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PTQ

Prelims Through Questions

for

ESE 2021

Electronics & Telecommunication

Day 1 of 11

Q.1 - Q.50

(Out of 500 Questions)

Network Theory + Digital Circuits + Materials Science

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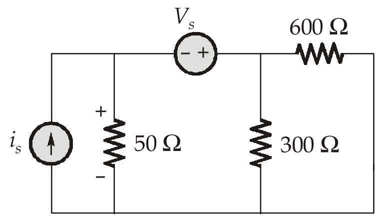
Q.1 Consider the circuit shown in the figure below:



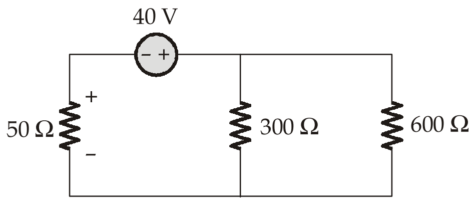
Let V_s = 40 V and i_s = 0 A, then find the voltage across 50 Ω resistance.

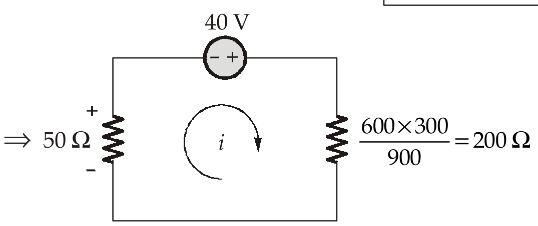
(a) 0 (b) 8 V

(c) –8 V (d) 16 V

1. **(c)**

$\because i_s = 0$ and $V_s = 40$ V, the circuit can be redrawn as



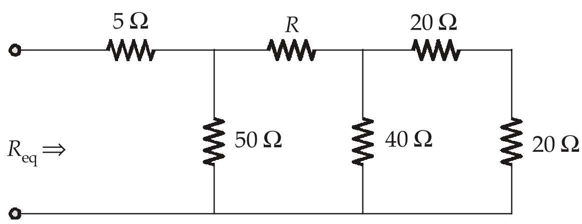


or $$i = \frac{40}{200+50} = \frac{40}{250} = 0.16\text{ A}$$

∴ Voltage across 50 Ω resistor is

$$V_{50\ \Omega} = -50 \times i = -50 \times 0.16$$
$$V_{50\ \Omega} = -8\text{ V}$$

Q.2 Consider the circuit shown in the figure below:



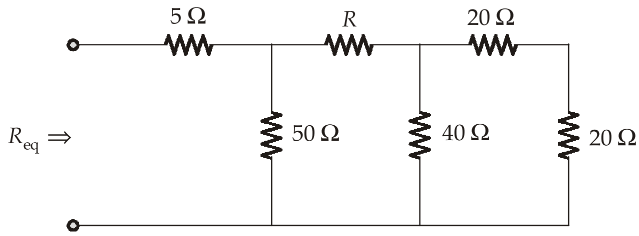
If $R = R_{eq}$ then, the value of R is

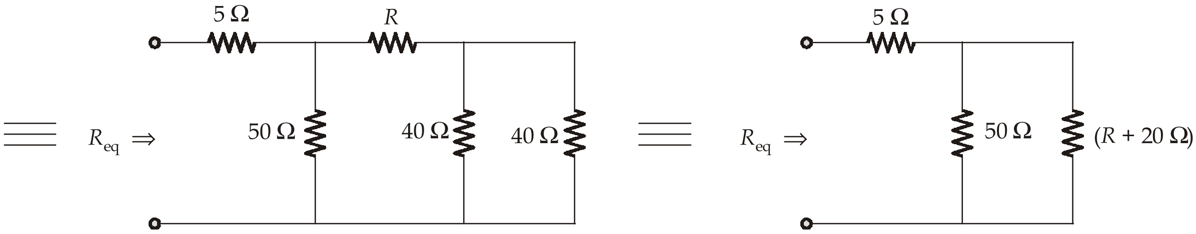
(a) 30 Ω (b) 45 Ω

(c) 15 Ω (d) 50 Ω

2. **(a)**

Redrawing the given circuit, we get,





Here, $$R_{eq} = 5 + \frac{50\times(R+20)}{70+R}$$

$\because$ $$R_{eq} = R$$

$$(70 + R)R = 5(70 + R) + 50R + 1000$$

$$R^2 + 70R = 350 + 5R + 50R + 1000$$

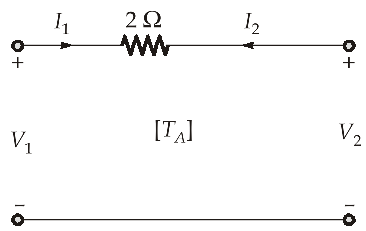
or, $$R^2 + 15R - 1350 = 0$$

On solving above equation, we get,

$$R = 30\ \Omega \text{ and } -45\ \Omega$$

The possible value of R will be 30 Ω.

Q.3 For the circuit shown in the figure below, the T parameter matrix is given by $[T_A] = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$



If the 2 Ω resistor is replaced by 10 Ω resistor, then the new T-parameter matrix $[T_B]$ is equal to

(a) $5[T_A]$

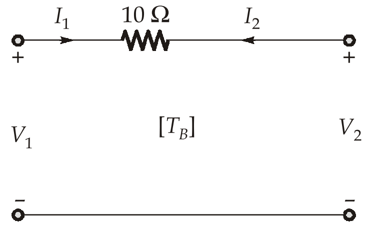
(b) $[T_A]^5$

(c) $[T_A]^3 + [T_A]$

(d) $[T_A]$

3. **(b)**

When 2 Ω is replaced by 10 Ω,



From the above figure, we get,

$$V_1 - V_2 = 10I_1 \quad \text{...(i)}$$

and
$$V_2 - V_1 = 10I_2 \quad \text{...(ii)}$$

From T parameter model,

$$V_1 = AV_2 - BI_2$$

and
$$I_1 = CV_2 - DI_2$$

from equation (ii), we get,

$$V_1 = V_2 - 10I_2 \qquad \Rightarrow A = 1 \text{ and } B = 10$$

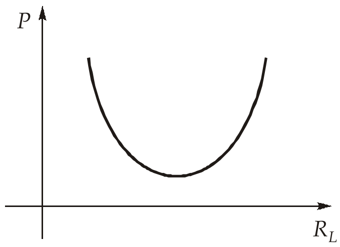
from equation (i), we get,

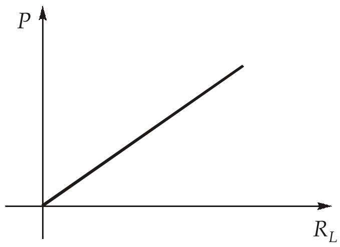
$$V_2 - 10I_2 - V_2 = 10I_1$$

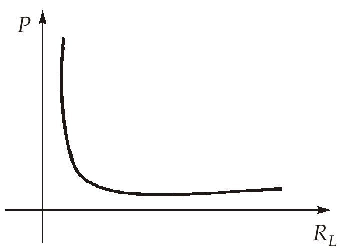
$$-I_2 = I_1 \qquad \Rightarrow C = 0 \text{ and } D = 1$$

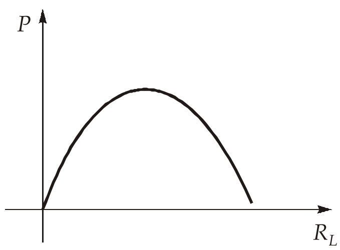
$$\therefore \qquad T_B = \begin{bmatrix} 1 & 10 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}^5 = [T_A]^5$$

Q.4 A voltage source with internal resistance R_s, supplies power to a load R_L. The maximum power delivered to the load R_L designated as 'P' varies with R_L as

(a)


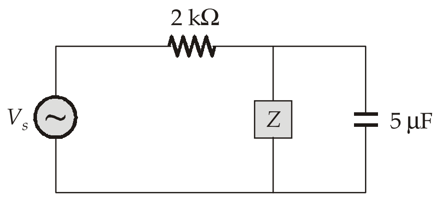
(b)


(c)


(d)


4. **(d)**

Q.5 The value of 'Z' in figure shown below, which is most appropriate to cause parallel resonance at 2 kHz is



(a) 7.89 mH
(b) 10 μF
(c) 1.27 mH
(d) 789.56 μF

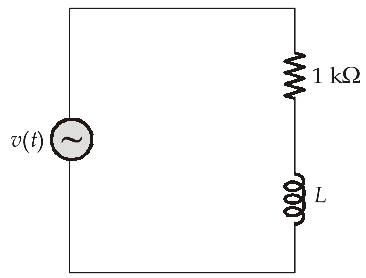
5. **(c)**

At resonance,
The circuit should be in unity power factor.
∴ Here 'Z' should be inductive in nature.
For parallel resonant circuit,

$$L = \frac{1}{\omega^2 C} = \frac{1}{(2\pi\times 2)^2 \times 5\,\mu\text{F}\times 10^6}$$

$$L = \frac{1}{(2\times 2\times \pi)^2 \times 5} = 1.27 \text{ mH}$$

Q.6 For the circuit shown in the figure below, the source voltage is given by $v(t)$ = 212.2sin500t V. If the rms voltage across the resistor is 120 V. Then the value of inductor will be



(a) 0.5 H
(b) 0.6 H
(c) 1 H
(d) 1.5 H

6. **(d)**

$$V_{\text{rms}} = \frac{V_m}{\sqrt{2}} = \frac{212.2}{\sqrt{2}} = \frac{150\times\sqrt{2}}{\sqrt{2}} = 150.04 \approx 150 \text{ V}$$

and $V_R = 120$ V (given)

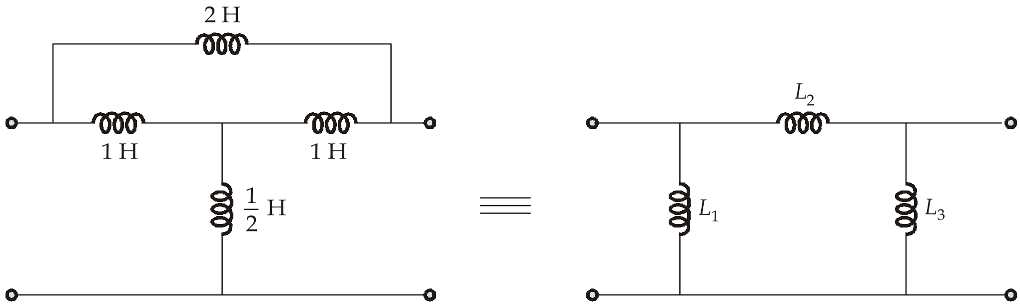
∴ $V_L = \sqrt{150^2 - 120^2} = 90$ V

∵ $|I| = \frac{V_R}{R} = \frac{120}{1\times 10^3} = 0.12$ A

∴ $|V_L| = |I| \times \omega L$

or $L = \frac{|V_L|}{\omega\times|I|} = \frac{90}{500\times 0.12} = 1.5$ H

Q.7 It is intended that the two networks of the figure be equivalent with respect to their terminals. Then the value of L_2 will be

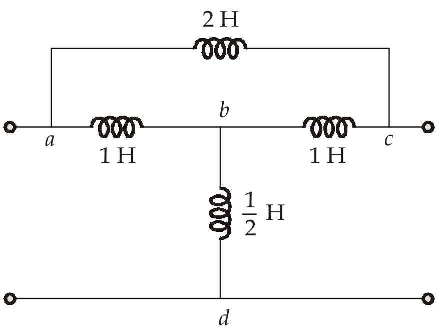


(a) $\frac{1}{5}$ H (b) $\frac{1}{3}$ H

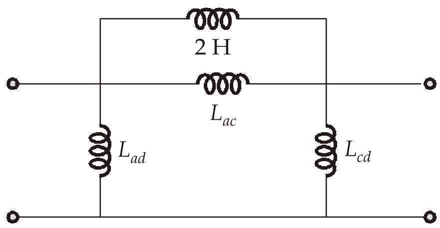
(c) $\frac{4}{3}$ H (d) $\frac{2}{5}$ H

7. **(c)**

The given circuit can be drawn as,



Converting 'Y' 'acd' to 'Δ', we get



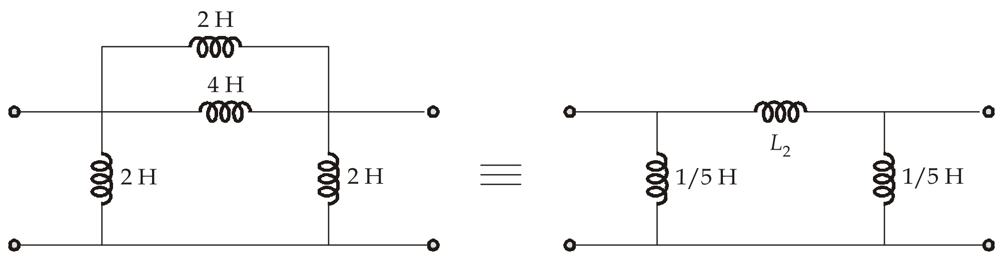
Here,

$$L_{cd} = \frac{1\times\frac{1}{2}+1\times\frac{1}{2}+1\times 1}{1} = 2\text{ H}$$

$$L_{ad} = \frac{1\times\frac{1}{2}+1\times\frac{1}{2}+1\times 1}{1} = 2\text{ H}$$

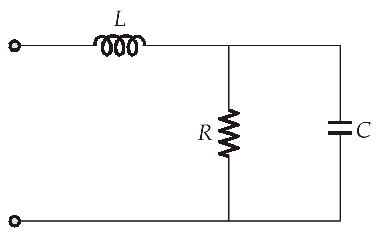
$$L_{ac} = \frac{1\times 1+1\times\frac{1}{2}+1\times\frac{1}{2}}{\frac{1}{2}} = 4\text{ H}$$

∴ The circuit can be redrawn as



where, $L_2 = \frac{2 \times 4}{2+4} = \frac{8}{6} = \frac{4}{3}$ H

Q.8 The resonant frequency of the circuit shown in the figure below is



(Assume R = 1 Ω, L = 2 H and C = 4 F)

(a) 0.25 rad/sec
(b) 0.35 rad/sec
(c) 0.5 rad/sec
(d) 0.65 rad/sec

8. **(a)**

$$Z(j\omega) = j\omega L + \left(R \Big\| \frac{1}{j\omega C}\right) = j\omega L + \frac{R}{1 + j\omega RC} = \frac{(R - \omega^2 RLC) + j\omega L}{(1 + j\omega RC)}$$

At resonance, $Z(j\omega) = 0$

$$\frac{\omega L}{(R - \omega^2 RLC)} = \omega RC$$

or, $\omega^2 LC^2R^2 = R^2C - L$

$$\omega^2 = \frac{1}{LC} - \left(\frac{1}{RC}\right)^2$$

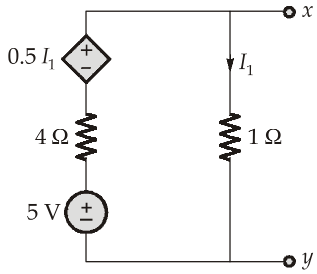
$$\omega = \sqrt{\frac{1}{LC} - \left(\frac{1}{RC}\right)^2}$$

For R = 1, L = 2 H and C = 4 F

$$\omega = \sqrt{\frac{1}{8} - \frac{1}{16}}$$

or, ω = 0.25 rad/sec

Q.9 The Norton's equivalent resistance across terminals x-y for the circuit shown in figure below is,



(a) $\frac{10}{9}\,\Omega$
(b) $\frac{10}{7}\,\Omega$
(c) $\frac{8}{9}\,\Omega$
(d) $\frac{9}{7}\,\Omega$

9. (c)

It is evident from figure that,

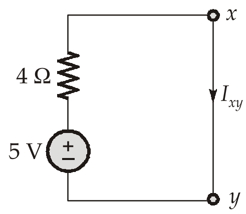
$$V_{x-y} = V_{OC} = 1 \times I_1 = I_1$$

Applying KVL in the left loop, we get

$$-5 + 4I_1 - 0.5\,I_1 + I_1 = 0$$

$$I_1 = \frac{5}{4.5} = \frac{50}{45}\,\text{A}$$

Next, short circuiting the x - y terminals, we get



$$I_{xy} = \frac{5}{4}\,\text{A}$$

$$V_{OC} = I_1 = \frac{50}{45}\,\text{V}$$

The Norton's resistance of the given circuit is,

$$R_N = \frac{V_{OC}}{I_{xy}} = \frac{50 \times 4}{45 \times 5} = \frac{8}{9}\,\Omega$$

Q.10 A series RLC circuit has inductance of 10 mH and resistance of 2 Ω. Assume the supply as 230 V, 1000 Hz. The maximum instantaneous energy stored in the inductor at resonance is

(a) 132.25 J
(b) 66.125 J
(c) 264.5 J
(d) 308.12 J

10. (a)

At resonance, current, $I_{0,\,\text{rms}} = \dfrac{V}{R}$

$$I_{0,\,\text{rms}} = \frac{230\angle 0^\circ}{2}$$

$$= 115\angle 0^\circ\ \text{A}$$

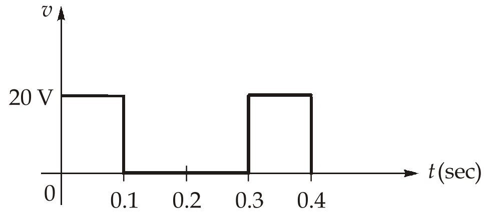
Energy in inductor (instantaneous, maximum)

$$= \frac{1}{2} L\, I_{0\text{max}}^2 = \frac{1}{2} \times L \times \left(\sqrt{2} I_{0\text{rms}}\right)^2 = L I_{0\text{rms}}^2$$

$$= 10 \times 10^{-3} \times (115)^2$$

$$= 132.25\ \text{J}$$

Q.11 Compute the root mean square value of the square wave shown below.



(a) 11.54 V
(b) 20 V
(c) 12.54 V
(d) 13.54 V

11. **(a)**

$$v_{\text{rms}}^2 = \frac{1}{T}\int_0^T v^2(t)dt$$

$$= \frac{1}{0.3}\int_0^{0.1} (20)^2 dt = \frac{1}{0.3} \times 400 \times 0.1 = 133.33$$

$$v_{\text{rms}} = 11.54 \text{ Volts}$$

Q.12 In a two port network,

$$Z_{11} = 2\ \Omega,$$
$$Z_{12} = Z_{21} = 5\ \Omega,$$
$$Z_{22} = 1\ \Omega$$

The value of h_{12} is

(a) –5
(b) 5
(c) $\frac{1}{5}$
(d) $-\frac{1}{5}$

12. **(b)**

To obtain h-parameters,

$$V_1 = 2I_1 + 5I_2 \quad \text{...(i)}$$
$$V_2 = 5I_1 + I_2 \quad \text{...(ii)}$$

These equations can be rewritten as

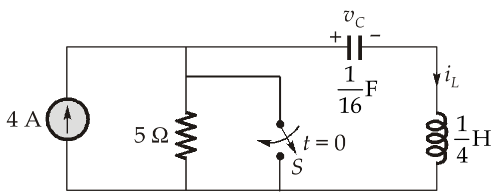
$$I_2 = V_2 - 5I_1$$

Putting value of I_2 in equation (i),

$$V_1 = 2I_1 + 5(V_2 - 5I_1)$$
$$V_1 = -23I_1 + 5V_2$$

So, $h_{12} = 5$

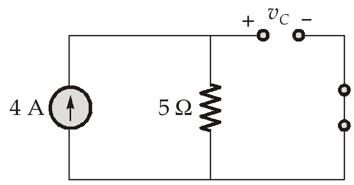
Q.13 In the circuit shown below, the switch is closed at $t = 0$ after long time. The current $i_L(t)$ for $t > 0$ is



(a) –10 cos 8t
(b) 10 cos 8t
(c) 10 sin 8t
(d) –10 sin 8t

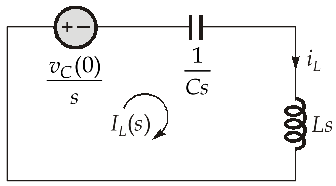
13. (d)

For $t < 0$,



$$v_C(0^-) = v_C(0^+) = 20\text{ V}$$
$$i_L(0^-) = i_L(0^+) = 0\text{ A}$$

Redrawing the circuit for $t > 0$,



Applying KVL, we get

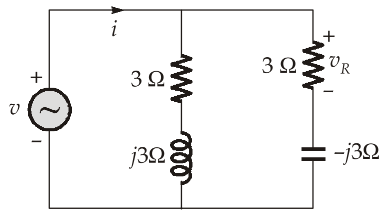
$$I_L(s) = \frac{-\frac{20}{s}}{\frac{1}{Cs} + Ls} = \frac{-80}{s^2 + 64}$$

$$I_L(s) = \frac{-10(8)}{s^2 + (8)^2}$$

Taking Laplace inverse, we get

$$i_L(t) = -10 \sin 8t$$

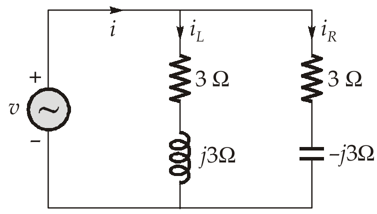
Q.14 In the circuit shown below, the voltage v_R equals to 30 V. The value of current i is



(a) 12 A
(b) 20 A
(c) $10\sqrt{2}$ A
(d) 10 A

14. (c)

Given, Voltage, $v_R = 30$ V



$$i_R = \frac{v_R}{R} = 10\,\text{A}$$

Magnitude of voltage, $v_c = X_C i_R$

$= 3 \times 10 = 30$ V

$$v = \sqrt{v_R^2 + v_C^2} = \sqrt{(30)^2 + (30)^2} = 30\sqrt{2}\ \text{V}$$

Current i_R leads the voltage v by 45°. The current i_L is also 10 A but lags voltage v by 45°. Current i_R and i_L have a phase difference of 90°.

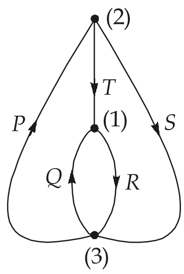
Thus, $$i = \sqrt{i_R^2 + i_L^2} = 10\sqrt{2}\,\text{A}$$

Q.15 Which of the following theorems enables a number of voltage (or current) source to be combined directly into a single voltage (or current) source?

(a) Compensation theorem
(b) Reciprocity theorem
(c) Superposition theorem
(d) Millman's theorem

15. (d)

Q.16 For the oriented graph shown below,



Which one of the following set of branches is "NOT" a tree of the graph?

(a) {T, S}
(b) {P, Q, T}
(c) {P, R}
(d) {S, R}

16. (b)

Q.17 Two two-port networks α and β having $ABCD$ parameters as

$$A_\alpha = D_\alpha = 4,\ B_\alpha = 3\ \Omega \text{ and } C_\alpha = 5\ \mho$$
$$A_\beta = D_\beta = 3,\ B_\beta = 4\ \Omega \text{ and } C_\beta = 2\ \mho$$

are connected in cascade in the order of α followed by β. The equivalent 'A' parameter of the combination is

(a) 7
(b) 12
(c) 18
(d) 30

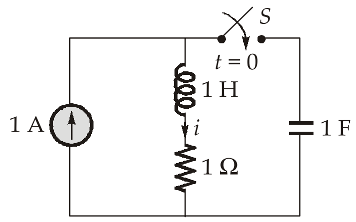
17. (c)

For cascade connection, $ABCD$ parameters are multiplied as,

$$\begin{bmatrix} 4 & 3 \\ 5 & 4 \end{bmatrix} \times \begin{bmatrix} 3 & 4 \\ 2 & 3 \end{bmatrix} = \begin{bmatrix} 12+6 & 16+9 \\ 15+8 & 20+12 \end{bmatrix}$$

$$T = \begin{bmatrix} 18 & 25\ \Omega \\ 23\ \mho & 32 \end{bmatrix}$$

Q.18 For the circuit shown below, the switch "S" is opened for a long time and closed at $t = 0$. The value of $\frac{di}{dt}$ at $t = 0^+$ is

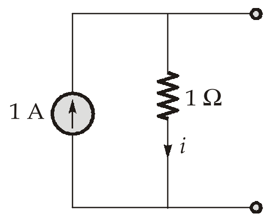


(a) zero
(b) –1 A/s
(c) 1 A/s
(d) ∞

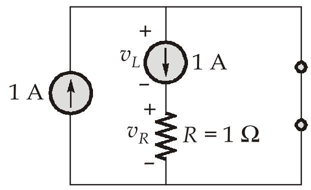
18. (b)

For $t < 0$, the switch was open and the circuit is an RL circuit, keeping inductor to be short circuited for dc.

$$i_L(0^-) = i_L(0^+) = 1\text{ A}$$



Following the switching, the capacitor will act as a short circuit. At $t = 0^+$, the circuit can be redrawn as



∴ at $t = 0^+$

$$v_R + v_L = 0$$

but, $v_R = 1 \times 1 = 1\text{ V}$

∴ $v_L = -v_R = -1\text{ V}$

But $v_L = L\frac{di}{dt}$

⇒ $\frac{di}{dt} = -1\text{ A/s}$

Q.19 Consider the following Boolean function:

$$f(W,X,Y,Z) = (X+W)(Y \oplus Z) + XW'$$

The minimized Boolean expression of the above function is

(a) $(X + W)\,(YZ' + Y'Z') + W'$
(b) $W(Y \oplus Z) + XW'$
(c) $X[Y \oplus Z + W']$
(d) None of the above

19. (b)

$$\begin{aligned} f(W, X, Y, Z) &= (X+W)(Y\oplus Z)+XW' \\ &= X(Y\oplus Z)+W(Y\oplus Z)+XW' \\ &= XYZ'+\underline{XY'Z}+WYZ'+\underline{WY'Z+XW'} \quad \text{(Consensus theorem)} \\ &= \underline{XYZ'}+WY'Z+\underline{XW'+WYZ'} \\ &= WY'Z+XW'+WYZ' \\ &= W(Y\oplus Z)+XW' \end{aligned}$$

Q.20 Consider the following statements:

1. A sequential circuit has memory elements.
2. A sequential circuit has at least one feedback path.
3. A sequential circuit exhibits cyclic nature.

Which of the above statements are true?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

20. (d)

Q.21 Consider the following statements:

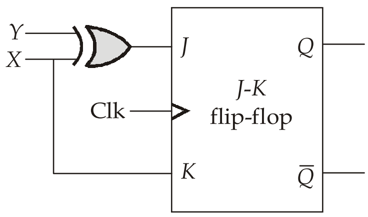
1. The $(r-1)$'s complement of an n-digit number N in base-r is defined as $(r^n - N - 1)$.
2. The r's complement of an n-digit number N in base-r is defined as $(r^n - N)$ for $N \neq 0$ and 0 for $N = 0$.

Which of the above statements is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

21. (c)

Q.22 Consider the circuit shown below:



The characteristic equation of the new flip-flop created from the above circuit is

(a) $\bar{Y}(\bar{X}+Q_n)+X\bar{Y}\bar{Q}_n$
(b) $\bar{X}(Y+Q_n)+X\bar{Y}\bar{Q}_n$
(c) $Q_n(Y+\bar{X})+\bar{X}Y\bar{Q}_n$
(d) $Q_n(\bar{Y}+\bar{X})+XYQ_n$

22. (b)

For J-K flip-flop, $\quad Q_{n+1} = J\bar{Q}_n + \bar{K}Q_n$

For the given circuit, $\quad Q_{n+1} = (X\oplus Y)\bar{Q}_n + \bar{X}Q_n \quad \because J = X\oplus Y$ and $K = X$

$$= \bar{X}Y\bar{Q}_n + \bar{X}Q_n + X\bar{Y}\bar{Q}_n = \bar{X}Q_n + \bar{X}Y + X\bar{Y}\bar{Q}_n$$

$$= \bar{X}(Y+Q_n)+X\bar{Y}\bar{Q}_n$$

Q.23 Consider the following series of numbers with a missing number:

$(101001)_2$, $(53)_8$, $(2F)_{16}$, $(110101)_2$, $(73)_8$, ...?

The numbers are represented with different bases. The missing number will be

(a) $(51)_{16}$
(b) $(28)_{16}$
(c) $(3D)_{16}$
(d) $(3F)_{16}$

23. (c)

Converting all into decimal format, we get,

$(41)_{10}$, $(43)_{10}$, $(47)_{10}$, $(53)_{10}$, $(59)_{10}$ ⇒ Prime numbers

Thus the next number in the series is 61.

$\therefore \quad (61)_{10} = (3D)_{16}$

Q.24 In a 5-bit parallel adder, each full adder takes 30 ns to produce sum and 10 ns to produce carry. Then the time required for the addition of two 5-bit numbers is

(a) 40 ns
(b) 50 ns
(c) 70 ns
(d) 80 ns

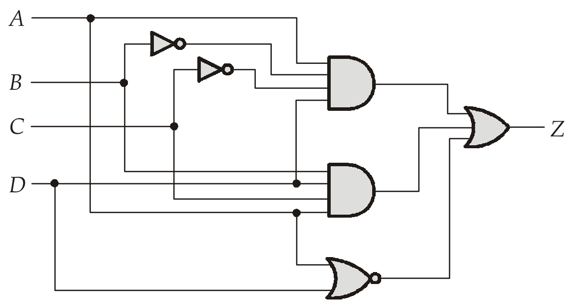
24. (c)

Time required to get sum = (5 – 1) × 10 ns + max[10, 30] = 40 + 30 = 70 ns

Time required to get carry = Nt_c = 5 × 10 = 50 ns

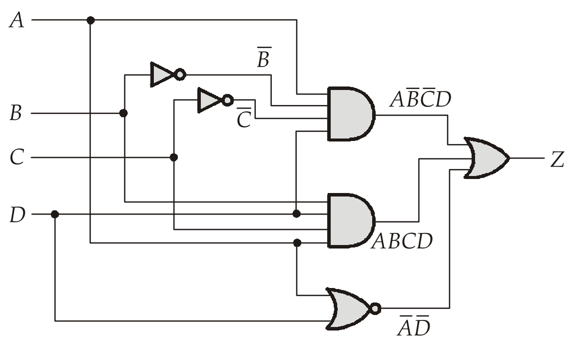
∴ Time required for addition = 70 ns

Q.25 In the following circuit, the output Z is



(a) $AD(B \oplus C) + \bar{A}\bar{D}$
(b) $AC(B \oplus D) + \bar{A}\bar{C}$
(c) $AD(B \odot C) + \bar{A}\bar{D}$
(d) $BC(A \odot D) + \bar{B}\bar{C}$

25. (c)



$$Z = A\bar{B}\bar{C}D + ABCD + \bar{A}\bar{D}$$
$$= AD[\bar{B}\bar{C} + BC] + \bar{A}\bar{D}$$
$$= AD(B \odot C) + \bar{A}\bar{D}$$

Q.26 The full scale output of a DAC is 10 mA. The minimum number of bits required to have a resolution of 40 µA is equal to

(a) 5
(b) 6
(c) 7
(d) 8

26. **(d)**

$$\text{Number of steps} = \frac{\text{Full scale}}{\text{Resolution}} = \frac{10\times10^{-3}}{40\times10^{-6}} = 250$$

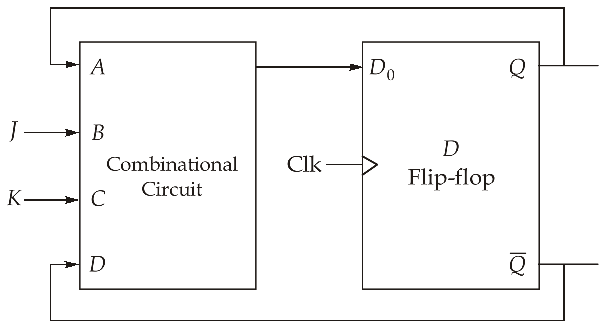
$$\text{Number of steps} \le 2^n - 1 \quad (n = \text{number of bits})$$

$$250 \le 2^n - 1$$

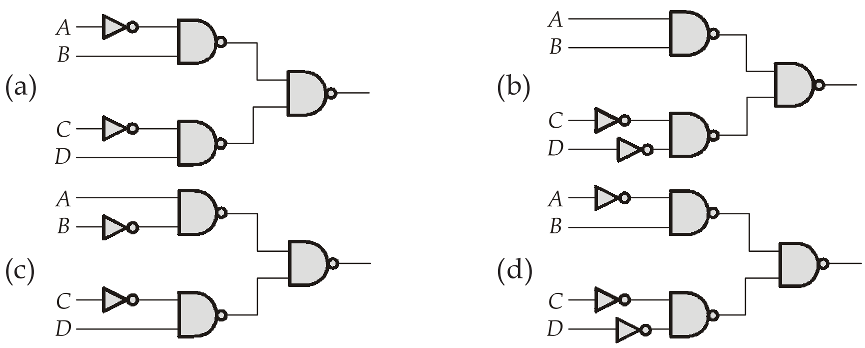
$$2^n \ge 251$$

$$\therefore \quad n_{min} = 8$$

Q.27 Consider the circuit shown below:



If the above circuit converts a D flip-flop into a J-K flip-flop, then the combinational circuit can be represented as



27. **(d)**

$$A = Q$$

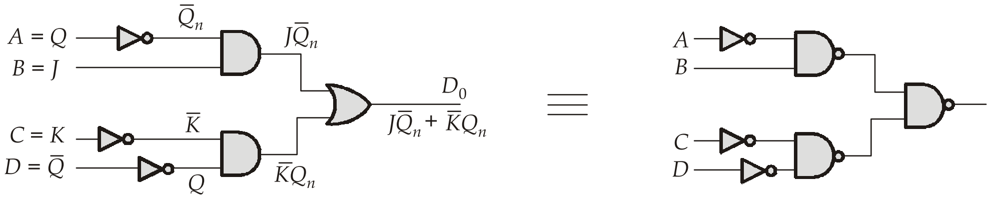
$$B = J$$

$$C = K$$

$$D = \bar{Q}$$

Now, D flip-flop can be converted into a JK flip-flop by using an equation.

$$D_0 = J\bar{Q}_n + \bar{K}Q_n$$



Q.28 A D/A converter has 5 V full scale output and an accuracy of ±0.2% on full scale output. Then the maximum error for any output will be equal to

(a) 5 mV
(b) 20 mV
(c) 15 mV
(d) 10 mV

28. (d)

$$V_{FS} = 5\text{ V}$$

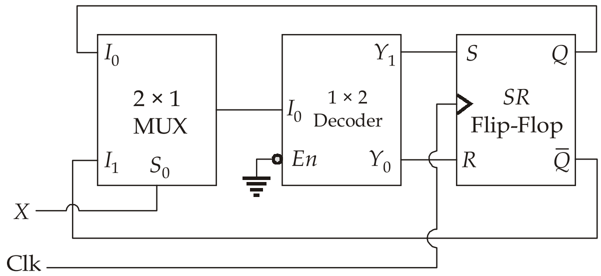
$$\text{Accuracy} = \pm 0.2\%$$

$$\%\text{Accuracy} = \frac{\text{Error}}{V_{FS}} \times 100$$

$$\frac{\text{Error}}{5\text{ V}} \times 100 = 0.2$$

$$\text{Error} = \frac{2 \times 5}{1000}\text{ V} = 10\text{ mV}$$

Q.29 Consider the circuit shown below:

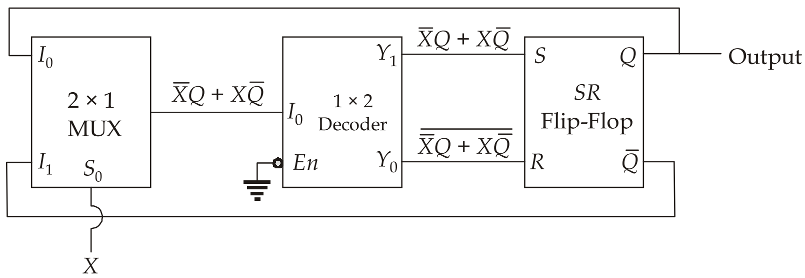


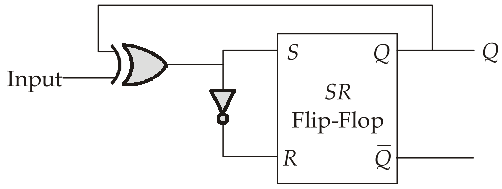
The circuit can work as

(a) *D*-flip flop
(b) Sequence detector
(c) 2-bit counter
(d) *T*-flip flop

29. (d)

The MUX in the circuit is working as an EX-OR gate and the 1 × 2 decoder as a NOT gate. Thus the circuit could be redrawn as





Thus, the circuit will function as a T-flip flop

$$\because \quad S = X \oplus Q_n \quad ; \quad R = \overline{X \oplus Q_n}$$

For SR-flip flop,

$$Q_{n+1} = S + \bar{R}Q_n = (Q_n \oplus X) + \overline{\overline{(Q_n \oplus X)}}Q_n = (X \oplus Q_n)(1 + Q_n)$$

$$Q_{n+1} = X \oplus Q_n$$

Excitation equation for T-flip flop.

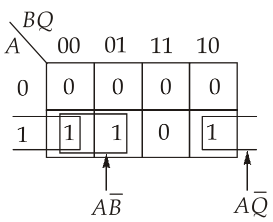
Q.30 The characteristic table of a flip-flop is shown below:

A	B	Q	Q^+
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

The characteristic equation of the flip-flop is

(a) $Q^+ = \bar{A}(B\bar{Q})$
(b) $Q^+ = A(\bar{B} + Q)$
(c) $Q^+ = A(\overline{BQ})$
(d) $Q^+ = \bar{B}(A + \bar{Q})$

30. **(c)**



$$\therefore \quad Q^+ = A\bar{B} + A\bar{Q} = A(\bar{B} + \bar{Q}) = A\overline{BQ}$$

Q.31 A certain 12-bit BCD-Digital to analog converter has a full scale output of 29.97 V. The step size of the converter is equal to

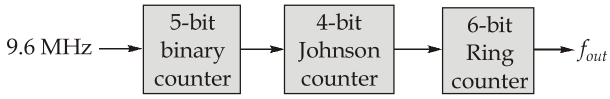
(a) 7.31 mV
(b) 20 mV
(c) 18.96 mV
(d) 30 mV

31. **(d)**

$\because$ 12 bit BCD corresponds to three decimal digits i.e. decimal numbers from 000 to 999. Thus, the output of the DAC has 999 possible steps in the range of 0 V to 29.97 V.

$$\text{Step size} = \frac{\text{Full scale output}}{\text{Number of steps}} = \frac{29.97 \text{ V}}{999} = 30 \text{ mV}$$

Q.32 Consider the counter stages shown below:



The output frequency f_{out} is equal to

(a) 3.42 kHz
(b) 6.25 kHz
(c) 8.14 kHz
(d) 12.5 kHz

32. (b)

$$f_{\text{in}} = 9.6 \text{ MHz}$$

$$\text{For Binary counter} \Rightarrow M_1 = 2^n = 2^5 = 32$$

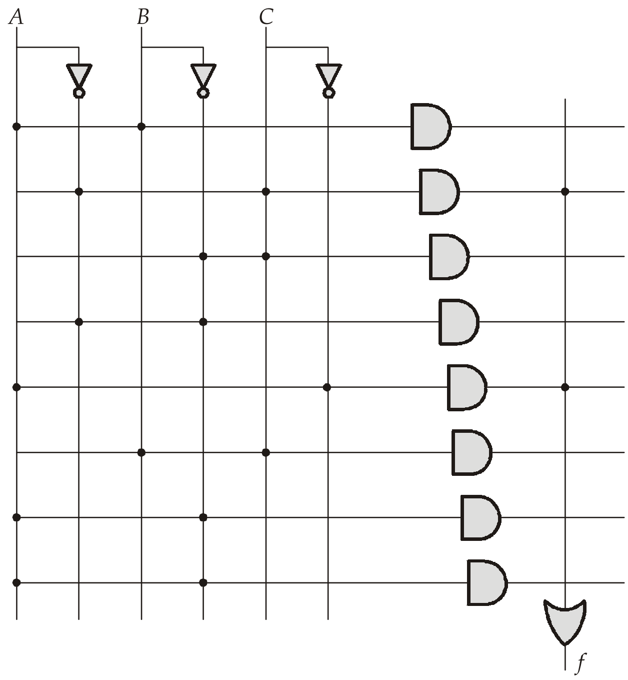
$$\text{For Johnson counter} \Rightarrow M_2 = 2n = 2 \times 4 = 8$$

$$\text{For Ring counter} \Rightarrow M_3 = n = 6$$

$$M = M_1 \times M_2 \times M_3 = 32 \times 8 \times 6 = 1536$$

$$\therefore \quad f_{\text{out}} = \frac{f_{\text{in}}}{M} = \frac{9.6 \times 10^6}{1536} \text{ Hz} = 6.25 \text{ kHz}$$

Q.33 Consider PLA circuit shown in the figure below:



the output $f(A, B, C)$ is equal to

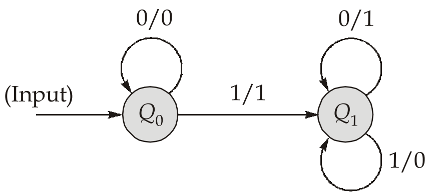
(a) $A\bar{B} + AC$
(b) $AC + B\bar{A}$
(c) $A \oplus C$
(d) $A \odot C$

33. (c)

$$f(A, B, C) = \bar{A}C + A\bar{C}$$

$$= A \oplus C$$

Q.34 The following diagram represents a finite state machine which takes as input a binary number from the least significant bit



(a) It computes 1's complement of the input number.
(b) It computes 2's complement of the input number.
(c) It performs right shift of a number.
(d) It performs swapping of digits from MSB to LSB.

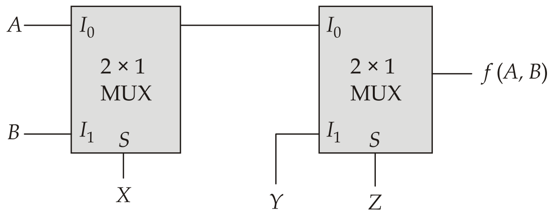
34. (b)

Let us see what task the machine is performing.

1. If LSB is equal zero then the output is equal to 0 without any change and the state does not change.
2. The state changes for 1st "1" encountered by the machine and the output is also equal to 1.
3. At state Q_1 all 1 will give output "0" and "0" will give output equal to 1.

Hence, the machine is performing a 2's complement function.

Q.35 Consider the circuit shown in the figure below:



The value of X, Y and Z for which the output function $f(A, B) = B$ is

(a) $X = A, Y = 0, Z = B$
(b) $X = B, Y = 1, Z = B$
(c) $X = A, Y = B, Z = A$
(d) $X = B, Y = B, Z = A$

35. (d)

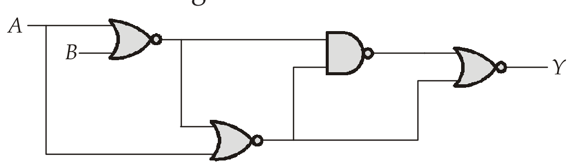
$$f(A, B) = \bar{Z}(A\bar{X} + BX) + ZY$$

Putting the above values, we get for option (d).

$$f(A, B) = \bar{A}(A\bar{B} + BB) + AB$$

$$= \bar{A}B + AB = B$$

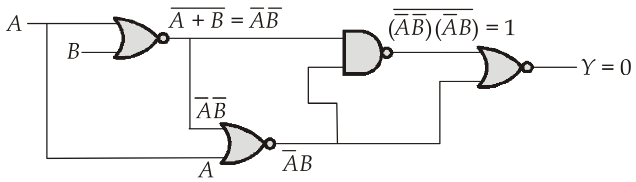
Q.36 Consider the circuit shown in the figure below:



Which of the following statement is correct about the circuit

(a) Output $Y = 1$, when $A = 0$ and $B = 0$
(b) Output $Y = 1$, when $A = 1$ and $B = 0$
(c) Output $Y = 1$, for all this inputs
(d) Output $Y = 0$, for all the inputs

36. (d)



The output of NOR gate is always zero if one of the input is equal to "1".

Q.37 By inserting a slab of dielectric material between the plates of a parallel plate capacitor, the energy stored in the capacitor has increased by 6 times. The dielectric constant of the material is

(a) $\sqrt{6}$ (b) 6
(c) 36 (d) 4

37. (b)

$$\text{Energy stored in a capacitor} = \frac{1}{2}CV^2$$

So, $E \propto C$

Also, $C = \frac{\varepsilon A}{d}$;

Hence, $E \propto \varepsilon$

$\therefore$ As energy stored is increased by 6 times, the dielectric constant of the material is also increased by 6 times.

Q.38 Consider the following statements about ferri magnetic materials:

1. These materials possess, net spontaneous magnetization in one direction.
2. These materials remains ferrimagnetic upto a critical temperature called as curie temperature and above curie temperature, they start behaving like paramagnetic materials.
3. These materials have higher resistivity than ferromagnetic materials.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 1 and 3 only

38. (b)

All the given statements are correct.

Q.39 A piezoelectric crystal has an Young's modulus of 130 GPa. The uniaxial stress that must be applied to increase its polarization from 500 to 520 cm^{-2} is

(a) 5.2 GPa (b) 2.6 GPa
(c) 2.55 GPa (d) 1.15 GPa

39. (a)

$$\text{Uniaxial stress } (P) = Y \cdot \frac{\Delta C}{C}$$

$$q = CV$$

$\Rightarrow$ Polarization, $P = \frac{q}{A} = \frac{C}{A} \cdot V$

Where A is area of the crystal capacitor.

$$\therefore \qquad \Delta P = \left(\frac{V}{A}\right) \times \Delta C$$

$$\Rightarrow \qquad \frac{\Delta P}{P} = \frac{\Delta C}{C}$$

$$\Rightarrow \qquad \text{Stress } (P) = Y \cdot \frac{\Delta P}{P} = \frac{130 \times 20}{500} = 5.2 \text{ GPa}$$

Q.40 Consider the following statements about Type-I superconductors:

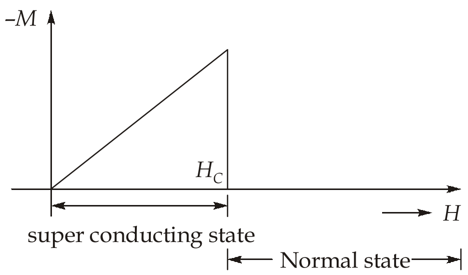
1. These are ideal or soft superconductors having very low values of critical field and critical temperature.
2. The change of state from super conducting to normal & vice-versa is gradual.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

40. **(a)**

For type-I super conductor the change of state from superconducting to normal and vice-versa is abrupt.



Q.41 Consider the following statements:

1. The key element of nano-technology is carbon. That's why sometimes it is also known as carbon-nano technology.
2. Carbon is the only element in periodic table that has allotropes from zero dimension to 3-Dimensions.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

41. **(c)**

Both the given statements are correct.

Q.42 Consider the following statements:

1. Graphene exhibits ballistic transport and quantum hall effect in two dimensions.
2. Graphene is a gapless semiconductor.
3. Graphene consists of a monolayer of a 2-D lattice of sp^3 bonded carbon.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 3 (d) 1 and 3 only

42. **(a)**

Graphene consists of a monolayer of a 2 D lattice of sp^2 bonded carbon.

Q.43 Consider the following statements about diamagnetic materials:

1. For these materials χ_m is independent of temperature.
2. These materials are repelled away from applied magnetic field.
3. These are having small and positive value of magnetic susceptibility.

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

43. **(b)**

Diamagnetic materials have small and negative value of magnetic susceptibility.

Q.44 Consider the following statements:

1. Magnetic susceptibility in paramagnetic materials is inversely related with temperature.
2. Some paramagnetic materials follow Curie-Weiss law given by $\chi_m = \dfrac{C}{T - \theta}$.

Which of the above statements is/are correct?

(a) 1 only (b) Both 1 and 2
(c) 2 only (d) Neither 1 nor 2

44. **(b)**

Both the given statements are correct.

Q.45 Consider the following statements:

1. Ferromagnetism is characterized by the presence of parallel alignment of permanent magnetic dipole moments in a single direction.
2. Ferromagnetic substances possess the property of spontaneous magnetization.
3. Ferromagnetic materials remains ferromagnetic upto a critical temperature called as Neel's temperature.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 1 and 3 only

45. **(a)**

Ferromagnetic materials remain ferromagnetic upto a critical temperature called as Curie's temperature.

Direction (Q.46 to Q.50): The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a 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.

Q.46 **Statement (I):** Below resonant frequency, a parallel RLC circuit acts like an RL circuit.
Statement (II): At resonance in the parallel RLC circuit, there is no current in the inductor and capacitor.

46. **(c)**
At resonance, the current circulates around the loop formed by L and C.

Q.47 **Statement (I) :** A volatile memory will lose its started data when electrical power is interrupted.
Statement (II) : ROM is a non-volatile memory.

47. **(b)**

Q.48 **Statement (I):** In an asynchronous ripple counter, output of each flip-flop serves as clock input signal for the next flip-flop.
Statement (II): In an asynchronous counter, all the flip-flops do not change states in exact synchronism with the clock pulses.

48. **(b)**

Q.49 **Statement (I):** A series RLC circuit having values $R = 20\ \Omega$, $L = 5$ H and $C = 20$ F is said to be overdamped.
Statement (II): The damping ratio $\xi > 1$ and hence the poles of the equation are complex conjugate.

49. **(c)**
Quality factor for series RLC circuit is

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{20}\sqrt{\frac{5}{20}} = \frac{1}{40}$$

$$\therefore \qquad \xi = \frac{1}{2Q} = 20$$

For overdamped condition the poles are always real, unequal and negative.

Q.50 **Statement (I):** The dielectric constant of a substance under the influence of alternating field is in general a complex quantity.
Statement (II): The real part of the dielectric constant is a measure of the dielectric loss in the substance.

50. **(c)**
The imaginary part of the dielectric constant is a measure of the dielectric loss in the substance.

■■■■