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. $(e^a - 1)(e^b - 1)(e^c - 1)$

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

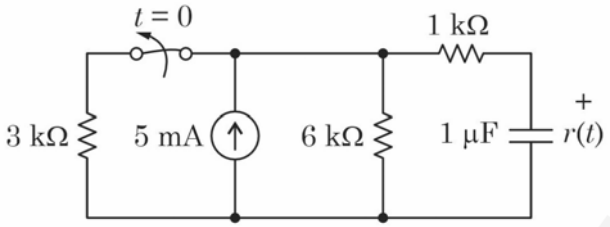
15 –INSTRUMENTATION, ELECTRONICS AND CONTROL ENGINEERING

(Answer ALL questions)

41. An inductor of 25 mH is subjected to an ac voltage of $v(t)$ = 100 cos (1000 t + 30°) V. Instantaneous power in the inductor at t = 0, will be,

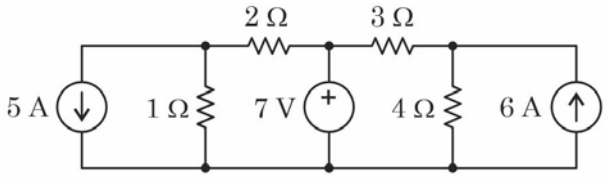
a. 25 W
b. 86.6 W
c. 150 W
d. 173.2 W

42. Assuming the circuit shown in figure below is in steady state before the switch opened at t = 0. The value of voltage across the capacitor $v(t)$ at $t = 0^+$ is,



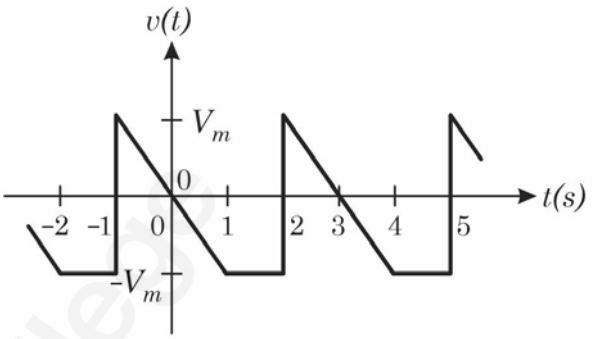
a. 10 V
b. 15 V
c. 20 V
d. 30 V

43. In the linear-bilateral network shown below according to superposition theorem the current through 1Ω resistor due to 5 A current source alone acting is,



a. 0.83 A
b. 3.33 A
c. 4.16 A
d. 5.31 A

44. The root mean square (rms) value of the voltage waveform shown below is

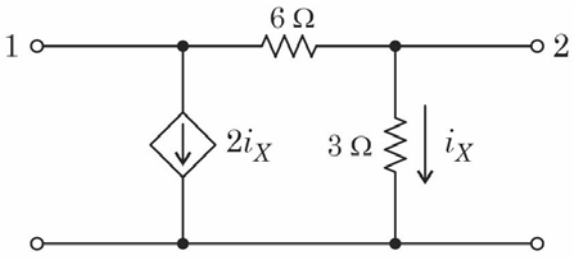


a. $V_m\sqrt{\frac{3}{2}}$
b. $V_m\sqrt{\frac{2}{3}}$
c. $V_m\sqrt{\frac{1}{2}}$
d. $V_m\sqrt{\frac{1}{3}}$

45. In a series RLC circuit, R=10 Ω , L= 1mH and C = 1nF. If the source voltage has a peak value of, V_m = 10 V, the power dissipated in the circuit at resonance is

a. 1 W
b. 2 W
c. 5 W
d. 10 W

46. In the two port network shown in figure below, the z-parameter, Z_{21} is



a. 1
b. –1
c. 3
d. –3

47. The system defined by the difference equation $y(n) = 0.3x(n) + 2$ can be classified as
a. Linear and Causal
b. Linear and Non-causal
c. Non-Linear and Causal
d. Non-Linear and Non-Causal

48. The Fourier transform of the signal $x(n) = 2^n u(n)$ is given by
a. $1/(1 - 2e^{j\omega})$
b. $1/(1 - 2e^{-j\omega})$
c. $1/(1 + 2e^{-j\omega})$
d. Fourier Transform does not exist for the given $x(n)$

49. The step response of a CT LTI system whose $h(t) = u(t)$ is given by
a. $e^{-t}u(t)$
b. $u(t)$
c. $tu(t)$
d. $\delta(t)$

50. Given $X(s) = 1/(s+a)$, ROC: $\sigma < -a$, the CT signal $x(t)$ is given by
a. $x(t) = -e^{-at}u(-t)$
b. $x(t) = -e^{at}u(t)$
c. $x(t) = e^{-at}u(-t)$
d. $x(t) = e^{at}u(t)$

51. The circular convolution of the sequences $x(n) = \{1,1,2,1\}$ and $x2(n) = \{1,2,3,4\}$ is given by
a. {2,3,5,5}
b. {13,14,12,12}
c. {1,2,6,4}
d. {13,14,11,12}

52. The desirable characteristics of the window sequence used in FIR filter design include
a. Narrow central lobe
b. Broad side lobes
c. Small central lobe energy
d. Gradually increasing side lobe energy

53. The reverse saturation current of a PN junction diode at room temperature is 10uA and the thermal voltage is 26mV. If η =2 for Silicon, the diode current for a forward bias voltage of 0.6V is approximately
a. 1 A
b. 1 mA
c. 10 A
d. 10 mA

54. A BJT has I_B = 80uA and I_C = 2mA. If I_B increases by 25%, find I_C.
a. 25 mA
b. 2.5 mA
c. 2 mA
d. 20 mA

55. Compared to the P-Channel MOSFET, N-Channel MOSFET has
    a. Smaller drain resistance and smaller size
    b. Smaller drain resistance and larger size
    c. Larger drain resistance and smaller size
    d. Larger drain resistance and larger size

56. With respect to the performance of CE, CB and CC configurations of BJT, Choose the wrong statement from the following:
    a. CB and CC have nearly the same voltage gain
    b. CC amplifier has the largest current gain
    c. CE amplifier has the smallest input impedance
    d. CB has the largest output impedance

57. An OPAMP is configured as a non-inverting amplifier with 10K resistance in the feedback path and 2K resistance connected between inverting terminal and GND. What is the gain of the amplifier?
    a. –5
    b. +5
    c. –6
    d. +6

58. An active HPF filter is designed with $R_f = R_i = 10K$, C = 0.01uF and R = 15.9K. The cut-off frequency f_0 and Pass band gain A are calculated as
    a. $f_0 = 10kHz,\ A = -2$
    b. $f_0 = 10kHz,\ A = 1$
    c. $f_0 = 1kHz,\ A = -1$
    d. $f_0 = 1kHz,\ A = 2$

59. The expression $(A + B)(\overline{B} + C)(\overline{A} + C)$ when converted to sum of products form, will become
    a. $\overline{A}\,BC$
    b. $\overline{A}\,BC + A\overline{B}C$
    c. $\overline{A}\,BC + A\overline{B}C + AC$
    d. $\overline{A}\,BC + A\overline{B}C + AC + BC$

60. In a 1- to -16 demultiplexer, the number of control inputs will be
    a. 4
    b. 1
    c. 2
    d. 16

61. Data sheet of a certain eight bit A/D convertor lists the following specification: 8 bits, full scale error: 0.02% of full scale; full scale analog input : +5V. What is the quantization step size?
    a. 1.96 mv
    b. 19.607 mv
    c. 1 mv
    d. 20.607 mv

62. Of the logic families mentioned below, which one that consumes the least power?
    a. Low power TTL
    b. Low power schottky TTL
    c. CMOS
    d. ECL

63. A 4 - bit binary UP/DOWN counter is initially reset to 0000. The UP/DOWN mode select terminal designated as $\overline{U}/D$ on the pin configuration diagram of the IC is tied to logic HIGH level. What will be Counter's output state at the end of first clock pulse?
    a. 0001
    b. 1000
    c. 1111
    d. 0000

64. The largest number that can be processed by a microprocessor in a single operation is determined by the size of its
    a. external data bus
    b. internal data bus
    c. address bus
    d. control bus

65. Which of the following is an absolute instrument?
    a. Permanent Magnet Moving Coil Instruments
    b. Moving Iron Instruments
    c. Tangent galvanometer
    d. Energy meter

66. Two resistors R1 and R2 are connected in series. The values of resistance are R1 = $100 \pm 0.2\ \Omega$ and R2 = $150 \pm 0.04\ \Omega$. What is the uncertainty in the combined resistance for series arrangements?
    a. $-50 \pm 0.01734\ \Omega$
    b. $250 \pm 0.24\ \Omega$
    c. $250 \pm 0.01734\ \Omega$
    d. $50 \pm 0.0209\ \Omega$

67. A Potentiometer is a device for
    a. Comparing two Current
    b. Comparing two Voltage
    c. Measuring Current
    d. Measuring Current and Voltage

68. Maxwell's Inductance-Capacitance bridge is used for measurement of Inductance of
    a. low Q coils
    b. medium Q coils
    c. high Q coils
    d. low and medium Q coils

69. The rise time of an oscilloscope is expressed as
    a. $t_r = \frac{0.35}{BW}$
    b. $t_r = 0.35 \times BW$
    c. $t_r = \frac{0.25}{BW}$
    d. $t_r = 0.25 \times BW$

70. Electrodynamometer-type wattmeters have a construction where
    a. current coil is fixed
    b. voltage coil is fixed
    c. both voltage and current coils are movable
    d. both voltage and current coils are fixed

71. The PH value of a solution is 4. It indicates that concentration of hydrogen ions is
    a. 10^{-4} g/L and the solution is acidic
    b. 10^{-4} g/L and the solution is alkaline
    c. 10^{-4} mg/L and the solution is acidic
    d. 10^{-4} mg/L and the solution is alkaline

72. Charge amplifiers are used in order to amplify the output signals of
    a. Inductive
    b. Capacitive
    c. Resistive
    d. Piezoelectric and capacitive transducers

73. A thermistor has a resistance temperature coefficient of -5% over a temperature range of 25°C to 50°C. If the resistance of the thermistor is 100 Ω at 25°C, what is the resistance at 35°C?
    a. 50 Ω
    b. 100 Ω
    c. 150 Ω
    d. 200 Ω

74. A linear resistance potentiometer is 50 mm long and is uniformly wound with wire having a resistance of 10000 Ω. Under normal conditions, the slider is at the center of the potentiometer. What is the linear displacement when the resistance of the potentiometer as measured by a Wheatstone bridge is 3850 Ω ?
   a. 5.75 mm
   b. 6.25 mm
   c. 6.50 mm
   d. 6.75 mm

75. A 2.5 mm thick quartz piezoelectric crystal having a voltage intensity of 0.055 Vm/N is subjected to a pressure of 1.4 MN/m^2. If the permittivity of quartz is 40.6 × 10^{-12} F/m, calculate the output voltage
   a. 190.5 V
   b. 192.5 V
   c. 194.5 V
   d. 196.5 V

76. Signal conditioning is carried out by the capillary tubes which convert gas pressure into a mercury height. The statement pertains to
   a. Bourdon tube pressure gauge
   b. Pirani gauge
   c. Mcleod gauge
   d. Diaphragm pressure transducer

77. The Detector used in IR spectroscopy is
   a. Photomultiplier tubes
   b. Electron capture detector
   c. Thermal detectors
   d. Mass analyzer

78. What is the main limitation of using Beer lambert's law?
   a. It cannot be used for concentrations less than 0.1 M
   b. It cannot be used for concentrations greater than 0.1 M
   c. It cannot be used for concentrations less than 0.01 M
   d. It cannot be used for concentrations greater than 0.01 M

79. Which of the following is false with respect to chromatography?
   a. The chromatography column must be temperature controlled
   b. Mobile phase must be sent along with the sample
   c. Mobile phase reacts with the sample
   d. Stationary phase is inside the column

80. Chromatography is preferred in industries due to
   a. High accuracy and online analysis
   b. Multicomponent analysis
   c. High accuracy
   d. Multicomponent and online analysis

81. Which of the following analyzers is used for testing the quality of boiler feedwater?
   a. Paramagnetic oxygen analyzer
   b. Dissolved oxygen analyzer
   c. Silica analyzer
   d. Hydrogen disulphide (H_2S) analyzer

82. pH value from a pH meter should always be reported along with
   a. Temperature
   b. Conductivity value
   c. Total dissolved solids
   d. Pressure

83. An Optical Time Domain Reflectometer (OTDR) is a device used for _____.
   a. measurement of current
   b. measurement of voltage
   c. measurement of pressure
   d. determining the characteristics of an optical fiber cable

84. How many number of Modes of an optical fiber are there whose core diameter is 50 µm, refractive index of core is 1.484, refractive index of cladding is 1.470, and the wavelength of the light source is 850 nm?
   a. 682
   b. 37
   c. 1098
   d. 359

85. Which one of the following is a PN junction device that emits light when a current passes through it in the forward direction?
a. Light Dependent Resistor
b. Light Emitting Diode
c. He-Ne Laser
d. Ruby Laser

86. The spectral range of a function extends from 10.0 MHz to 10.2 MHz. What is the minimum sampling rate?
a. 4000 MHz
b. 400 MHz
c. 0.4 MHz
d. 40 MHz

87. An amplitude modulated wave $10[1+0.6\cos 2\pi 10^3 t]\cos 2\pi 10^6 t$ is to be detected by a linear diode detector. Find the value of resistance R if the capacitor used is 100pF.
a. $2.12\times10^6\ ohm$
b. $200\times10^{13}\ ohm$
c. $0.199\times10^{15} ohm$
d. $900\times10^2 ohm$

88. Which of the following statements is true in the case of TV transmission?
a. Frequency Modulation is employed for both sound and picture
b. Amplitude Modulation for picture and Frequency Modulation for sound are employed
c. Frequency Modulation for picture and Amplitude Modulation for sound are employed
d. Amplitude Modulation is employed for both sound and picture

89. Gain margin for marginally stable system in dB is
a. Greater than Zero
b. Less than Zero
c. Equal to Zero
d. Equal to One

90. What is the critical gain value of the system with characteristic equation
$s^4+5s^3+5s^2+4s+K=0$?
a. 1.36
b. 2.36
c. 3.36
d. 4.36

91. Lead compensator behaves like
a. Integrator
b. Differentiator
c. Low pass filter
d. Band pass filter

92. If the transfer function of open loop system is $G(s)H(s)=\frac{10(s+3)}{(s+2)(s-1)'}$ then how many encirclements, the Nyquist plot has around $-1+j0$ point in anticlockwise direction in the G(s)H(s) plane for stable closed loop system?
a. 0
b. 1
c. 2
d. 3

93. A system is described by the following state space model:-
$\dot{X}=\begin{bmatrix}-1 & 0\\ 1 & -2\end{bmatrix}X+\begin{bmatrix}1\\0\end{bmatrix}r(t)$ and $Y=[1\quad 1]X$.
The transfer function of the system is
a. $G(s)=\frac{(s+1)}{(s+2)(s+3)}$
b. $G(s)=\frac{(s+2)}{(s+1)(s+3)}$
c. $G(s)=\frac{(s+3)}{(s+1)(s+2)}$
d. $G(s)=\frac{(s+1)}{(s-1)(s-2)}$

94. The open loop transfer function of the system with unity feedback system is given by $G(s) = \frac{K}{s^2(s+1)(s+4)}$ and the input signal applied to the system is given by $r(t) = 1 + 8t + 9t^2$

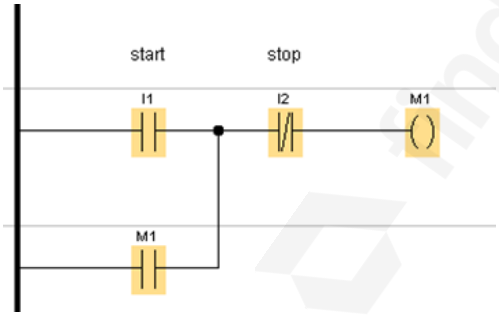
The value of K for steady state error 0.8 is

a. 60
b. 70
c. 80
d. 90

95. According to IEC-61131-3 which is **NOT** a programming types of PLC

a. Functional Block Diagram
b. Sequential Function Chart
c. Continuous Function Chart
d. Ladder Logic

96. Convert the ladder logic to Structured Text program



a. m1=i1 or m1 nand i2
b. m1:=(i1 or m1) nand i2;
c. m1:=(i1 or m1) and not i2;
d. m1:=(i1 nand i2) and i2;

97. What is the role of segment coupler in the DCS?

a. Couples PROFIBUS DP devices transparently to PROFIBUS PA
b. Couples PROFIBUS PA devices transparently to PROFIBUS DP
c. Couples PROFINET devices transparently to PROFIBUS DP
d. Couples PROFIBUS PA devices transparently to PROFINET

98. Which modulation is used in HART Protocol?

a. Pulse Shift Keying
b. Amplitude Shift Keying
c. Binary phase-shift keying
d. Frequency Shift Keying

99. Which is the only digital Fieldbus protocol developed to fully meet with the original IEC 61158 requirements?

a. Foundation Fieldbus H1
b. Foundation Fieldbus HSE
c. Profibus-DP
d. ProfiNet

100. The state transition matrix of discrete time system A^k is

a. $Z^{-1}\{(ZI - A)^{-1} - Z^{-1}\}$
b. $Z^{-1}\{(ZI - A)\ Z\}$
c. $Z^{-1}\{(ZI - A)^{-1}\ Z\}$
d. $Z^{-1}\{(ZI - A) - Z^{-1}\}$