EC Objective Paper I (Set - D)

1. If a system produces frequencies in the output are not present in the input, then the system cannot be

    (A) Minimum phase system   (B) Linear shift invariant

    (C) Stable and causal   (D) Stable and linear

Key: **(B)**

Exp: Since linearity and time-invariance (shift-invariance) doesn't effect the frequency of input to get the output the system can't be LTI.

2. In eddy current damping system, the disc employed should be of

    (A) Conducting and magnetic material

    (B) Conducting but non-magnetic material

    (C) Magnetic but non-conducting material

    (D) Non-conducting and non-magnetic material

Key: **(B)**

3. Which of the following can act as in inverse transducer?

    (A) LVDT   (B) Strain

    (C) Piezo electric crystal   (D) Bimetal strip

Key: **(C)**

4. Which one of the following thermocouple pairs has maximum sensitivity around 273 K?

    (A) Nichrome-constant   (B) Copper-Nickel

    (C) Platinum-constantan   (D) Nickel-constantan

Key: **(A)**

5. Maximum power will be delivered from an ac source to a resistive load in a network when the magnitude of the source impedance is equal to

    (A) Half the load resistance   (B) Double the load resistance

    (C) The load resistance   (D) Zero

Key: **(D)**

Exp: The equation of power for resistive load is

$$P_{R_L} = \left(\frac{V_S}{Z_S + R_L} \right)^2 R_L$$

So we can say power is maximum when $Z_S = 0$,

$\rightarrow$ Note that maximum power transfer theorem is not applicable here as we are not calculating the value of R_L (variable). We are going in reverse way.

6. The dc resistivity and permeability exhibited by a type 1 superconductor are respectively:

    (A) Zero and zero   (B) Zero and unity

    (C) Unity and zero   (D) Unity and Unity

Key: **(A)**

Exp: $x_m = \mu_r - 1$

In super conductors $x_m = -1$ (negative)

$\mu_r = 0,$

$\rightarrow$ super conductor has zero Resistivity.

Directions: Each of the next **Fourteen (14)** items consists of two statements one labeled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below.

Codes:

(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

7.   Statement (I):   One of the mechanism by which a transistor's usefulness may be terminated, as the collector voltage is increased, is called punch through.

     Statement (II):   Punch through results from the increased width of the collector-junction transition region with increased collector-junction voltage.

Key: **(A)**

Exp: Punch through:
When the base–collector voltage reaches a certain (device specific) value, the base–collector depletion region boundary meets the base–emitter depletion region boundary. When in this state the transistor effectively has no base. The device thus loses all gain when in this state.

8.   Statement (I):   In ferroelectric materials, domains with permanent electric dipoles may be created that would align along external electric field.

     Statement (II):   Ferroelectric materials undergo phase transformation of symmetric to asymmetric structure below a critical temperature.

Key: **(B)**

9.   Statement (I):   Conduction takes place in an enhancement MOSFET only for gate voltages below the threshold level.

     Statement (II):   In an enhancement MOSFET, a channel of semiconductor of the same type as the source and drain is induced in the substrate by a positive voltage applied to the gate.

Key: **(D)**

Exp: $V_{GS} > V_t$ conduction takes places

      $V_{GS} < V_t$ no conduction take place in MOSFET

10.   Statement (I):   MOSFET is a field effect transistor whose drain current is controlled by the voltage applied at the gate.

      Statement (II):   MOSFET is an insulated gate FET

Key: **(A)**

11. Statement (I):   All passive components can be fabricated in a single chip.

     Statement (II):   As opposed to discrete circuits where all components are separately inserted and connected, in an integrated circuit, they are simultaneously created on a chip of semiconductor material during manufacturing.

Key: (B)

12. Statement (I):   The total energy of an energy signal falls between the limits 0 and ∞.

     Statement (II):   The average power of an energy signal is zero.

Key: (B)

Exp: Energy signal is a signal with finite energy and zero average power. Thus statement (I) and (II). Both are correct but statement (II) is not giving explanation/reasoning to statement (I).

13. Statement (I):   Sinusoidal signals are used as basic function in electrical systems.

     Statement (II):   The response of a linear system to a sinusoidal input function remains sinusoidal.

Key: (A)

14. Statement (I):   Dirichlet's conditions restrict the periodic signal x(t), to be represented by Fourier series, to have only finite number of maximal and minima.

     Statement (II):   x(t) should possess only a finite number of dis-continuities.

Key: (B)

Exp: Strong Dirichlet conditions states that the Fourier series exists if and only if the signal has a finite number of maxima and minima (or) finite number of discontinuities.

15. Statement (I):   Ferrite cored coils are used in high frequency tuned circuits.

     Statement (II):   Ferrite cored coils have high Q as compared to iron-cored coils.

Key: (A)

Exp:

16. Statement (I):   A cylindrical conductor of radius R carries a current

     I. The magnetic Field intensity within the conductor increases linearly with the radial distance r < R.

     Statement (II):   The current enclosed increases as the square of the radial distance while the circumference increases linearly with the radial distance.

Key: (A)

Exp:
$$\oint_L H.dl = \int_s j.ds$$

$$H.2\pi r = \frac{I}{\pi R^2}\pi r^2$$

$$H = \frac{Ir}{2\pi R^2}$$

$\boxed{H \propto r}$ statement (I) is correct

Statement (II) is correct explanation to Statement (I).

17.   Statement (I):   Hall voltage is given by $V_H = R_H \dfrac{I.H}{t}$ Where I is the current, H is the magnetic field strength, **t** is the thickness of probe and R_H is the Hall constant.

        Statement (II):   Hall effect does not sense the carrier concentration.

Key: (C)

Exp: $V_H = \dfrac{BI}{\rho W}$

$R_H = \dfrac{1}{\rho}$

So, $V_H = R_H \cdot \dfrac{BI}{W}$

W = t = width (or) thickness

$B = \mu H$

Hall Effect measures density of the carries, and their sign (whether electron (or) holes)

18.   Statement (I):   For an energy meter, careful design and treatment of breaking magnet during its manufacture are essential in order to ensure consistency of break magnet during the use of meter.

        Statement (II):   Steady rotational speed of energy meter disc is directly proportional to flux of the break magnet.

Key: (A)

19.   Statement (I):   If the limiting errors of measurement of power consumed by and the current passing through a resistance are $\pm 1.5\%$ and $\pm 1.0\%$ respectively, then the limiting error of resistance measurement will be $\pm 2.5\%$.

        Statement (II):   Mathematically if f = xyz. Then $\Delta f = (\Delta x)yz + x(\Delta y)z + xy(\Delta z)$

Key: (A)

Exp: It is given that the limiting error of power is Power is $\pm 1.5\%$ and

                                                                    Current is $\pm 1.0\%$

$\rightarrow R = \dfrac{P}{I^2}$ so the limiting error will be $\pm[1.5 + 2(1.0)]\% = \pm 3.5\%$

20.   Statement (I):   Integrating DVM measures the true average value of the input voltage over a fixed measuring period.

        Statement (II):   Since the display of measured signal is a decimal number, the errors due to parallax and observation error are eliminated.

Key: (B)

21.   Measurement of pressure can be done by using wire, foil or semiconductor type Strain Gauges. The disadvantage of the semiconductor type of strain gauge compared to other two is in terms of

        (A) Gauge factor   (B) Hysteresis characteristics

        (C) Temperature sensitivity   (D) Frequency response

Key: (C)

22.   The Fourier series of a periodic function $x_T(t)$ with a period T is given by

$\sum_{k=-\infty}^{\infty} X_s(k)e^{jk\omega_o t}$, where $\omega_o = 2\pi/T$ And the Fourier coefficient $X_s(K)$ is defined as,

$X_s(k) = \dfrac{1}{T}\int x_T(t)e^{-jk\omega_o t}dt$

If $x_T(t)$ is real and odd, the Fourier coefficients $X_s(K)$ are

(A) Real and odd   (B) Complex   (C) Real   (D) Imaginary

Key: **(D)**

Exp: Consider $x_s(k) = \dfrac{1}{T}\displaystyle\int_{-T/2}^{T/2} x_T(t)e^{-jk\omega_0 t}dt$

$= \dfrac{1}{T}\left[\displaystyle\int_0^{T/2} x_T(t)e^{-jk\omega_0 t}dt + \int_0^{T/2} x_T(-t)e^{jk\omega_0 t}dt\right]$

$\because x_T(t)$ is odd, $x_T(t) = -x_T(-t)$

$\therefore x_s(k) = \dfrac{-1}{T}\displaystyle\int_0^{T/2}\left[e^{jk\omega_0 t} - e^{-jk\omega_0 t}\right]x_T(t)dt$

$\therefore x_s(k) = \dfrac{-2j}{T}\displaystyle\int_0^{T/2}(\sin k\omega_0 t)x_T(t)dt$

Thus $x_s(k)$ is imaginary.

23.   Consider a continuous time period signal x(t) with fundamental period T and Fourier series coefficient X[K]. What is the Fourier series coefficient of the signal

$y(t) = x(t - t_o) + x(t + t_o)$?

(A) $2\cos\left(\dfrac{2\pi}{T}Kt_o\right)X[K]$

(B) $2\sin\left(\dfrac{2\pi}{T}Kt_o\right)X[K]$

(C) $e^{-t_o}X[K] + e^{t_o}X[-K]$

(D) $e^{-t_o}X[-K] + e^{t_o}X[K]$

Key: **(A)**

Exp: $y(t) = x(t-t_0) + x(t+t_0)$

$x(t)\xrightarrow{FS}x[k]$

By using time-shifting property of Fourier series,

$x(t - t_0)\xrightarrow{FS}x[k]e^{-jk\omega_0 t_0}$

$x(t + t_0)\xrightarrow{FS}x[k]e^{+jk\omega_0 t_0}$

$\therefore$ Fourier series of $y(t) = 2x[k]\left[\dfrac{e^{jk\omega_0 t_0} + e^{jk\omega_0 t_0}}{2}\right]$

$= 2x[k]\cos k\omega_0 t_0$

$= 2x[k]\cos\left[\dfrac{2\pi}{T}kt_0\right]$

24. Consider the following transfer functions:

   1. $\dfrac{1}{j\omega+1}$

   2. $\dfrac{1}{(j\omega+1)^2}$

   3. $\dfrac{1}{(j\omega+1)(j\omega+2)}$

   The transfer functions which have a non linear phase are:

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

Key: **(D)**

25. A continuity equation is also called as the law of conservation of

   (A) Mass   (B) Energy   (C) Charge   (D) Power

Key: **(C)**

Exp: Continuity equation is based upon the law of conservation at charge.

26. The basic structure of an avalanche photodiode is

   (A) $p^+ - i - p - n^+$ (B) $p^+ - i - n^+$ (C) $p^+ - p^- - n^+$ (D) $i - p^+ - n^+$

Key: **(A)**

27. Consider two infinite duration input sequences $\{x_1[n], x_2[n]\}$. When will the Region of Convergence [ROC] of Z-transform of their superposition i.e. $\{x_1[n] + x_2[n]\}$ be entire Z plane except possibly at $Z = 0$ or $Z = \infty$?

   (A) When their linear combination is of finite duration

   (B) When they are left sided sequences

   (C) When they are right sided sequences

   (D) When their linear combination is causal
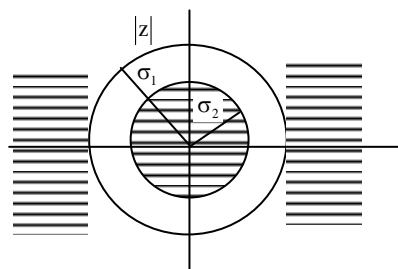
Key: **(A)**

Exp: For a finite duration sequence the ROC will be entire Z-plane except z = 0 and/or $Z = \infty$.

28. If the lower limit of Region of Convergence (ROC) is greater than the upper limit of ROC, the series $X(Z) = \sum_{n=-\infty}^{\infty} x(n)Z^{-n}$

   (A) Converges   (B) Zero

   (C) Does not converge   (D) None of the above

Key: **(C)**

Exp:

If σ_1 is lower limit and σ_2 is upper limit of ROC then ROC is $\sigma_1 < |z| < \sigma_2$.

Accordingly, the signal corresponding to σ_1 is Right-sided and the signal corresponding to σ_2 is left sided. Since, it is given that $\sigma_1 > \sigma_2$, ROC does not converge.

29. For a random signal (continuous time) x(t) defined for $t \geq 0$, its probability density function (pdf) at $t = t_o$ is such that

    (A) It is non-negative and it's integral

    (B) Need not be non-negative, but integral equals 1

    (C) It is non-negative, but integral is not 1

    (D) None of the above

Key: (D)

30. The response of a system to a complex input $x(t) = e^{j2t}$ is specified as $y(t) = t.e^{j2t} + e^{-j2t}$. The system

    (A) is definitely LTI   (B) is definitely not-LTI

    (C) may be LTI   (D) Information is insufficient

Key: (B)

Exp: $x(t) = e^{2jt}; y(t) = te^{2jt} + e^{-2jt}$

y(t) = tx(t) + x(-t)

consider y(t) = y₁(t) + y₂(t)

y₁(t) = t x(t) is linear but non-time invariant

Similarly y₂(t) = x(-t) is also linear but non time-invariant

Thus the system is non-LTI.

31. The rise time of the output response of a low pass filter circuit when a step input is applied will be

    (A) Proportional to the band width   (B) Inversely proportional to the band width

    (C) Half the value of band width   (D) $\dfrac{1}{\sqrt{2}}$ of the band width

Key: (B)

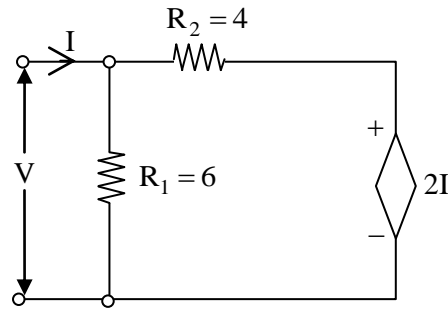$$t_r = \frac{0.35}{\text{Bandwidth}}$$

32. Consider an LTI system subjected to a wide sense stationary input $\{x(n)\}$, which is a white noise sequence. The cross correlation $\Phi_{XY}[m]$ between input x(n) and output y(n) is

    (A) $\sigma_x^2 h[m]$ (B) $\sigma_x h[m]$ (C) $\dfrac{\sigma_x^2}{2} h[m]$ (D) $\dfrac{\sigma_x}{2} h[m]$

    Where $\Phi_{xx}[m] = \sigma_x^2 \delta[m]$ and $h[.]$ is impulse response

Key: (A)

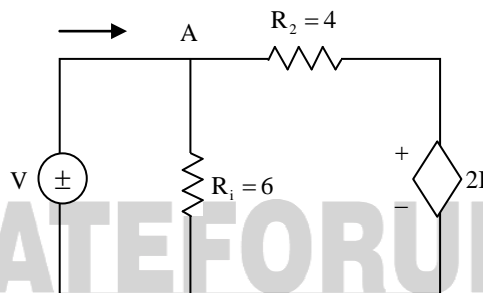33.   For the active network shown in Figure, the value of V/I is

$R_2 = 4$

I

V $R_1 = 6$

+

2I

−

(A) 2Ω (B) 2.4Ω (C) 3.6Ω (D) 10Ω

Key: **(C)**

Exp: Since it is a dead network with dependent source to find V/I we have to connect an external source and measure it writing nodal equation at node A

$$V\left(\frac{1}{6} + \frac{1}{4}\right) = I + \frac{2I}{4}$$
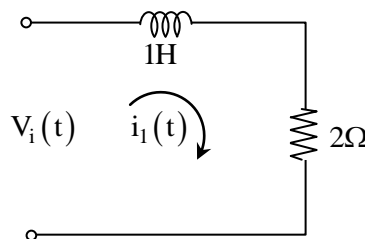
$$\Rightarrow \frac{V}{I} = 3.6\Omega$$

A $R_2 = 4$

V $\pm$ $R_i = 6$

+

2I

−

34.   In a discrete-time Low pass Filter, the frequency response is

(A) A periodic

(B) A periodic with response restricted to $\left(-\omega_c, +\omega_c\right)$

(C) Periodic with period 2π

(D) Quasi periodic with response extending to infinity

Key: **(C)**

35.   For the R-L circuit shown, the current i(t) for unit step input voltage will rise to 0.63 in

(A) 1s

(B) 2s

(C) 0.5s

(D) 1.5s

1H

$V_i(t)$ $i_1(t)$ 2Ω

Key: *****

Exp: $I_{(S)} = \dfrac{1}{S(S+2)}$

$$= \frac{1/2}{S} + \frac{-1/2}{S+2}$$

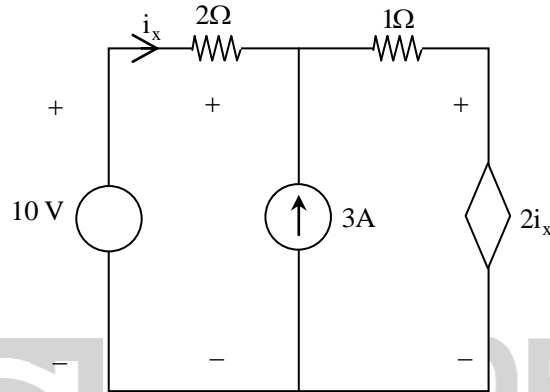$$i(t) = \frac{1}{2}\left(1 - e^{-2t}\right)u(t)$$

$$0.63 = 0.5\left(1 - e^{-2t}\right)$$

$$\Rightarrow 1.26 = 1 - e^{-2t}$$

$$\Rightarrow e^{-2t} = -0.26$$

No value of t will satisfy this equation

36. In the circuit the value of i_x is

    (A) 2A   (B) –0.6A   (C) 2.6A   (D) 1.4A

Key: (D)

Exp: Writing nodal equation A

$$V_A \left(\frac{1}{2} + \frac{1}{1}\right) = 3 + \frac{10}{2} + 2i_x$$

$$\text{and } i_x = \frac{10 - V_A}{2}$$

$$\Rightarrow V_A = 10 - 2i_x$$

Solving equation (1) and (2)

$i_x = 1.4A$ and $V_A = 7.2V$

37. When the frequency of the applied voltage (sine wave) across an inductor is increased then the current will

    (A) Decrease   (B) Increase   (C) Remain same   (D) Be zero

Key: (A)

Exp: $I_L = \dfrac{V_L}{j\omega L}$

$$\Rightarrow I_L \alpha \frac{1}{\omega}$$

So when frequency increase current will decreases

38. A series resonant circuit is tuned to 10 MHz and provides 3-dB bandwidth of 100 kHz. The quality factor Q of the circuit is

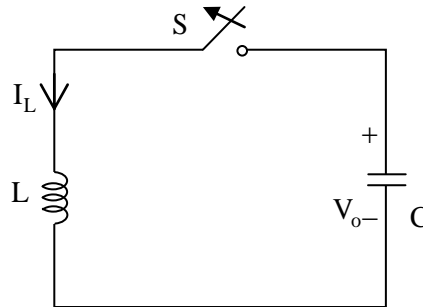   (A) 30   (B) 1   (C) 100   (D) 10

Key: (C)

Exp: $f_0 = 10\text{MHz}$

B.W $= 100\text{ kHz}$

We know $\text{B.W} = \dfrac{f_0}{Q}$

$$\Rightarrow Q = \dfrac{f_0}{BW} = \dfrac{10 \times 10^6}{100 \times 10^3} = 100$$

39. In the figure, initial voltage on C is V_o. S is closed at t = 0. The I_L for t > 0 is_____

Where $\omega_0{}^2 = \dfrac{1}{LC}$

(A) $-\omega_0 CV_o \sin\omega_o t$

(B) $\omega_o V_o \sin\omega_o t$

(C) $-\omega_o V_o \sin\omega_o t$

(D) $\omega_o CV_o \sin\omega_o t$

Key: (D)

Exp: Capacitor has initial voltage V_0

Inductor has initial current 0

Drawing the Laplace equivalent circuit for closed switch

$$I_{L(s)} = \dfrac{V_0}{S\left(SL + \dfrac{1}{SC}\right)}$$

$$= \dfrac{V_0}{S^2 L + \dfrac{1}{C}}$$

$$= \dfrac{V_0}{L}\dfrac{1}{S^2 + \dfrac{1}{LC}}$$

$$= \dfrac{V_0}{L} \times \sqrt{LC}\left(\dfrac{\left(1/\sqrt{LC}\right)}{S^2 + \left(\dfrac{1}{\sqrt{LC}}\right)^2}\right) = V_0\sqrt{\dfrac{C}{L}}\left[\dfrac{1/\sqrt{LC}}{S^2 + \left(\dfrac{1}{\sqrt{LC}}\right)^2}\right]$$

$$= \text{substituting } \omega_0 = \dfrac{1}{\sqrt{LC}}$$

$$I_L(t) = \omega_0 cV_0 \sin\omega_0 t$$

40. A reduced incidence matrix of a graph is given by

$$[A] = \begin{bmatrix} 1 & 1 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 & 0 \\ -1 & 0 & -1 & -1 & 0 \end{bmatrix}$$

The number of possible trees is

(A) 14   (B) 15   (C) 16   (D) 17

Key: *** It have 8 tress**

Exp: $\left| AA^T \right| = $ Number of possible trees in graph

$$A.A^T = \begin{bmatrix} 1 & 1 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 & 0 \\ -1 & 0 & -1 & -1 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 1 & -1 & 0 \\ 0 & +1 & -1 \\ 0 & 0 & -1 \\ 1 & 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

$$\left| A.A^T \right| = 15 - 4 - 3 = 8$$

41. The antenna efficiency of a $\lambda/8$ long dipole antenna is 89.159%. The equivalent loss resistance of the antenna is

(A) $1.5\,\Omega$ (B) $15\,\Omega$ (C) $12.33\,\Omega$ (D) $125\,\Omega$

Key: **(A)**

Exp: $\eta = \dfrac{R_{rad}}{R_{rad} + R_{loss}} \times 100$

$$R_{rad} = 80\pi^2 \left(\frac{dl}{\lambda} \right)^2$$

$$= 80\pi^2 \left(\frac{1}{8} \right)^2$$

$$R_{rad} = 12.33\,\Omega$$

$$89.159 = \frac{12.33}{12.33 + R_{loss}} \times 100$$

$$12.33 + R_{loss} = 13.82$$

$$\boxed{R_{loss} = 1.5\,\Omega}$$

42. A small elemental wire antenna is excited with a sinusoidal current of frequency 1 MHz The induction field and radiation field are at equal distance d from the antenna. The value of d will be nearly

(A) 300   (B) 50 m   (C) 150 m   (D) 20 m

Key: **(B)**

Exp: The induction field and radiation field are equal at $1 = \dfrac{\lambda}{6}$.

$$1 = \frac{\lambda}{6}$$

$$\lambda = \frac{3 \times 10^8}{10^6} = 300$$

$$1 = \frac{300}{6} = 50m$$

43. Error caused by the act of measurement on the physical system being tested is

(A) Hysteresis error   (B) Random error   (C) Systematic error   (D) Loading error

Key: **(D)**

44. Four independent observations recorded voltage measurement of 110.02V, 110.11 V, 110.08 V and 110.03 V. The average range of error will be

(A) 110.06V   (B) 0.05 V   (C) ± 0.045 V   (D) ± 0.9 V

Key: **(C)**

45. A 1kΩ resistor with an accuracy of $\pm 10\%$ carries a current of 10 mA. The current was measured by an analog ammeter on a 25 mA range with an accuracy of $\pm 2\%$. The accuracy in calculating the power dissipated in the resistor would be

(A) $\pm 4\%$ (B) $\pm 12\%$ (C) $\pm 15\%$ (D) $\pm 20\%$

Key: **(D)**

Exp: $R = 1 \pm 10\%$

$I = 10\,mA$

$\rightarrow$ Meter specification $25 \pm 2\% = 25 \pm 0.5$

It means the meter will introduce a constant error of 0.5 mA, since meter error is correct. F.s.v which is constant.

$\rightarrow$ So the current range would be

$I = 10 \pm 0.5 = 10 \pm 5\%$

$P = I^2R$

So the error of power $= \pm \left[2(5) + 10 \right]\% = \pm 20\%$

46. Consider the following statements regarding error occurring in current transformer:

1. It is due to the magnetic leakage in secondary winding

2. It is due to power consumption in the metering circuit

3. It is due to the exciting mmf required by the primary winding to produce flux

4. It is due to the non-linear relation between flux density in the core and magnetizing force

Which of the above statements are correct?

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

Key: **(A)**

47. The different torques acting on the coil of a moving coil of a moving coil instruments are

    (A) Deflecting torque and control torque

    (B) Deflecting torque and damping torque

    (C) Control torque and damping torque

    (D) Deflecting torque, control torque and damping torque

Key: **(D)**

Exp: Deflecting torque is needed to move the pointer

Controlling torque is needed to stop the pointer

Damping torque is needed to control the speed

48. A resistance strain gauge is cemented to a steel member, which is subjected to a strain of 2×10^{-6}. If the original resistance is $100\,\Omega$ and change in resistance is $600\,\mu\Omega$, the gauge factor will be

    (A) 3   (B) 0.33   (C) 300   (D) 0.03

Key: **(A)**

49. An ac source is delivering power to a complex load $Z_L = 4 + j3$. The maximum power is transferred if the source impedance is

    (A) $4\,\Omega$ (B) $j3\,\Omega$ (C) $(4 - j3)\Omega$ (D) $(4 + j3)\Omega$

Key: **(C)**

Exp: $P_{Z_{load}} = \left|I^2_{load}\right| R_{load} = \left[\dfrac{V_s}{Z_s + 4 + j3}\right]^2 4$

So the power to be maximum $\lfloor Z_s + 4 + j3 \rfloor$ should minimum among the option (4-j3) satisfies this.

50. A ± 1 count error occurs in digital frequency meter due to

    (A) Trigger level uncertainly   (B) Spurious interference

    (C) Clock uncertainty   (D) Gate time uncertainty

Key: **(D)**

51. True RMS voltmeter is ideal for the measurement of RMS value, because it employs

    (A) Feedback   (B) High gain amplifier

    (C) Two thermocouples   (D) Two heaters, heated by ac and dc

Key: **(C)**

52. The principle of working of D'Arsonval Galvanometer is based upon

    (A) Heating effect of current   (B) Induction effect of current

    (C) Magnetic effect of current   (D) Electrostatic effect of current

Key: **(C)**

53. Examples of an active display and a passive display respectively are

     (A) LCD and Gas discharge plasma   (B) LED and LCD

     (C) Gas discharge plasma and LED   (D) Electrophoretic Image display and LED

Key: (B)

Exp: Active displays are CRT, LED's

     Passive displays is LCD

54. For displaying high frequency signals, cathode ray tube should have

     (A) High persistence

     (B) Focusing system

     (C) Very high input impedance

     (D) Provision for post deflection acceleration

Key: (D)

55. A sinusoidal waveform has peak-peak amplitude of 6 cm viewed on a CRO screen. The vertical sensitivity is set to 5V/cm. The RMS value of the signal is

     (A) 15V   (B) 12.6   (C) 21.2V   (D) 10.6V

Key: (D)

Exp: Peak-peak amplitude in 6-cm

$$V_{p-p} = 30$$

$$V_p = 15$$

$$V_{rms} = \frac{V_p}{\sqrt{2}} = 10.6$$

Type-II

$$V_{pp} = (5V/cm) \times (6cm) = 30V$$

$$V_{peak} = \frac{30}{2} = 15V$$

$$V_{rms} = \frac{15}{\sqrt{2}} = 10.6$$

56. Consider the following types of digital voltmeters

     1. Ramp type

     2. Dual slope integrating type

     3. Integrating type using voltage to frequency conversion

     4. Successive approximation type

     5. Servo balanced potentiometer type

     Which of these require a fixed reference voltage at the comparator stage?

     (A) 1 and 2 only   (B) 3, 4 and 5 only   (C) 2 and 3 only   (D) 1, 4 and 5 only

Key: (C)

57. Which of the following flow meters is capable of giving the rate of flow as well as the total flow?

    (A) Nutating disc flow meter   (B) Electromagnetic flow meter

    (C) Orifice meter   (D) Lobed impeller flow meter

Key: **(B)**

58. Which of the following types of transducers can be used for the measurement of the angular position of a shaft?

    1. Circular potentiometer

    2. LVDT

    3. e-pickup

    4. Synchronal pair

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

Key: **(C)**

59. Which one of the following plays an important role in the fine recording of audio signals on magnetic tape recorder?

    (A) Width of the air gap of the recording head

    (B) Thickness of the tape used for recording

    (C) Material of the recording head

    (D) Speed of the motor

Key: **(D)**

60. A resistance strain gauge with a gauge factor of 3 is fixed to a steel member subjected to a stress of 100 N/mm^2.. The Young's modulus of steel is $2 \times 10^5 \ N/mm^2$.

    (A) 0.1%   (B) 0.15%   (C) 1.0 %   (D) 1.5%

Key: **(B)**

Exp: $G = \dfrac{\dfrac{\Delta R}{R}}{Strain}$

$Strain = \dfrac{stress}{young\ modulus}$

$= \dfrac{100}{2 \times 10^5} = 5 \times 10^{-4}$

$\dfrac{\Delta R}{R} = G \times 5 \times 10^{-4} = 15 \times 10^{-4}$

$\dfrac{\Delta R}{R} \times 100 = 0.15\%$

61. The radius of the first Bohr orbit of electrons in hydrogen atom is 0.529 A. What is the radius of the second Bohr orbit in singly ionized helium atom?

    (A) $1.058 \overset{o}{A}$ (b) $0.264 \overset{o}{A}$ (C) $10.58 \overset{o}{A}$ (D) $0.0264 \overset{o}{A}$

Key: **(A)**

Exp: Radius of Bohr's orbit in hydrogen and hydrogen like species can be calculated by using formula

$$r = \frac{n^2h^2}{4\pi^2me^2} \times \frac{1}{Z}$$

$$= 0.529 \times \frac{n^2}{Z} A°$$

For helium Z(atomic number) = 2

$$So\, r(n=2) = 2 \times 0.529 A°$$

$$= 1.058 A°$$

62. For which one of the following materials, is the Hall coefficient closest to zero?

(A) Metal   (B) Insulator

(C) Intrinsic semiconductor   (D) Alloy

Key: **(A)**

63. Copper has a resistivity of $17 \times 10^{-9}\,\Omega m$. what is the end to end resistance of a copper strip, 2 cm long with cross sectional dimensions $5mm \times 1mm$?

(B) $34\,\mu\Omega$ (B) $68\,\mu\Omega$ (C) $34\,m\Omega$ (D) $68\,m\Omega$

Key: **(B)**

Exp: $R = \dfrac{\rho L}{A}$

$\rho = \text{Resistivity} = 17 \times 10^{-9}\,\Omega - m$

$L = 2 \times 10^{-2}\,m$

$A = 5 \times 10^{-6}\,m^2$

$R = \dfrac{17 \times 10^{-9} \times 2 \times 10^{-2}}{5 \times 10^{-6}} = 68\,\mu\Omega$

64. At temperature of 298 Kelvin, Silicon is not suitable for most electronic applications, due to small amount of conductivity. This can be altered by

(A) Gettering   (B) Doping   (C) Squeezing   (D) Sintering

Key: **(B)**

Exp:

65. The energy gap in the energy band structure of a material is 9 eV at room temperature. The material is

(A) Semiconductor   (B) Conductor   (C) Metal   (D) Insulator

Key: **(D)**

Exp: A material with fully occupied or empty energy bands is then an insulator. This is the case when the gap energy exceeds ~9eV, because for such gaps

66.   By doping Germanium with Gallium, the types of semi-conductors formed are:

1.   N type

2.   P type

3.   Intrinsic

4.   Extrinsic

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

Key: (B)

Exp: Silicon/Germanium is doped with P-type (or) n-type materials it becomes extrinsic semiconductors

P-type materials are: Gallium

Indium

Boron

Aluminum

n-type materials are: Phosphorous

Arsenic

Antimony

67.   An n-type of silicon can be formed by adding impurity of:

1.   Phosphorus

2.   Arsenic

3.   Boron

4.   Aluminium

Which of the above are correct?

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

Key: (A)

Exp: Silicon/Germanium is doped with P-type (or) n-type materials it becomes extrinsic semiconductors

P-type materials are: Gallium

Indium

Boron

Aluminum

n-type materials: Phosphorous

Arsenic

Antimony

68.   According to Einstein's relationship for a semiconductor, the ratio of diffusion constant to the mobility of the charge carriers is

(A) Variable and is twice the volt equivalent of the temperature

(B) Constant and is equal to the volt equivalent of the temperature

(C) Equal to two and is twice the volt equivalent of the temperature

(D) Equal to one and is equal to the volt equivalent of the temperature

Key: (B)

Exp: By Einstein's Relation ship

$$\frac{D_n}{\mu_n} = \frac{D_p}{\mu_p} = V_T \left(Thermal\, voltage \right)$$

69.   Swept-out voltage in PIN diode happens when PIN diode is

(A) Forward biased and the thickness of the depletion layer decreases till I-region becomes free of mobile carriers

(B) Reverse biased and the thickness of the depletion layer increase till I-region becomes free of mobile carriers

(C) Forward biased and the thickness of the depletion layer increase till I-region free of mobile carriers

(D) Reverse biased and the thickness of the depletion layer decrease till I-region becomes free of mobile carriers

Key: (B)

70.   Consider the following statement related to piezoelectric effect:

1.   It gives electrical response in terms of voltage change when mechanical stress occurs in some materials

2.   It gives mechanical response in terms of dimensional change due to electrical excitation of some materials

Which of the above statements is/are correct?

(B) 1 only   (B) 2 only   (C) neither 1 nor 2   (D) Both 1 and 2

Key: (D)

71.   A 2-port Network is shown in figure. The parameter h_{21} for this network can be given by
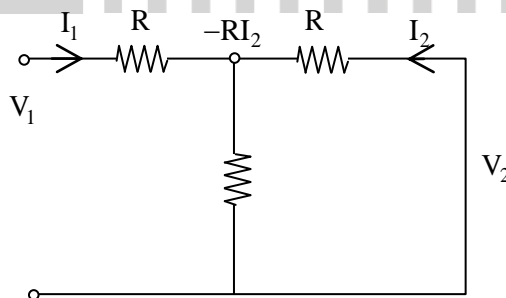
(A) $-1/2$ (B) $+1/2$ (C) $-3/2$ (D) $+3/2$

Key: (A)

Exp: $h_{21} = \dfrac{I_2}{I_1}\bigg|_{V_2=0}$

$I_2 = -\left\lfloor \dfrac{I_1 R}{2R} \right\rfloor$

$\Rightarrow \dfrac{I_2}{I_1} = -1/2$
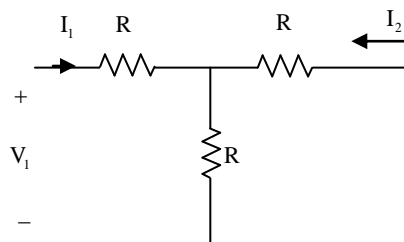
72.   The four band colour code on a carbon composite resistor is as follows

First band colour   : Yellow

Second band colour   : Violet

Third band colour   : Red

Fourth band colour   : Silver

The specification of the resistor is

(A) $35\,k\Omega\pm10\%$ (B) $4.7\,k\Omega\pm10\%$ (C) $6.8\,k\Omega\pm5\%$ (D) $46\,k\Omega\pm2\%$

Key: **(B)**

Band colour code	Tolerance
Black – 0	
Brown – 1	1%
Red – 2	2%
Orange – 3	
Yellow – 4	
Green – 5	
Blue – 6	
Violet – 7	
Grey – 8	
White – 9	
Gold – 0.1	5%
Silver – 0.01	10%

Exp: (table above)

So, $47\times10^2\pm10\%$

$4.7k\Omega\pm10\%$

73. Which one of the following materials has temperature coefficient of resistance very close to zero?

(A) Manganin   (B) Nichrome   (C) Carbon   (D) Aluminum

Key: **(A)**

74. The equivalent resistance between the points A and D is
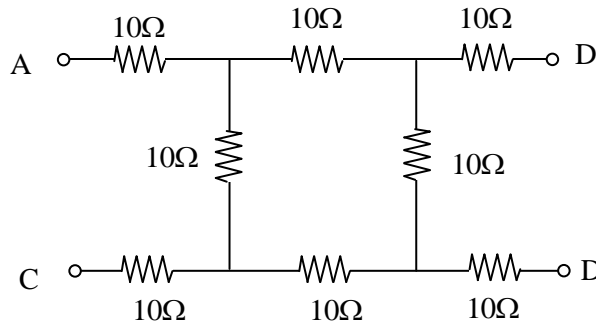
(A) $10\,\Omega$ (B) $20\,\Omega$ (C) $30\,\Omega$ (D) $40\,\Omega$

Key: **(C)**

Exp: Between A and D if we are finding Required no current will pass through 10Ω which is connected to B and C.

So Required = 10+[(10+10)//(10+10)]+10 = 10+10+10 $=30\Omega$

75. Seven resistances each of 5Ω are connected as shown in the figure. The equivalent resistance between the points A and B is
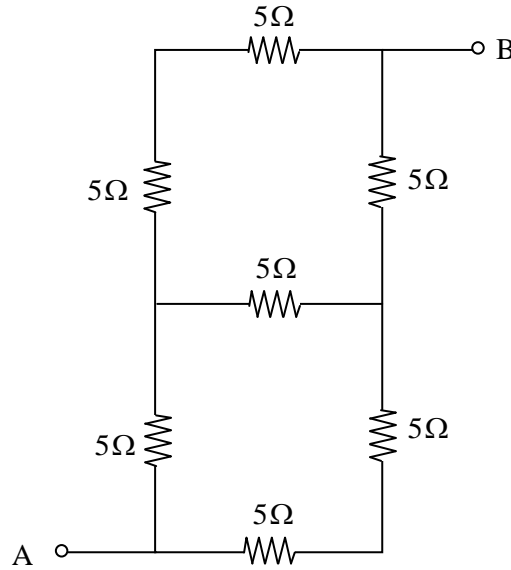
(A) 3Ω   (B) 11Ω   (C) 15Ω   (D) None of these
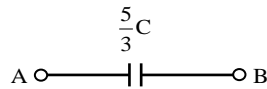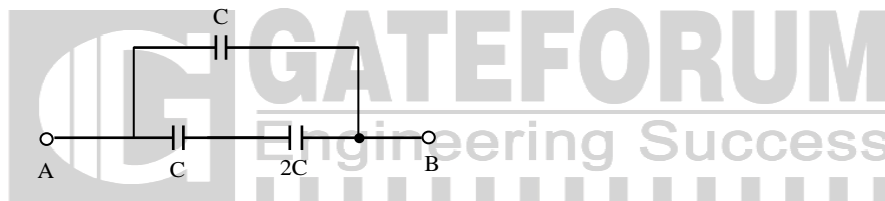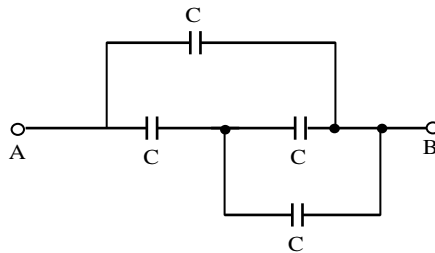
Key: **(D)**

Exp:

$R_{AB} = 2.5 + [6.25//7.5] = 7$ ohm
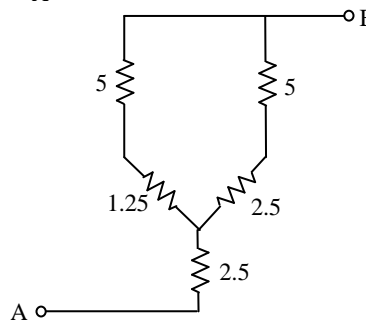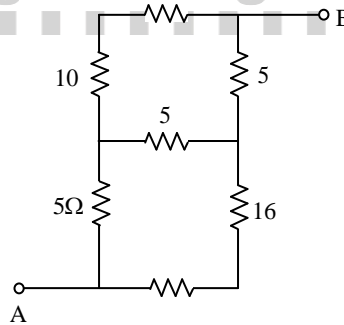
76. The capacitance of each capacitor is $C = 3\mu F$ in the figure shown. The effective capacitance between points A and B is
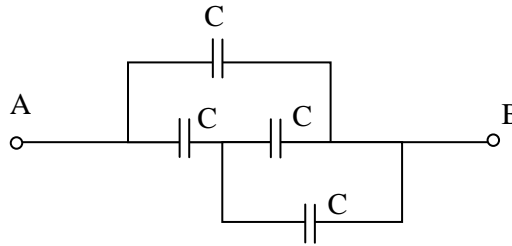
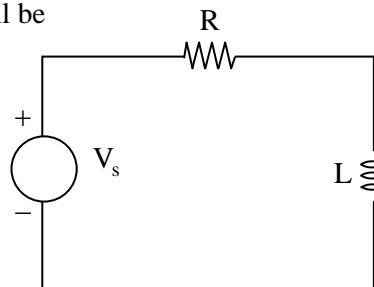(A) $2\mu F$ (B) $3\mu F$ (C) $4\mu F$ (D) $5\mu F$

Key: (D)

Exp:

$$C_{AB} = \left(\frac{5}{3}\right)(3] = 5\mu f$$

77. Vs = 5 cos t and the complex power drawn is $P_{complex} = \dfrac{3}{2} + 2j,$ the value of R and L respectively will be

(A) $\dfrac{3}{5} \text{ and } \dfrac{4}{5}$ (B) $\dfrac{16}{3} \text{ and } \dfrac{16}{5}$

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

Key: (D)

Exp: $P_{complex} = \dfrac{\left|V_{rms}^2\right|}{Z^*}$

$$Z^* = \dfrac{\left|V_{rms}^2\right|}{P_{complex}} = \dfrac{\left(5/\sqrt{2}\right)^2}{1.5 + 2j} + \dfrac{12.5}{1.5 + 2j} = 3 - 4i$$

$$Z = 3 + 4j = R + j\omega L$$

$$so\, R = 3$$

$$L = 4\,(\omega = 1)$$

78. The complex permeability of ferrite at radio frequency is given as
$\mu = \mu' - j\mu''$. Here μ'' represents

(A) Relative permeability   (B) Relative permittivity

(C) Loss parameter   (D) Resistivity

Key: (C)

Exp: $\mu = \mu' - J\mu''$

$$\downarrow$$

$$\text{loss parameter}$$

79. The number of holes in and N-type silicon with intrinsic value $1.5 \times 10^{10}/cm^3$ and doping concentration of $10^{17}/cm^3$, by using mass-action law is

(A) $6.67 \times 10^6/cc$ (B) $4.44 \times 10^{-25}/cc$ (C) $1.5 \times 10^{-24}/cc$ (D) $2.25 \times 10^3/cc$

Key: (D)

Exp: By mass action law

$$n.p = n_i^2, In\, N - type, N_D >> n_i$$

$$n_n \approx N_D$$

$$P_n = \dfrac{n_i^2}{N_D}$$

$$= \dfrac{2.25 \times 10^{20}}{10^{11}}$$

$$= 2.25 \times 10^3/cm^3$$

80. A tunnel-diode is best suited for

(A) Very low frequencies   (B) 50 Hz

(C) 100 kHz   (D) Microwave frequencies

Key: (D)

Exp:

A tunnel diode is best suited at very high frequencies.

(Microwave frequencies)

81. In a singly connected network if there are b number of branches and n number of nodes, then the number of independent meshes M and independent nodes N are respectively.

(A) n and b

(B) $b - n + 1$ and $n - 1$

(C) $b - n$ and b

(D) $b + n - 1$ and $n + 1$

Key: (B)

82. For a symmetric lattice network the value of the series impedance is $3\,\Omega$ and that of the diagonal impedance is $5\,\Omega$, then the Z-parameter of the network are

(A) $Z_{11} = Z_{22} = 2\Omega$ and $Z_{12} = Z_{21} = \dfrac{1}{2}\Omega$

(B) $Z_{11} = Z_{22} = 4\Omega$ and $Z_{12} = Z_{21} = 1\Omega$

(C) $Z_{11} = Z_{22} = 8\Omega$ and $Z_{12} = Z_{21} = 2\Omega$

(D) $Z_{11} = Z_{22} = 16\Omega$ and $Z_{12} = Z_{21} = 4\Omega$

Key: (B)

Exp:
$$Z_{11} = Z_{12} = \frac{Z_b + Z_a}{2}$$
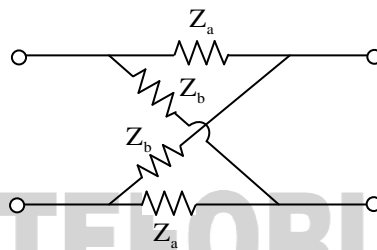
$$Z_{12} = Z_{21} = \frac{Z_b - Z_a}{2}$$

$\to Z_a = 3\Omega\,(\text{series arm})$
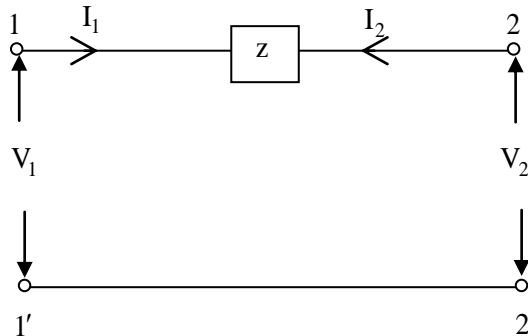
$\quad Z_b = 5\Omega\,(\text{diagonal})$

$\to$ so

$\quad Z_{11} = Z_{22} = 4\Omega$

$\quad Z_{12} = Z_{21} = 1\Omega$

83. Z-parameters for the network shown in the figure are

(A) $Z_{11} = Z, Z_{22} = Z, Z_{12} = Z_{21} = Z$

(B) $Z_{11} = 1/Z, Z_{22} = 1/Z, Z_{12} = Z_{21} = 1/Z$

(C) Cannot be determined

(D) $Z_{11} = Z, Z_{22} = Z, Z_{12} = 1/Z$

Key: (C)

84. If $y(s) = 1 + s$, the network has 1Ω resistor and

(A) 1F capacitor in series

(B) 1F capacitor in parallel

(C) 1H inductor in series

(D) 1H inductor in parallel

Key: (B)

Exp: $Y(s) = 1 + S$

$$Y(s) = Y_1(S) + Y_2(S)$$

$$= \frac{1}{Z_1(S)} + \frac{1}{Z_2(S)}$$

$$= \frac{1}{1} + \frac{1}{1/S}$$

$$Z_1 = 1\Omega, Z_2 = 1F$$

As admittance are added only when there are in parallel so we can say 1Ω & $1F$ are in parallel

85. The solutions to many problems involving electric fields are simplified by making use of equipotential surfaces. An equipotential surface is a surface:

1. On which the potential is same everywhere
2. The movement of charge over such a surface would required no work
3. The tangential electric field is zero
4. The normal electric field is zero

   Which of the above statements are correct?

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

Key: (A)

Exp: An equipotential surface.

1. On which the potential is same every where
2. The movement of charge such a surface would require no work.
3. The tangential electrical field is zero.

86. A charge 'Q' is divided between two point charges. What should be the values of this charge on the objects so that the force between them is maximum?

   (A) $\dfrac{Q}{3}$ (B) $\dfrac{Q}{2}$ (C) $(Q-2)$ (D) $2Q$

Key: (B)

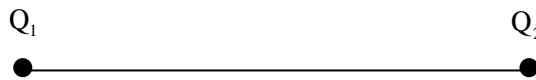**Exp:** $F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q_1 Q_2}{R^2}$

$Q_1 + Q_2 = Q$

$F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q_1(Q - Q_1)}{R^2}$

$\dfrac{dF}{dQ_1} = \dfrac{1}{4\pi\varepsilon_0 R^2}\left[Q_1(-1) + (Q - Q_1) \right]$

$\dfrac{dF}{dQ_1} = 0$

$Q_1 = \dfrac{Q}{2}$

$Q_2 = \dfrac{Q}{2}$

Q₁ ●————————————————● Q₂

87. What is the force developed per meter length between two current-carrying conductors 10 cm apart and carrying 1000 A and 1500 A currents, respectively?

(A) 3N   (B) $\dfrac{N}{3}$ (C) 2N   (C) $\dfrac{N}{2}$

Key: (C)

Exp: From Ampere's force law

$$F = \frac{\mu_0 . I_1 . I_2}{2\pi r}$$

$$F = \frac{4\pi \times 10^{-7} \times 10^3 \times 15 \times 10^2}{2\pi \times 10^{-2}}$$

$$\boxed{F = 3N}$$

88. A practical dc current source provides 20 kW to a $50\,\Omega$ load and 20 kW to a $200\,\Omega$ load. The maximum power the can drawn from it, is

(A) 22.5 kW   (B) 30.3 kW   (C) 40.5 kW   (D) 45.0 kW

Key: (A)

Exp: $P_{50\Omega} = 20kW$

$$I_{50\Omega}{}^2 = \frac{20k}{50} = 400$$

$$I_{50\Omega} = 20A$$

So, by nodal analysis

$$I = \frac{1000}{R} + 20 \_\_(1)$$

$$P_{200} = 20k$$

$$I_{200}^2 = \frac{20k}{200} = 100$$

$$I_{200} = 10A$$

So, by K.C.L

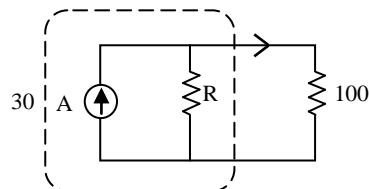$$I = \frac{2000}{R} + 10 \_\_(2)$$

From (1) and (2)

$$\frac{1000}{R} = 10$$
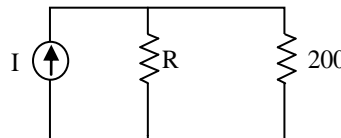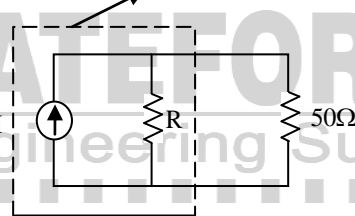
$$R = 100, I = 30$$

So, by maximum power transfer theorem

$V_{Th} = 3000$

$R_{Th} = 100$

$$P_{max} = \frac{9 \times 10^6}{4 \times 100} = 22.5kW$$

89.   If an ammeter is to be used in place of a voltmeter, we must connect with the ammeter a

(A) High resistance in parallel   (B) High resistance in series

(C) Low resistance in parallel   (D) Low resistance in series

Key: (B)

Exp: Since ammeter internal resistance is very low, if we connect it in parallel across the load then it may damage and huge amount of current will flow through it. So its resistance should be increased by connecting a high value of resistance in series.

90.   A point charge is located at origin. At point (a, a), electric field is E_1. At point $(-a, a)$ the electric field is E_2 and at a point $(-a, -a)$ the electric field E_3.

(A) $E_1 \cdot E_2 = 0$

(B) $|E_1 \times E_3| = 0$

(C) Both $E_1 \cdot E_2 = 0$ and $|E_1 \times E_3| = 0$

(D) Neither $E_1 \cdot E_2 = 0$ nor $|E_1 \times E_3| = 0$

Key: (C)

Exp: $E_1 = \dfrac{1}{4\pi\varepsilon_0} \cdot \dfrac{Q}{2\sqrt{2}a^3}\left(a\hat{a}_x + a\hat{a}_y\right)$

$E_1 = k\left(a\hat{a}_x + a\hat{a}_y\right)$

$k = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{2\sqrt{2}a^3}$
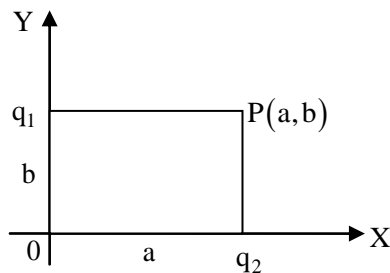
$E_2 = k\left(-a\hat{a}_x + a\hat{a}_y\right)$

$E_3 = k\left(-a\hat{a}_x - a\hat{a}_y\right)$

$E_1 \times E_3 = k^2 a^2 \begin{vmatrix} a_x & a_y & a_z \\ 1 & 1 & 0 \\ -1 & -1 & 0 \end{vmatrix}$

$\boxed{E_1 \times E_3 = 0}$
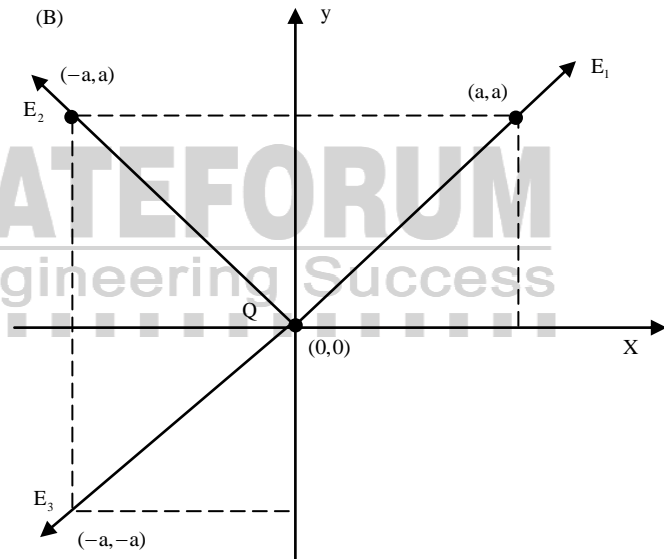
91.   Two point charges $q_1 = 2\mu C$ and $q_2 = 1\mu C$ are placed at distances b = 1 cm and a = 2 cm from the origin on the Y and X axes as shown in figure. The electric field vector at point P(a, b) that will subtend at angle θ with the X-axis is

(A) $\tan\theta = 1$ (B) $\tan\theta = 2$ (C) $\tan\theta = 3$ (D) $\tan\theta = 4$

Key: (B)

Exp: $E_1 = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2}{8}(2a_x) = \dfrac{1}{4\pi\varepsilon_0}\dfrac{1}{2}a_x$
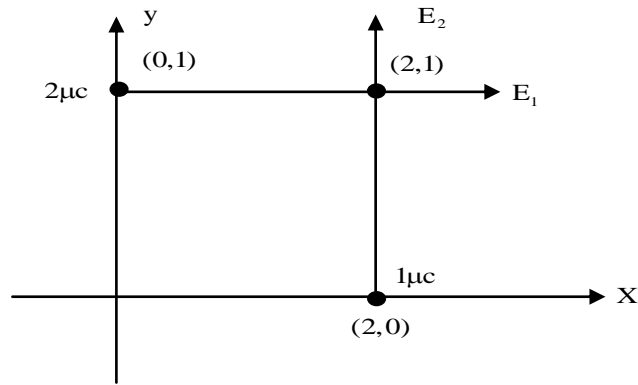
$E_2 = \dfrac{1}{4\pi\varepsilon_0}\dfrac{1}{1}a_y$

$E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{1}{1}a_y$

$E = \dfrac{1}{4\pi\varepsilon_0}\left[\dfrac{1}{2}a_x + a_y\right]$

$\tan\theta = \dfrac{E_y}{E_x} = 2$

$\boxed{\tan\theta = 2}$

92. In a coaxial transmission line $(\varepsilon_r = 1)$, the electric field intensity is given by:

$E = \dfrac{100}{\rho}\cos\left(10^9 t - 6z\right)u_p \text{ V/m}$

The displacement current density is

(A) $-\dfrac{100}{\rho}\sin\left(10^9 t - 6z\right)u_p \text{ A/m}^2$

(B) $\dfrac{116}{\rho}\sin\left(10^9 t - 6z\right)u_p \text{ A/m}^2$

(C) $-\dfrac{0.9}{\rho}\sin\left(10^9 t - 6z\right)u_p \text{ A/m}^2$

(D) $-\dfrac{216}{\rho}\cos\left(10^9 t - 6z\right)u_p \text{ A/m}^2$

Key: **(C)**

Exp: Displacement current density

$J_d = \dfrac{\partial D}{\partial t} = \varepsilon_0\dfrac{\partial E}{\partial f}$

$J_d = -8.854 \times 10^{-12}\dfrac{100}{\rho}\sin\left(10^9 t - 6z\right)\times 10^9 u_p$

$J_d = -\dfrac{0.9}{\rho}\sin\left(10^9 t - 6z\right)u_p$

93. Consider the following properties of electromagnetic waves:

1. These waves do not require any material medium to propagate

2. Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of waves

3. The energy in electromagnetic wave is divided equally between electric and magnetic vectors

4. Both electric and magnetic field vectors attain the maxima and minima at the same place and same time

Which of the above properties of electromagnetic waves are correct?

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

Key: **(B)**

94. Electromagnetic waves are transverse in nature due to

(A) Reflection   (B) Diffraction   (C) Interference   (D) Polarization

Key: **(D)**

Exp: EM waves are orthogonal due to polarization

95. In an pn junction diode, $\dfrac{dV}{dT}$ is equal to

(A) $2.3\,mV/^{o}C$ (B) $3.5\,mV/^{o}C$ (C) $10.0\,mV/^{o}C$ (D) $12.5\,mV/^{o}C$

Key: **(A)**

Exp: $\dfrac{dV}{dT} = -2.3\,mV/°C$

96. A transmission line having a characteristic impedance of $50\,\Omega$ is terminated at one end by $j50\,\Omega$. The voltage standing wave ratio produced will be

(A) ∞ (B) $+j$ (C) 1   (D) 0

Key: **(A)**

Exp: $\Gamma = \dfrac{z_L - z_0}{z_L + z_0} = \dfrac{J50 - 50}{J50 + 50}$

$\Gamma = \dfrac{J-1}{J+1}.$

$|\Gamma| = 1$

$VSWR(s) = \dfrac{1+|\Gamma|}{1-|\Gamma|}$

$\quad\quad = \infty$

97. In viscosity meters the quantity measured is

(A) Buoyant force   (B) Frictional force

(C) Coriolis force   (D) Centrifugal force

Key: **(B)**

98. The cut-off frequency of a rectangular waveguide in dominant mode is 10 Hz. The width of the wave guide is

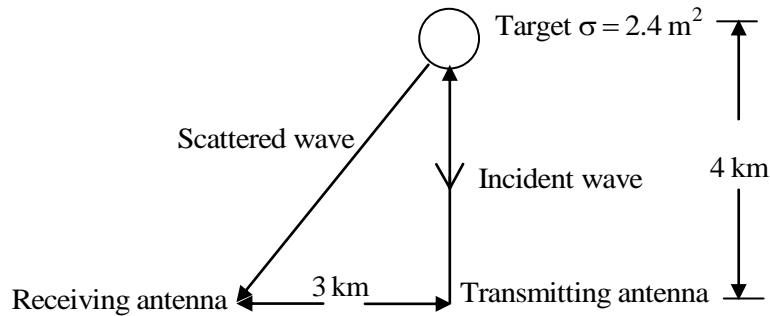(A) 2 cm   (B) 1.5 cm   (C) 1 cm   (D) 2.5 cm

Key: **(B)**

Exp: $f_c = \dfrac{c}{2a}$

$10 \times 10^9 = \dfrac{3 \times 10^8}{2a}$

$a = \dfrac{3 \times 10^8}{2 \times 10^{10}}$

$\boxed{a = 1.5cm}$

99. A bistatic radar system shown in figure has following parameters: f = 5 GHz, $G_{dt} = 34\,dB$, $G_{dr} = 22\,dB$. To obtain a return power of 8p W the minimum necessary radiated power should be

Target $\sigma = 2.4\,m^2$

Scattered wave

Incident wave

4 km

Receiving antenna　　3 km　　Transmitting antenna

(A) 1.394 kW　　(B) 2.046 kW　　(C) 1.038 kW　　(D) 3.46 kW

Key: **(*)**

Exp: No answer is matching

f = 5GHz

$\lambda = \dfrac{3 \times 10^8}{5 \times 10^9} = 6 \times 10^{-2}\,m$

$G_t = 34dB = 10^{3.4}$
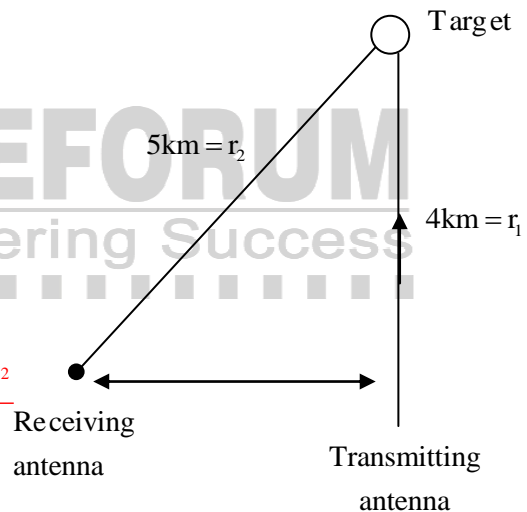
$G_r = 22dB = 10^{2.2}$

$P_{rad} = \dfrac{4\pi}{G_t G_r} \left(\dfrac{4\pi r_1 r_2}{\lambda} \right)^2 \dfrac{P_r}{\sigma}$

$= \dfrac{4\pi}{10^{3.4} 10^{2.2}} \left(\dfrac{4\pi \times 4 \times 10^3 \times 4 \times 10^3}{6 \times 10^{-2}} \right) \dfrac{8 \times 10^{-12}}{2.4}$

$P_{rad} = 1846\,W$

$\boxed{P_{rad} = 1.846kW}$

Target

5km = r_2

4km = r_1

Receiving antenna

Transmitting antenna

100. For the microwave antenna
  (A) Shape only depends on the frequency range used
  (B) Size only depends on the frequency range used
  (C) Neither shape nor size depend on the frequency range used
  (D) Both shape and size depend on the frequency range used

Key: **(B)**

101. Small recovery time of a diode is most significant for
  (A) Line-frequency rectification
  (B) Switching operations
  (C) High-frequency rectification and switching operations
  (D) Low-frequency rectification and switching operations

Key: **(C)**

102. In JFET, when operated above the pinch off voltage, the

    (A) Depletion region becomes smaller

    (B) Drain current starts decreasing

    (C) Drain current remains practically constant

    (D) Drain current increases steeply

Key: (C)

103. Thermal runaway is not possible in FET because, as the temperature of FET increases

    (A) The drain current increases   (B) The mobility of charge carrier decreases

    (C) The mobility of charge carriers increases(D) The transconductance increases

Key: (B)

104. Consider the following statements regarding an N-P-N Bipolar Junction Transistor:

    1.   Emitter diode is forward biased and collector diode is reverse biased

    2.   Emitter has many free electrons

    3.   Free electrons are injected into base and pass through collector

    4.   Depletion layers around junction J1 and J2 of BJT are widened.

    Which of the above statements are correct?

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

Key: (D)

Exp:
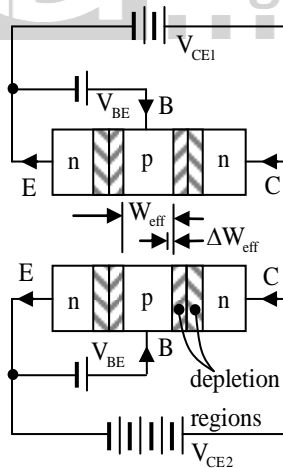
Top: NPN base widths for low collector-base reverse bias;
Bottom: Narrower NPN base widths for large collector-base reverse bias

105. A freewheeling diode in a phase controlled rectifier

    (A) Improves the line power factor

    (B) Enables inverse operation

    (C) is responsible for additional reactive power

    (D) is responsible for additional harmonics

Key: (A)

106. In a thyristor, the minimum current required to maintain the device in the 'ON' state is called

   (A) Latching current   (B) Ignition current

   (C) Holding current   (D) Avalanche current

Key: (C)

Exp: Holding current may be defined as the minimum anode current required to maintain the thyristor in the on state without gate signal below which the thyristor stops conduction. Latching current is the minimum anode current required to maintain the thyristor in the on state with at gate signal. Here we should note that even the thyristor anode current falls below latching current (once it is turned on and gate signal is removed) thyristor does not stop conduction

107. The zeners incorporated within the encapsulations of some MOSFETs are meant for

   (A) Reducing the cost

   (B) Biasing the gate circuit

   (C) Self-protecting the device against transients

   (D) None of the above

Key: (C)

108. Which of the following magnetic materials has the highest reluctance?

   (A) Ferromagnetic   (B) Paramagnetic

   (C) Diamagnetic   (D) None of the above

Key: (A)

Exp: The opposition that a material presents *to* magnetic lines of force is called reluctance. Most off the magnetic materials(paramagnetic, ferromagnetic etc) reluctance is low, so Diamagnetic have High Reluctance

109. When UJT is used for triggering and SCR, the wave-shape of the signal obtained from UJT circuit is

   (A) Sine wave   (B) Saw tooth wave

   (C) Trapezoidal wave   (D) Square wave

Key: (B)

110. Darlington pairs are frequently used in linear ICs because, they

   (A) Do not require any capacitors or inductors

   (B) Have enormous impedance transformation capability

   (D) Can be readily formed/hooked from two adjacent transistors

   (D) Resemble emitter follower

Key: (B)

111.   In a MOS capacitance fabricated on a P-type semiconductor, strong inversion occurs, when potential is

(A) Equal to Fermi level

(B) Zero

(C) Negative and equal to Fermi potential in magnitude

(D) Positive and equal to Fermi potential in magnitude

Key: (C)

112.   A CMOS amplifier when compared to an N channel MOSFET has the advantage of

(A) Higher cutoff frequency

(B) Higher voltage gain

(C) Higher current gain

(D) Lower power dissipation

Key: (D)

113.   Consider the following statements regarding optocouplers:

1.   Optocouplers are LEDs driving photodiodes in a single package to provide electrical isolation between input and output

2.   Optocoupler is LED driving a phototransistor in a single package that replaces pulse transformers working at input zero crossing

3.   Optocouplers are used as temporary non fixed joints between optical fibre terminations

Which of the above statements are correct?

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

Key: (C)

114.   Which of the following does not cause permanent damage to an SCR?

(A) High current   (B) High rate of rise of current

(C) High temperature rise   (D) High rate of rise of voltage

Key: (A)

115.   The discrete LTI system is represented by impulse response

$h(n) = \left(\frac{1}{2}\right)^n u(n)$, then the system is

(A) Causal and stable

(B) Causal and unstable

(C) Non causal and stable

(D) Non causal and unstable

Key: (A)

Exp: $h[n] = \left(\frac{1}{2}\right)^n u[n]$ is Right sided sequence thus it is causal

For stability consider,

$$\sum_{h=-\infty}^{\infty} |h[n]| = \sum_{n=0}^{\infty} \left| \left(\frac{1}{2}\right)^n \right| < \infty$$

$$= \frac{1}{1-\frac{1}{2}} = 2 < \infty$$

Thus the system is stable.

116. In the first Cauer LC network, the first element is a series inductor when the driving point function consists of a

   (A) Pole at $\omega = \infty$ (B) Zero at $\omega = \infty$ (C) Pole at $\omega = 0$ (D) Zero at $\omega = 0$

Key: **(A)**

117. Consider a complex exponential sequence $e^{j\omega_0 n}$ with frequency ω_0. Suppose $\omega_0 = 1$, then

   (A) Such a sequence is periodic

   (B) Such a sequence is not periodic at all

   (C) Periodic for some value of period 'N'

   (D) Some definite range $N_0 < n < N_1$ exists for a periodic sequence

Key: **(B)**

Exp: A discrete exponential sequence $e^{j\omega_0 n}$ is discrete if and only if ω_0 is a rational multiple of 2π

   $\because \omega_0 = 1$, the signal $e^{j\omega_0 n}$ is a periodic.

118. Ideal low pass filter as a discrete time system is

   (A) Causal, realizable

   (B) Non causal, physically/computationally unrealizable

   (C) Non causal, physically realizable

   (D) None of the above

Key: **(B)**

119. Consider a continuous time system A, modeled by the equation $y(t) = tx(t) + 4$ and a discrete time system B modeled by the equation $y[n] = x^2[n]$. These systems are

   (A) A-time invariant and B-time invariant   (B) A-time varying and B-time invariant

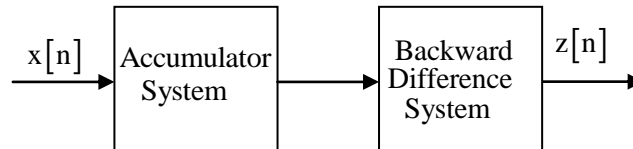   (C) A-time invariant and B-time varying   (D) A time varying and B-time varying

Key: **(B)**

Exp: $y(t) = t\, x(t) + 4$: system A

   D define $x_1(t) = x(t-\tau)$, obtain $y_1(t) = tx_1(t) + 4$

   $\therefore y_1(t) = tx(t-\tau) + 4$

   2) Obtain $y(t-T) = (t-T)\, x(t-T) + 4$

   $\because y_1(t) \neq y(t-T)$ System A is time-variant

   $Y[n] = x^2[n]$: system B

   1) Define $x[n] = x[n-N_0]$, obtain $y_1[n] = x_1^2[n]$

$$\therefore y_1[n] = x^2[n - N_0]$$

2) Obtain $y[n-N_0] = x^2[n-N_0]$

$$\therefore y_1[n] = y[n - N_0], \text{ System B is time-invariant}$$

120. Consider a discrete time accumulator system $y[n] = \sum_{k=-\infty}^{n} x[k]$ and the backward difference system $y[n] = x[n-1]$ where $x[\cdot]$ represents the input and $y[\cdot]$ represents the output of the individual systems.

$$x[n] \rightarrow \boxed{\begin{array}{c}\text{Accumulator}\\\text{System}\end{array}} \rightarrow \boxed{\begin{array}{c}\text{Backward}\\\text{Difference}\\\text{System}\end{array}} \xrightarrow{z[n]}$$

When these two systems are cascaded as in figure, the impulse response of combined system with output z[n] is

(A) Unit impulse sequence (B) Unit step sequence

(C) Unit ramp sequence (D) None of the above

Key: (A)