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. $\left(\sqrt{14},\ \sqrt{46}\right)$

   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

03 – ELECTRICAL AND ELECTRONICS ENGINEERING

(Answer ALL questions)

41. The resultant magnetic flux generated in the closed surface will be
    a. Zero
    b. Continuous
    c. Constant
    d. Unity

42. The motion of electrons in a CRTs is due to
    a. Charge density
    b. Columbic Force
    c. Lorentz Force
    d. Electron Gun

43. H in the region $0 \le l \le a$ for an infinitely long co-axial transmission line is
    a. $H = Il/2\pi a^2$
    b. $H = I/\pi a^2$
    c. $H = 0$
    d. $H = Il^3/\pi a^2$

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
    a. Faraday's Law
    b. Lenz's Law
    c. Biot - Savart Law
    d. Gauss Law

45. The electromagnetic wave propagates in free space with a speed of
    a. 1.9×10^6 m/s
    b. 3×10^8 m/s
    c. 2.12×10^2 m/s
    d. 3.8×10^4 m/s

46. Energy stored in the capacitor is
    a. $\frac{1}{2} CI^3$
    b. $\frac{1}{2} CV^3$
    c. $\frac{1}{2} CV^2$
    d. $\frac{1}{2} CI^2$

47. 200 V, 50 Hz inductive circuit takes a current of 10 A lagging the voltage by 30^o. Calculate inductance of the circuit
    a. 31.85 mH
    b. 51.85 mH
    c. 21.85 mH
    d. 11.85 mH

48. Which of the following motors is expected to have maximum full-load efficiency
    a. 1 kW
    b. 5 kW
    c. 30 kW
    d. 100 kW

49. Dynamic braking is very effective for
    a. DC series motor
    b. DC shunt motor
    c. Separately excited DC motor
    d. 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
    a. 1
    b. 100
    c. 0.01
    d. 0.1

51. Power factor of a power transformer on no load will be about
    a. 1
    b. 0.75
    c. 0.5
    d. 0.35

52. To eliminate 5th harmonic voltage from the phase voltage of and alternator, the coils should be short pitched by an electrical angle of

a. 30 degree

b. 36 degree

c. 72 degree

d. 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

a. Leakage flux

b. Main flux

c. Cross-magnetizing flux

d. Demagnetizing flux

54. AC machines should have proper ———— in order to limit the operating temperature

a. Voltage rating

b. Current rating

c. Speed

d. kW rating

55. The nuclear plants are suitable for

a. Peak load

b. Intermediate loads

c. Base load

d. Both base and peak loads

56. Corona loss increases with

a. Decrease in conductor size and increase in supply frequency

b. Increase in conductor size and decrease in supply frequency

c. Increase in both conductor size and supply frequency

d. Decrease in both conductor size and supply frequency

57. Which of the following matrices reveals the topology of the power system network?

a. Bus incidence matrix

b. Primitive impedance matrix

c. Primitive admittance matrix

d. 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

a. 700 MVA

b. 500 MVA

c. 300 MVA

d. 200 MVA

59. Magnetizing inrush current is rich in

a. 3rd harmonics

b. 5th harmonics

c. 7th harmonics

d. 2nd harmonics

60. Negative phase sequence current in an alternator produces

a. Over speed

b. Over voltage

c. Rotor heating

d. Under frequency

61. SVC is basically

a. A FACTS controller connected to transmission line by series insertion transformer only

b. A compensator used to exchange real power at fundamental frequency

c. A series connected FACTS controller

d. 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

a. $2e^{-t}u(t)$

b. $0.5\,e^{-2t}u(t)$

c. $e^{-2t}u(t)$

d. $e^{-t}u(t)$

63. The steady state error due to unit acceleration input for a type 2 system is

a. Zero

b. Infinity

c. $1/K_a$

d. $1/K_v$

64. A system has two zeros and four poles. Then two asymptotes in the root loci plane move towards infinity along

a. ± 60 degree

b. ± 90 degree

c. ± 45 degree

d. ± 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

a. $k > 1$

b. $0.5 < k < 1$

c. $0 < k < 1$

d. $0 < k < 0.5$

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

a. once in clockwise direction

b. twice in clockwise direction

c. once in anti-clockwise direction

d. 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. $a < b$

b. $a > b$

c. $K < ab$

d. $K > ab$

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

a. $s = \pm 2$

b. $s = \pm j2$

c. $s = \pm j3$

d. $s = \pm 3$

69. In a single phase semi-converter without freewheeling diode, for discontinuous conduction and extinction angle $\beta > \pi$, each SCR conducts for the period

a. $\pi - \alpha$

b. $\beta - \alpha$

c. α

d. β

70. For a single phase full wave uncontrolled rectifier with purely R load, the form factor is

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

b. $\frac{2}{\pi}$

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

d. $\frac{\pi}{2}$

71. A single-phase inverter has square wave output voltage. The percentage of the fifth harmonic component in relation to the fundamental component is

a. 10

b. 20

c. 30

d. 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 2.4 Ω is

a. $\frac{4\times48}{\sqrt{2}\,\pi}V$

b. $\frac{48}{2\sqrt{2}\,\pi}V$

c. $\frac{\sqrt{2}\times48}{\pi}V$

d. $\frac{4\times48}{\pi}V$

73. When the MOSFET is in the ON state, the channel of the device behaves like

a. Constant resistance

b. Inductance

c. Capacitance

d. Resistance and Inductance

74. The duty cycle value of buck converter when the switching frequency is 250 kHz and the ON time is 2μs is

a. 0.4

b. 0.8

c. 0.5

d. 0.2

75. Which load torque will be used in regenerative braking?

a. Fan hype load torque

b. Frictional load torque

c. Passive load torque

d. 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
```

a. 0.723 msec

b. 7.23 msec

c. 0.07231 msec

d. 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.
```

a. 1234 h

b. 7938 h

c. 7939 h

d. 129 Bh

78. On execution of the program segment,

```
MVI A, 0Ah
SIM
....
```

a. RST 6.5 is disabled, but other interrupts are enabled

b. RST 7.5 is disabled, but other interrupts are enabled.

c. RST 5.5 is disabled, but other interrupts are enabled.

d. 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:

a. JNB TF0, 0FEh

b. JB TF0, 0FEh

c. JB TF1, 0FEh

d. 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. A = 10
b. [01] = 20
c. [10] = 20
d. [20] = 10

81. What is the operation carried out by the 8051 instruction: 'SETB 0D3'?
a. It disables all of the interrupts temporarily
b. It doubles the baud rate of the serial communication
c. It switches to bank1 from the default bank0
d. 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
a. Only causal
b. Only BIBO stable
c. BIBO stable and causal
d. None of the above

83. Which of the following is true regarding the number of computations required to compute N-point DFT
a. N^2 complex multiplications and N(N–1) complex additions
b. N^2 Complex additions and N(N–1) complex multiplications
c. N^2 complex multiplications and N(n+1) complex additions
d. N^2 complex additions and N(N+1) complex multiplications

84. Which of the following justifies the linearity property of z-transform? [x(n) ↔ X(z)].
a. x(n) + y(n) ↔ X(z)Y(z)
b. x(n) + y(n) ↔ X(z) + Y(z)
c. x(n) y(n) ↔ X(z) + Y(z)
d. x(n) y(n) ↔ 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?
a. π/M
b. $2\pi/M$
c. $4\pi/M$
d. $8\pi/M$

86. With reference to the Fast Fourier Transform if $W_4^1 = W_x^2$, then what is the value of x ?
a. 2
b. 4
c. 8
d. 16

87. Which of the following defines the FIR filter for length M, input x(n) and output y(n)?
a. $y(n) = \sum_{K=0}^{M} b_k\, x(n-k)$
b. $y(n) = \sum_{K=0}^{M+1} b_k\, x(n+k)$
c. $y(n) = \sum_{K=0}^{M-1} b_k\, x(n-k)$
d. $y(n) = \sum_{K=0}^{M} b_k x(n+k)$

88. Surge impedance of loss less transmission line is (if L =inductance/m C = capacitance/m)
a. $\sqrt{C/L}$
b. $\sqrt{L/C}$
c. $1/\sqrt{LC}$
d. $\sqrt{LC}$

89. Time lag for breakdown is
a. time required for gas to breakdown under pulse application
b. time taken for the voltage to rise before breakdown occurs
c. time difference between instant of applied voltage and occurrence of breakdown
d. time required for ionization

90. In impulse testing of transformers fault location is usually done by
a. neutral current oscillogram
b. chopped wave oscillogram
c. observing for noise or smoke
d. scanning method

91. The breakdown strength of air for small gaps (1 mm) under uniform field condition and standard atmospheric conditions will be

a. 50 kV/cm

b. 43.45 kV/cm

c. 25.58 kV/cm

d. 40.59 kV/cm

92. Optimum number of stages for Cockcroft Walton voltage multiplier circuit are

a. $\sqrt{V_{max}/If\ C}$

b. $\sqrt{If\ C/V_{max}}$

c. $\sqrt{V_{max}f/IC}$

d. $\sqrt{V_{max}fC/I}$

93. The most important test to assert the proper functions of a surge diverter is

a. 100% impulse withstand test

b. Front of wave spark over and residual voltage tests

c. Impulse current test

d. Pollution tests

94. An R-C voltage divider has an HV arm capacitance, C_1 = 600 pf, resistance = 400 Ω and equivalent ground capacitance C_g = 240 pF. The effective time constant of the divider in nanoseconds is

a. 32

b. 100

c. 67

d. 25

95. Electric traction uses power supply of

a. 25 kV, AC, 50Hz

b. 25kV, DC

c. 50kV, AC, 50Hz

d. 50kV, DC

96. Filament lamps operate normally at a power factor of

a. 0.6 lagging

b. 0.6 leading

c. Zero power factor

d. Unity power factor

97. Candela is the unit of

a. Luminous flux

b. Luminous intensity

c. Light

d. Brightness

98. A slab of insulating material 130 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

a. 837 kV

b. 837 V

c. 652 V

d. 552 V

99. Spot welding is used for

a. Thin metal sheets

b. Thick metal rods

c. Thick Square sections

d. Rough and irregular surfaces

100. Material used for solar cell is

a. Germanium

b. Silicon

c. Silica gel

d. Mercury