EC-Objective-Paper-I (Set-D)

1. Consider an LTI system representing a passive electrical network. If the input is a sinusoidal signal, then the steady-state output of the network is

   (A) Sinusoidal with the same amplitude, frequency and phase

   (B) Sinusoidal with the same frequency, but possibly different amplitude and phase

   (C) Non-sinusoidal

   (D) Sinusoidal with a different frequency

Key: (B)

2. A series R-L circuit ($R = 4\Omega$ and L = 0.01) is excited by a voltage (in volt) V(t) = 283sin (300t + 90°). The current in the circuit will be

   (A) $40\sin\left(300t + 53.1^{\circ}\right)A$

   (B) $40\sin 53.1^{\circ}\,A$

   (C) $40\sqrt{2}\sin\left(300t + 53.1^{\circ}\right)A$

   (D) $40\sqrt{2}\sin 53.1^{\circ}\,A$

Key: (C)

Exp: $$(s) = \frac{\text{Laplace of Desired Response}}{\text{Laplace of Excitation}} = \frac{I(s)}{V(s)} = Y(s)$$

$$H(s) = \frac{1}{Z(s)} = \frac{1}{R + sL} = \frac{1}{R + j\omega L}$$

$$H(\omega) = \frac{1}{\sqrt{R^2 + (\omega L)^2}} \angle -\tan^{-1}\frac{\omega L}{R} = \frac{1}{\sqrt{4^2 + 3^2}} \angle -\tan^{-1}\frac{3}{4}$$

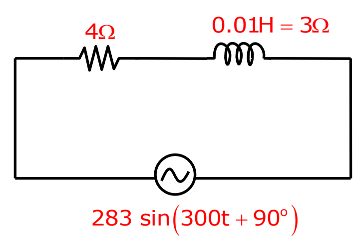
$$= \frac{1}{5} < -36.86$$

Since the network is LTI, so when the input is sinusoidal output is also sinusoidal with same frequency with possible change in its magnitude and phase which it obtained from H(s). So to obtain the response we have to multiply the magnitude and add the phase to the excitation.

$$i(t) = \frac{1}{5} 283\sin\left[300t + 90^{\circ} - 36.86\right]$$

$$= 56.6\sin(300t + 53.1)$$

$$= 40\sqrt{2}\sin(300t + 53.1)$$



3. An inductor L and 5Ω and 10Ω resistors are all connected in series across a voltage source $V(t) = 50\cos\omega t$ volt. If the power consumed by the 5Ω resistor is 10 W, then the power factor of the circuit is

(A) 0.3 (B) 0.4 (C) 0.6 (D) 0.8

Key: (C)

Exp:

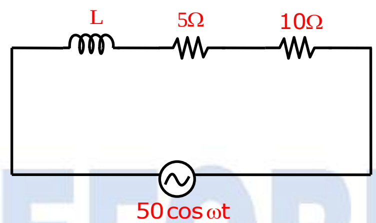
$P_{5\Omega} = 10W$

$(I^2_{rms})5\Omega = 10W \Rightarrow I_{rms} = \sqrt{2}A$

Power in a circuit is consumed only by resistance

So total power consumed is $P_{total} = I^2_{rms}(5\Omega + 10\Omega) = 30W$

Also we know that in a circuit



$P_{total} = V_{rms} I_{rms} \cos\phi$

$\Rightarrow 30W = \left(\frac{50}{\sqrt{2}}\right)\left(\sqrt{2}\right)\cos\phi$

$\Rightarrow \cos\phi = 0.6(\text{lagging})$

4. A graph in which at least one path (disregarding orientation) exists between any two nodes of the graph is a

(A) Connected graph (B) Directed graph

(C) Sub-graph (D) Fundamental graph

Key: (A)

5. If Q_t and Q_l be the sub-matrices of Q_f (fundamental cut-set matrix) corresponding to twigs and links of a connected graph respectively, then

1. Q_t is an identity matrix.
2. Q_l is a rectangular matrix
3. Q_f is of rank (n – 1)

Which of the above are correct?

(A) 1 and 2 only (B) 1 and 3 only (C) 2 and 3 only (4) 1, 2 and 3

Key: (B)

EXP: Q_t is a unitary matrix

Q_l is a may be rectangula or square matrix..it depends upon a tree fundamental cut-set matrix : n-1

6. Tellegen's theorem (as applicable to any lumped d.c. network, regardless of the elements being linear or non-linear, time-varying or time-invariant) implies that

(A) Sum of the voltage drops across each network element is equal to the total voltage applied to the network.

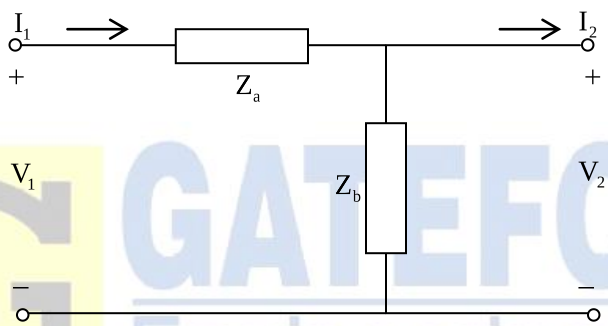
(B) Sum of the powers taken by all elements, in the network, within the constants imposed by KCL and KVL is zero.

(C) Sum of the currents meeting at any node is not the same as the current in that mesh.

(D) It is applicable to a branch which is not coupled to other branches of the network.

Key: (B)

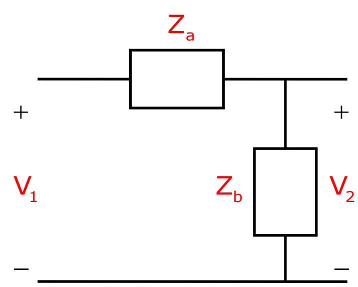
7. For the two-port network shown in the figure the transmission parameter C is



(A) Z_a (B) $1+\frac{Z_a}{Z_b}$ (C) Z_b (D) $\frac{1}{Z_b}$

Key: (D)

Exp: The T parameter is



$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$
$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} \quad \text{i.e., output port open circuit}$$
$$V_2 = I_1 Z_b \Rightarrow \frac{I_1}{V_2} = \frac{1}{Z_b} = C$$

8. Two identical two-port network having transmission matrix $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$ are cascaded. What will be the resultant transmission matrix of the cascade?

(A) $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$ (B) $\begin{bmatrix} 2A & 2B \\ 2C & 2D \end{bmatrix}$

(C) $\begin{bmatrix} A^2+BC & AB+BD \\ AC+CD & BC+D^2 \end{bmatrix}$ (D) $\begin{bmatrix} A^2 & B^2 \\ C^2 & D^2 \end{bmatrix}$

Key: (C)

Exp: When two networks are in cascade, the overall, transmission parameter is obtained by multiplying the individual T-matrix

$$T_{overall} = \begin{bmatrix} A & B \\ C & D \end{bmatrix}\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} A^2+BC & AB+BD \\ AC+CD & BC+D^2 \end{bmatrix}$$

9. The unit impulse response of a system is $-4e^{-t}+6e^{-2t}$. The step response of the same system for $t \geq 0$ is $Ae^{-t}+Be^{-2t}+C$, where A, B and C are respectively.

(A) −4, −3 and +1 (B) +4, −3 and −1 (C) -4, −3 and −1 (D) +4, −3 and +1

Key: (B)

Exp: $h(t) = -4e^{-t}+6e^{-2t}$

Step response = $s(t) = \int h(t)dt$

$s(t) = \int\left(-4e^{-t}+6e^{-2t}\right)dt$

$= -4\dfrac{e^{-t}}{(-1)} + 6\dfrac{e^{-2t}}{(-2)} + K$

$\therefore$ A=4, B=-3

s(0) = 4-3+K

s(0) = 1+K

Considering system with no memory

s(0) = 0; K = C = -1

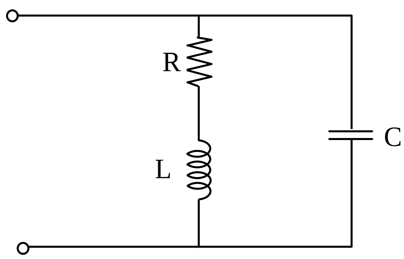
10. The network function, H(s) is equal to

(A) $\dfrac{y(s)}{x(s)}$ (B) $\dfrac{x(s)}{y(s)}$ (C) $x(s)\,y(s)$ (D) $\dfrac{1}{x(s)\,y(s)}$

Key: (A)

Exp: The network function is ratio of L.T. of output and L.T. of input considering y(s) as output and x(s) an input $H(s)=\dfrac{y(s)}{x(s)}$

11. The driving-point impedance of the network shown in the figure has a zero at −4 and poles at $-2\pm j5$.



If Z(0) = 1, the values of R, L and C are respectively

(A) $\frac{1}{4}, 1$ and $\frac{4}{29}$ (B) $1, \frac{1}{4}$ and $\frac{4}{29}$ (C) $\frac{4}{29}, \frac{1}{4}$ and 1 (D) $1, 2$ and $\frac{2}{29}$

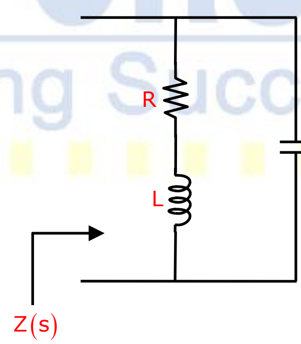
Key: (B)

Exp: According to the data given

$$Z(s)=\frac{K(s+4)}{(s+2+j5)(s+2-j5)}=\frac{K(s+4)}{s^2+4s+29}$$

$$Z(s)=\frac{1}{Y(s)}=\frac{1}{\frac{1}{R+sL}+sC}=\frac{sL+R}{s^2LC+sCR+1}$$

$$=\frac{\left(1/C\right)\left(s+R/L\right)}{\left(s^2+\frac{R}{L}s+\frac{1}{LC}\right)}$$



So, $K=\frac{1}{C}, \frac{R}{L}=u$ and $\frac{1}{LC}=29$

Since $Z(0)=1 \Rightarrow 1=\frac{4k}{29} \Rightarrow K=\frac{29}{4}$

$\Rightarrow \boxed{C=\frac{4}{29}F}, \frac{1}{LC}=29 \Rightarrow L=\frac{1}{29C}=\frac{1}{4}H$

and $\frac{R}{L}=4$

$\Rightarrow \boxed{F=4L=1\Omega}$

So, $R=1\Omega,\ L=\frac{1}{4}H\ \&\ C=\frac{4}{29}F$

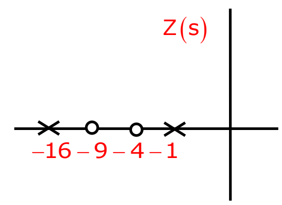
12. If $Z(s)=\dfrac{(s+4)(s+9)}{(s+1)(s+16)}$ is a driving point impedance, it represents an

(A) R-C impedance (B) R-L impedance

(C) L-C impedance (D) R-L-C impedance

Key: (D)

Exp: The pole zero pattern of Z(s) is as shown.



The properties are networks are as follows -

RC impedance: Pole and zero are alternate and pole is near to origin

RL impedance: Pole and zero are alternate but zero is near to origin

LC impedance: Pole and zero are alternate and i.e., on $j\omega$ axis

All the above 3 properties are not satisfied with the given Z(s), so it is a RLC impedance function.

13. The numerical value of the ratio of electric field intensity E and magnetic field intensity H is

(A) $350\,\Omega$ (B) $377\,\Omega$ (C) $37.7\,\Omega$ (D) $35\,\Omega$

Key: (B)

Exp: $\dfrac{E}{H}=\eta=\sqrt{\dfrac{\mu_0}{\epsilon_0}}=120\pi=377\Omega$

14. Consider a long line charge of λ coulomb/metre perpendicular to the plane of a paper. The electrical field lines and equipotential surfaces are respectively.

(A) Radial, radial concentric with line charge

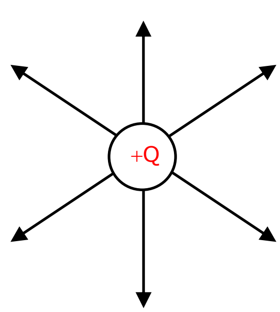
(B) Cylindrical concentric with line charge, radial

(C) Radial, radial but opposite in direction

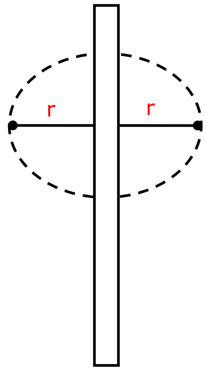
(D) Concentric with line charge, parallel to line charge

Key: (A)

Exp:



Electric field lines are radial.



The potential at a distance 'r' from the conductor along the length of the conductor is constant; those surfaces are called equipotential surfaces. So, equipotential surfaces are cylindrical concentric with the line charge.

15. Which of the following statements about electric field lines associated with electric charges is false?

(A) Electric field line and can be either straight or curved

(B) Electric field lines form closed loops

(C) Electric field lines begin on positive charges and end on negative charges.

(D) Electric field lines do not intersect

Key: (B)

Exp: For incase of Electric field

$\nabla.D = \rho_v$

$\nabla.E = \dfrac{\rho_v}{\in}$

From the above equation, we can conclude that electric field is a divergency field; it's not a circulating field. So, electric field lines never form closed path.

16. Which of the following represents Maxwell's divergence equation for static electric field?

(A) $\nabla\cdot B = 0$ (B) $\nabla\times H = 0$ (C) $\nabla\cdot B = \mu$ (D) $\nabla\times H = \mu$

Key: (A)

Exp:

$$\left.\begin{array}{l} \nabla .D = \rho_v \\ \nabla .B = 0 \\ \nabla\times E = 0 \\ \nabla \times H = J \end{array}\right\} \begin{array}{l}\text{Maxwell's equations} \\ \text{for static fields}\end{array}$$

17. A current of 5 A passes along the axis of a cylinder of 5 cm radius. The flux density at the surface of the cylinder is

(A) $2\mu T$ (B) $20\ \mu T$ (C)) $200\ \mu T$ (D) $2000\ \mu T$

Key: (B)

Exp: $B = \frac{\mu I}{2\pi R} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 5 \times 10^{-2}} = 20\ \mu T$

18. Maxwell's major contribution to EM theory was to assert

(A) That an electric field varying with time in free space gives rise to a current

(B) That a magnetic field varying with time gives rise to an electric field

(C) That a magnetic field varying with space gives rise to an electric field

(D) That energy density due to an electric field is $\frac{1}{2}\varepsilon E^2$

Key: (A)

Exp: $\nabla \times H = \in \frac{\partial E}{\partial t}$

The time varying electric field will produce a space varying orthogonal magnetic field.

19. Consider the following statements regarding Maxwell's equation in differential form:

1. For free space $\nabla \times H = (\sigma + j\omega\varepsilon)E$
2. For free space, $\nabla . D = \rho$
3. For steady current, $\nabla \times H = J$
4. For static electric field, 6

Which of the above statements are correct?

(A) 1 and 2 (B) 2 and 3 (C) 3 and 4 (D) 4 and 1

Key: (C)

Exp: For free space, the Maxwell's equations are:

	For static case
1. $\nabla . D = 0$	1. $\nabla . D = \rho_v$
2. $\nabla \times E = -\frac{\partial B}{\partial t}$	2. $\nabla \times E = 0$
3. $\nabla \times H = \frac{\partial D}{\partial t}$	3. $\nabla \times H = J$
4. $\nabla . B = 0$	4. $\nabla . B = 0$

20. The equation which states the non-existence of isolated magnetic pole is

(A) $\nabla \cdot D = \rho$ (B) $\nabla \cdot B = 0$ (C) $\nabla \cdot J = -\frac{\partial \rho}{\partial t}$ (D) $\nabla \times H = J$

Key: (B)

Exp: 1. $\nabla . D = \rho_v$ → Gauss law

2. $\nabla \times E = -\frac{\partial B}{\partial t}$ → Faraday's law

3. $\nabla \times H = J + \frac{\partial D}{\partial t}$ → Ampere's law

4. $\nabla . B = 0$ → non-existance of isolated magnetic pole

21. A periodic function satisfies Dirichlet's condition. This implies that the function

(A) is non-linear
(B) is not absolutely integrable
(C) guarantees that Fourier series representation of the function exists
(D) has infinite number of maxima and minima within a period

Key: (C)

22. Consider Fourier representation of continuous and discrete-time systems. The complex exponentials (i.e., signals), which arise in such representation, have

(A) Same properties always
(B) Different properties always
(C) Non-specific properties
(D) Mostly same properties

Key: (A)

23. If a dipole antenna has a radiation resistance of $73\,\Omega$ the loss resistance of $7\,\Omega$ and the power gain is 16, then the directivity is

(A) 17.53 dB
(B) 24.7 dB
(C) 40 dB
(D) 14.6 dB

Key: (D)

Exp:

$$\eta_r = \frac{G_P}{G_d} = \frac{R_{rad}}{R_{rad} + R_\ell} = 0.9125$$

$$D = G_d = \frac{G_P}{0.9125} = 17.53$$

$$D(\text{in dB}) = 10\log_{10} D = 12.4\,\text{dB}$$

Nearest approximation is Option (D)

24. An LTI system is causal if an only if

(A) h(t) = 0 for t < 0
(B) h(t) is finite for $0 < t < \infty$
(C) h(t) is finite for t < 0
(D) h(t) is non-zero for all t

Key: (A)

25. Let u[n] be the unit-step signal and $x[n]=\left(\frac{1}{2}\right)^n u[n]+\left(-\frac{1}{3}\right)^n u[n]$. The region of convergence of z-transform of x[n] is

(A) $|z|>\frac{1}{3}$ (B) $\frac{1}{3}<|z|<\frac{1}{2}$ (C) $|z|>\frac{1}{2}$ (D) $|z|<\frac{1}{2}$

Key: (C)

Exp: $x[n]=\left(\frac{1}{2}\right)^n u[n]+\left(\frac{-1}{3}\right)^n u[n]$

$$x[n]=\left[\left(\frac{1}{2}\right)^n+\left(\frac{-1}{3}\right)^n\right]u[n]$$

$$X(z)=\sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

$$=\sum_{n=0}^{\infty}\left[\left(\frac{1}{2}\right)^n+\left(\frac{-1}{3}\right)^n\right]z^{-n}$$

$$=\sum_{n=0}^{\infty}\left(\frac{1}{2}z^{-1}\right)^n+\sum_{n=0}^{\infty}\left(\frac{-1}{3}\times z^{-1}\right)^n=\sum_{n=0}^{\infty}\left(\frac{1}{2z}\right)^n+\sum_{n=0}^{\infty}\left(\frac{-1}{3z}\right)^n$$

$$=\left(\frac{1}{2z}\right)^o+\left(\frac{1}{2z}\right)^1+.....+\infty+\left(\frac{-1}{3z}\right)+\left(\frac{-1}{3z}\right)^1+......+\infty$$

$$=\frac{1}{1-\left(\frac{1}{2z}\right)}+\frac{1}{1-\left(\frac{-1}{3z}\right)}$$

$$ROC_1:\left|\frac{1}{2z}\right|<1 \quad ;ROC_2:\left|\frac{-1}{3z}\right|<1$$

$$ROC_1:\left|\frac{1}{2}\right|<z \quad ;ROC_2:\left|\frac{1}{3}\right|<z$$

$$\boxed{\therefore \text{Common ROC}=|z|>\frac{1}{2}}$$

26. If the z-transform of a sequence $x[n] = \{1, 1, -1, -1\}$ is $X[z]$, then the value of $X\left(\frac{1}{2}\right)$ is

(A) 9 (B) 1.875 (C) −1.125 (D) 15

Key: -9 (Not matching with given options)

Exp: $X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$

$$X(z) = \sum_{n=0}^{3} x[n]z^{-n}$$

$$X(z) = z^{-o} + z^{-1} - z^{-2} - z^{-3}$$

$$X\left(\frac{1}{2}\right) = 1 + 2 - 2^2 - 2^3 = -9$$

27. If the z-transform of a system is given by $H(z) = \frac{\alpha + z^{-1}}{1 + \alpha z^{-1}}$ where α is real-valued, $|\alpha| < 1$, ROC: $|z| > |\alpha|$, then the system is

(A) A low-pass filter (B) A band-pass filter

(C) An all-pass filter (D) A high-pass filter

Key: (C)

28. Consider a discrete random variable assuming finitely many values. The cumulative distribution function of such a random variable is

(A) Non-increasing function

(B) Non-decreasing function with finitely many discontinuities and assuming values less than one

(C) Non-decreasing function without discontinuities

(D) Non-decreasing function assuming values larger than one.

Key: (B)

29. A continuous random variable X has uncountably many values in the interval [a, b]. If C is a value in the interval [a, b], then P{X = C}.

(A) is zero (B) is strictly non-zero

(C) depends on the limits {a, b} (D) is less than one, but non-zero

Key: (A)

30. In the case of a random variable dealing with non-deterministic signals.

(A) It is a function from space of outcomes to the real/complex numbers

(B) It is a function with the probabilities of outcomes as random numbers

(C) The values assumed by signals are always deterministic

(D) Sometimes the events associated with random variable are deterministic

Key: (A)

31. The correlation function of a wide sense stationary random process representing a non-deterministic signal is

(A) Not a deterministic function

(B) Deterministic, but not symmetric function

(C) Sometimes non-deterministic function

(D) Always deterministic and symmetric function

Key: (D)

32. What is an advantage of MOS transistor structure in integrated circuits?

(A) Faster switching

(B) Less capacitance

(C) Higher component density and lower cost

(D) Lower resistance

Key: (C)

33. An LTI system has a wide-sense stationary (WSS) input signal with zero mean. Its output is

(A) Non-zero mean and non-WSS signal

(B) Zero mean and WSS signal

(C) Non-zero mean and WSS signal

(D) Zero mean and non-WSS signal

Key: (B)

34. Which of the following statement are correct in association with the superposition theorem?

1. It is applicable to networks having more than one source.

2. It is used to determine the current in a branch or voltage across branch.

3. It is applicable to direct current circuits only.

4. It is applicable to networks having linear and bilateral elements.

Select the correct answer using the code given below.

(a) 1, 2 and 3 (b) 1, 2 and 4

(c) 1, 3 and 4 (d) 2, 3 and 4

Key: (B)

35. A network N consists of resistors, dependent and independent voltage and current sources. If the current in one particular resistance is I A, it will be doubled if the values of all the

(a) Independent voltage sources are doubled.

(b) Independent current sources are doubled

(c) Dependent and independent voltage and current sources are doubled

(d) Independent voltage and current sources are doubled

Key: (D)

Exp: From the superposition theorem we know that the response across a particular element is the sum of response of the independent voltage and current source present in network there is not contribution of dependent source on it.

And by homogeneity if a source it multiplied by K, response will also be multiplied by K. So if current is doubled i.e., the response is doubled then all the excitations (independent sources) will also be doubled.

36. The reactance of a $10\mu F$ capacitor at f=0Hz (d.c) and f=50 Hz are respectively.

(A) ∞ and $318.47\,\Omega$ (B) 10.0Ω and 318.47Ω

(C) ∞ and 31.84Ω (D) 0.01Ω and 31.84Ω

Key: (A)

Exp: $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

When $f = 0 \Rightarrow X_C = \infty$ & When $f = 50 \Rightarrow X_C = 318.47\Omega$

37. Consider the following statements:

Any element is redundant if connected in

1. Series with an ideal current source
2. Parallel with an ideal current source
3. Series with an ideal voltage source
4. Parallel with an ideal voltage source

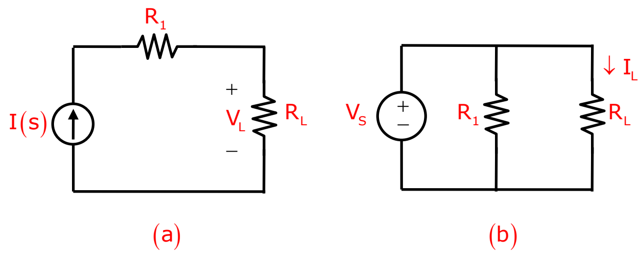
Which of the above statements are correct?

(A) 1 and 3 (B) 1 and 4

(C) 2 and 3 (D) 2 and 4

Key: (B)

Exp:



→ From figure (a), observe that if we keep or remove R_1 the load voltage and current are same so R_1 is redundant here

→ From figure (b), observe that if we keep or remove R_1, V_L & I_L is same and hence R_1 is redundant

→ Note that in figure (a) R_1 can't be ∞ and in figure (b) R_1 can't be 0, as it will result in violation of Kirchoff's law

38. Inductive reactance X is a function of inductance L and frequency f. The value of X increases when

(A) Both L and f increase (B) L increases and f decreases

(C) Both L and f decrease (D) L decreases and f increases

Key: (A)

Exp: $X_L = 2\pi fL$

$X_L \propto L$ and $X_L \propto f$

So, X_L increases when both f and L increases.

39. An alternating voltage is given by the equation $v = 282.84\sin\left(377t + \frac{\pi}{6}\right)$

What are the values of r.m.s voltage, frequency and time period?

(A) 20V, 60 Hz and 0.0167 s

(B) 200 V, 50 Hz and 0.02 s

(C) 200 V, 60 Hz and 0.0167 s

(D) 20 V, 50 Hz and 0.0167 s

Key: (C)

Exp: The standard form of A.C. voltage is $V(t) = V_m \sin(2\pi f t + \theta)$

$$V(t) = 282.84 \sin\left(377t + \frac{\pi}{6}\right)$$

Comparing the above 2 equation

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{282.84}{\sqrt{2}} = 200V$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{377} = 0.0167 \text{ sec}$$

$$f = \frac{1}{T} = 60\,Hz$$

40. If a capacitor is energized by a symmetrical square-wave current source, then the steady-state voltage across the capacitor will be

(A) A square wave
(B) A triangular wave
(C) A step function
(D) An impulse function

Key: (B)

Exp: In a capacitor

$$V = \frac{1}{C}\int_{-\infty}^{t} i\,dt$$

Since integration of square wave is always a triangular wave, voltage in steady state across capacitor will always be a triangular wave.

41. The electric field in an electromagnetic wave (in vacuum) is described by

$$E = E_{max} \sin(kx - \omega t)$$

where $E_{max} = 100 N/C$ and $K = 1\times10^{7}\ m^{-1}$

Speed of light is $3\times10^{8}\ m/s$. What is the amplitude of the corresponding magnetic wave?

(A) $300\,\mu\Omega$
(B) $2.99\times10^{-7}T$
(C) $3.33\times10^{-7}T$
(D) $2.99\times10^{7}\ T$

Key: (C)

Exp: Given

$$E = E_m \sin(kx - \omega t)$$

$$E_m = 100\ N/C$$

$$\frac{E}{H} = \eta$$

$$H = \frac{E}{\eta} = \frac{100}{120\pi}\ A/m$$

$$B = \mu_0 H = 4\pi \times 10^{-7} = \frac{100}{120\pi}\ \text{Tesla}$$

$$B = 3.33 \times 10^{-7}\,T$$

42. For transverse electric waves between parallel plates, the lowest value of m, without making all the field components zero, is equal to

(A) 3 (B) 2 (C) 1 (D) 0

Key: (C)

Exp: For transverse electric wave the lowest value of m is

$TE_m \to TE_1$

When $m = 0$, all the components will become zero

$\therefore m = 1$

43. A 20 dB directional coupler is shown in the figure.

The power output at port 3 will be

(A) 10 mW (B) 1 mW (C) 5 mW (D) 2 mW

Key: (B)

Exp: Coupling factor = 20 =10 $\log \frac{P_1}{P_3}$

$$\frac{P_1}{P_3} = 100 \Rightarrow P_3 = \frac{P_1}{100} = \frac{100\,mW}{100} = 1mW$$

44. A loss-less transmission line of length *l* is open-circuited and has characteristic impedance Z_o. The input impedance is

(A) $+jZ_o \tan\beta l$ (B) $-jZ_o \tan\beta l$ (C) $-jZ_o \cot\beta l$ (D) $+jZ_o \cot\beta l$

Key: (C)

Exp: The input impedance at the open circuited lossless transmission line is $Z_{in} = -jZ_0 \cot\beta l$

45. Conditions for a transmission line to be of low loss are

(A) $R \gg \omega L, G \gg \omega C$ (B) $R \ll \omega L, G \gg \omega C$

(C) $R \ll \omega L, G \ll \omega C$ (D) $R \gg \omega L, G \ll \omega C$

Key: (C)

Exp: Condition for low loss,

$$\frac{R}{\omega L} << 1 \qquad \frac{G}{\omega C} << 1$$

$$R << \omega L \qquad G << \omega C$$

46. In a waveguide, attenuation near the cut-off frequency is

(A) Low (B) High

(C) Very high (D) Zero

Key: (C)

Exp: Near the cut off frequency, attenuation is almost infinite.
So, attenuation is very high.

47. The phase velocity of waves propagating in a hollow metal waveguide is

(A) Equal to the group velocity

(B) Equal to the velocity of light in free space

(C) Less than the velocity light in free space

(D) Greater than the velocity of light in free space

Key: (D)

Exp: Phase velocity of waves propagating in a hollow metal waveguide is greater than the free space velocity.

$$V_P = \frac{V}{\sqrt{1-\left(\frac{f}{f_c}\right)^2}} \text{ ; Always, } V_p \geq V$$

48. Compensation theorem applicable to antennas is also called as

(A) Millman's theorem (B) Superposition theorem

(C) Substitution theorem (D) Power transfer theorem

Key: (C)

49. An isotropic radiator is one which radiates energy.

(A) In a well –defined direction
(B) uniformly in all directions
(C) Inside a hollow space
(D) uniformly in horizontal plane

Key: (B)

Exp: Isotropic radiator, which radiates energy uniformly in all directions.

50. The effective length of an antenna is a measure of

(A) Length of the antenna neglecting fringe effects
(B) Effectiveness of the antenna as a radiator/collector of electromagnetic energy
(C) Power consumed by the antenna
(D) Range of the antenna

Key: (B)

Exp: Effective length of an antenna means, effectiveness of the antenna as a radiator of electromagnetic energy.

51. For a dipole antenna

(A) The radiation intensity is maximum along the normal to the dipole axis
(B) The current distribution along its length is uniform irrespective of the length
(C) The effective length equals its physical length
(D) The input impedance is independent of the location of the feed-point

Key: (A)

Exp: For a dipole antenna, the radiation intensity is maximum along the normal to the dipole axis.

52. An ideal voltage source and an ideal voltmeter have internal impedances respectively

(A) Zero, zero
(B) Zero, infinite
(C) Infinite, zero
(D) Infinite, infinite

Key: (B)

Exp: In the voltage source (ideal), if R_s=0 then only load voltage is independent of current drawn. In voltmeter internal impedance should be infinity, to avoid loading effect.

53. The current in a circuit is measured as $235\mu A$ and the accuracy of measurement is $\pm 0.5\%$. This current passes through a resistor $35k\Omega \pm 0.2\%$. The voltage is estimated to be 8.23 V. The error in the estimation would be

(A) $\pm 0.06V$
(B) $\pm 0.04V$
(C) $\pm 0.016V$
(D) $\pm 0.1V$

Key: (A)

Exp: $I = 235\mu A \pm 0.5\%$

$$R = 35\,k\Omega \pm 0.2\%$$
$$V = IR$$
$$= (235)\times 10^{-6} \times 35 \times 10^{3}$$
$$V = 8.225 \text{ Volts}$$
$$\%V = \pm[0.5 + 0.2]$$
$$\%V = \pm 0.7\%$$
$$V = \pm\frac{8.225 \times 0.7}{100} = \pm 0.0575 \approx \pm 0.06V$$
$$V = (8.225 \pm 0.06)\text{ Volts}$$

54. The full-scale deflecting torque of a 20A moving-iron ammeter is 6×10^{-5} N – m. What is the rate of change of self-inductance with respect to the deflection of the pointer of the ammeter at full scale?

(A) $0.5\mu H/rad$ (B) $0.2\mu H/rad$ (C) $1.3\mu H/rad$ (D) $0.3\,\mu H/rad$

Key: (D)

Exp: For Moving Iron Ammeter,

$$T_{def} = \frac{I^2}{2}.\frac{dL}{d\theta}$$

Given $T_{def} = 6\times 10^{-5}$ N – m and $I = 20A$

i.e., rate of change of self-inductance w.r.t. deflection

$$\frac{dL}{d\theta} = \frac{2T_{def}}{I^2} \Rightarrow \frac{2\times 6\times 10^{-5}}{(20)^2} = 0.3\mu H/rad$$

55. The expected value of the voltage across a resistor is 80 V. However, the voltmeter reads 79V. The absolute error in the measurement is

(A) 0.875V (B) 0.125V (C) 1.00V (D) 1.125V

Key: (C)

Exp: Absolute error = Measured value – True value $= 79 - 80 = 1$Volt

56. A current of $2 \pm 0.5\%$ A passes through a resistor of $100 \pm 0.2\%\Omega$. The limiting error in the computation of power will be

(A) 0.7% (B) 0.9% (C) 1.2% (D) 1.5%

Key: (C)

Exp: $I = 2 \pm 0.5\%\ A$

$R = 100 \pm 0.2\%\ \Omega$

$P = I^2R \Rightarrow 4(100) = 400$ Watts

$\%P = \pm[2(0.5) + 1(0.2)] = \pm 1.2\%$

57. A voltmeter reads 40 V on its 100 V range and an ammeter reads 75 mA on its 150 mA range in a circuit. Both the instruments are guaranteed $\pm 2\%$ accuracy on FSD. The limiting error on the measured power is

(A) 4% (B) 5% (C) 9% (D) 12%

Key: (C)

Exp:

Measured value	Full scale	Accuracy
$V \rightarrow$ 40V	100V	±2%
$I \rightarrow$ 75mA	150mA	±2%

$\%\text{Error in } V = \frac{(100)(\pm 2\%)}{40} = \pm 5\%$; $\%\text{Error in } I = \frac{(150)(\pm 2\%)}{75} = \pm 4\%$

$\%\text{ Error in } P = \pm[5+4] = \pm 9\%$

58. A voltmeter, having a guaranteed accuracy of 1% reads 9 V on a 0V to 150V range full scale reading. The percentage limiting error is

(A) 0.167% (B) 1.67% (C) 16.7% (D) 0.0167%

Key: (C)

Exp: $(0-150)V \rightarrow$ Guaranteed accuracy of 1%

$$\%\text{ Limiting Error} = \frac{(150)(\pm 1\%)}{9} = \pm 16.67\%$$

59. A moving coil instrument has a resistance of 10Ω and gives a full scale deflection when carrying a current of 50 mA. What external resistance should be connected so that the instrument can be used to measure current up to 50 A?

(A) 20Ω in parallel (B) 100Ω in series

(C) $0.010\,\Omega$ in parallel (D) $18.7\,\Omega$ in series

Key: (C)

Exp: Given, $R_m = 10\Omega$

$$I_{fs} = 50\,mA$$
$$I = 50A$$
$$R_{sh} = \frac{10}{\frac{50}{50\times10^{-3}} - 1} = 0.010\ \Omega$$

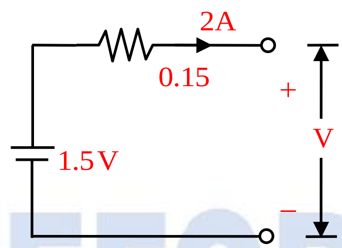
60. A current of 2.0 A passes through a cell of e.m.f 1.5V having internal resistance of 0.15Ω. The potential difference across the terminals of the cell is

(A) 1.35 V (B) 1.50 V (C) 1.00 V (D) 1.20 V

Key: (D)

Exp: By KVL, $-1.5 + 2(0.15) + V = 0$

$$V = 1.5 - 0.3$$
$$V = 1.20\text{ Volts}$$

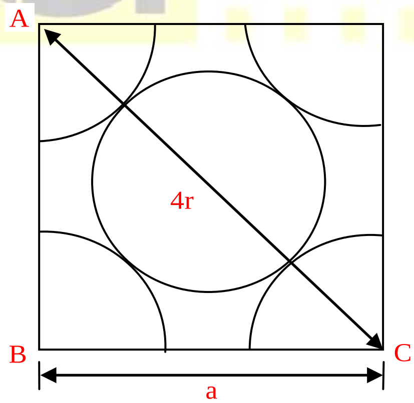


61. The atomic packing factor for face centered cubic (FCC) crystal structure is

(A) 0.63 (B) 0.74 (C) 7.4 (D) 6.3

Key: (B)

Exp:



$AC = 4r$

From the triangle ABC,

$$AC^2 = AB^2 + BC^2$$
$$AC^2 = a^2 + a^2$$
$$AC^2 = 2a^2$$
$$AC = \sqrt{2}a$$

Atomic Packing Factor, $APF = N\frac{V_{atom}}{V_{unitcell}}$

Where 'N' is no. of atoms in the unit cell

V_{atom} (Volume of an atom) $= \frac{4\times\pi r^3}{3}$

$V = a^3$

$APF = \frac{4\times 4\pi r^3}{3a^3}$

Substituting $r = \frac{\sqrt{2}a}{4}$, we get

$$APF = \frac{4\times 4\pi\left(\frac{\sqrt{2}a}{4}\right)^3}{3a^3} = 0.74$$

Thus, 74 percent of the volume of the FCC unit cell is occupied by atoms and the remaining 26 percent volume of the unit cell is vacant or void space.

62. Drift velocity in a metal is

(A) Inversely proportional to the force on an electron due to applied electric field

(B) Directly proportional to the mass of an electron

(C) Proportional to the mobility of an electron

(D) Inversely proportional to the strength of the applied electric field

Key: (C)

Exp: $V_d = \mu E$, μ = mobility of an electron

$V_d \propto \mu$

63. The three kinds of breakdowns possible in solid dielectrics are electrothermal, purely electrical and

(A) Electromechanical (B) Purely thermal

(C) Electrochemical (D) Spontaneous

Key: (C)

Exp: The break down mechanism in dielectric material can be classified into are -

(1) Avalanche Breakdown (pure electrical)

(2) Thermal Breakdown (electrothermal)

(3) Electro-chemical Breakdown

(4) Defect Breakdown

64. For a particular material, the Hall coefficient is found to be zero. The material is

(A) Intrinsic semiconductor (B) Extrinsic semiconductor

(C) Metal (D) Insulator

Key: (D)

65. A 12 V automobile light is rated at 30 W. The total charge that flows through the filament in one minute is

(A) 30 C (B) 12 C (C) 150 C (D) 180 C

Key: (C)

Exp: $Q = it \quad ; \quad p = vi$

$i = \frac{30}{12} = 2.5$

$Q = 2.5 \times 60 = 150$ Coulombs in one minute

66. At very high temperature, an n-type semiconductor behaves like

(A) A p-type semiconductor (B) An intrinsic semiconductor

(C) A superconductor (D) An n-type semiconductor

Key: (B)

Exp: **Effect of Temperature:** When the temperature of an n-type semiconductor is raised, the number of electron-hole pairs due to thermal excitation from the valence band to the conduction band will increase. Thus at a very high temperature the concentration of thermally generated free electrons from the valence band will be much larger than the concentration of free electrons contributed by the donors. At this situation, the hole and the electron concentrations will be nearly equal and the semiconductor will behave like an intrinsic one.

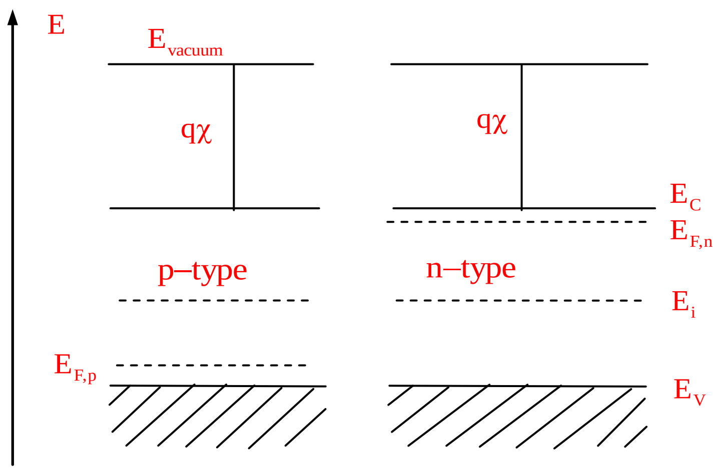
67. The Fermi level in a p-type semiconductor lies close to

(A) Top of the valence band (B) Bottom of the valence band

(C) Top of the conduction band (D) Bottom of the conduction band

Key: (A)

Exp:



68. Covalent bond energy in germanium is about

(A) 7.4 eV (B) 31 eV (C) 3.4 eV (D) 20.4 eV

Key: 0.72 eV (Not matching with given options)

Exp: E_g for Ge = 0.72eV

69. The relationship between relative permeability (μ_r) and magnetic susceptibility (χ) of the medium is

(A) $\mu_r = 1+\chi$ (B) $\mu_r = \frac{1}{1+\chi}$ (C) $\mu_r = 1-\chi$ (D) $\mu_r = \frac{1}{\chi}$

Key: (A)

Exp: $\chi = \mu_r - 1$

70. Ferromagnetic property may be explained on the basis of

(A) Faraday's theory (B) Curie-Weiss theory

(C) Domain theory (D) Einstein's theory

Key: (C)

Exp: **Weiss** proposed **domain theory** to explain ferromagnetism. According to this theory, a single crystal of ferromagnetic solid compresses a large number of small regions and each region is spontaneously magnetized to saturation extent called a domain.

71. Soft iron is characterized by the saturation magnetization M_S, coercivity H_C and retentivity B_C. It is suitable for an electromagnet because

(A) M_S, H_C and B_C are small

(B) M_S, is small, H_C and B_C are large

(C) M_S, is large, H_C and B_C are small

(D) M_S, H_C and B_C are large

Key: (C)

Exp: The various applications of soft iron require the following properties -

Ease of magnetization to high values, high saturation polarization, high maximum permeability, and low coercivity which means that M_S is large and H_C, B_C are small.

72. Diamagnetic susceptibility is very

(A) Small and negative

(B) Small and positive

(C) Large and negative

(D) Large and positive

Key: (A)

Exp: Magnetic susceptibility is negative for diamagnetic material. As a result, the magnetic field is weakened in the presence of the material.

73. Magnetostriction is the effect produced when change of magnetization in magnetic material results in

(A) Change of permeability

(B) Change in dimensions

(C) Change of temperature

(D) Change of magnetic field strength

Key: (B)

Exp: Magnetostriction is a property of ferromagnetic materials that causes them to change their shape or dimensions during the process of magnetization. The variation in magnetization due to the applied magnetic field on material changes the magnetostrictive strain until reaching its saturation value.

74. Commonly used dielectric in electrolytic capacitors is

(A) Magnesium oxide

(B) Cadmium nitride

(C) Aluminium oxide

(D) Manganese oxide

Key: (C)

75. How many $6\mu F, 200V$ capacitors are needed to make a capacitor of $18\mu F, 600V$?

(A) 18 (B) 9 (C) 3 (D) 27

Key: (D)

Exp: Energy principle must be statisfied.

Here $C_T = 18\mu F$

$V_T = 600$

$$\frac{1}{2}C_T V_T^2 = n\left[\frac{1}{2}CV^2\right]$$

$$n = \frac{3\times6\times6}{2\times2} = 27$$

76. A voltage of 2000 V exists across 1 cm insulating space between two parallel conducting plates. An electron of charge 1.6×10^{-19} coulomb is introduced into the space. The force on the electron is

(A) 18.2×10^{-26} N (B) 3.2×10^{-14} N (C) 1.6×10^{-19} N (D) 4.5×10^{26} N

Key: (B)

Exp: $F = qE = q\frac{v}{l} = 1.6\times10^{-19}\times\frac{2000}{1\times10^{-2}}$

$F = 3.2\times10^{-14}$ N

77. A capacitor of $100\mu F$ stores 10 mJ of energy. What is the amount of charge (in coulomb) stored in it

(A) 1.414×10^{-6} (B) 1.414×10^{-3} (C) 2.303×10^{-6} (D) 2.303×10^{-3}

Key: (B)

Exp: $\frac{1}{2}\times100\mu\times V^2 = 10mJ$

$V = 14.14$

$Q = CV = 1.414\times10^{-3}C$

78. In degenerately doped n-type semiconductor, the Fermi level lies in conduction band when

(A) Concentration of electrons in the conduction band exceeds the density of states in the valence band.

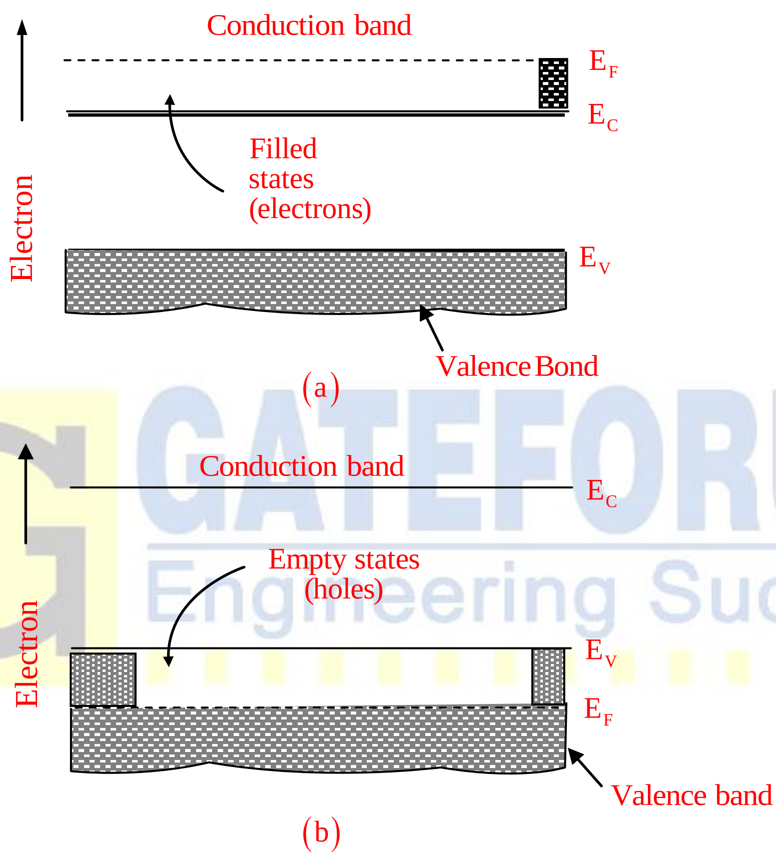
(B) Concentration of electrons in the valence band exceeds the density of states in the conduction band.

(C) Concentration of electrons in the conduction band exceeds the product of the density of states in the valence band and conduction band

(D) None of the above

Key: (B)

Exp:



Simplified Energy Band Diagram for degenerately doped
(a) n–type semiconductor (b) p–type semiconductor

79. The electrical conductivity and electron mobility for aluminium are $3.8 \times 10^{7} (\text{ohm} - \text{m})^{-1}$ and $0.0012\,\text{m}^2/\text{V-s}$ respectively. What is the Hall voltage for an aluminium specimen that is 15 mm thick for a current of 25 A and a magnetic field of 0.6 tesla (imposed in a direction perpendicular to the current) for the given value of Hall coefficient R_H as $-3.16 \times 10^{-11}\,\text{V} - \text{m}/\text{A-tesla}$?

(A) -316×10^{-8} V (B) -3.16×10^{-8} V (C) 316×10^{-8} V (D) 3.16×10^{-8} V

Key: (B)

Exp: $V_H = \dfrac{R_H BI}{\text{Thickness}(d)}$

$$= \frac{-3.16\times10^{-11}\times0.6\times25}{15\times10^{-3}}$$

$$= -3.16\times10^{-8}\ \text{Volts}$$

80. The purpose of connecting a Zener diode in a UJT circuit, used for triggering thyristors, is to

(A) Expedite the generation of triggering pulses

(B) Delay the generation of triggering pulses

(C) Provide a constant voltage to UJT to prevent erratic firing

(D) Provide a variable voltage to UJT as the source voltage changes

Key: (C)

81. A moving-coil meter has a resistance of 3Ω and gives full-scale deflection with 30 mA. What external resistance should be added in series so that it can measure voltages up to 300 V?

(A) 10Ω (B) 9997Ω (C) 0.19Ω (D) $0.01\,\Omega$

Key: (B)

Exp: Given, $R_m = 3\Omega$

$$I_m = 30\,\text{mA}$$

$$V = I_m R_m = 90\ \text{mV}$$

$$V = 300\ \text{Volts}$$

$$R_{se} = R_m(m-1)$$

$$= 3\left(\frac{300}{90*10^{-3}} - 1\right)$$

$$= 9997\Omega$$

82. Consider the following system function of a discrete-time LTI system: $H(z) = \dfrac{z^{-1} - a^*}{1 - az^{-1}}$

where a* is the complex conjugate of a. The frequency response of such a system is

(A) Aperiodic; depends on frequency ω

(B) Aperiodic; does not depends on frequency ω

(C) Periodic; depends on frequency ω

(D) Periodic; does not depends on frequency ω

Key: (D)

Exp: $H(z) = \frac{z^{-1} - a^*}{1 - az^{-1}}$

This is a standard transfer function of APF with magnitude response $|H(\omega)|^2 = 1$

(***Link for reference:***

http://www-mmsp.ece.mcgill.ca/documents/Reports/2011/KabalR2011a.pdf)

83. Absolute encoders are normally used for

(A) One revolution

(B) Continuous speed in clockwise direction

(C) Continuous speed in counter-clockwise direction

(D) Counting least significant bits

Key: (A)

Exp: Absolute encoders are position feedback devices that report absolute positional information. An absolute encoder generates a unique code for each position.

84. Consider the following statements:

Piezoelectric transducer has

1. A very good HF response
2. Typical output voltage of the order of 1 mV to 30 mV per unit of acceleration
3. No requirement of external power and is self-generating
4. No response for static conditions

Which of the above statements are correct?

(A) 1, 2 and 3 only (B) 1, 2 and 4 only (C) 3 and 4 only (D) 1, 2, 3 and 4

Key: (D)

85. An inductive pick-up used to measure the speed of a shaft has 120-tooth wheel. If the number of pulses produced in a second is 3000, the r.p.m of the shaft is

(A) 1200 (B) 1500 (C) 1800 (D) 3600

Key: (B)

Exp: $$\text{R.P.M of shaft} = \frac{3000 \times 60}{120}$$
$$= 1500$$

86. A piezoelectric crystal having a thickness of 2 mm and a voltage sensitivity of 0.02 V-m/N is subjected to a pressure of 20×10^{3} Pa. What is the output voltage?

(A) 0.775 V (B) 0.80 V (C) 0.002×10^{-6} V (D) 0.2×10^{-6} V

Key: (B)

Exp: Output voltage = P × g × t

$$=20\times10^{3}\times0.02\times2\times10^{-3}=0.8\text{V}$$

87. A resistance strain gauge with gauge factor of 3 is cemented to a steel member subjected to a strain 2×10^{-6}. If the original resistance is 100Ω, what is the change in resistance?

(A) $600\mu\Omega$ (B) $600\text{m}\Omega$ (C) $300\mu\Omega$ (D) $200\mu\Omega$

Key: (A)

Exp: $$G=\frac{\frac{\Delta R}{R}}{\varepsilon(\text{strain})}$$

$\Delta R=?$

$\Delta R=G\times R\times\varepsilon$

$=3\times2\times10^{-6}\times100$

$=6\times10^{-4}=600\ \mu\Omega$

88. The dynamic characteristics of capacitive transducers are similar to those of

(A) Low-pass filter (B) High-pass filter

(C) Notch filter (D) Band-stop filter

Key: (B)

89. Cold junction in a thermocouple is

(A) The reference junction maintained at a known constant temperature

(B) The junction maintained at a very low temperature

(C) The junction at which the temperature is sensed

(D) None of the above

Key: (A)

Exp: The thermocouple voltage is a function of the difference between the hot junction temperature T_A and the cold junction temperature T_B. If the cold junction temperature is kept fixed or constant, the thermocouple output is a measure of the hot junction temperature T_A.

90. The output voltage of a linear variable differential transformer is 1.5 V at maximum displacement. At a load of $0.5M\Omega$, the deviation from linearity is maximum and it is $\pm 0.003V$ from a straight line through origin. What is the linearity at the given load?

(A) $\pm 1.5\%$ (B) $\pm 0.2\%$ (C) $\pm 2.2\%$ (D) $\pm 15\%$

Key: (B)

Directions:

Each of the next **Ten (10)** items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the code given below.

Code:

(A) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(B) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement-(I)

(C) Statement (I) is true but Statement (II) is false

(D) Statement (I) is false but Statement (II) is true

91. Statement (I):

Hard magnetic materials are used for making permanent magnets

Statement (II):

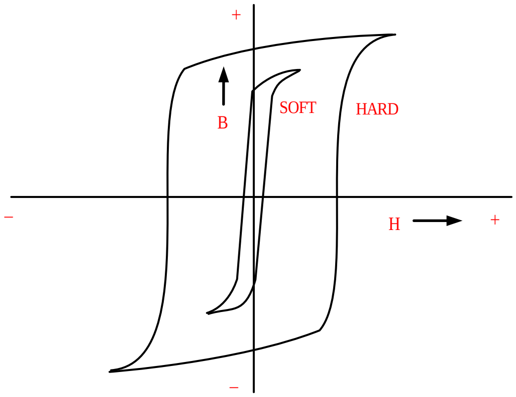
Hard magnetic materials have relatively small and narrow hysteresis loop.

Key: (C)

Exp: **Statement (I) - True**

Ferromagnetic materials are difficult to magnetize, but once magnetized, it is difficult to demagnetize. These materials are called hard magnetic materials, and are suitable for applications such as permanent magnets and magnetic recording media. Hard magnetic materials have high magnetocrystalline anisotropy. Since large magnetic field is required to demagnetize their coercivity, H_c is usually high.

Statement (II) - False



Large hysteresis loop for hard magnetic materials

92. Statement (I):

With a small additional energy usually thermal, the valence electrons in germanium can become free electrons.

Statement (II):

The valence electrons in germanium are in the fourth orbit and are at high energy level.

Key: (B)

93. Statement (I):

An FET is a current-controlled device.

Statement (II):

Operation of an FET depends only on majority carriers.

Key: (D)

Exp: FET is a voltage-controlled device and its operation depends only on majority carriers.

So Statement – I is wrong, Hence, ans is (D)

94. Statement (I):

Thermal runaway is not possible in an FET

Statement (II):

As the temperature of FET increases, the mobility of carriers decreases

Key: (A)

Exp: **Statement (I) - True**

FETs prevent the thermal runaway phenomena that may occur in BJTs.

Statement (II) - True

This means that, as the device temperature increases, the current through the device decreases due to two competing mechanisms.

1. Increasing the temperature of an FET tends to decrease the mobility of the charge carriers in the channel, effectively reducing the current through the channel.
2. Simultaneously however, increasing the temperature also narrows the depletion regions of the pn junctions, thereby increasing the drain current.

Statements I and II both are correct and Statement-II is correct explanation of Statement-I.

95. Statement (I):

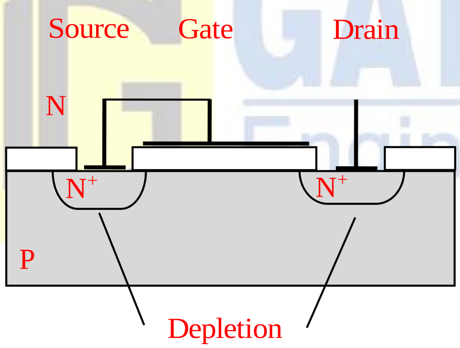
In an enhancement type MOSFET (with n-type source and drain regions), only positive voltage can be applied to the gate with respect to the substrate (p-type)

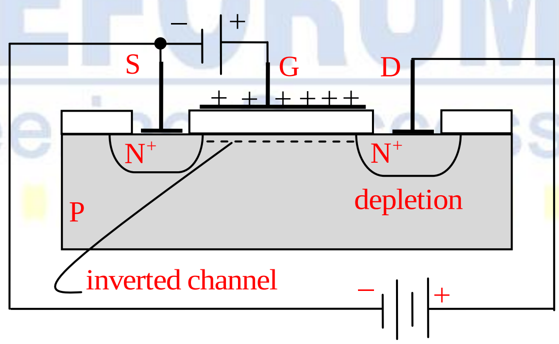
Statement (II):

Only with a positive voltage to the gate, an 'inversion layer' is formed and conduction can take place.

Key: (A)

Exp:





96. Statement (I):

Under steady-state condition, a pure capacitor behaves as an open circuit for direct voltage.

Statement (II):

The current through a capacitor is proportional to the rate of change of voltage.

Key: (A)

Exp:

$$i = C\frac{dV}{dt}$$

$\frac{dV}{dt}$ for D.C. is always 0

So $i = 0 \Rightarrow$ open circuit

Since $\frac{dV}{dt}$ i.e., rate of change of voltage is 0

Capacitor is behaving like open circuit.

97. Statement (I):

The standard definition of stability precludes $\sin\omega_0 t$ term in impulse response.

Statement (II):

$\sin\omega_0 t$ is a periodic function.

Key: (A)

98. Statement (I):

Helical antenna has the largest bandwidth, high directivity and circular polarization.

Statement (II):

Log-periodic antenna has a broad bandwidth.

Key: (B)

99. Statement (I):

Current-limiting resistor is used in series with the light-emitting diode (LED) to limit current and light output.

Statement (II):

The light output of a light-emitting diode (LED) is approximately proportional to the current passing through it.

Key: (A)

Exp: **Statement (I):** Series resistors are a simple way to stabilize the LED current, but energy is wasted in the resistor. The resistance of the cell itself is usually the only **current limiting** device.

Statement (II): Light emitting diode can "emit" any form of light. It needs a current to flow through it, as it is a current dependent device with their light output intensity being directly proportional to the forward current flowing through the LED.

100. Statement (I):

An analog system has at its output stage a PMMC indicating instrument, while a digital meter output stage has an LCD/LED display device.

Statement (II):

Since the analog system is continuous in time, display device can respond to it if the signal frequency is low, while digital system being a discrete one, it does not require change and can be latched at the value of measurement.

Key: (C)

101. A bridge rectifier uses a 9V a.c. input voltage. The diodes are ideal. What is the d.c. output voltage?

(A) 12.726 V (B) -12.726 V (C) 9 V (D) 8.1 V

Key: (D)

Exp: $V_{dc} = \frac{2V_m}{\pi}$; $V_{rms} = \frac{V_m}{\sqrt{2}}$

$V_m = 12.72$

$V_{dc} = \frac{2\times 12.72}{\pi} = 8.102\text{ V}$

102. A half-wave rectifier is used to supply 50V d.c. to a resistive load of $800\,\Omega$. The diode has resistance of $25\,\Omega$. What is the required a.c. voltage?

(A) $50\,\pi$ (B) $51.5\,\pi$ (C) $25.7\,\pi$ (D) $25\,\pi$

Key: (B)

Exp: $V_{dC} = \frac{V_M}{\pi}$

$V_m = 50\pi$

A.C voltage across diode $= \left(\frac{50\pi}{800}\times 25\right) = 1.562\pi$

Require A.C. voltage $= 50\pi + 1.56\pi = 51.56\pi$

103. If an input signal ranges from $20\,\mu A$ -$40\,\mu A$ with an output signal ranging from 0.5 mA-1.5 mA, what is the $\beta_{a.c.}$?

(A) 0.05 (B) 20 (C) 50 (D) 500

Key: (C)

Exp: $\beta_{a.c} = \frac{1.5\,mA - 0.5\,mA}{40\,\mu A - 20\,\mu A} = \frac{1mA}{20\,\mu A} = 50$

104. The best device for improving the switching speeds of bipolar transistors is

(A) Speed-up capacitor (B) Transistor with higher cut-off frequency

(C) Clamping diode (D) Clamping diode with zero storage time

Key: (D)

105. The early effect in bipolar junction transistor is caused by

(A) Fast turn-off

(B) Fast turn-on

(C) Large emitter to base forward bias

(D) Large collector to base reverse bias

Key: (D)

Exp: The Early effect is the variation in the width of the base in a bipolar junction transistor (BJT) due to a variation in the applied base-to-collector voltage, A greater reverse bias across the collector-base junction, for example, increases the collector-base depletion width, decreasing the width of the charge neutral portion of the base.

106. The basic material for fabrication of an LED is

(A) Gallium arsenide (B) Gallium arsenide phosphide

(C) Indium antimonide (D) Indium antimonide phosphide

Key: (A)

Exp: In LED, direct band gap materials are used for fabrication (GaAs, GaN, InN, AIN, GaP, InP etc.) among which the basic binary parent compound is Gallium Arsenide.

107. To get higher cut-off frequency in a BJT, sheet resistance should be

(A) Low (B) High (C) Equal to cut-off frequency (D) Zero

Key: (A)

Exp: In order to reduce the transit time, the base width is required to scale to provide an increase in the unity current gain cutoff frequency, f_T. Moreover, the base doping concentration must be increased to achieve a high unity power gain cutoff frequency, f_{MAX}, to provide a low base sheet resistance as the base width is scaled.

108. A BJT operates as a switch

(A) In the active region of transfer characteristics

(B) With no signal condition

(C) Under small signal conditions

(D) Under large signal conditions

Key: (D)

109. n-p-n transistors are preferred over p-n-p transistors because they have

(A) High mobility of holes

(B) High mobility of electrons

(C) Low mobility of holes

(D) Higher mobility of electrons than the mobility of holes in p-n-p transistors

Key: (B)

110. What is the biasing condition of junctions in bipolar junction transistor to work as an amplifier?

(A) Reverse biased base to emitter junction and reverse biased base to collector junction.

(B) Forward biased base to emitter junction and reverse biased base to collector junction.

(C) Forward biased base to emitter junction and forward biased base to collector junction.

(D) Reverse biased base to emitter junction and forward biased base to collector junction.

Key: (B)

111. In a JFET, operating above pinch-off voltage, the

(A) Drain current increases steeply.

(B) Drain current remains practically constant.

(C) Drain current starts decreasing.

(D) Depletion region reduces.

Key: (B)

Exp: (i) The drain current I_D rises rapidly with drain-source voltage (V_{DS}) but then becomes constant. The drain-source voltage above which drain current becomes constant is known as pinch off voltage.

(ii) After pinch off voltage, the channel width becomes so narrow that depletion layers almost touch each other. The drain current passes through the small passage between these layers.

Therefore, increase in drain current is very small with V_{DS} above pinch off voltage. Consequently, drain current remains constant.

112. If V_{CC} = 18V, voltage divider resistances $R_1 = 4.7k\Omega$ and $R_2 = 1500\Omega$, what is the base bias voltage?

(A) 8.70 V (B) 4.35 V (C) 2.90 V (D) 0.70 V

Key: (B)

Exp: $V_B = \frac{V_{CC} \times 1500}{1500 + 4.7k} = \frac{18 \times 1500}{1500 + 4.7k} = 4.35V$

113. An SCR has an anode supply of sine voltage 200 $V_{r.m.s.}$, 50 Hz applied through a 100Ω resistor and fired at an angle of 60°. Assuming no voltage drop, the r.m.s. value of the output voltage is nearly.

(A) 90 V (B) 126 V (C) 166 V (D) 200 V

Key: (B)

Exp: $$V_{o(rms)} = \frac{V_m}{2\sqrt{\pi}}\left[(\pi - \alpha) + \frac{\sin 2\alpha}{2}\right]^{1/2}$$

$$= \frac{\sqrt{2} \times 200}{2\sqrt{\pi}}\left[\left(\pi - \pi/3\right) + \frac{\sin 120}{2}\right]^{1/2}$$

$$= 80 \times \left[\frac{2\pi}{3} + 0.433\right] \simeq 126\text{ V}$$

114. In a GTO, anode current begins to fall when gate current

(A) Is negative peak at time t = 0.

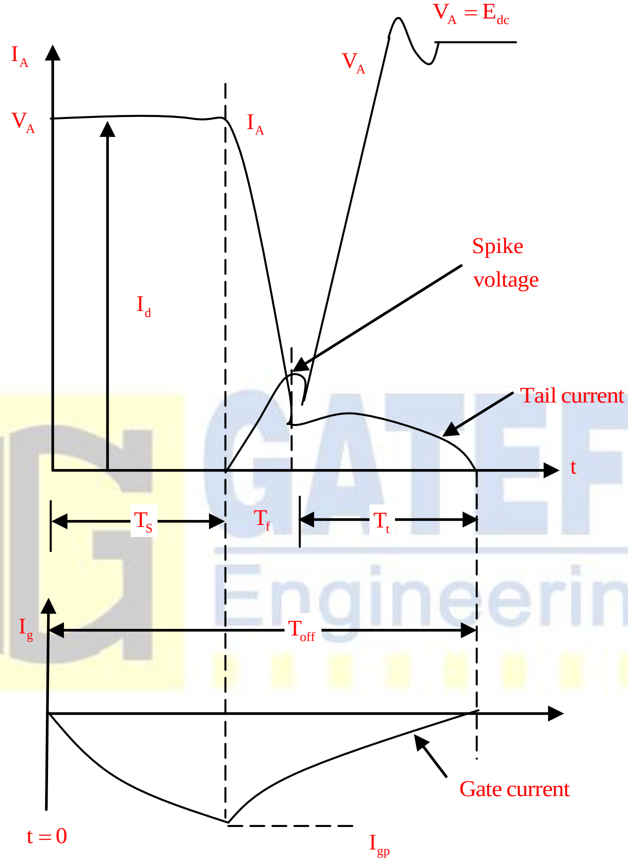
(B) Is negative peak at time t = storage period

(C) Just begins to become negative at t = 0

(D) Just begins to become positive at t = 0

Key: (B)

Exp:



Voltage and Current waveforms during turn – off of a GTO

115. An SCR is turned off when its turn-off time is

(A) Less than the circuit time constant

(B) Greater than the circuit time constant

(C) Less than the circuit turn-off time

(D) Greater than the circuit turn-off time

Key: (C)

Exp: For realiable turn-off of device, device turn-off time (t_q) should be less than circuit turn off time (t_c).

116. A system is characterized by the input-output relation y(t) = x(2t)+x(3t) for all t, where y(t) is the output and x(t) is the input. It is

(A) Linear and causal
(B) Linear and non-causal
(C) Non-linear and causal
(D) Non-linear and non-causal

Key: (B)

Exp: Let input = $x_1(t)$ & output = $y_1(t)$

$$\therefore \quad y_1(t) = x_1(2t) + x_1(3t)$$

Let input = $x_2(t)$ & output = $y_2(t)$

$$\therefore y_2(t) = x_2(2t) + x_2(3t)$$

Let input = $x_1(t) + x_2(t)$ and output be $y_3(t)$

$$y_3(t) = (x_1(2t) + x_2(2t)) + (x_1(3t) + x_2(3t))$$

$$y_3(t) = x_1(2t) + x_1(3t) + x_2(2t) + x_2(3t)$$

$$y_3(t) = y_1(t) + y_2(t)$$

Hence system is linear.

For causality substitute certain values.

Let t =1, $y(1) = x(2) + x(3)$

Present output defends on future inputs

Hence system is non-causal.

117. A discrete-time system has input x[.] and output y[.] satisfying $y[m] = \sum_{j=-\infty}^{m} x[j]$. The system is

(A) Linear and unstable
(B) Linear and stable
(C) Non-linear and stable
(D) Non-linear and unstable

Key: (A)

Exp: $$y_1[m] = \sum_{j=-\infty}^{m} x_1(j)$$

$$y_2[m] = \sum_{j=-\infty}^{m} x_2[j]$$

$$y_3[m] = \sum_{j=-\infty}^{m} (x_1[j] + x_2[j])$$

$$= \sum_{j=-\infty}^{m} x_1[j] + \sum_{j=-\infty}^{m} x_2[j]$$

$y_3[m] = y_1[m] + y_2[m]$

System is linear.

Let input x[j] be a bounded input u[j].

$\therefore\ y[m] = \sum_{j=-\infty}^{m} u[j]$

$y[m] = \sum_{j=0}^{m} u[j]$

$y[m] = r[m+1]$ = ramp sequence = unbounded output.

Hence system is unstable.

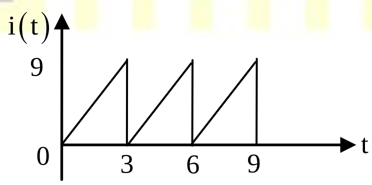
118. The Fourier transform of a rectangular pulse for a period $t = -\frac{T}{2}$ to $t = \frac{T}{2}$ is

(A) A sinc function
(B) A sine function
(C) A cosine function
(D) A sine-squared function

Key: (A)

Exp: Fourier transform of a finite durated rectangular pulse of a certain period transformers to a sine function of infinite duration.

119. The current waveform i(t) in a pure resistor of $20\,\Omega$ is shown in the figure



The power dissipated in the resistor is

(A) 135 W
(B) 270 W
(C) 540 W
(D) 14.58 W

Key: (C)

Exp: $P = i_{RMS}^2(t)R$

$P = i_{RMS}^2(t).20$

$i_{RMS} = \sqrt{\frac{1}{3}\int_{t=0}^{3}(3t)^2\,dt}$

$i_{RMS}^2 = \frac{1}{3}\int_0^3 9t^2 dt$

$$= \frac{1}{3}.9.\left(\frac{t_3}{3}\right)_0^3$$

$$i^2_{RMS} = (27)$$

$$P = 27 \times 20$$

$$\boxed{P = 540W}$$

120. A p-type silicon sample has an intrinsic carrier concentration of $1.5\times10^{10}/cm^3$ and a hole concentration of $2.25\times10^{15}/cm^3$. Then the electron concentration is

(A) $1.5\times10^{25}/cm^3$ (B) $10^5/cm^3$ (C) $10^{10}/cm^3$ (D) 0

Key: (B)

Exp: By mass-action law, $np = n_i^2$

In P-type

$$n_p\, p_p = n_i^2$$

$$n_p = \frac{n_i^2}{p_p} = \frac{\left(1.5\times10^{10}\right)^2}{2.25\times10^{15}}$$

$$n_p = 10^5 / cm^3$$