

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. $(\sqrt{14}, \sqrt{46})$
 - 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

03 – ELECTRICAL AND ELECTRONICS ENGINEERING

(Answer ALL questions)

41. The resultant magnetic flux generated in the closed surface will be
- Zero
 - Continuous
 - Constant
 - Unity
42. The motion of electrons in a CRTs is due to
- Charge density
 - Columbic Force
 - Lorentz Force
 - Electron Gun
43. H in the region $0 \leq l \leq a$ for an infinitely long co-axial transmission line is
- $H = Il / 2\pi a^2$
 - $H = I / \pi a^2$
 - $H = 0$
 - $H = Il^3 / \pi a^2$
44. The direction of current flow in the circuit is such that the induced magnetic field produced by the induced current will oppose the original magnetic field. This is
- Faraday's Law
 - Lenz's Law
 - Biot - Savart Law
 - Gauss Law
45. The electromagnetic wave propagates in free space with a speed of
- 1.9×10^6 m/s
 - 3×10^8 m/s
 - 2.12×10^2 m/s
 - 3.8×10^4 m/s
46. Energy stored in the capacitor is
- $\frac{1}{2} CI^3$
 - $\frac{1}{2} CV^3$
 - $\frac{1}{2} CV^2$
 - $\frac{1}{2} CI^2$
47. 200 V, 50 Hz inductive circuit takes a current of 10 A lagging the voltage by 30°. Calculate inductance of the circuit
- 31.85 mH
 - 51.85 mH
 - 21.85 mH
 - 11.85 mH
48. Which of the following motors is expected to have maximum full-load efficiency
- 1 kW
 - 5 kW
 - 30 kW
 - 100 kW
49. Dynamic braking is very effective for
- DC series motor
 - DC shunt motor
 - Separately excited DC motor
 - Cumulatively compound DC motor
50. A transformer steps up the voltage by a factor of 100. The ratio of current in the primary to that in the secondary is
- 1
 - 100
 - 0.01
 - 0.1
51. Power factor of a power transformer on no load will be about
- 1
 - 0.75
 - 0.5
 - 0.35

52. To eliminate 5th harmonic voltage from the phase voltage of an alternator, the coils should be short pitched by an electrical angle of
- 30 degree
 - 36 degree
 - 72 degree
 - 18 degree
53. The flux set up by the armature current, which does not cross the air gap and takes a different path is called as
- Leakage flux
 - Main flux
 - Cross-magnetizing flux
 - Demagnetizing flux
54. AC machines should have proper _____ in order to limit the operating temperature
- Voltage rating
 - Current rating
 - Speed
 - kW rating
55. The nuclear plants are suitable for
- Peak load
 - Intermediate loads
 - Base load
 - Both base and peak loads
56. Corona loss increases with
- Decrease in conductor size and increase in supply frequency
 - Increase in conductor size and decrease in supply frequency
 - Increase in both conductor size and supply frequency
 - Decrease in both conductor size and supply frequency
57. Which of the following matrices reveals the topology of the power system network?
- Bus incidence matrix
 - Primitive impedance matrix
 - Primitive admittance matrix
 - Bus admittance matrix
58. Four identical alternators each rated for 20 MVA, 11 kV having a sub-transient reactance of 16% are working in parallel. The short circuit level at the bus bars is
- 700 MVA
 - 500 MVA
 - 300 MVA
 - 200 MVA
59. Magnetizing inrush current is rich in
- 3rd harmonics
 - 5th harmonics
 - 7th harmonics
 - 2nd harmonics
60. Negative phase sequence current in an alternator produces
- Over speed
 - Over voltage
 - Rotor heating
 - Under frequency
61. SVC is basically
- A FACTS controller connected to transmission line by series insertion transformer only
 - A compensator used to exchange real power at fundamental frequency
 - A series connected FACTS controller
 - A shunt connected FACTS controller
62. The Impulse Response of an initially relaxed linear system is $e^{-2t}u(t)$. To produce a response of $te^{-2t}u(t)$, the input should be
- $2e^{-t}u(t)$
 - $0.5 e^{-2t}u(t)$
 - $e^{-2t}u(t)$
 - $e^{-t}u(t)$

63. The steady state error due to unit acceleration input for a type 2 system is
- Zero
 - Infinity
 - $1/K_a$
 - $1/K_v$
64. A system has two zeros and four poles. Then two asymptotes in the root loci plane move towards infinity along
- ± 60 degree
 - ± 90 degree
 - ± 45 degree
 - ± 30 degree
65. A closed loop system has the characteristic equation given by $s^3 + ks^2 + (k + 2)s + 3 = 0$. For the system to be stable the value of k is
- $k > 1$
 - $0.5 < k < 1$
 - $0 < k < 1$
 - $0 < k < 0.5$
66. Loop transfer function of a feedback system is $G(s)H(s) = \frac{10}{(s-2)}$. Assume the Nyquist contour in the clockwise direction. Then the Nyquist plot of $G(s)$ encircles $-1 + j0$
- once in clockwise direction
 - twice in clockwise direction
 - once in anti-clockwise direction
 - twice in anti-clockwise direction
67. The transfer function of a first order controller is given as $G_c(s) = K(s + a) / (s + b)$, where K, a, b are positive real numbers. The condition for this controller to act as a phase lag compensator is
- $a < b$
 - $a > b$
 - $K < ab$
 - $K > ab$
68. The state variable description of a system is $\dot{X} = AX + BU$; $A = \begin{bmatrix} 0 & 3 \\ 3 & 0 \end{bmatrix}$. The poles of the system are located at
- $s = \pm 2$
 - $s = \pm j2$
 - $s = \pm j3$
 - $s = \pm 3$
69. In a single phase semi-converter without freewheeling diode, for discontinuous conduction and extinction angle $\beta > \pi$, each SCR conducts for the period
- $\pi - \alpha$
 - $\beta - \alpha$
 - α
 - β
70. For a single phase full wave uncontrolled rectifier with purely R load, the form factor is
- $\frac{2\sqrt{2}}{\pi}$
 - $\frac{2}{\pi}$
 - $\frac{\pi}{2\sqrt{2}}$
 - $\frac{\pi}{2}$
71. A single-phase inverter has square wave output voltage. The percentage of the fifth harmonic component in relation to the fundamental component is
- 10
 - 20
 - 30
 - 40

72. The RMS output voltage at fundamental frequency of a single phase, full bridge inverter with input voltage of 48V DC, feeding a load of 2.4Ω is
- $\frac{4 \times 48}{\sqrt{2} \pi} V$
 - $\frac{48}{2\sqrt{2} \pi} V$
 - $\frac{\sqrt{2} \times 48}{\pi} V$
 - $\frac{4 \times 48}{\pi} V$
73. When the MOSFET is in the ON state, the channel of the device behaves like
- Constant resistance
 - Inductance
 - Capacitance
 - Resistance and Inductance
74. The duty cycle value of buck converter when the switching frequency is 250 kHz and the ON time is $2 \mu s$ is
- 0.4
 - 0.8
 - 0.5
 - 0.2
75. Which load torque will be used in regenerative braking?
- Fan hype load torque
 - Frictional load torque
 - Passive load torque
 - Archive load torque
76. Assuming 3 MHz clock frequency, the execution time taken by the delay subroutine is :
- Delay : MVI C, 9Ah
 Loop : DCR C
 JNZ Loop
 RET
- 0.723 msec
 - 7.23 msec
 - 0.07231 msec
 - 72.34 μsec .
77. The output of the following program is :
- ```
LXI H, 1234h
MVI C, 05h
MVI B, 67h
DCR C
DAD B
SHLD Result
HLT.
```
- 1234 h
  - 7938 h
  - 7939 h
  - 129 Bh
78. On execution of the program segment,
- ```
MVI A, 0Ah
SIM
....
```
- RST 6.5 is disabled, but other interrupts are enabled
 - RST 7.5 is disabled, but other interrupts are enabled.
 - RST 5.5 is disabled, but other interrupts are enabled.
 - Both RST 5.5 and RST 6.5 are disabled, but other interrupts are enabled.
79. The 8051 program segment, which performs 'software polling' to check if the timer-0 counting has completed, is:
- JNB TF0, 0FEh
 - JB TF0, 0FEh
 - JB TF1, 0FEh
 - JNB TF1, 0FEh

80. The output of the following 8051 Assembly code is,
- ```

MOV A, #10
MOV 01H, A
MOV A, #20
MOV @R1, A

```
- $A = 10$
  - $[01] = 20$
  - $[10] = 20$
  - $[20] = 10$
81. What is the operation carried out by the 8051 instruction: 'SETB 0D3'?
- It disables all of the interrupts temporarily
  - It doubles the baud rate of the serial communication
  - It switches to bank1 from the default bank0
  - It makes the timer-0 run in mode-3
82. If all the poles of  $H(z)$  are outside the unit circle, then the system is said to be
- Only causal
  - Only BIBO stable
  - BIBO stable and causal
  - None of the above
83. Which of the following is true regarding the number of computations required to compute N-point DFT
- $N^2$  complex multiplications and  $N(N-1)$  complex additions
  - $N^2$  Complex additions and  $N(N-1)$  complex multiplications
  - $N^2$  complex multiplications and  $N(n+1)$  complex additions
  - $N^2$  complex additions and  $N(N+1)$  complex multiplications
84. Which of the following justifies the linearity property of z-transform?  $[x(n) \leftrightarrow X(z)]$ .
- $x(n) + y(n) \leftrightarrow X(z)Y(z)$
  - $x(n) + y(n) \leftrightarrow X(z) + Y(z)$
  - $x(n) y(n) \leftrightarrow X(z) + Y(z)$
  - $x(n) y(n) \leftrightarrow X(z)Y(z)$
85. What is the width of the main lobe of the frequency response of a rectangular window of length M-1?
- $\pi/M$
  - $2\pi/M$
  - $4\pi/M$
  - $8\pi/M$
86. With reference to the Fast Fourier Transform if  $W_4^1 = W_x^2$ , then what is the value of  $x$  ?
- 2
  - 4
  - 8
  - 16
87. Which of the following defines the FIR filter for length M, input  $x(n)$  and output  $y(n)$ ?
- $y(n) = \sum_{K=0}^M b_k x(n-k)$
  - $y(n) = \sum_{K=0}^{M+1} b_k x(n+k)$
  - $y(n) = \sum_{K=0}^{M-1} b_k x(n-k)$
  - $y(n) = \sum_{K=0}^M b_k x(n+k)$
88. Surge impedance of loss less transmission line is (if  $L$  = inductance/m  $C$  = capacitance/m)
- $\sqrt{C/L}$
  - $\sqrt{L/C}$
  - $1/\sqrt{LC}$
  - $\sqrt{LC}$
89. Time lag for breakdown is
- time required for gas to breakdown under pulse application
  - time taken for the voltage to rise before breakdown occurs
  - time difference between instant of applied voltage and occurrence of breakdown
  - time required for ionization
90. In impulse testing of transformers fault location is usually done by
- neutral current oscillogram
  - chopped wave oscillogram
  - observing for noise or smoke
  - scanning method

91. The breakdown strength of air for small gaps (1 mm) under uniform field condition and standard atmospheric conditions will be
- 50 kV/cm
  - 43.45 kV/cm
  - 25.58 kV/cm
  - 40.59 kV/cm
92. Optimum number of stages for Cockcroft Walton voltage multiplier circuit are
- $\sqrt{V_{\max}/IfC}$
  - $\sqrt{IfC/V_{\max}}$
  - $\sqrt{V_{\max}f/IC}$
  - $\sqrt{V_{\max}fC/I}$
93. The most important test to assert the proper functions of a surge diverter is
- 100% impulse withstand test
  - Front of wave spark over and residual voltage tests
  - Impulse current test
  - Pollution tests
94. An R-C voltage divider has an HV arm capacitance,  $C_1 = 600$  pf, resistance =  $400 \Omega$  and equivalent ground capacitance  $C_g = 240$  pF. The effective time constant of the divider in nanoseconds is
- 32
  - 100
  - 67
  - 25
95. Electric traction uses power supply of
- 25 kV, AC, 50Hz
  - 25kV, DC
  - 50kV, AC, 50Hz
  - 50kV, DC
96. Filament lamps operate normally at a power factor of
- 0.6 lagging
  - 0.6 leading
  - Zero power factor
  - Unity power factor
97. Candela is the unit of
- Luminous flux
  - Luminous intensity
  - Light
  - Brightness
98. A slab of insulating material  $130 \text{ cm}^2$  in area and 1 cm thick is to be heated by dielectric heating. The power required is 380 W at 30 MHz. The material has a relative permittivity of 5 and power factor of 0.05. Determine the necessary voltage
- 837 kV
  - 837 V
  - 652 V
  - 552 V
99. Spot welding is used for
- Thin metal sheets
  - Thick metal rods
  - Thick Square sections
  - Rough and irregular surfaces
100. Material used for solar cell is
- Germanium
  - Silicon
  - Silica gel
  - Mercury