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UPPSC AE 2019
ASSISTANT ENGINEER

ELECTRICAL ENGINEERING

Test 1

Part Syllabus Test-1

Networks and Systems

ANSWER KEY

1.	(c)	**11.**	(a)	**21.**	(b)	**31.**	(d)	**41.**	(c)
2.	(a)	**12.**	(b)	**22.**	(a)	**32.**	(b)	**42.**	(d)
3.	(b)	**13.**	(d)	**23.**	(c)	**33.**	(b)	**43.**	(d)
4.	(a)	**14.**	(b)	**24.**	(c)	**34.**	(b)	**44.**	(a)
5.	(b)	**15.**	(c)	**25.**	(a)	**35.**	(b)	**45.**	(c)
6.	(c)	**16.**	(b)	**26.**	(d)	**36.**	(b)	**46.**	(b)
7.	(a)	**17.**	(d)	**27.**	(b)	**37.**	(b)	**47.**	(c)
8.	(a)	**18.**	(c)	**28.**	(b)	**38.**	(d)	**48.**	(c)
9.	(b)	**19.**	(d)	**29.**	(d)	**39.**	(b)	**49.**	(a)
10.	(a)	**20.**	(a)	**30.**	(d)	**40.**	(b)	**50.**	(d)

DETAILED EXPLANATIONS
Networks and Systems

1. **(c)**

An element is said to be linear if its characteristic is a straight line passing through the origin.
An element is said to be active if it delivers a net amount of energy to the outside world.
An element is said to be bilateral if it offers the same impedance for different direction of current flow.

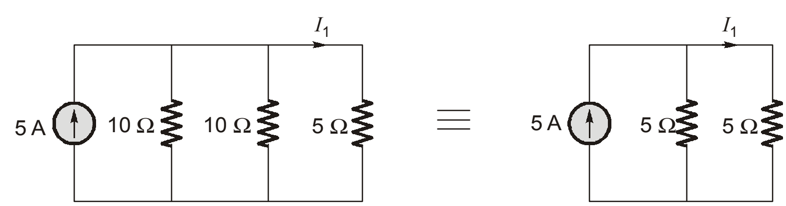
2. **(a)**

V_{AB} = Work done by the source to move a positive charge of 1 C from B to A.
= –[Work done by the source to move a positive charge of 1 C from A to B]

$$V_{AB} = -\frac{\text{Work done}}{\text{Charge}} = -\frac{40}{24}\text{ V} = -1.67\text{ V}$$

3. **(b)**

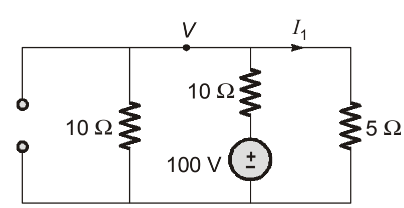
Using Superposition Theorem,
Considering 5 A source alone, we get,



By current division rule,

$$I_1' = \frac{5 \times 5}{10} = 2.5\text{ A}$$

Considering 100 V source alone, we get,
By applying KCL at V, we get,



$$\frac{V}{10} + \frac{V-100}{10} + \frac{V}{5} = 0$$

$$4\,V - 100 = 0$$

or, $$V = 25\text{ V}$$

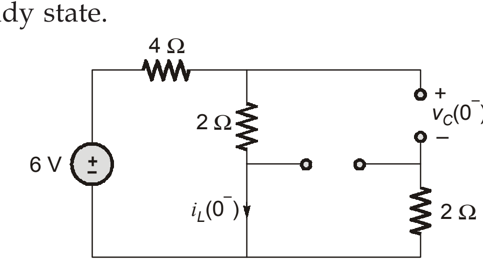
$\therefore$ $$I_1'' = \frac{V}{5} = \frac{25}{5} = 5\text{ A}$$

$\therefore$ $$I_1 = I_1' + I_1'' = 7.5\text{ A}$$

4. **(a)**

At $t < 0$; the circuit is in steady state.

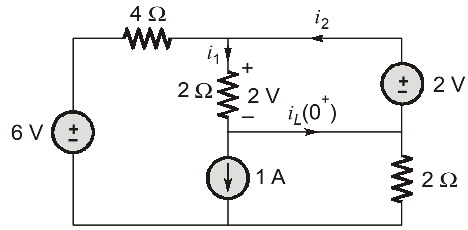
$\therefore$



$\therefore$ $$i_L(0^-) = \frac{6}{6} = 1\text{ A}$$

$$v_C(0^-) = i_L(0^-) \times 2\ \Omega = 2\text{ V}$$

At $t = 0^+$



Here, $$i_1 = i_L(0^+) + 1\text{ A} = \frac{2\text{ V}}{2\ \Omega} = 1\text{ A}$$

So, $$i(0^+) = 0\text{ A}$$

5. (b)

Considering each options, we get,

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{Y_{22}}{\Delta Y} = \frac{4}{12-10} = \frac{4}{2} = 2\ \Omega$$

From h-parameters, $$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} = -\frac{1}{3}$$

From transmission parameters,

$$B = -\left.\frac{V_1}{I_2}\right|_{V_2=0} = -\frac{1}{10}$$

From Y-parameters, $$Y_{21} = -\left.\frac{I_2}{V_1}\right|_{V_2=0} = 10\ ℧$$

6. (c)

Fundamental period, $N = 8$

$$\omega_0 = \frac{2\pi}{N} = \frac{2\pi}{8} = \frac{\pi}{4}$$

7. (a)

Given, $$f(t) = \cos\left[\frac{\pi t}{4} - \frac{\pi}{4}\right]$$

Compare with $\cos\left(\frac{2\pi t}{T} - \theta\right)$

$$\Rightarrow \quad \frac{2\pi}{T} = \frac{\pi}{4}$$

$$\Rightarrow \quad T = 8\text{ sec}$$

8. (a)

$$g(t) = \frac{1}{\sigma\sqrt{2\pi}} e^{-t^2/2\sigma^2}$$

$$G(\omega) = e^{-\frac{\omega^2\sigma^2}{2}}$$

10. (a)

Convolution of 2 same duration rectangular waveforms results in triangular waveform.

11. (a)

Transfer function is defined only for causal LTI systems.

12. (b)

For the LTI system to be stable.

$$\sum_{n=-\infty}^{+\infty} |h[k]| < \infty$$

So for the sum to be finite,

$$|a| > 1,$$
$$|b| < 1$$

13. (d)

When two rectangular pulses are convolved then limits where they exists are summation of limits of individual signals.

14. (b)

First derivative in continuous time system is equivalent to first difference in discrete time systems.

15. (c)

For odd function

$$a_k = 0 \text{ for all } K$$

$$b_k = \frac{4}{T}\int_0^{T/2} f(t)\sin k\omega_0 t\, dt$$

$$f(t) = \sum_{n=1}^{\infty} b_n \sin n\,\omega_0 t$$

16. (b)

$e^{-\pi t^2} \xleftrightarrow{FT} e^{-\pi f^2}$

$$e^{-\alpha t^2} = e^{-\pi\left(\sqrt{\frac{\alpha}{\pi}}\,t\right)^2}$$

Also:

If $x(t) \xrightarrow{FT} X(j\omega)$

then $x(at) \xrightarrow{FT} \frac{1}{|a|} \times \left(\frac{j\omega}{a}\right)$

So, $e^{-\pi \cdot \left(\sqrt{\frac{\alpha}{\pi}}\, t\right)^2} \xrightarrow{FT} \sqrt{\frac{\pi}{\alpha}}\, e^{-\pi f^2 \pi/\alpha}$

$$= \sqrt{\frac{\pi}{\alpha}}\, e^{-\frac{\pi^2 f^2}{\alpha}}$$

17. (d)

$$X(j\omega) = \int_{-\infty}^{\infty} x(t) \cdot e^{-j\omega t} dt$$

$$X(j0) = \int_{-\infty}^{\infty} x(t) dt$$

Area under the graph $x(t)$,

$$A = \int_{-\infty}^{\infty} x(t) dt$$

$\Rightarrow$ $$X(j0) = \frac{1}{2} \times 1 + 2 \times 1 + \frac{1}{2} \times 1 = 3$$

18. (c)

As per final value theorem (steady state)

$$Y_{ss} = \lim_{s \to 0} sy(s)$$

$$X(s) = \frac{10}{s}$$

$$y(s) = G(s)X(s) = \frac{10(4s+3)}{s(s^2+2s+5)}$$

$$y_{ss} = \lim_{s \to 0} \frac{10(4s+3)}{s(s^2+2s+5)} = \frac{30}{5} = 6$$

As per initial value theorem

$$y(0) = \lim_{s \to \infty} sy(s)$$

$$= \lim_{s \to \infty} s \cdot \frac{10}{s} \cdot \frac{4s+3}{s^2+2s+5} = 0$$

20. (a)

$$f(t) = \cos(\omega t + \alpha)$$
$$= \cos\omega t \cos\alpha - \sin\omega t \sin\alpha$$

$$L\, f(t) = F(s) = \frac{s\cos\alpha}{s^2+\omega^2} - \frac{\omega\sin\alpha}{s^2+\omega^2}$$

$$= \frac{s\cos\alpha - \omega\sin\alpha}{s^2+\omega^2}$$

21. (b)

From given figure, impulse response can be written as:

$$h(n) = (-1)^n\, u(n)$$

$$\Rightarrow \qquad H(z) = \frac{1}{\left[1-(-1)z^{-1}\right]} = \frac{1}{1+z^{-1}}$$

$\therefore$ Pole is at $z = -1$

22. (a)

Given, $$X(Z) = \frac{Z(8Z-7)}{(Z-1)(4Z-3)}$$

Final value theorem:

$$\lim_{n\to\infty} x[n] = \lim_{z\to 1}(z-1)\cdot\frac{Z(8z-7)}{(z-1)(4z-3)}$$

$$= \frac{1(8-7)}{(4-3)} = 1$$

23. (c)

$$u(n) \to X_1(z) = \sum_{n=-\infty}^{+\infty} u(n)z^{-n} = \sum_{n=0}^{+\infty} z^{-n} = \frac{z}{z-1}, \qquad \text{ROC } (|z| > 1)$$

$$u[-n-1] \to X_2(z) = \sum_{n=-\infty}^{+\infty} u[-n-1]z^{-n} = \sum_{n=-\infty}^{-1} z^{-n} = \sum_{1}^{\infty} z^n$$

$$= 1 - \sum_{0}^{\infty} z^n, \ |z| < 1$$

$$= \frac{z}{z-1}, \ |z| < 1 \to \text{ROC}$$

24. (c)

$$f(x) = \cos^2 x = \frac{1+\cos 2x}{2}$$
$$= 0.5 + 0.5\cos 2x$$

25. (a)

From final value theorem

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$$

$$= \lim_{s\to 0} s\left(\frac{5s^2+23s+6}{s(s^2+2s+2)}\right)$$

$$= \frac{6}{2} = 3$$

27. (b)

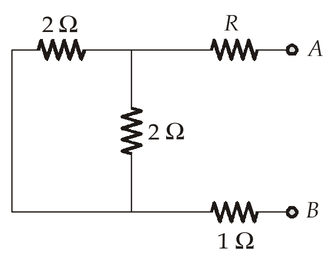
$$\tau = RC$$

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

Thus, the circuit represents an RL circuit.

28. (b)

Thevenin's equivalent resistance can be calculated as,



$$R_{eq} = [2\ \Omega \,||\, 2\ \Omega] + R + 1\ \Omega$$

$$4\ \Omega = 1\ \Omega + R + 1\ \Omega$$

$\therefore$ $$R = 4\ \Omega - 2\ \Omega = 2\ \Omega$$

29. (d)

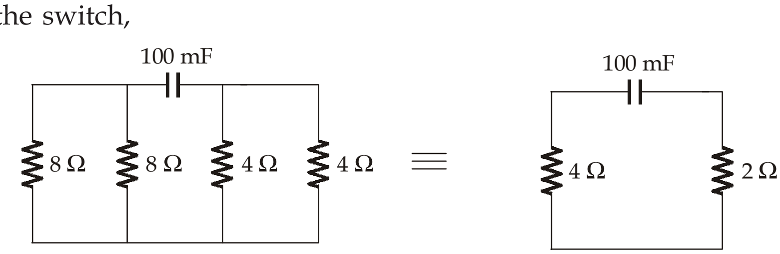
From superposition theorem,

$$P = \left[\left(\sqrt{P_1}\right) \pm \left(\sqrt{P_2}\right)\right]^2 = \left[\left(\sqrt{16}\right) \pm \left(\sqrt{4}\right)\right]^2 = (4 \pm 2)^2$$

$$= 36 \text{ W or } 4 \text{ W}$$

30. (d)

After closing of the switch,



The time constant, $$\tau = R_{eq}C = (4+2)\Omega \times 100 \text{ mF}$$

$$= 600 \text{ ms}$$

31. (d)

For y-parameter,

$$I_1 = y_{11}V_1 + y_{12}V_2$$
$$I_2 = y_{21}V_1 + y_{22}V_2$$

$\because$ Output port is short circuited

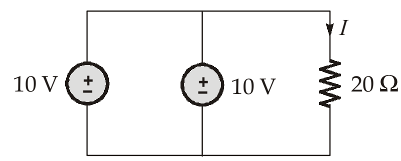
$\therefore$ $V_2 = 0$

and $V_1 = 1\text{ V}$

$\therefore$ $y_{21} = I_2$

33. (b)

The circuit can be redrawn as



Two 10 V source are in parallel, hence the KVL is satisfied and the current I is given by

$$I = \frac{V}{R} = \frac{10}{20} = \frac{1}{2} = 0.5\text{ A}$$

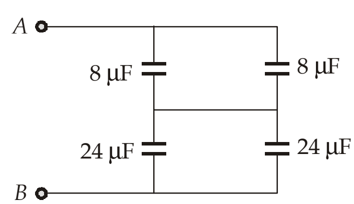
34. (b)

If two, 2-port networks are cascaded, the overall T-parameter is given by the multiplication of the individual network parameters,

$\therefore$
$$[T]_{\text{new}} = [T]_A \times [T]_B$$
$$= \begin{bmatrix} 1 & 2 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 4 \\ 2 & 3 \end{bmatrix}$$

35. (b)

After closing the switch, the circuit can be redrawn as



$$C_{\text{eq}} = (8+8)\,\mu\text{F} \,\|\, (24+24)\,\mu\text{F}$$
$$= \frac{16\times 48}{16+48} = \frac{16\times 48}{64} = 12\,\mu\text{F}$$

36. (b)

For parallel connection, aiding the equivalent inductance, we get,

$$L_{\text{eq}} = \frac{L_1L_2 - M^2}{L_1 + L_2 - 2M} = \frac{4\times 8 - 4}{4+8-4} = \frac{28}{8} = 3.5\text{ H}$$

37. (b)

$$\tan\theta = \frac{\omega L}{R}$$

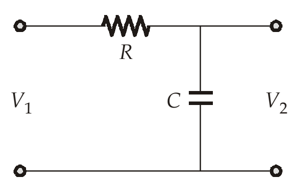
$$\because \quad \theta = 60°$$

$$\tan 60° = \sqrt{3} = \frac{\omega \times 60 \times 10^{-3}}{20}$$

$$\omega = \frac{20\sqrt{3}}{60} \times 10^{3} = \frac{1}{\sqrt{3}}\,\text{k rad/sec}$$

38. (d)

Simple RC integrator circuit is



$$\frac{V_2}{V_1} = \frac{1/Cs}{R + \frac{1}{Cs}} = \frac{1}{1 + RCs}$$

It is clear from the above expression that voltage transfer function of a simple RC integrator has a finite pole and a zero at infinity.

39. (b)

Driving point admittance function

$$y(s) = \frac{1/RLs}{\frac{1}{R} + \frac{1}{Ls}} + Cs = \frac{1/RLs}{\frac{Ls + R}{RLs}} + Cs = \frac{1}{Ls + R} + Cs$$

40. (b)

Given,

$$f(t) = e^{-3t}u(t) - e^{-3t}u(t-3)$$

$$= e^{-3t}u(t) - e^{-9}e^{-3(t-3)}\,u(t-3)$$

$$= \frac{1}{s+3} - e^{-9}\frac{e^{-3s}}{s+3}$$

$$X(s) = \frac{1}{(s+3)}\left(1 - e^{-3(s+3)}\right) \quad \text{ROC : real part of s} > -3$$

41. (c)

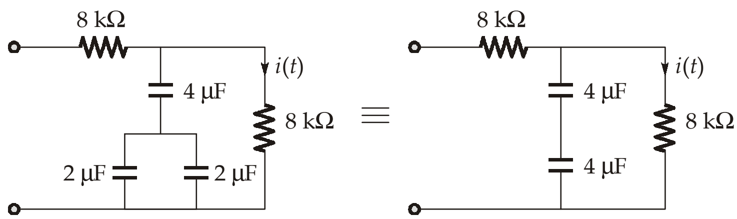
$$\frac{1}{Z(s)} = \frac{1}{1+s} + s + 1$$

$$\frac{1}{Z(s)} = \frac{(s+1)^2 + 1}{s+1}$$

$$\Rightarrow \quad Z(s) = \frac{s+1}{s^2 + 2s + 2}$$

43. (d)

For time constant calculation, the circuit can be redrawn as



where, $R_{eq} = 8\ k\Omega$

and $C_{eq} = 2\ \mu F$

$\therefore$ $\tau = R_{eq}C_{eq} = 16\ ms$

44. (a)

In a reciprocal two port network,

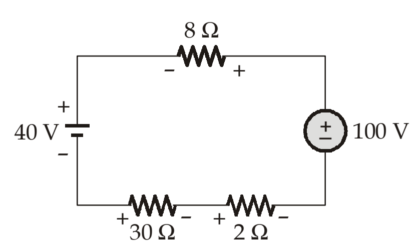
$$AD - BC = 1$$

45. (c)

$$V_1 = 10\ I_1 + 5I_2$$
$$V_2 = 5\ I_1 + 15I_2$$

Now,
$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$
$$I_2 = 0$$
$$\frac{V_1}{I_1} = \frac{A}{C} = 10$$
$$I_1 = 0$$
$$\frac{V_2}{I_2} = \frac{D}{C} = 15$$
$$\frac{A/C}{D/C} = \frac{A}{D} = \frac{10}{15} = \frac{2}{3}$$

46. (b)



$$40 + 8I + 30I + 2I = 100$$
$$40I = 60$$
$$I = 1.5\ A$$

Voltage drop across 30 Ω = 30 × 1.5 = 45 V

47. (c)

The average power is the power dissipated in the resistive part only,

$$P_{avg} = \frac{I_m^2}{2}R = \frac{5^2}{2}\times 5 = 62.5 \text{ W}$$

48. (c)

In the circuit shown the resistance R_L is fixed, for maximum power transfer to load,

$$R_S = 2\ \Omega$$

49. (a)

$$V = \frac{8di}{dt} - \frac{4di}{dt} + \frac{10di}{dt} - \frac{4di}{dt} + \frac{5di}{dt} + \frac{6di}{dt} + \frac{5di}{dt} = \frac{26di}{dt}$$

$$V/(di/dt) = 26 \text{ H}$$

50. (d)

For oscillatory response;

$$\xi < 1$$

for RLC circuit, $$\xi = \frac{R}{2}\sqrt{\frac{C}{L}}$$

i.e $$\frac{R}{2}\sqrt{\frac{C}{L}} < 1$$

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

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