of inlet
  - inside the inlet
  - at the entry of combustion chamber
84. Ram efficiency is defined as
- Real local temperature rise/ ideal temperature rise
  - Actual rise in static pressure/ ideal rise in static pressure
  - Actual total temperature rise/ ideal total temperature rise
  - Real total pressure rise/ ideal total pressure rise
85. The combustion in a gas turbine is a
- Isochoric process
  - Isobaric process
  - Isothermal process
  - Partially isobaric and partially isochoric process
86. What is the purpose of a fuel injection system in the combustor?
- to accelerate the flow in the combustor.
  - to increase the stagnation pressure of the fuel-air mixture.
  - to ignite the fuel-air mixture.
  - to convert the bulk fuel into tiny droplets.
87. The critical mass flow rate through a converging-diverging nozzle
- is inversely proportional to stagnation speed of sound
  - is directly proportional to stagnation speed of sound
  - is directly proportional to stagnation temperature
  - 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
- Increases
  - Decreases
  - remains constant
  - first increases and then decreases
89. Pressure gradient in the flow direction
- is adverse in axial flow compressor
  - is negative in axial flow compressor
  - is positive in axial flow turbine
  - 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
- reaction machine
  - impulse machine
  - 50% reaction machine
  - 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).
- decreases, increases
  - decreases, decreases
  - increases, increases
  - increases, decreases
92. Characteristic velocity of a rocket engine is equal to
- twice the discharge coefficient
  - square root of discharge coefficient
  - inverse of discharge coefficient
  - thrust of the rocket divided by initial mass of rocket
93. Specific impulse of a rocket
- is proportional to combustion chamber temperature
  - is inversely proportional to square root of molecular weight of combustion products
  - is proportional to molecular weight of combustion products
  - is proportional to square root of molecular weight of combustion products
94. The concept of erosive burning in solid propellant rocket operation pertains to
- erosion of propellant grain due to ageing
  - decreased burning rate of propellant grain due to melting of propellant
  - increased burning rate of propellant grain due to high velocity cross flow gases
  - increased burning rate of propellant grain due to rocket motion
95. Which one of the following is not an example of an adapted nozzle?
- Expansion-Deflection nozzle
  - Plug nozzle
  - Spike nozzle
  - Bell nozzle
96. The laminar flame speed in a combustion chamber of a jet engine is
- inversely proportional to square root of thermal diffusivity of reactant mixture
  - proportional to thermal diffusivity of reactant mixture
  - inversely proportional to the temperature of reactant mixture
  - proportional to viscosity of reactant mixture
97. For isentropic flows the value of work-done factor for a turbo machine ( $\psi$ ) will be
- $\Psi = 0$
  - $\Psi = 1$
  - $\Psi > 1$
  - $\Psi < 1$
98. Which of these analyses needs a stretched grid?
- Transient flow over a flat plate
  - Incompressible flow over a flat plate
  - Viscous flow over a flat plate
  - Subsonic flow over a flat plate
99. Numerical panel methods are applicable for
- steady, incompressible and inviscid flows only
  - unsteady, incompressible and inviscid flows
  - steady, compressible and inviscid flows
  - unsteady, compressible and inviscid flows
100. Which type of grids is the best for flow over an airfoil?
- Stretched grids
  - Adaptive grids
  - Boundary-fitted grids
  - Elliptic grids