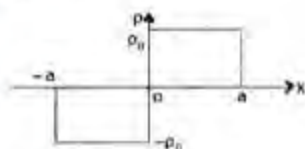


# ELECTRICAL ENGINEERING

## PAPER-I

1. A charge distribution is shown in the given figure:



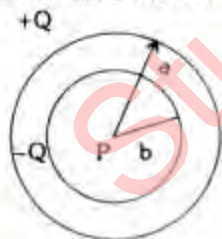
Which of the following expressions for the displacement flux density  $\vec{D}$  due to the given charge distribution is correct?

1.  $\vec{D} = -\rho_0 a \vec{i}_x$  for  $x < -a$
2.  $\vec{D} = -\rho_0 (x+a) \vec{i}_x$  for  $-a < x < 0$
3.  $\vec{D} = +\rho_0 (x-a) \vec{i}_x$  for  $0 < x < a$
4.  $\vec{D} = +\rho_0 a \vec{i}_x$  for  $x > a$

Select the correct answer using the codes given below:

- a. 1 and 4
- b. 2 and 3
- c. 1, 2 and 3
- d. 2, 3 and 4

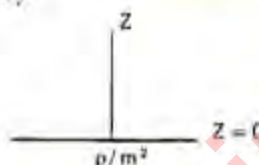
2. Two concentric metallic spheres of radii 'a' and 'b' carry charges +Q and -Q respectively as shown in the given figure. Potential at the centre 'P' will be



- a. Zero
- b.  $\frac{Q}{4\pi\epsilon_0 b}$
- c.  $\frac{-Q}{4\pi\epsilon_0 a}$
- d.  $\frac{Q}{4\pi\epsilon_0} \left( \frac{1}{a} - \frac{1}{b} \right)$

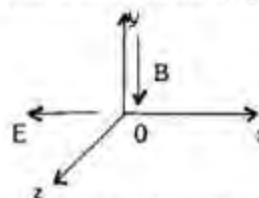
3. An infinite plane surface carries a uniform charge density  $\rho/m^2$  as shown in the figure.

The electric field  $E$  at any point  $Z$  is given by



- a.  $\vec{E} = \frac{\rho}{\epsilon_0 |Z|} \vec{a}_z$
- b.  $\vec{E} = \frac{\rho}{\epsilon_0 |Z|} \vec{a}_z, Z > 0; 0, Z = 0$
- c.  $\vec{E} = \frac{\rho}{\epsilon_0 |Z|} \vec{a}_z, |Z| > 0; 0, Z = 0$
- d.  $\vec{E} = \frac{\rho |Z|}{\epsilon_0 Z} \vec{a}_z, Z < 0$   
 $= 0, Z = 0$

4. A magnetic field  $\vec{B}$  and an electric field  $\vec{E}$  are at right angles to each other along the y-axis and x = axis respectively as shown in the given figure. the path of an electron which starts at the origin will be

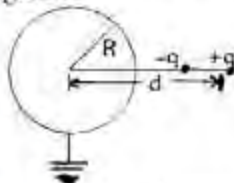


- a. Straight along the y-axis
  - b. Cycloidal along the x-axis
  - c. Straight along the z-axis
  - d. Cycloidal along the z-axis
5. An infinitely long conductor carrying a current  $I$  in a region permeability  $\mu_1$  and in the vicinity of another region of permeability  $\mu_2$  is shown in the given figure for calculating the field in the first region, the effect of discontinuity is replaced by an image  $I'$  and with  $\mu_1 < \mu_2$

which one of the following statements is correct in this regard?



- I and I' have the same strength and direction
  - I and I' have opposite direction but the same strength
  - I and I' have the same direction but different strength
  - I and I' have opposite direction and different strength
6. The image of the dipole of moment P in the grounded sphere shown in the given figure is



- A dipole of moment P
  - A dipole of moment  $PR/d$
  - A dipole of moment  $PR^2/d^2$
  - Not a dipole
7. If two concentric square loops A and B shown in the given figure carry equal currents in the same sense, then the magnetic field at 'O' due to the two loops A and B will be in the ratio



- $1:\sqrt{2}$
  - $1:1$
  - $\sqrt{2}:1$
  - $2:1$
8. Match List-I (Phenomena) with List-II (Reasons) and select the correct answer using the codes given below the lists:

**List I**

- Force on a unit north pole due to current
- Flux density intensity relation in a magnetic material
- Force of attraction between a current carrying conductor and a magnetic slab

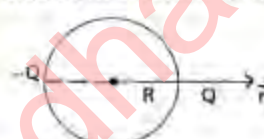
- Identically zero magnetic field outside a coaxial cable

**List II**

- Magnetic Polarization
- Maximization of magnetic lines of force
- Work done along a closed path is equal to total current flow
- Force between magnetic elements

	A	B	C	D
a.	3	1	2	4
b.	4	1	2	3
c.	3	2	1	4
d.	4	2	1	3

9. Two point charges Q and -Q are located on the surface of a sphere of radius R as shown in the figure. The average electric field in the volume of the sphere is



- Infinite
  - $\frac{2Q}{4\pi\epsilon_0 R^2}(-\vec{n})$
  - $\frac{2Q}{4\pi\epsilon_0 R^2}(+\vec{n})$
  - Zero
10. A flat slab of dielectric ( $\epsilon_r = 5$ ) is placed normal to a uniform field with a flux density  $D = 1$  Coulomb/m<sup>2</sup>. The slab is uniformly polarized. Polarization V in the slab (in Coulomb/m<sup>2</sup>) will be
- 0.8
  - 1.2
  - 4.0
  - 6.0
11. A parallel plate capacitor with air as dielectric is charged and then disconnected from the supply. The force between the plates is F. If the capacitor is now immersed in a liquid dielectric of dielectric constant  $\epsilon$ , then the force between the plates will be
- $\epsilon^2 F$
  - $\epsilon F$
  - F
  - $F/\epsilon$
12. Match List-I with List-II and select the correct answer using the codes given below the Lists: (Symbols have the usual meanings)



**List I**

- A. Poisson's equation  
 B. Laplace's equation  
 C. Joule's equation  
 D. Helmholtz's equation

**List II**

1.  $\nabla^2 \phi = 0$   
 2.  $\nabla^2 E + K_0^2 E = 0$  where  $K_0 = \omega \sqrt{\mu_0 \epsilon_0}$   
 3.  $\nabla^2 \phi = -\frac{\rho}{\epsilon_0}$   
 4.  $\frac{dP}{dV} = U/V = E \cdot J$

	A	B	C	D
a.	2	1	4	3
b.	3	4	1	2
c.	3	1	4	2
d.	2	4	1	3

13. A circular loop has its radius increasing at a rate of 2m/s. The loop is placed perpendicular to a constant magnetic field of  $0.1 \text{ Wb/m}^2$ . When the radius of the loop is 2 m, the emf induced in the loop will be

- a.  $0.8\pi V$   
 b.  $0.4\pi V$   
 c.  $0.2\pi V$   
 d. Zero

14. Kirchhoff's current law for direct currents is implicit in the expression

- a.  $\nabla \cdot \vec{D} = \rho$   
 b.  $\int \vec{J} \cdot n \, ds = 0$   
 c.  $\nabla \cdot \vec{B} = 0$   
 d.  $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

15. A rectangular loop in the x-z plane bounded by the lines  $x = 0$ ,  $x = a$ ,  $z = 0$  and  $z = b$ , is in a time-varying magnetic field given by

$$\vec{B} = B_0 \cos \omega t \vec{a}_y$$

Where  $B_0$  is a constant,  $\omega$  is the angular frequency and  $\vec{a}_y$  is the unit vector in the y-direction, the emf induced in the loop is given by

- a.  $abB_0 \cos \omega t$   
 b.  $abB_0 \omega \sin \omega t$   
 c.  $B_0 \omega \sin \omega t$   
 d. Zero

16. In a broadside array, the maximum radiation

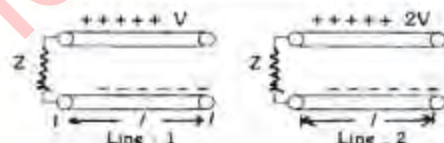
- a. Occurs at  $90^\circ$  to the line of the array  
 b. Occurs at  $45^\circ$  to the line of the array

- c. Occurs along the line of the array  
 d. Could occur at any angle to the line of the array

17. At a certain frequency 'f' a uniform plane wave is found to have established a wavelength  $\lambda$  in a good conductor. Of the source frequency is doubled, then the wavelength would change to

- a.  $\frac{\lambda}{\sqrt{2}}$   
 b.  $\sqrt{2}\lambda$   
 c.  $2\lambda$   
 d.  $4\lambda$

18. Two loss-less transmission lines 1 and 2 shown in the given figure have each a characteristic impedance  $Z$ . Line 1 is charged to a voltage of  $V$  and line 2 to a voltage of  $2V$ . Then both of them are discharged through resistances  $Z$  as shown. If line 1 gets fully discharged in time  $T$ , then line 2 will fully discharged in time



- a.  $T/4$   
 b.  $T/2$   
 c.  $T$   
 d.  $2T$

19. As the temperature of a 'p' type semiconductor is gradually and continuously increased, the Fermi level will move

- a. Into the valence band  
 b. Into the conduction band  
 c. Towards the middle of the forbidden gap  
 d. Into the region between the acceptor level and the valence band

20. Which one of the following polarization mechanisms/ sets of mechanisms contribute (s) to the static dielectric constant of a homopolar neutral dielectric?

- a. Electronic  
 b. Electronic and ionic  
 c. Electronic, ionic and dipolar  
 d. Electronic, and dipolar

21. Consider the following materials:

1. Pure silica  
 2. Bakelite  
 3. Hard rubber  
 4. Paraffin

The correct sequence of the DECREASING order of loss angle (60 Hz) these dielectric materials is

- 1, 2, 3, 4
- 1, 4, 3, 2
- 4, 1, 2, 3
- 4, 3, 1, 2

22. Which one of the following materials is piezoelectric?

- $\text{Pb}_2\text{Au}$
- $\text{BaTiO}_3$
- $\text{MgAl}_2\text{O}_4$
- $\text{NiFe}_2\text{O}_4$

23. The residual resistivity of metals

- Is essentially independent of temperature
- Increase linearly with increasing temperature
- Decrease linearly with increasing temperature
- Initially increases linearly with temperature and then remains constant.

24. Consider the following metals:

- Zinc.
- Gold.
- Silver.
- Copper.

The correct sequence of the increasing order of their resistivities is

- 4, 3, 1, 2
- 3, 4, 2, 1
- 4, 3, 2, 1
- 3, 4, 1, 2

25. Match List-I with List-II and select the correct answer:

List I (Class of material)

- Ferromagnetic
- Superconductor
- Semiconductor
- Piezoelectric

List II (Material)

- $\text{YBa}_2\text{Cu}_3\text{O}_7$
- $\text{LiNbO}_3$
- Co
- InGaAsP

	A	B	C	D
a.	3	1	2	4
b.	3	1	4	2
c.	1	3	2	4
d.	1	3	4	2

26. A type I superconductor maintained at a temperature  $T < T_c$  is subjected to a magnetic field  $H < H_c$ . The superconductor will exhibit

- Perfect diamagnetism
- Partial diamagnetism
- Perfect paramagnetism
- Partial paramagnetism

27. The magnetic susceptibility of a paramagnetic material is

- Less than zero
- Less than one but positive
- Greater than one
- Equal to zero

28. Magnetostriction is phenomenon whereby the magnetization of a ferromagnetic material leads to a change in

- Relative permeability
- Physical dimensions
- Spontaneous magnetization
- Magnetic susceptibility

29. Match List - I with List-II and select the correct answer

List I (Type of magnetic material)

- Ferromagnetic
- Anti-ferromagnetic
- Ferromagnetic

List II (Orientation of individual dipole moments)

- $\downarrow \uparrow \downarrow \uparrow$
- $\uparrow \downarrow \uparrow \downarrow$
- $\uparrow \searrow \swarrow \nwarrow$
- $\uparrow \uparrow \uparrow \uparrow$

	A	B	C
a.	4	2	1
b.	1	2	4
c.	2	1	3
d.	4	2	3

30. Match List-I with List-II and select the correct answer

List I (Application)

- Power transformer
- Audio transformer
- Pulse transformer
- Welding transformer

List II (Core material)

- Si-Fe alloy
- Permalloy
- Ferrite
- Supermalloy
- Hypersil

	A	B	C	D
a.	1	2	4	5
b.	2	3	4	5
c.	1	2	3	4
d.	2	3	5	4

31. Two initially identical samples A and B of pure germanium are doped with donors to



concentrations of  $1 \times 10^{20} \text{ m}^{-3}$  and  $3 \times 10^{20} \text{ m}^{-3}$  respectively. If the hole concentration in A is  $9 \times 10^{12} \text{ m}^{-3}$ , then the hole concentration in B at the same temperature will be

- $3 \times 10^{12} \text{ m}^{-3}$
- $7 \times 10^{12} \text{ m}^{-3}$
- $11 \times 10^{12} \text{ m}^{-3}$
- $27 \times 10^{12} \text{ m}^{-3}$

32. Consider the following statements:

Pure germanium and pure silicon are examples of

- Direct band-gap semiconductors.
- Indirect band-gap semiconductors.
- Degenerate semiconductors.

Of these statements

- 1 alone is correct
- 2 alone is correct
- 3 alone is correct
- 1 and 3 are correct

33. Consider the following statements:

In a semiconductor, the measurement of Hall coefficient provides quantitative information on

- Density of carriers.
- Polarity of carriers.
- Effective mass of the carriers.
- Mobility of the carriers.

Of these statements

- 1 and 2 are correct
- 2 and 3 are correct
- 1 and 3 are correct
- 1, 2, 3 and 4 are correct

34. Silicon carbide reinforced aluminum metal matrix- composites find application in

- The manufacture of transformer cores
- The manufacture of cutting tools.
- The manufacture of standard resistors
- Aerospace industry

35. GaAsLEDs emit radiation in the

- Ultra-violet region
- Violet-blue-green range of the visible region
- Visible region
- Infra-red region

36. A series RLC circuit, consisting of  $R = 10$  ohms,  $X_L = 20$  ohms and  $X_C = 20$  ohms is connected across an ac supply of 100 V (rms). The magnitude and phase angle (with reference to supply voltage) of the voltage across the inductive coil are respectively

- 100 V;  $90^\circ$

- 100 V;  $90^\circ$
- 200 V;  $-90^\circ$
- 200 V;  $90^\circ$

37. From a sinusoidal voltage source  $V_s$  of impedance  $Z_s = R_s + jX_s$ , power is drawn by a load  $Z_L = R_L + jX_L$ . The condition for maximum power in  $Z_L$  is given in List - II for the constraints shown in List - I. Match List - I with List - II and select the correct answer using the codes given below the Lists:

**List I**

- $X_s = \text{zero}$
- $X_L = \text{zero}$
- $R_L$  fixed
- $X_L$  fixed

**List II**

- $Z_L^2 = R_s^2 + X_s^2$
- $Z_L = R_s - jX_s$
- $Z_L = R_s - jX_s$
- $Z_L = R_s$
- $Z_L = R_s^2 + [(X_s + X_L)^2]^{1/2} + jX_L$

	A	B	C	D
a.	4	1	2	3
b.	2	3	4	5
c.	4	1	2	5
d.	1	3	4	5

38. For the networks shown in figures A and B to be duals, it is necessary that  $R$ ,  $L$  and  $C$  are respectively equal to

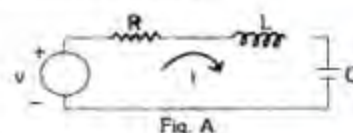


Fig. A

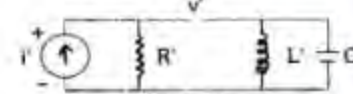
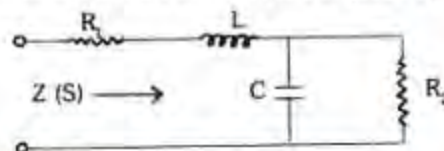


Fig. B

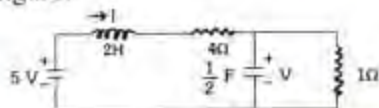
- $1/R$ ,  $C$  and  $L$
- $1/R$ ,  $1/L$  and  $1/C$
- $1/R$ ,  $1/L$  and  $C$
- $R$ ,  $L$  and  $C$

39. The impedance  $Z$  (s) of the one-port network shown in the figure is given by



- a.  $\frac{s^2 + s \frac{L}{C} + \frac{R_1}{LC}}{s + \frac{1}{LC}}$
- b.  $L \frac{s^2 + s \frac{L + R_1 R_2 C}{R_2 LC} + \frac{R_1 + R_2}{R_2 LC}}{s + \frac{1}{R_2 C}}$
- c.  $L \frac{s^2 + s \frac{L + C}{R_1 R_2} + \frac{R_1}{LC}}{s + \frac{1}{R_1 C}}$
- d.  $\frac{s^2 + s \frac{L + R_2 C}{R_1 LC} + \frac{R_1 + R_2}{R_1 LC}}{s + \frac{1}{R_1 C}}$

40. Which of the following statement (s) is/are true of the circuit shown in the given figure?



1. It is a first order circuit with steady-state values of  $V = \frac{5}{3}V$ ,  $I = \frac{5}{3}A$
2. It is a second order circuit with steady-state values of  $V = 1V$ ;  $I = 1A$
3. The network function  $V(s)/I(s)$  has one pole.
4. The network function  $V(s)/I(s)$  has two poles.

Select the correct answer using the codes given below:

- a. 1 and 3
- b. 2 and 4
- c. 2 alone
- d. 1 alone

41. In addition to the condition that  $Y(s)$  is real when ' $s$ ' is real, for an admittance function  $Y(s)$  to be positive real, which of the following conditions are to be satisfied?

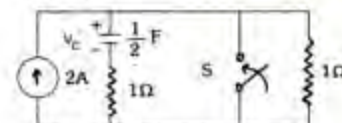
1.  $\operatorname{Re} Y(s) \leq 0$  for  $\operatorname{Re} s \geq 0$
2.  $\operatorname{Re} Y(s) \geq 0$  for  $\operatorname{Re} s \geq 0$
3.  $|\operatorname{Arg} Y(s)| \leq |\operatorname{Arg} s|$  for  $|\operatorname{Arg} s| \leq \pi/2$
4.  $|\operatorname{Arg} Y(s)| \geq |\operatorname{Arg} s|$  for  $|\operatorname{Arg} s| \leq \pi/2$

Select the correct answer using the codes given below:

- a. 1 and 3 are correct

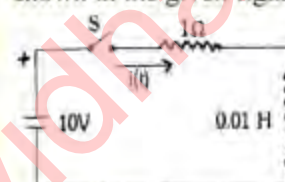
- b. 1 and 4 are correct
- c. 2 and 3 are correct
- d. 2 and 4 are correct

42. The circuit shown in the given figure is in steady-state with, switch 'S' open. The switch is closed at  $t = 0$ . The values of  $V_c(0^+)$  and  $V_c(\infty)$  will be respectively



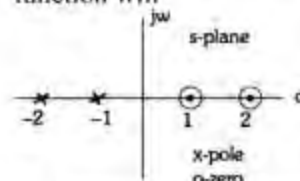
- a. 2V, 0V
- b. 0V, 2V
- c. 2V, 2V
- d. 0V, 0V

43. After closing the switch 'S' at  $t = 0$ , the current  $i(t)$  at any instant ' $t$ ' in the network shown in the given figure will be



- a.  $10 + 10e^{100t}$
- b.  $10 - 10e^{100t}$
- c.  $10 + 10e^{-100t}$
- d.  $10 - 10e^{-100t}$

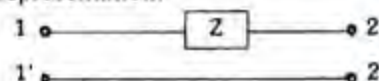
44. The pole-zero configuration of a network transfer function is shown in the given figure. The magnitude of the transfer function will



- a. Decrease with frequency
- b. Increase with frequency
- c. Initially increase and then decrease with frequency
- d. Be independent of frequency

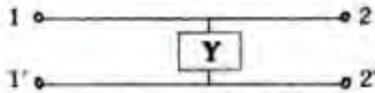
45. Consider the following statements:

1. The two-port network shown below does NOT have an impedance matrix representation.



2. The following two-port network does NOT have an admittance matrix representation





3. A two-port network is said to be reciprocal if it satisfies  $z_{12} = z_{21}$

Of these statements

- 1 and 2 are correct
- 1, 2 and 3 are correct
- 1 and 3 are correct
- None is correct

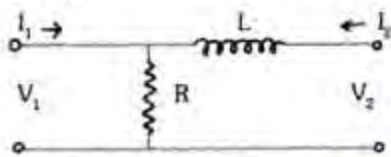
46. Match List - I with List - II for the two-port network shown in the given figure and select the correct answer

**List I**

- $Z_{11}$
- $Z_{12}$
- $Z_{21}$
- $Z_{22}$

**List II**

- R
- $R+L$
- $R-Ls$
- $R+Ls$



- |    | A | B | C | D |
|----|---|---|---|---|
| a. | 1 | 2 | 1 | 4 |
| b. | 2 | 1 | 1 | 3 |
| c. | 1 | 1 | 1 | 4 |
| d. | 2 | 1 | 3 | 4 |

47. Consider the following statements:

I: Any function in 's' which can be expressed as a ratio of any two arbitrary polynomials in 's' can be realized as a driving-point function of a passive network.

II: Any function in 's' which can be expressed as a ratio of two arbitrary polynomials in 's', is a positive real function.

Of these statements

- both I and II are true
- I is true but II is false
- both I and II are false
- I is false but II is true

48. Consider the following polynomials:

- $s^4 + 7s^3 + 17s^2 + 17s + 6$
- $s^4 + 11s^3 + 41s^2 + 61s + 30$
- $s^4 + s^3 + 2s^2 + 3s + 2$

Among these polynomials, those which are Hurwitz would include

- 1 and 3
- 2 and 3
- 1 and 2
- 1, 2 and 3

49. Match List-I with List-II and select the correct answer:

**List I (Function)**

- Unit ramp
- Unit step
- Unit impulse
- Unit doublet

**List II (Laplace transform)**

- s
- 1
- $1/s$
- $1/s^2$

- |    | A | B | C | D |
|----|---|---|---|---|
| a. | 4 | 3 | 2 | 1 |
| b. | 3 | 4 | 1 | 2 |
| c. | 4 | 3 | 1 | 2 |
| d. | 3 | 4 | 2 | 1 |

50. A system is represented by

$$\frac{dy}{dt} + 2y = 4tu(t)$$

The ramp component in the forced response will be

- $Tu(t)$
- $2t u(t)$
- $3t u(t)$
- $4t u(t)$

51. The Laplace transform of the function  $i(t)$

$$\text{is: } I(s) = \frac{10s+4}{s(s+1)(s^2+4s+5)} \text{ its final}$$

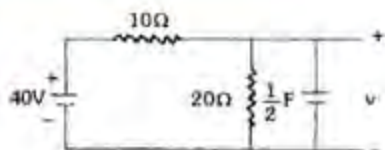
value will be

- 4/5
- 5/4
- 4
- 5

52. If the unit step response of a network is  $(1 - e^{-at})$ , then its unit impulse response will be

- $\alpha e^{-at}$
- $\alpha e^{-t/\alpha}$
- $\frac{1}{\alpha} e^{-at}$
- $(1 - \alpha) e^{-at}$

53. In the network shown in the given figure, if the voltage  $v$  at the time considered is 20 V, then  $dv/dt$  at that time will be



- 1 V/s
- 2 V/s
- 2 V/s
- zero

54. Which one of the following pairs of poles and responses is correctly matched?

Poles Response

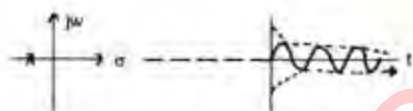
a.



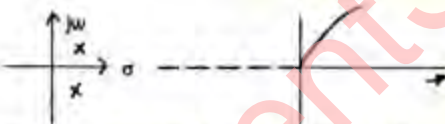
b.



c.



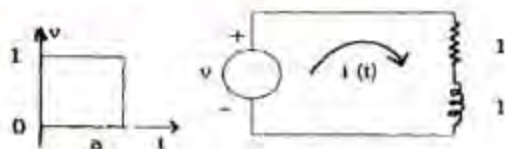
d.



55. The impulse response of an R-L circuit is a

- Rising exponential function
- Decaying exponential function
- Step function
- Parabolic function

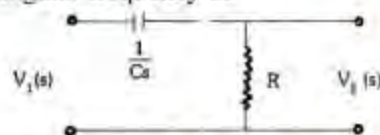
56. A pulse of unit amplitude and width 'a' is applied to a series RL circuit as shown in the figure. The current  $i(t)$  as 't' tends to infinity will be



- Zero
- 1 A
- A value between zero and one depending upon the width of the pulse
- Infinite

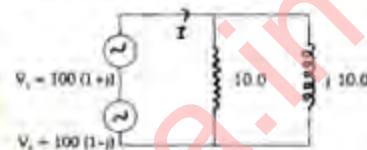
57. The sinusoidal steady-state voltage gain of the network shown in the given figure will

have magnitude equal to 0.707 at an angular frequency of



- zero
- RC rad/s
- 1/RC rad/s
- 1 rad/s

58. The phase angle of the current 'I' with respect to the voltage  $V_1$  in the circuit shown in the figure is:



- 0°
- +45°
- 45°
- 90°

59. A second order system is given by

$$\frac{d^2 y}{dt^2} + 12 \frac{dy}{dt} + 100y = 0$$

The damped natural frequency in rad/sec is

- 100
- 10
- $\sqrt{44}$
- 8

60. An alternator is delivering power to a balanced load at unity power factor. The phase angle between the line voltage and the line current is

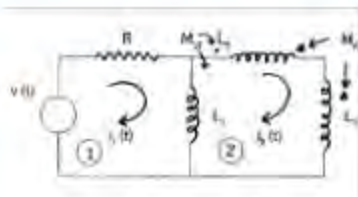
- 90°
- 60°
- 30°
- 0°

61.  $E_{oa}$ ,  $E_{ob}$  and  $E_{oc}$  are three phase voltages while  $E_{ab}$ ,  $E_{bc}$  and  $E_{ca}$  are the line voltage of a balanced three-phase system having a-b-c phase sequence. In relation to  $E_{oc}$   $E_{bc}$  would

- Lag by 30°
- Lead by 30°
- Have the same phase
- Have no definite phase relationship

62. For loop 1 of the network shown in the given figure, the correct loop equation is:





$$v(t) = Ri_1(t) + L_1 \frac{di_1(t)}{dt} + M_{12} \frac{di_2(t)}{dt}$$

a.

$$-M_{12} \frac{di_2(t)}{dt}$$

b.

$$v(t) = Ri_1(t) + L_1 \frac{di_1(t)}{dt} + M_{12} \frac{di_2(t)}{dt}$$

c.

$$-M_{12} \frac{di_2(t)}{dt} - M_{21} \frac{di_1(t)}{dt}$$

d.

$$L_1 \frac{di_1(t)}{dt} + L_2 \frac{di_2(t)}{dt} + M_{12} \frac{di_2(t)}{dt} + M_{21} \frac{di_1(t)}{dt}$$

$$= 2(M_{12} + M_{21}) \frac{di_2(t)}{dt} - M_{12} \frac{di_1(t)}{dt}$$

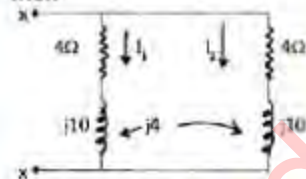
$$L_1 \frac{di_1(t)}{dt} + L_2 \frac{di_2(t)}{dt} + M_{12} \frac{di_2(t)}{dt} + M_{21} \frac{di_1(t)}{dt}$$

d.

$$= (M_{12} \frac{di_1(t)}{dt} - 2(M_{12} + M_{21}) \frac{di_2(t)}{dt})$$

63.

Consider the following statements:

In the circuit shown in the figure, if the equivalent impedance between x-x is  $Z_{eq}$  then

1.  $Z_{eq} = 2 + j5$

2.  $Z_{eq} = 2 + j3$

3.  $I_1 = -I_2$

4.  $I_1 = I_2$

Of these statements

a. 1 alone is true

b. 2 and 4 are correct

c. 2 and 3 are correct

d. 1 and 4 are correct

64.

The residues at the pole of  $Y(s)$ , of an R-C network are

a. Real and negative

b. Real and positive

c. Complex with positive real part

d. Complex with negative real part

65.

Consider the following statements:

In a measuring instrument,

1. Linearity is more important than sensitivity

2. High precision indicates high accuracy.

3. Accuracy cannot be better than resolution.

Of these statements

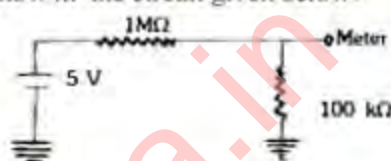
a. 1, 2, and 3 are correct

b. 1, and 2 are correct

c. 2 and 3 are correct

d. 1 and 3 are correct

66.

What voltage would a voltmeter with impedance  $20,000 \Omega$  and range  $0-1V$  show in the circuit given below?

a. 82 mV

b. 100 mV

c. 118 mV

d. 5V

67.

Match List-I with List-II and select the correct answer;

**List I**

A. Cesium

B. Manganin

C. Standard voltage

D. IEEE 488

**List II**

1. Standard resistance

2. Atomic clock

3. Instrument interface

4. Josephson Junction

	A	B	C	D
a.	2	1	3	4
b.	2	1	4	3
c.	1	2	3	4
d.	1	2	4	3

a. 2 1 3 4

b. 2 1 4 3

c. 1 2 3 4

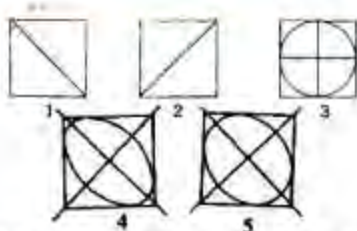
d. 1 2 4 3

68.

The limiting errors of measurement of power consumed by and the current passing through a resistance are  $\pm 1.5\%$  and  $\pm 1\%$  respectively; The limiting error of measurement of resistance will then bea.  $\pm 0.5\%$ b.  $\pm 1.0\%$ c.  $\pm 2.5\%$ d.  $\pm 3.5\%$ 

69.

Horizontal deflection in a CRO is due to  $E \sin \omega t$  while vertical deflection is due to  $E \sin (\omega t + \theta)$  with a positive  $\theta$ . Consider the following patterns obtained in the CRO.

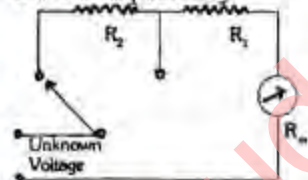


The correct sequence of these patterns in increasing order of the value of  $\theta$  is:

- 3, 2, 5, 1, 4
  - 3, 2, 4, 5, 1
  - 2, 3, 5, 1, 4
  - 2, 3, 5, 4, 1
70. Which of the following until are present in a spectrum analyzer?
- Mixer.
  - Saw-tooth generator.
  - Local oscillator.

Select the correct answer using the codes given below:

- 1, 2 and 3
  - 1 and 2
  - 1 and 3
  - 2 and 3
71. For the voltmeter circuit shown in the given figure, the basic D'Arsonval meter used has full-scale current of 1 mA and meter resistance ( $R_m$ ) of 100 ohms. The values of the series resistance  $R_1$  and  $R_2$  required for 10V range and 50 V range will be respectively



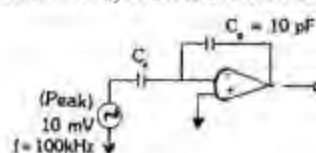
- 9.9k $\Omega$  and 40 k $\Omega$
  - 10 k $\Omega$  and 50 k $\Omega$
  - 20 k $\Omega$  and 30 k $\Omega$
  - 200 k $\Omega$  and 250 k $\Omega$
72. Electronic voltmeter provides more accurate readings in high resistance circuits as compared to a non-electronic voltmeter because of its
- High V/ohm ratings
  - High ohm/ratings
  - High meter resistance
  - Low resolution
73. A current transformer has a phase error of +30°. The phase angle between the primary and secondary currents is
- 30°
  - 177°

c. 180°

d. 183°

74. Modern electronic multimeters measure resistance by
- Using a bridge circuit
  - Using an electronic bridge compensator for nulling
  - Forcing a constant current and measuring the voltage across the unknown resistor
  - Applying a constant voltage and measuring the current through the unknown resistor
75. In the case of power measurement by two-wattmeter method in a balanced 3-phase system with a pure inductive load,
- Both the watt meters will indicate the same value but of opposite sign
  - Both the watt meters will indicate zero
  - Both the watt meters will indicate the same value and of the same sign
  - One wattmeter will indicate zero and the other will indicate some non-zero value

76. Many modern capacitance meters measure capacitance by making the unknown capacity an element in a charge amplifier. A schematic of the same is given below. If the maximum permissible output voltage is limited to 1V<sub>peak</sub> due to slew rate constraint, then the maximum  $C_x$  will be



- 10 pF
  - 100 pF
  - 1000 pF
  - 10 nF
77. A 230 V, 10 A, single-phase energy meter makes 90 revolutions in 3 minutes at half load rated voltage and unity pf. If the meter constant is 1800 revolution/kWh, then its error at half load will be
- 13.04% slow
  - 13.04% fast
  - 15% slow
  - 15% fast
78. A strain gauge bridge measures the strain in a cantilever where the gauge is fixed. With strain  $\epsilon$ , the gauge resistance increases from 110 $\Omega$  to 110.520 $\Omega$ . If the



gauge factor is 2.03, then the strain in the cantilever will be

- $2.06 \times 10^{-3}$
- $3.15 \times 10^{-3}$
- $3.81 \times 10^{-3}$
- $4.33 \times 10^{-3}$

79. Consider the following statements:  
The causes of error in the measurement of temperature using a thermistor are

- Self heating
- Poor sensitivity.
- Non-linear characteristics.

Of these statements

- 1, 2 and 3 are correct
- 1 and 2 are correct
- 2 and 3 are correct
- 1 and 3 are correct

80. A piezoelectric transducer has the following parameter values:

Crystal capacitance =  $10^{-9}$  F

Cable capacitance =  $2 \times 10^{-10}$  F

Charge sensitivity =  $4 \times 10^{-6}$  Coulomb/cm.

If the oscilloscope used for read-out has an input resistance of 1 M $\Omega$  in parallel with  $C = 4 \times 10^{-10}$  F, then the voltage sensitivity constant will be

- 2500 V/cm
- 3334 V/cm
- 4000 V/cm
- 4500 V/cm

81. For a thermocouple pair (A,B), the extension wires (C,P)

- Should be identical pair elements
- Should have identical temperature - emf relationship
- Can be of any two dissimilar materials
- Should have very small temperature - emf sensitivity

82. A 7-bit successive approximation DVM will convert the analog input into digital output in a period of

- 7 clock pulses
- 8 clock pulses
- 

$$\frac{\text{input signal amplitude}}{\text{full-scale output amplitude}} \times 7 \text{ clock pulses}$$

- $\frac{\text{input signal amplitude}}{\text{full-scale output amplitude}} \times 8 \text{ clock pulses}$

83. Match List-I with List-II. and select the correct answer:

### List I

- Low pass filter
- High pass filter
- Band pass filter
- Band reject filter

### List II

- $\frac{Ts}{1+Ts}$
- $\frac{1}{1+\left(Ts+\frac{1}{Ts}\right)}$
- $\frac{T_s+\frac{1}{Ts}}{1+\left(Ts+\frac{1}{Ts}\right)}$
- $\frac{1}{1+Ts}$

	A	B	C	D
a.	1	4	3	2
b.	4	1	2	3
c.	1	4	2	3
d.	4	1	3	2

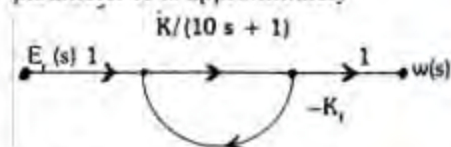
84. Data buffering means

- A buffer stock of data already stored in a computer unit
- An electronic circuit which is used to maintain the level of data
- That data are first collected in an external unit and then processed into the computer
- Application of buffer (unity gain amplifier) at input interface to the computer

85. A circuit draws a current  $T^*$ . When a single-phase ac voltage  $V$  is applied to it. If the power factor is  $\cos \phi$  then the dimensions of  $VI \cos \phi$  would be

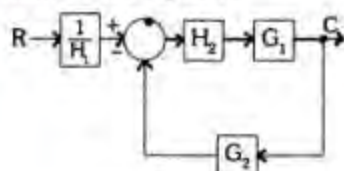
- $ML^3T^{-2}$
- $ML^2T^{-3}$
- $ML^3T^{-3}$
- $ML^2T^{-3}$

86. Given:  $KK_1 = 99$ ;  $s = j1$  rad/s, the sensitivity of the closed-loop system (shown in the given figure) to variation in parameter  $K$  is approximately

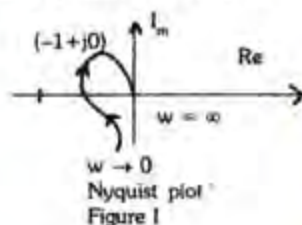


- 0.01
- 0.1
- 1.0

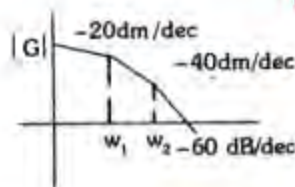
87. d. 10  
The transfer function  $C/R$  of the system shown in the figure is:



- a.  $\frac{G_1 G_2 H_2}{H_1 (1 + G_1 G_2 H_2)}$   
b.  $\frac{G_1 H_1}{H_1 (1 + G_1 G_2 H_2)}$   
c.  $\frac{G_1 H_2}{H_1 (1 + G_1 G_2 H_1)}$   
d.  $\frac{G_1 H_1}{H_2 (1 + G_1 G_2 H_2)}$
88. The Nyquist plot for a control system is shown in Figure 1. The Bode plot for the same system will be as in



- a.
- b.
- c.
- d.

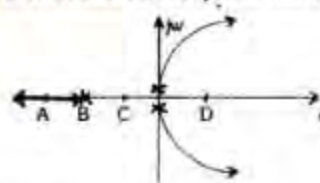


89. A unity feedback second order control system is characterized by

$$G(s) = \frac{K}{s(Js + B)}$$

where  $J$  = moment of inertia,  $K$  = system gain  $B$  viscous damping coefficient. The transient response specification which is NOT affected by variation of system gain is the

- a. Peak overshoot  
b. Rise time  
c. Settling time  
d. Damped frequency of oscillations
90. The root-locus plot for an uncompensated unstable system is shown in the given figure. The system is to be compensated by a compensating zero. The most desirable location of the compensating zero would be the point marked.



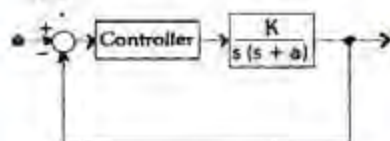
- a. A  
b. B  
c. C  
d. D
91. The open-loop transfer function of a unity feedback control system is
- $$G(s)H(s) = \frac{30}{s(s+1)(s+T)}$$
- where  $T$  is a variable parameter. The closed-loop system will be stable for all values of
- a.  $T > 0$   
b.  $0 < T < 3$   
c.  $T > 5$   
d.  $3 < T < 5$
92. The Nyquist plot of the open-loop transfer function  $G(s)H(s)$  is shown in the given figure. It indicates that





- The open-loop system is unstable but the closed-loop system is stable
- Both open-loop and closed-loop systems are unstable
- Open-loop system is stable but closed-loop system is unstable
- Both open-loop and closed-loop systems are stable

93. In the control system shown in the given figure, the controller which can give zero steady-state error to a ramp input, with  $K=9$  is



- Proportional type
- Integral type
- Derivative type
- Proportional plus derivative type

94. The gain cross-over frequency and bandwidth of a control system are  $\omega_{cu}$  and  $\omega_{bu}$  respectively. A phase-lag network is employed for compensating the system. If the gain cross-over frequency and bandwidth of the compensated system are  $\omega_{cc}$  and  $\omega_{bc}$  respectively, then

- $\omega_{cc} < \omega_{cu}$ ,  $\omega_{bc} < \omega_{bu}$
- $\omega_{cc} > \omega_{cu}$ ,  $\omega_{bc} < \omega_{bu}$
- $\omega_{cc} < \omega_{cu}$ ,  $\omega_{bc} > \omega_{bu}$
- $\omega_{cc} > \omega_{cu}$ ,  $\omega_{bc} > \omega_{bu}$

95. The transfer function of a certain system is

$$\frac{Y(s)}{U(s)} = \frac{1}{s^4 + 5s^3 + 7s^2 + 6s + 3}$$

The  $A$ ,  $B$  matrix pair of the equivalent state-space model will be

- $$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -3 & -6 & -7 & -5 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

- $$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -3 & -5 & -6 & -7 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

- $$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -5 & -7 & -6 & -3 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

- $$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -3 & -6 & -7 & -5 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

96. A linear system is described by the state equations

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r, \quad C = x_2$$

where  $r$  and  $c$  are the input and output respectively. The transfer function is:

- $1/(s+1)$
- $1/(s+1)^2$
- $1/(s-1)$
- $1/(s-1)^2$

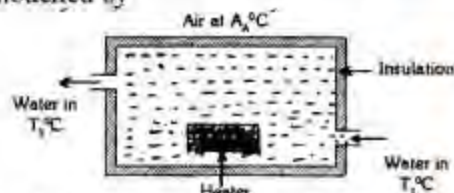
97. The state equation of a dynamic system is given by  $\dot{X}(t) = AX(t)$

$$A = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -6 & -3 & 4 \\ 0 & 0 & 0 & -4 & -3 \end{bmatrix}$$

The eigenvalues of the system would be

- Real non-repeated only
- Real non-repeated and complex
- Real repeated
- Real repeated and complex

98. A simple electric water heater is shown in the given figure. The system can be modelled by

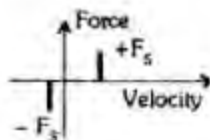


- A first order differential equation
- A second order differential equation
- A third order differential equation
- An algebraic equation

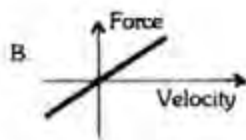
99. Match List-I with List-II and select the correct answer

**List I (Properties of frictional force)**

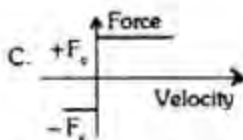
A.



B.



C.



**List II (Frictional force)**

1. Coulomb friction
2. Viscous friction
3. Static friction

	A	B	C
a.	1	2	3
b.	2	1	3
c.	3	2	1
d.	2	3	1

100. Laplace transform of the output response of a linear system is the system transfer function when the input is

- a. A step signal
- b. A ramp signal
- c. An impulse signal
- d. A sinusoidal signal

101. Match List-I with list-II and select the correct answer.

**List I**

- A. Hydraulic actuator
- B. Flapper valve
- C. Potentiometer error detector
- D. Dumb-bell rotor

**List II**

1. Linear device
2. A.C. servo systems
3. Large power to weight ratio
4. Pneumatic systems

	A	B	C	D
a.	4	3	2	1
b.	3	4	2	1
c.	3	4	1	2
d.	4	3	1	2

102. Which of the following statements regarding an ac servo system employing a synchro error detector are correct?

1. Sensitivity of the error detector is measured in volts/degree.
  2. The transfer function of the synchro error detector is  $\frac{E}{\theta_r - \theta_c}$  where E = error voltage,  $\theta_r$  and  $\theta_c$  are reference and controlled shaft positions.
  3. Sensitivity of the error detector has the same sign at the two null positions.
- a. 1, 2 and 3
  - b. 1 and 2
  - c. 2 and 3
  - d. 1 and 3

103. Four speed-torque curves (labelled I, II, III and IV) are shown in the given figure. That of an ac servomotor will be as in the curve labelled



- a. I
- b. II
- c. III
- d. IV

104. A non-linear control system is described by the equation  $\frac{d^2x}{dt^2} + \sin x = 0$

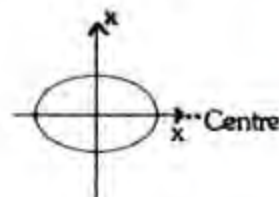
The type of singularity at  $x = \pi$  and  $\frac{dx}{dt} = 0$  is;

- a. Centre
- b. Stable focus
- c. Saddle point
- d. Stable node

105. Which one of the following pairs of phase-plane diagram and types of singularities is NOT correctly matched?

Phase-plane diagram      Singularity

a.

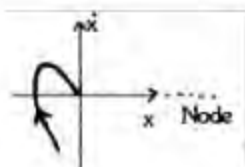


b.

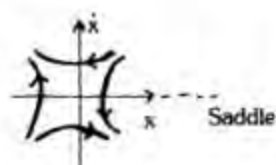




c.



d.



106. Consider the following state equations for a discrete system:

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} -\frac{1}{2} & 0 \\ -\frac{1}{4} & -\frac{1}{4} \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = [1 \ 1] \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} - 4u(k)$$

The system given above is

- Controllable and observable
  - Uncontrollable and unobservable
  - Uncontrollable and observable
  - Controllable and unobservable
107. Which one of the following systems is open-loop?
- The respiratory system of man
  - A system for controlling the movement of the slide of a copying milling machine
  - A thermostatic control
  - Traffic light control
108. **Assertion A:** In general, circulation of the magnetic field intensity is zero.  
**Reason R:** Vector source of circulation is the current density.
- Both A and R are true and R is the correct explanation of A
  - Both A and R are true but R is NOT a correct explanation of A
  - A is true but R is false
  - A is false but R is true
109. **Assertion A:** In some semiconductors, the Hall coefficient is positive.

**Reason R:** In these semiconductors, the mobility of holes is greater than that of electrons.

- Both A and R are true and R is the correct explanation of A
- Both A and R are true but R is NOT a correct explanation of A
- A is true but R is false
- A is false but R is true

110. **Assertion A:** Intrinsic germanium does not show n-type behavior.

**Reason R:** In intrinsic germanium, the number of electrons is less than the number of holes.

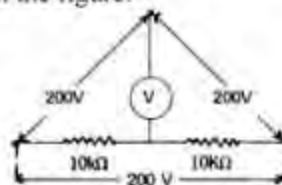
- Both A and R are true and R is the correct explanation of A
- Both A and R are true but R is NOT a correct explanation of A
- A is true but R is false
- A is false but R is true

111. **Assertion A:** Quartz crystal is preferred over Rochelle salt crystal for commercial piezoelectric applications.

**Reason R:** Rochelle salt is mechanically weaker.

- Both A and R are true and R is the correct explanation of A
- Both A and R are true but R is NOT a correct explanation of A
- A is true but R is false
- A is false but R is true

112. A voltmeter with a resistance of  $10 \text{ k}\Omega$  is connected with two other  $10 \text{ k}\Omega$  resistors across a  $200 \text{ V}$  3-phase mains, as shown in the figure:



**Assertion A:** The voltmeter reading will be  $115 \text{ V}$ .

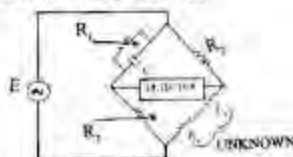
**Reason R:** The connections are similar to Scott connection.

- Both A and R are true and R is the correct explanation of A
- Both A and R are true but R is NOT a correct explanation of A
- A is true but R is false
- A is false but R is true

113. **Assertion A:** The bridge shown in the figure is balanced by first adjusting  $R_1$  for inductive balance and then adjusting  $R_3$  for



resistive balance, and this is repeated till balance is achieved.



**Reason R:** For medium-Q coils, the resistance effect is not pronounced and balance is reached after a few adjustments.

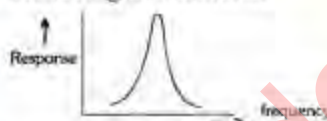
- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

114. **Assertion A:** Electrometers are used at the output stage of electrode pH meters.

**Reason R:** In electrode type pH meters, the potential is measured using reference and measuring electrodes.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

115. **Assertion A:** The frequency response shown in the given figure is that of a vibration galvanometer.



**Reason R:** A vibration galvanometer is the most suitable detector in ac potentiometer method of measurement.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

116. **Assertion A:** The solution of  $3\frac{1}{2}$  digit voltmeter is 0.001.

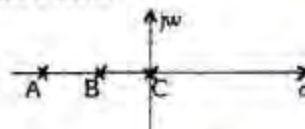
**Reason R:** Addition of  $\frac{1}{2}$  digit to a digital voltmeter increases the range of the meter.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.

c. A is true but R is false

d. A is false but R is true

117. **Assertion A:** Section AB on the negative real axis in the given figure lies on the root-locus.



**Reason R:** All the points in between A and B have two poles to the right of the points.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

118. **Assertion A:** Feedback control systems are often compensated by phase lead/phase-lag networks.

**Reason R:** Phase-lead/phase-lag networks are easily realizable and obtainable.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

119. **Assertion A:** A discrete data system having the characteristic equation  $Z^2 - 1.5Z - 1 = 0$  is unstable.

**Reason R:** The negative coefficients of the characteristic equation in the z-plane represent an unstable discrete system.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true

120. **Assertion A:** A dipole placed in a uniform field experiences a torque tending to align the dipole axis with the field.

**Reason R:** A dipole placed in a uniform field does not experience a translational force.

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is NOT a correct explanation of A.
- A is true but R is false
- A is false but R is true