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PTQ

Prelims Through Questions

for

ESE 2021

Electrical Engineering

Day 1 of 11

Q.1 - Q.50

(Out of 500 Questions)

Electric Circuits + Systems & Signal Processing

Electric Circuits + Systems & Signal Processing

Q.1 Two coupled coils have $K = 0.5$, $N_1 = 250$ turns, $N_2 = 500$ turns and the mutual flux being 0.7 Wb. If the primary coil current be 70 A, then the primary coil self inductance will be

(a) 1.2 H (b) 2.4 H
(c) 3.25 H (d) 5 H

1. **(d)**

Let ϕ_1 = primary coil flux

ϕ_{12} = mutual flux

where $\phi_{12} = K\phi_1 = 0.5 \times \phi_1 = 0.7$

$$\therefore \quad \phi_1 = \frac{0.7}{0.5} = \frac{7}{5} = 1.4 \text{ Wb}$$

∴ The primary coil inductance,

$$L_1 = \frac{N_1\phi_1}{I_1} = \frac{250 \times \frac{7}{5}}{70}$$

$$= \frac{25}{5} = 5 \text{ H}$$

Q.2 For an RLC parallel circuit, which one of the following statements is NOT correct?

(a) For constant L and C, the quality factor increase if R increases.
(b) The bandwidth decreases if C increases.
(c) Below resonant frequency the circuit acts like an RL circuit.
(d) The bandwidth decreases if L increases.

2. **(d)**

$$\text{Bandwidth} = \frac{\text{Resonant frequency}}{\text{Quality factor}}$$

For parallel RLC circuit,

$$Q = R\sqrt{\frac{C}{L}}$$

and

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\therefore \quad \text{BW} = \frac{1\sqrt{L}}{R\sqrt{LC} \times \sqrt{C}}$$

$$\text{BW} = \frac{1}{RC} \Rightarrow \text{BW is independent of } L$$

Q.3 Choose the correct combination from the following statements:

1. If $Y_{11} = Y_{22}$, the network is symmetric with $A = D$.
2. If $h_{11} = h_{22}$, the network is symmetric with $AD - BC = 0$.
3. If $h_{21} = -h_{12}$, the network is reciprocal with $Z_{12} = Z_{21}$.
4. If $A = D$, the network is reciprocal.

(a) 1 and 2 only (b) 2 and 4 only
(c) 1 and 3 only (d) 1 and 4 only

3. (c)

Parameters	Condition for symmetrical	Condition for reciprocal
Z-parameter	$Z_{11} = Z_{22}$	$Z_{12} = Z_{21}$
Y-parameter	$Y_{11} = Y_{22}$	$Y_{12} = Y_{21}$
h-parameter	$\Delta h = 1$	$h_{12} = -h_{21}$
$ABCD$ parameter	$A = D$	$\Delta T = 1$

Q.4 The incident matrix of a connected graph is given below:

Node \ Branch	1	2	3	4	5	6
a	–1	0	–1	0	1	0
b	0	–1	1	0	0	0
c	1	1	0	1	0	1
d	0	0	0	–1	–1	–1

The following statements are associated with the above matrix.

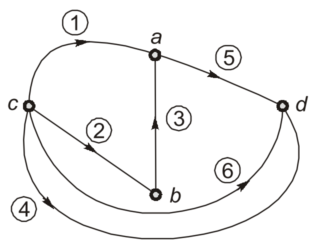
1. Branches 4 and 6 are in series.
2. Branches 2 and 3 are in series.
3. Voltages of branch 1, 2 and 3 forms an independent set.

Out of the above statements

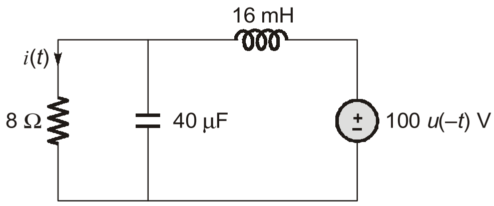
(a) 1 only is correct
(b) 2 only is correct
(c) 2 and 3 are correct
(d) 1, 2 and 3 are correct

4. (c)

The connected graph is



Q.5 Consider the circuit shown in the figure below:

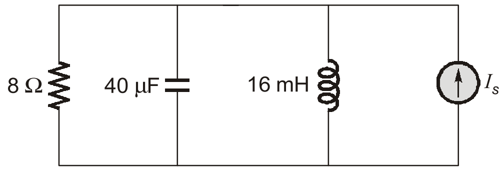


The response of the circuit will be

(a) Undamped
(b) Overdamped
(c) Underdamped
(d) Critically damped

5. (b)

By applying source transformation, we come to known that the circuit act as a parallel RLC circuit.

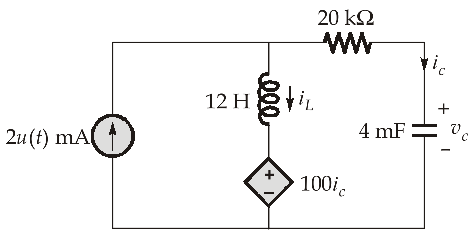


$$\therefore \quad Q = R\sqrt{\frac{C}{L}} = 8\sqrt{\frac{40}{16}\times 10^{-3}} = 8\times\frac{1}{20} = \frac{8}{20}$$

The damping factor, $\xi = \dfrac{1}{2Q} = \dfrac{1}{2\times\dfrac{8}{20}} = \dfrac{20}{16} = 1.25$

$\because \quad \xi > 1 \Rightarrow$ Overdamped

Q.6 Consider the circuit shown below:



The value of $\dfrac{dv_c(0^+)}{dt}$ will be

(a) 1 V/sec
(b) 1.6 V/sec
(c) 2 V/sec
(d) 0.5 V/sec

6. (d)

For $t < 0$, source $2u(t) = 0$

Therefore, $i_L(0^-) = i_L(0^+) = 0$ A

$v_C(0^-) = v_C(0^+) = 0$ V

For $t > 0$ $\quad i_C(0^+) = 2$ mA

$$\because \qquad i_C(0^+) = C\frac{dv_C(0^+)}{dt}$$

$$\therefore \qquad \frac{dv_C(0^+)}{dt} = \frac{i_c(0^+)}{C} = \frac{2\times10^{-3}}{4\times10^{-3}} = 0.5\text{ V/sec}$$

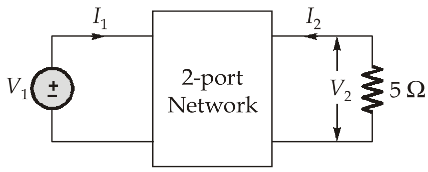
Q.7 Two networks are said to be dual when
(a) their node equations are same.
(b) the loop equations of one network are analogous to the node equations of the other.
(c) their loop equations are same.
(d) the voltage sources of one network are analogous to the current sources of the other.

7. (b)

Duality means, the mathematical representation of both the networks should be identical (KVL and KCL).

$\therefore$ Loop equations of one network are analogous to the node equations of the other.

Q.8 The input impedance of the network shown below having transmission parameter matrix of $[T] = \begin{bmatrix} 1 & 2\,\Omega \\ 3\,℧ & -1 \end{bmatrix}$ is



(a) $\frac{1}{4}\,\Omega$
(b) $\frac{1}{2}\,\Omega$
(c) $-\frac{1}{2}\,\Omega$
(d) $1\,\Omega$

8. (b)

From transmission parameters,

$$V_1 = AV_2 - BI_2 = V_2 - 2I_2 \qquad \text{...(i)}$$

$$I_1 = CV_2 - DI_2 = 3V_2 + I_2 \qquad \text{...(ii)}$$

From the given circuit, $V_2 = -5I_2$ ...(iii)

From equations (i), (ii) and (iii),

$$Z_{in} = \frac{V_1}{I_1} = \frac{-5I_2 - 2I_2}{-15I_2 + I_2} = \frac{-7}{-14} = \frac{1}{2}\ \Omega$$

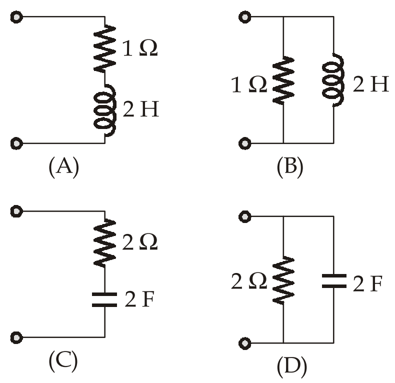
Q.9 Which one of the following statements is **incorrect**?
(a) ideal voltage sources of different values can't be connected in parallel.
(b) ideal current sources of different values can't be connected in series.
(c) an ideal voltage source and an ideal current source can't be connected in series.
(d) an ideal voltage source and an ideal current source can be connected in parallel.

9. (c)

Ideal voltage sources of different values cannot be connected in parallel, because voltage across a parallel paths will be equal.

Ideal current sources of different values cannot be connected in series, because current through a series circuit path is same.

Q.10 Consider the following circuits:



If all the circuits are excited by a sinusoidal source of frequency 1 rad/sec, then the correct arrangement of the circuits in increasing order of their quality factors will be

(a) B - A - C - D
(b) A - B - D - C
(c) C - B - A - D
(d) B - D - A - C

10. (c)

Quality factor of circuit (A),

$$Q_A = \frac{\omega L}{R} = \frac{(1)(2)}{(1)} = 2$$

Quality factor of circuit (B),

$$Q_B = \frac{R}{\omega L} = \frac{(1)}{(1)(2)} = \frac{1}{2}$$

Quality factor of circuit (C),

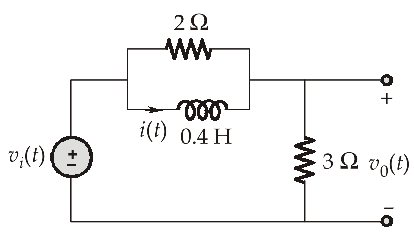
$$Q_C = \frac{1}{\omega RC} = \frac{1}{(1)(2)(2)} = \frac{1}{4}$$

Quality factor of circuit (D),

$$Q_D = \omega RC = (1)\ (2)\ (2) = 4$$

$\therefore\ Q_C < Q_B < Q_A < Q_D$

Q.11 Consider the circuit shown below:

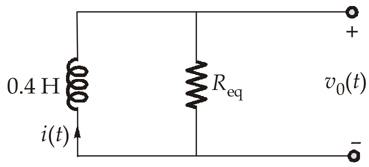


If $i(0)$ = 9 A and $v_i(t)$ = 0, then the voltage $v_0(t)$ for $t > 0$ will be

(a) $-1.2e^{-3t}$ V
(b) $-0.5e^{-t/3}$ V
(c) zero
(d) $10.8e^{-3t}$ V

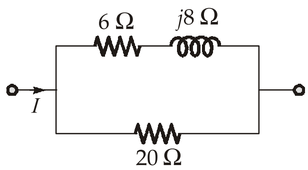
11. (d)

For $v_i(t)$ = 0, the circuit can be redrawn as



Here,
$$R_{eq} = \frac{2\times 3}{2+3} = \frac{6}{5}\,\Omega$$
$$L_{eq} = 0.4 \text{ H}$$
$$\therefore \quad \tau = \frac{L_{eq}}{R_{eq}} = \frac{0.4}{6/5} = \frac{2}{6} = \frac{1}{3}\text{ sec}$$
$$\because \quad i(t) = i(0)e^{-t/\tau} = 9e^{-3t} \text{ A}\;;\; t > 0$$
$$v_0(t) = R_{eq}\, i(t) = 10.8e^{-3t} \text{ V}\;;\; t > 0$$

Q.12 Consider the circuit shown below:

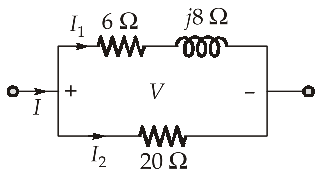


If the total average power absorbed by the circuit is 4400 W, then the average power absorbed by 6 Ω resistor will be

(a) 2000 W
(b) 400 W
(c) 2400 W
(d) 3384 W

12. (c)

Redrawing the given circuit, we get,



$$\because \quad V = Z \times I \qquad \Rightarrow I \propto \frac{1}{Z}$$
$$\therefore \quad \frac{I_{1\,\text{effective}}}{I_{2\,\text{effective}}} = \frac{Z_2}{Z_1} = \frac{20}{\sqrt{6^2+8^2}} = 2$$
$$\therefore \quad \frac{P_{6\,\Omega}}{P_{20\,\Omega}} = \frac{I_1^2(6)}{I_2^2(20)} = \left(\frac{I_1}{I_2}\right)^2 \times \frac{6}{20} = (2)^2 \times \frac{6}{20} = \frac{6}{5} \qquad \text{...(i)}$$

$\because$ $$P_{20\,\Omega} = \frac{5}{6}P_{6\,\Omega}$$

and $$P_{6\,\Omega} + P_{20\,\Omega} = 4400 \quad \text{...(ii)}$$

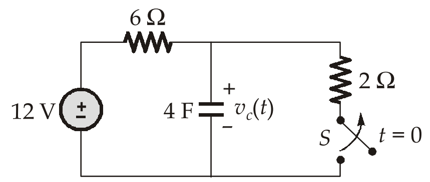
$$P_{6\,\Omega} + \frac{5}{6}P_{6\,\Omega} = 4400$$

$\Rightarrow$ $$P_{6\,\Omega} = \frac{4400}{11/6} = 400 \times 6 = 2400 \text{ W}$$

Q.13 Which one of the following statements is incorrect regarding reciprocity theorem?
(a) It is applicable for single voltage source only.
(b) Initial conditions are assumed to be zero.
(c) There should not be any extra dependent or independent source in the network.
(d) It is applicable to the linear and unilateral networks only.

13. (d)

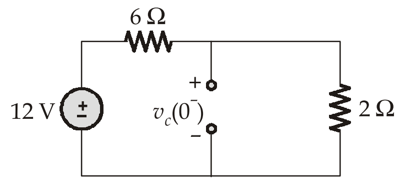
Q.14 Consider the circuit shown below:



The switch "S" is closed for a long time and opened at t = 0. The value of the voltage $v_c(t)$ at $t = 0^-$ is
(a) 3 V (b) 12 V
(c) 4 V (d) 8 V

14. (a)

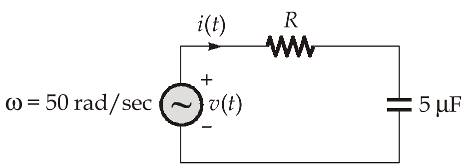
Just before t = 0, the circuit is in steady state and therefore, the capacitor will act like an open circuit.



Here, by voltage division rule:

$$v_c(0^-) = \frac{12 \times 2}{6+2} = 3 \text{ V}$$

Q.15 Consider the circuit shown below:



If the phase difference between $v(t)$ and $i(t)$ in steady state is –45°, then the value of 'R' is

(a) 4 kΩ (b) 20 kΩ
(c) 50 kΩ (d) 100 kΩ

15. (a)

Taking Laplace transform of the given circuit,

we have,
$$\frac{V(s)}{I(s)} = R + \frac{1}{sC}$$
$$\frac{V(s)}{I(s)} = R - \frac{j}{\omega C}$$

$\therefore$ The phase shift $= -\tan^{-1}\frac{1}{\omega RC} = -45^\circ$

or $\omega RC = 1$

or $R = \frac{1}{\omega C} = \frac{1}{50\times 5\,\mu\text{F}} = \frac{10^6}{250} = \frac{100}{25}\times 10^3 = 4\text{ k}\Omega$

Q.16 Three identical resistance are connected in a star fashion against a balanced three phase voltage supply. If one of the resistances be removed then the percentage reduction in power is

(a) 17.32% (b) 33.33%
(c) 14.14% (d) 50%

16. (d)

When all the resistances are present:
$$P = \frac{3V_{ph}^2}{R} = 3\left(\frac{V_L}{\sqrt{3}}\right)^2 \times \frac{1}{R} = \frac{V_L^2}{R}$$

When one of the phase resistances is removed,
$$P = 2\left(\frac{V_L}{2}\right)^2 \times \frac{1}{R} = \frac{V_L^2}{2R}$$

$\therefore$ Reduction in power $= \dfrac{\frac{V_L^2}{R} - \frac{V_L^2}{2R}}{\frac{V_L^2}{R}} \times 100 = 50\%$

Q.17 The energy in a network in Laplace domain is given by,
$$E(s) = \frac{(s+4)}{s(s+1)(s+3)}$$

The initial and the final values of the instantaneous power are respectively

(a) 1 W and 0 (b) 1 W and $\frac{4}{3}$ W
(c) 0 and ∞ (d) $\frac{4}{3}$ W and 0

17. (a)

As we know, $$p(t) = \frac{d}{dt}e(t)$$

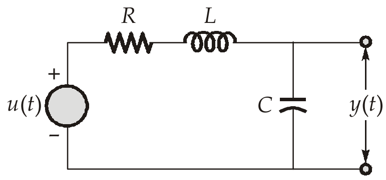
or $$P(s) = sE(s)$$

$\therefore$ $$p(0) = \lim_{s\to\infty} sP(s) = \lim_{s\to\infty} s\times\frac{s(s+4)}{s(s+1)(s+3)}$$

$$= \lim_{s\to\infty}\frac{s^2\left(1+\frac{4}{s}\right)}{s^2\left(1+\frac{1}{s}\right)\left(1+\frac{3}{s}\right)} = 1\text{ W}$$

and $$p(\infty) = \lim_{s\to 0} sP(s) = \lim_{s\to 0} s\times\frac{s(s+4)}{s(s+1)(s+3)} = 0\text{ W}$$

Q.18 The condition on R, L and C such that the step response $y(t)$ in the figure has no oscillations, is



(a) $R \geq \frac{1}{2}\sqrt{\frac{L}{C}}$

(b) $R \geq 2\sqrt{\frac{L}{C}}$

(c) $R \geq \sqrt{\frac{L}{C}}$

(d) $R \geq \frac{1}{2}\sqrt{\frac{C}{L}}$

18. (b)

$$\text{Transfer function} = \frac{\frac{1}{sC}}{R+sL+\frac{1}{sC}} = \frac{1}{s^2LC+sCR+1}$$

$$\frac{Y(s)}{U(s)} = \frac{\frac{1}{LC}}{s^2+\frac{R}{L}s+\frac{1}{LC}}$$

$$2\xi\omega_n = \frac{R}{L}$$

$$\omega_n = \frac{1}{\sqrt{LC}}$$

$$\xi = \frac{R}{2}\sqrt{\frac{C}{L}}$$

For no. oscillations, $\xi \geq 1$

$$\frac{R}{2}\sqrt{\frac{C}{L}} \geq 1$$

$$R \geq 2\sqrt{\frac{L}{C}}$$

Q.19 Consider the following statements associated with mesh and nodal analysis of electric circuits:

1. In the nodal method, the number of independent node equations needed is one less than the number of junction in the network.
2. The nodal method is advantageous when the network has less parallel circuits.

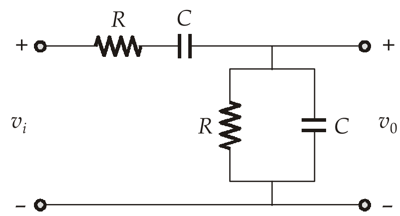
Which of the above statements is/are true?

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

19. (a)

- If "n" is the number of independent node equations and "j" the number of junctions, then $n = (j - 1)$.
- Statement-2 is false.

Q.20 The RC circuit shown in the figure is

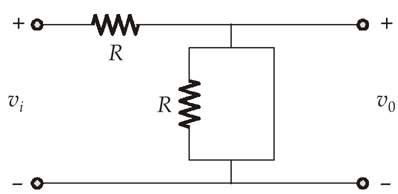


(a) a low pass filter
(b) a high pass filter
(c) a band-pass filter
(d) a band-reject filter

20. (c)

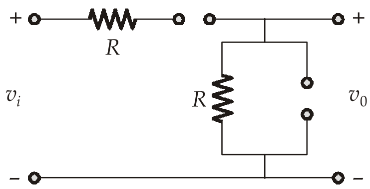
At $\omega \to \infty$, capaitor will get short circuited.

Circuit looks like,



$$\frac{V_0}{V_i} = 0$$

At $\omega \to 0$, capacitor will get open circuited circuit looks like



$$\frac{V_0}{V_i} = 0$$

So the circuit is a band pass filter.

Q.21 In a symmetrical three-phase system, phase sequence RYB, a capacitive reactance 10 ohm is across YB and a coil $R + jX$ across RY. When $I_Y = 0$, which of the following gives the values of R and X in ohms respectively?

(a) 10 and 10
(b) $10\sqrt{3}$ and 10
(c) $5\sqrt{3}$ and 5
(d) 5 and $5\sqrt{3}$

21. (c)

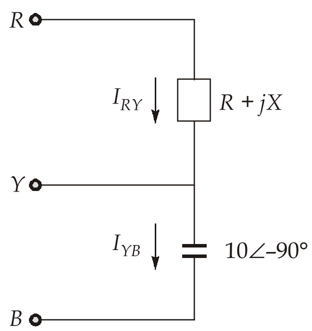
$$V_{RY} = V\angle 0°$$
$$V_{YB} = V\angle -120°$$

As $\quad I_Y = 0$

So, $\quad I_{RY} = I_{YB}$

$$I_{YB} = \frac{V\angle -120°}{10\angle -90°}$$

$$I_{RY} = \frac{V\angle 0°}{R + jX}$$



So, $\quad R + jX = 10\angle 30° = (5\sqrt{3} + j5)\Omega$

$\therefore \quad R = 5\sqrt{3}\,\Omega, \qquad X = 5\ \Omega$

Q.22 In a two-port network, the output short-circuit current was measured while the source voltage at the input was 1 V, the value of the output current would provide the parameter

(a) B
(b) y_{12}
(c) h_{21}
(d) y_{21}

22. (d)

$$I_2 = y_{21} V_1 + y_{22} V_2$$

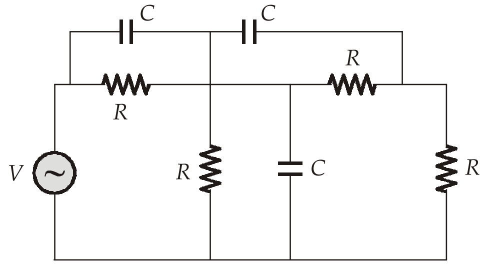
$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

$V_2 = 0$ (output shorted)

$V_1 = 1$ V

$y_{21} = I_2$ (output current)

Q.23 The minimum number of equations required to analyse the circuit shown in the figure is



(a) 3
(b) 4
(c) 6
(d) 7

23. (a)

As voltage at 1 node is known

$\therefore$ only 3 equations required to perform nodal analysis.

Q.24 Let $x(n) = \{3,\underset{\uparrow}{4},5,6\}$, then $h(n) = x(0.5n - 1)$ will be

(a) $h(n) = \{\underset{\uparrow}{4},6\}$
(b) $h(n) = \{3,3,4,4,\underset{\uparrow}{5},5,6,6\}$
(c) $h(n) = \{3,0,\underset{\uparrow}{4},0,5,0,6,0\}$
(d) $h(n) = \{\underset{\uparrow}{4},4,6,6\}$

24. (c)

We first apply time-shifting operation to find,

$$y(n) = x(n-1) = \{3,\underset{\uparrow}{4},5,6\}$$

$$h(n) = y\left(\frac{n}{2}\right) = x(0.5n-1) = \{3,0,\underset{\uparrow}{4},0,5,0,6,0\}$$

Q.25 Find the inverse Laplace transform of

$$X(s) = \frac{-3}{(s+2)(s-1)}$$

if the ROC is $-2 < R(s) < 1$

(a) $x(t) = e^{-2t}\,u(t) - e^{t}\,u(t)$
(b) $x(t) = -e^{-2t}\,u(-t) + e^{t}\,u(-t)$
(c) $x(t) = e^{-2t}\,u(t) + e^{t}\,u(-t)$
(d) $x(t) = e^{-2t}\,u(t) - e^{t}\,u(-t)$

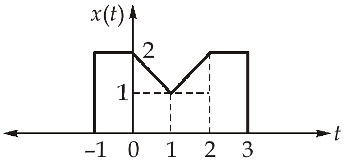
25. (c)

$$X(s) = \frac{1}{s+2} - \frac{1}{s-1}$$

$$-2 < R(s) < 1$$

$$x(t) = e^{-2t}\,u(t) + e^{t}\,u(-t)$$

Q.26 Let $X(j\omega)$ denotes the Fourier transform of the signal $x(t)$ depicted in figure below:



then $\int_{-\infty}^{\infty} |X(j\omega)|^2 \, d\omega$ is

(a) $\frac{35\pi}{3}$ (b) $\frac{76\pi}{3}$

(c) $\frac{45\pi}{3}$ (d) $\frac{50\pi}{3}$

26. (b)

$$E_{x(t)} = \int_{-\infty}^{\infty} |x(t)|^2 \, dt$$

$$= \left[\int_{-1}^{0} 2^2 \, dt + \int_{0}^{1} (-t+2)^2 \, dt + \int_{1}^{2} t^2 dt + \int_{2}^{3} 2^2 \, dt\right]$$

$$= 4 + \frac{7}{3} + \frac{7}{3} + 4 = 8 + \frac{14}{3} = \frac{24+14}{3} = \frac{38}{3}$$

So, $$\int_{-\infty}^{\infty} |X(\omega)|^2 \, d\omega = 2\pi E_{x(t)} = \frac{2\pi \times 38}{3} = \frac{76\pi}{3}$$

Q.27 The Laplace transform of the given expression $f(t) = u(t(t^2 - 9))$ is

(a) $\frac{e^{3s}}{s} - \frac{e^{-3s}}{s} - \frac{1}{s}$ (b) $\frac{e^{3s}}{s} - \frac{e^{-3s}}{s} + \frac{1}{s}$

(c) $\frac{e^{3s}}{s} + \frac{e^{-3s}}{s} - \frac{1}{s}$ (d) $\frac{e^{3s}}{s} + \frac{e^{-3s}}{s} + \frac{1}{s}$

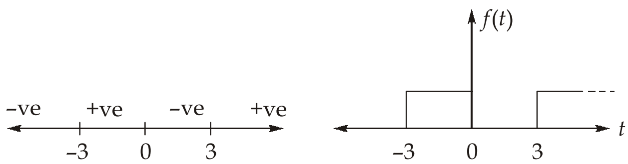
27. (c)

$$f(t) = u(t\,(t^2 - 9))$$

the value of $f(t)$ will be 1 if

$$t(t^2 - 9) \geq 0$$

$$t(t + 3)(t - 3) \geq 0$$



from the definition of Laplace transform,

$$F(s) = \int_{-\infty}^{\infty} e^{-st} f(t)\, dt$$

$$F(s) = \int_{-3}^{0} e^{-st} dt + \int_{3}^{\infty} e^{-st} dt$$

$$F(s) = \left.\frac{e^{-st}}{-s}\right|_{-3}^{0} + \left.\frac{e^{-st}}{-s}\right|_{3}^{\infty}$$

$$F(s) = -\frac{1}{s}\left[1 - e^{3s}\right] - \frac{1}{s}\left[0 - e^{-3s}\right]$$

$$F(s) = \frac{e^{3s}}{s} + \frac{e^{-3s}}{s} - \frac{1}{s}$$

Q.28 Consider the following statements:

1. Discrete Fourier transform is discrete and finite in length in time but not in frequency domain.
2. Input and output of DFT can be stored in a finite memory device.

Which of the above statement(s) is/are correct?

(a) 1 only
(b) 2 only
(c) both 1 and 2
(d) neither 1 nor 2

28. (b)

Discrete Fourier transform is discrete and finite in length in both time and frequency domain.

Q.29 Consider a causal LTI system whose input $x[n]$ and output $y[n]$ are related by the difference equation

$y[n] = 0.25\, y[n-1] + x[n]$

If $x[n] = \delta[n-1]$, then $y[4]$ is ______

(a) $\frac{1}{4}$
(b) $\frac{1}{16}$
(c) $\frac{1}{64}$
(d) $\frac{1}{256}$

29. (c)

Since the system is causal

$$y[n] = 0 \text{ for } n < 1$$

$$y[1] = \frac{1}{4}y[0] + x[1] = 0 + 1 = 1$$

$$y[2] = \frac{1}{4}y[1] + x[2] = \frac{1}{4}\cdot 1 + 0 = \frac{1}{4}$$

$$y[3] = \frac{1}{4}y[2] + x[3] = \frac{1}{4}\times\frac{1}{4} + 0 = \frac{1}{(4)^2}$$

Therefore, $$y(n) = \left(\frac{1}{4}\right)^{n-1}$$

$\therefore$ $$y(4) = \frac{1}{4^3} = \frac{1}{64}$$

Q.30 Consider a non periodic, odd and continuous real signal $x(t)$, then its fourier transform $X(j\omega)$ will be

(a) non periodic, odd, discrete and real signal.
(b) continuous, odd, non periodic and real signal.
(c) continuous, odd, non periodic and imaginary signal.
(d) non periodic, even, continuous and imaginary signal.

30. (c)

$x(t) \xleftrightarrow{\text{F.T.}} X(j\omega)$

Aperiodic $\xleftrightarrow{\text{F.T.}}$ continuous

Discrete $\xleftrightarrow{\text{F.T.}}$ periodic

odd + real $\xleftrightarrow{\text{F.T.}}$ odd + imaginary

Q.31 A continuous time linear system S with input $x(t)$ and output $y(t)$ yields the following input-output pairs:

$x(t) = e^{j2t} \xrightarrow{S} y(t) = e^{j3t}$

$x(t) = e^{-j2t} \xrightarrow{S} y(t) = e^{-j3t}$

If $x_1(t) = \cos(2t)$ and corresponding output $y_1(t)$ for system 'S' is $\cos(\alpha t + \beta)$ then the value of α and β are respectively

(a) 3, 0
(b) 0, 3
(c) 1, 3
(d) 3, 1

31. (a)

Since the system is linear,

$$x_1(t) = \frac{1}{2}\left[e^{j2t} + e^{-j2t}\right] \xrightarrow{S} y_1(t)$$

$$y_1(t) = \frac{1}{2}\left[e^{j3t} + e^{-j3t}\right]$$

Now, $x_1(t) = \cos 2t$

and $y_1(t) = \cos 3t$

$\therefore$ $\alpha = 3,$

$\beta = 0$

Q.32 Consider the following statements:

1. The ROC of an infinite duration causal sequence is the exterior of a circle of radius α where $z = \alpha$ is the largest pole in $X(z)$.
2. The ROC of an infinite duration two sided sequence is a ring in z-plane or the z-transform does not exists at all.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 only
(c) both 1 and 2 (d) neither 1 nor 2

32. (c)

Both statements are correct.

Q.33 Consider the system given by:

$$H(z) = \frac{1+2z^{-1}}{1+\left(\frac{6}{5}\right)z^{-1}+\left(\frac{9}{25}\right)z^{-2}}$$

The given system is

(a) Both causal as well as stable (b) Causal but not stable
(c) Stable but not causal (d) Neither causal nor stable

33. (a)

Given,
$$H(z) = \frac{1+2z^{-1}}{1+\left(\frac{6}{5}\right)z^{-1}+\left(\frac{9}{25}\right)z^{-2}} = \frac{z(z+2)}{z^2+\frac{6}{5}z+\frac{9}{25}} = \frac{z(z+2)}{\left(z+\frac{3}{5}\right)^2}$$

The location of the poles is at $z = \frac{-3}{5}$

Since all the poles are lying inside the unit circle in the z-plane, the system is both causal and stable.

Q.34 Given the signal

$x(t) = 10\cos(2000\pi t) \times \cos(8000\pi t)$,

then the minimum sampling rate based on the bandpass sampling theorem is

(a) 2 kHz (b) 3 kHz
(c) 4 kHz (d) 5 kHz

34. (d)

$$x(t) = 10\cos(2000\pi t)\cdot\cos(8000\pi t)$$
$$x(t) = 5\cos(6000\pi t) + 5\cos(10000\pi t)$$
$$f_1 = 3\text{ kHz},$$
$$f_2 = 5\text{ kHz}$$
$$B = f_H - f_L = 5\text{ kHz} - 3\text{ kHz} = 2\text{ kHz}$$

therefore, the minimum sampling frequency is,

$$f_s = \frac{2f_H}{K}$$

where $K = \left[\frac{f_H}{B}\right]$ (where K is greatest integer value)

$$= \left[\frac{5k}{2k}\right] = [2.5] = 2$$

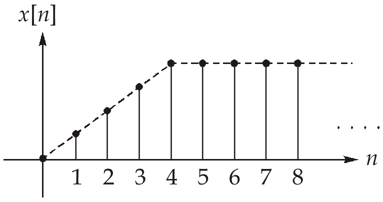
$$f_s = \frac{2f_H}{K} = \frac{2\times 5k}{2} = 5\text{ kHz}$$

Q.35 The power of the signal is ______ watts

$x[n] = r[n] - r[n-4]$

(a) 4
(b) 8
(c) 16
(d) 32

35. (b)



$$\text{Power of the signal, } P = \lim_{N\to\infty}\frac{1}{2N+1}\sum_{n=-N}^{N}|r[n]-r[n-4]|^2$$

$$= \lim_{N\to\infty}\frac{1}{2N+1}\left[\sum_{n=0}^{4} n^2 + \sum_{n=5}^{N}(4)^2\right] = 8\text{ Watts}$$

Q.36 Which one of the following cannot be the Fourier series expansion of a periodic signal?

(a) $x_1(t) = 2\cos(2t) + 3\cos(3t)$
(b) $x_2(t) = 4\cos(4\pi t) + 5\cos(5\pi t)$
(c) $x_3(t) = 6 + 7\cos(7\pi t)$
(d) $x_4(t) = \cos(t) + \cos(\pi t)$

36. (d)

The Fourier series expansion of a periodic signal is also periodic.

Among the given signals, $x_4(t)$ is not a periodic signal.

Q.37 If $X(s)$ is Laplace transform of $x(t) = \cos(2t)\, u(t)$, then time signal corresponding to $X(s+2)$ would be:

(a) $\cos 2(t-2)\, u(t)$
(b) $e^{-2t}\cos 2t\, u(t)$
(c) $\cos 2(t+2)\, u(t)$
(d) $\frac{1}{3}\cos 6t\, u(t)$

37. (b)

$$X(s-s_0) \xleftrightarrow{L^{-1}} e^{ts_0}x(t)$$

$$X(s+2) \xleftrightarrow{L^{-1}} e^{-2t}x(t)$$

$$\xleftrightarrow{L^{-1}} e^{-2t}\cos(2t)u(t)$$

$\Rightarrow$ Option (b) is correct.

Q.38 Which one of the following relations is **not** correct?

(a) $f(t)\ \delta(t) = f(0)\ \delta(t)$

(b) $\int_{-\infty}^{\infty} f(t)\,\delta(\tau)\,d\tau = 1$

(c) $\int_{-\infty}^{\infty} \delta(\tau)\,d(\tau) = 1$

(d) $f(t)\ \delta(t-\tau) = f(\tau)\ \delta(t-\tau)$

38. (b)

Properties of delta function:

1. $\int_{-\infty}^{\infty} \delta(t)\,dt = 1$
2. $x(t)\ \delta(t) = x(0)\ \delta(t)$
3. $x(t)\ \delta(t-t_0) = x(t_0)\ \delta(t-t_0)$
4. $\delta(at) = \dfrac{1}{|a|}\delta(t)$
5. $\int_{-\infty}^{\infty} x(t)\,\delta(t)\,d\tau = x(0)$

So option (b) does not represent a property of delta function.

Q.39 Nyquist sampling rate for $x(t) = \frac{1}{2}\text{Sa}(100\pi t) + \frac{1}{3}\text{Sa}(50\pi t)$ is:

(a) 50 Hz
(b) 100 Hz
(c) 150 Hz
(d) 200 Hz

39. (b)

Given, $x(t) = \frac{1}{2}\text{Sa}(100\pi t) + \frac{1}{3}\text{Sa}(50\pi t)$

i.e. $x(t) = \frac{1}{2}\sin\frac{(100\pi t)}{100\pi t} + \frac{1}{3}\sin\frac{(50\pi t)}{50\pi t}$

$$= \frac{1}{2}\sin\frac{(\omega_{m1}t)}{\omega_{m1}t} + \frac{1}{3}\sin\frac{(\omega_{m2}t)}{\omega_{m2}t}$$

$\therefore \quad \omega_{m1} = 100\,\pi$

and $\quad \omega_{m2} = 50\,\pi$

$\omega_m = \omega_{m1} = 100\,\pi$[larger of ω_{m1} and ω_{m2}]

Highest frequency component,

$$f_m = \frac{\omega_m}{2\pi} = \frac{100\pi}{2\pi} = 50 \text{ Hz}$$

$\therefore$Nyquist sampling rate, $f_N = 2f_m$

$= 2 \times 50 = 100$ Hz

Q.40 Which one of the following is the correct relation?

(a) $f(at) \xleftrightarrow{\text{F.T.}} aF(\omega/a)$
(b) $f(at) \xleftrightarrow{\text{F.T.}} aF(a\omega)$
(c) $f(t/a) \xleftrightarrow{\text{F.T.}} aF(\omega/a)$
(d) $f(at) \xleftrightarrow{\text{F.T.}} (1/a)F(\omega/a)$

40. (d)

Q.41 Consider the given signal:

$$x(t) = \begin{cases} t-2 & -2 \le t \le 0 \\ 2-t & 0 \le t \le 2 \\ 0 & \text{otherwise} \end{cases}$$

The given signal is a/an,

(a) Energy signal
(b) Power signal
(c) Neither energy nor power signal
(d) Both energy and power signal

41. (a)

Energy of the signal, $\quad E = \int_{-\infty}^{\infty} |x(t)|^2\, dt = \int_{-2}^{0} (t-2)^2\, dt + \int_{0}^{2} (2-t)^2\, dt$

$$= \frac{64}{3} \text{ Joules}$$

Power of the signal, $P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2\, dt = \lim_{T\to\infty} \frac{1}{2T}\left[\frac{64}{3}\right] = 0$

Since energy is finite and power is zero, it is an energy signal.

Q.42 Consider the following statements:

1. A signal is said to be discrete if time is discontinuous and amplitude is continuous.
2. Sampler is a device which converts continuous time signal into discrete time signal.

Which of the above statement(s) is/are correct?

(a) 1 and 2
(b) 1 only
(c) 2 only
(d) neither 1 nor 2

42. (a)

Both statements are correct.

Q.43 Z-transform of $y(z) = \log(1 - az^{-1})$, $|z| > a$ is given by:

(a) $\dfrac{-(a)^n u[n-1]}{n}$ (b) $\dfrac{a^n u[n]}{n}$

(c) $\dfrac{-a^{n-1} u[n-1]}{n-1}$ (d) $\dfrac{-a^{n+1} u[n]}{(n-1)}$

43. (a)

Differentiating $y(z)$:

$$\frac{dY(z)}{dz} = \frac{1 \times a}{(1 - az^{-1})} \cdot z^{-2}$$

Multiplying with z:

$$-\frac{z\,dY(z)}{dz} = -\frac{a \cdot z^{-2} \cdot z}{(1 - az^{-1})}$$

Let, $$X(z) = \frac{1}{1 - az^{-1}}$$

$$x[n] = a^n\, u[n]$$

$$-\frac{z\,dY(z)}{dz} = -az^{-1}\, X[z]\,; \qquad |z| > a$$

IZT:

$$ny[n] = -ax\,[n-1];\ |z| > a$$

$$y(n) = \frac{-a}{n}(a)^{n-1} \cdot u[n-1]$$

$$\Rightarrow \qquad y[n] = \frac{-(a)^n u[n-1]}{n}$$

Q.44 A system defined by

$$y[n] = \sum_{m=-\infty}^{n} x[m] \text{ is an example of}$$

(a) Memoryless system (b) Non-invertible system

(c) Averaging system (d) Invertible system

44. (d)

$$y[n] = \sum_{m=-\infty}^{n} x[m]$$

$$x[n] \rightarrow y[n] = \sum_{m=-\infty}^{n} x[K] \rightarrow y[n]$$

$$y[n] \rightarrow W[n] = y[n] - y[n-1] \rightarrow W[n] = x[n]$$

If a system is invertible, then an inverse system exists that, when cascaded with the original system, yields an output $W[n]$ equal to the input $x[n]$ to the first system.

Q.45 Consider the following statements:

1. Convolution of two rectangular pulses of equal duration will be a trapezoid.
2. Convolution of two rectangular pulses of unequal duration will be a triangle.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 only
(c) both 1 and 2 (d) neither 1 nor 2

45. (d)

- Convolution of two rectangular pulses of equal duration will be a triangle.
- Convolution of two rectangular pulses of unequal duration will be a trapezoid.

Q.46 The initial and final values of a signal whose Laplace transform is given by $X(s) = \frac{s+4}{s^2+3s+5}$ are given by:

(a) 1, 0 (b) 0, 1
(c) 1, 1 (d) 0, ∞

46. (a)

Given, $X(s) = \frac{s+4}{s^2+3s+5}$

Initial value: $x(0) = \lim_{s\to\infty} sX(s) = \lim_{s\to\infty}\frac{s(s+4)}{(s^2+3s+5)} = \lim_{s\to\infty}\frac{s^2+4s}{s^2+3s+5} = 1$

Final value: $x(\infty) = \lim_{s\to 0} sX(s) = \lim_{s\to 0}\frac{s(s+4)}{s^2+3s+5} = 0$

Direction (Q.47 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.47 Statement (I): All networks made-up of passive, bilateral, linear time invariant elements are reciprocal.

Statement (II): Only passive and time invariance of elements guarantee reciprocity of the network.

47. (c)

Elements should be also bilateral to satisfy the reciprocity.

Q.48 **Statement (I):** A network is said to be in resonance when the voltage and current at the network input terminals are in phase.
Statement (II): In a two terminal network containing at least one inductor and one capacitor, the resonance is defined as the condition which exists when the input impedance of the network is purely resistive.

48. **(a)**

Q.49 **Statement (I):** The system described by $y^2(t) + 2y(t) = x^2(t) + x(t) + c$ is a linear and static system.
Statement (II): The dynamic system can be characterized by differential equation.

49. **(d)**

$$y^2(t) + 2y(t) = x^2(t) + x(t) + c$$

is a non linear system.

Q.50 **Statement (I):** An unstable system is a system which may produces an unbounded output for a bounded input.
Statement (II): An invertible system is one which does not have a unique relation between its input and output.

50. **(c)**

An invertible system is one which have a unique relation between its input and output.

■■■■