CLASS TEST

Sl. 02 SK_EE_EFSGHI_200722[G]

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ELECTRIC CIRCUITS

ELECTRICAL ENGINEERING

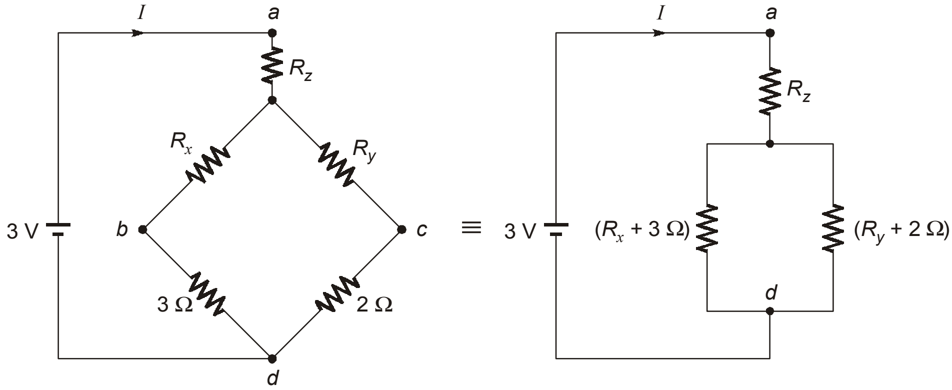
Date of Test : 20/07/2022

ANSWER KEY

1.	(c)	7.	(a)	13.	(b)	19.	(a)	25.	(a)
2.	(d)	8.	(c)	14.	(c)	20.	(d)	26.	(c)
3.	(d)	9.	(b)	15.	(a)	21.	(c)	27.	(b)
4.	(d)	10.	(a)	16.	(a)	22.	(c)	28.	(c)
5.	(b)	11.	(b)	17.	(c)	23.	(b)	29.	(b)
6.	(b)	12.	(c)	18.	(a)	24.	(c)	30.	(c)

1. (c)

Let us convert Δ *abc* to Y *xyz* where R_x R_y and R_z are the component resistors. Thus, the given circuit can be redrawn as



$$\therefore \qquad R_{ad} = \left[(R_x+3)\|(R_y+2)\right]+R_z$$

Where, $R_x = R_y = R_z = \frac{5}{3} = 1.667\ \Omega$

$$\therefore \qquad R_{ac} = \left[(1.667+3)\|(1.667+2)\right]+1.667$$

$$= [(4.667\,\|\,3.667)+1.667]\Omega = 3.721\ \Omega$$

$$\therefore \qquad \text{Source current} \quad I = \frac{3}{3.721} = 0.806\text{ A}$$

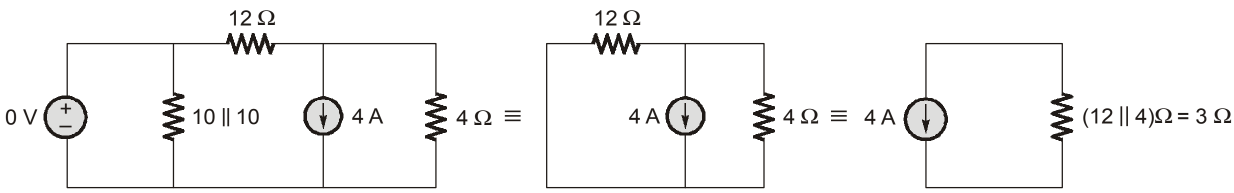
2. (d)

Here 5 V and –5 V sources are in series

$$\therefore \qquad 5-5 = 0\text{ V} \quad \text{(short circuit)}$$

Also 4 A and 4 A sources are in series which is equivalent to a 4A source.

∴ The circuit can be redrawn as



3. (d)

For maximum power to be transferred,

$$Z_L = Z_s^*$$

Here, $Z_s = (2 - j4)\Omega$

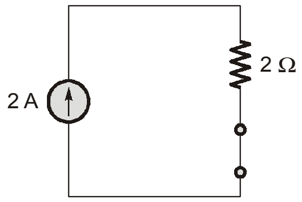
$$\therefore \qquad Z_s^* = (2-j4)^* = (2+j4)\ \Omega$$

4. (d)

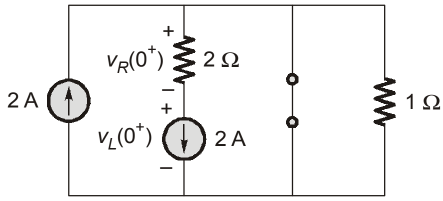
When the switch was open, the current source drives the current through *R-L* circuit thus

$$i_L(0^-) = i_L(0^+) = 2\text{ A}$$

and $\qquad v_c(0^-) = v_c(0^+) = 0\text{ V}$



After closing the switch, at $t = 0^+$ the capacitor acts as a short circuit.



However, the inductor current remains at 2 A.

$$\therefore \quad v_R(0^+) + v_L(0^+) = 0 \text{ V}$$

$$v_L(0^+) = -v_R(0^+) = -i_L(0^+) \times R = -2 \times 2 = -4 \text{ V}$$

5. (b)

$$v_2(t) = M\frac{di_1(t)}{dt} \qquad (\because \text{ secondary coil is open circuited})$$

$$M = k\sqrt{L_1 L_2} = 0.25\sqrt{0.6 \times 0.6} = 0.15 \text{ H}$$

So,
$$v_2(t) = M\frac{di_1(t)}{dt} = 0.15\frac{d}{dt}(6\sin 100t)V$$

or,
$$v_2(t) = 0.15 \times 6 \times 100\cos 100t \text{ V} = 90 \cos 100t \text{ V}$$

6. (b)

$$i(t) = \frac{V}{Z} = \frac{A\cos\omega t}{2 + j\omega}$$

Now,
$$V_2 = Z_2(j\omega)i(t)$$

$$V_1 = Z_1(j\omega)i(t)$$

$$\frac{V_2}{V_1} = \frac{1 + j\omega}{1} = 1 + j\omega$$

$$\therefore \quad \phi = \tan^{-1}\left(\frac{\omega}{1}\right) = \frac{\pi}{4}$$

$$\frac{\omega}{1} = 1$$

$$\omega = 1 \text{ rad/sec}$$

7. (a)

$$V_1 = 5I$$

Applying KVL around the loop we get

$10 \angle 30° - 1 \times I - 0.5(5I) - 5I = 0$

$$V_{oc} = 5I = \frac{10\angle 30°}{8.5} \times 5 = \frac{10\angle 30°}{1.7}$$

$$I_{sc} = \frac{10\angle 30°}{1} = 10\angle 30° \text{A}$$

$$\therefore \qquad Z_{th} = \frac{V_{oc}}{I_{sc}} = \frac{1}{1.7} = 0.588\ \Omega$$

8. (c)

For parallel resonant circuit

$$Q_0 = R\sqrt{\frac{C}{L}}$$

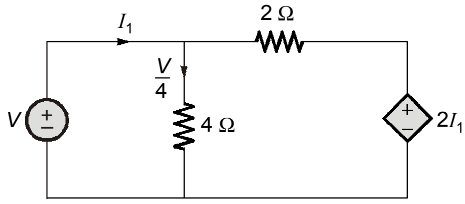
$$Q_0 = 2000\sqrt{\frac{54\times10^{-6}}{240\times10^{-3}}}$$

$$Q_0 = 2000\sqrt{\frac{9}{4}\times10^{-4}} = \frac{2000}{100}\times\frac{3}{2} = 30$$

9. (b)

Since no independent source in the network, thus $V_{\text{th}} = 0$ V.

$$\therefore \qquad V = R_{eq}\, I_1$$



$$-I_1 + \frac{V-0}{4} + \frac{V-2I_1}{2} = 0$$

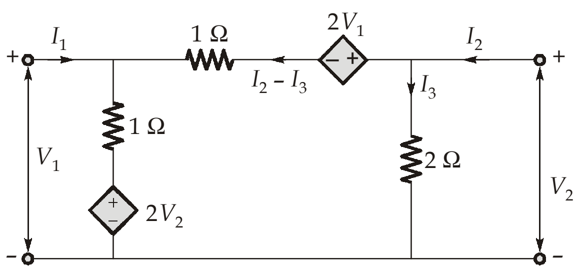
or
$$-I_1 + \frac{V}{4} + \frac{V-2I_1}{2} = 0$$

$$\frac{V}{4} + \frac{V}{2} = 2\, I_1$$

or
$$\frac{V}{I_1} = R_{eq} = 2.667\ \Omega$$

10. (a)

Transforming the dependent current source in to voltage source, the network is shown as,



Let I_3 be the current through 2 Ω

Apply KVL in outer loop,

$$-V_2 + 2V_1 + I_2 - I_3 + V_1 = 0$$

$$-V_2 + 3V_1 + I_2 - I_3 = 0 \qquad \text{...(i)}$$

Also,

$$-V_1 + I_1 + I_2 - I_3 + 2V_2 = 0 \qquad \text{...(ii)}$$

$$V_1 = I_1 + I_2 - I_3 + 2V_2$$

From equation (i) and (ii), we get

$$5V_2 + 3I_1 + 4I_2 - 4I_3 = 0$$

Where, $$I_3 = \frac{V_2}{2}$$

$$V_2 = -I_1 - \frac{4}{3}I_2$$

Hence, $$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = -1\Omega$$

11. (b)

$$Z_{Th} = (40 - j30) \parallel j20$$

$$= \frac{j20(40-j30)}{j20+40-j30} = (9.412 + j22.35)\ \Omega$$

By voltage division,

$$V_{th} = \frac{j20}{j20+40-j30}(150\angle 30°)$$

$$= 72.76\angle 134°\ \text{V}$$

The value of R_L that will absorb he maximum average power is

$$R_L = |Z_{th}| = \sqrt{(9.412)^2 + (22.35)^2} = 24.25\ \Omega$$

The current through the load is,

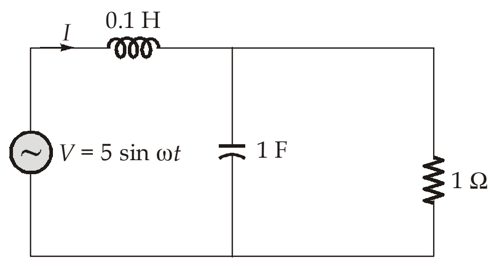
$$I = \frac{V_{th}}{Z_{th} + R_L} = \frac{72.76\angle 134°}{33.66 + j22.35} = 1.8\angle 100.416°$$

The maximum average power absorbed by R_L is

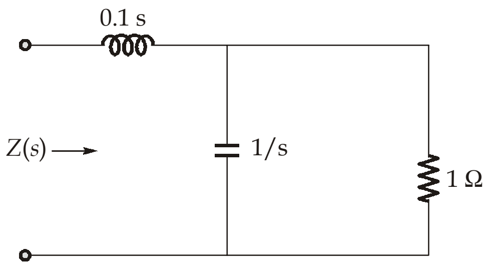
$$P_{max} = \frac{1}{2}|I|^2 R_L = \frac{1}{2}(1.8)^2(24.25)$$

$$= 39.285 \approx 39.29\ \text{W}$$

12. (c)



For V and I in phase imaginary part of $Z(s)$, should be zero,



$$Z(s) = \frac{\frac{1}{s}\times 1}{\frac{1}{s}+1} + 0.1s = \frac{1+0.1s+0.1s^2}{s+1}$$

multiplying numerator and denominator by $(s - 1)$

$$Z(s) = \frac{(0.1s^2+0.1s+1)(s-1)}{(s+1)(s-1)}$$

$$= \frac{0.1s^3+0.1s^2+s-0.1s^2-0.1s-1}{s^2-1}$$

Put $s = j\omega$

$$Z(j\omega) = \frac{0.1(j\omega)^3+0.9(j\omega)-1}{(j\omega)^2-1} = \frac{j(0.9\omega-0.1\omega^3)-1}{-\omega^2-1}$$

Equating imaginary part to zero,

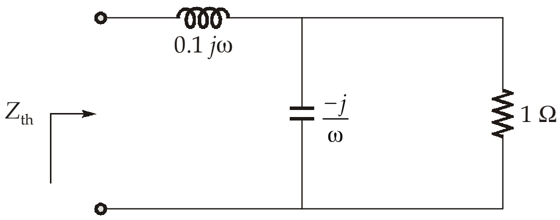
$$0.9\,\omega - 0.1\,\omega^3 = 0$$

$$\omega^2 = 9$$

$$\omega = \pm 3 \text{ rad/sec}$$

Alternative Solution:

In frequency domain,



$$Z_{th} = \frac{(1)(-j/\omega)}{1-j/\omega} + 0.1j\omega$$

$$\Rightarrow \quad \frac{j}{j-\omega} + 0.1j\omega = 0$$

$$\Rightarrow \quad \frac{j(j+\omega)}{(j-\omega)(j+\omega)} + 0.1j\omega = 0$$

$$\Rightarrow \quad \frac{1-j\omega}{1+\omega^2} + 0.1j\omega = 0$$

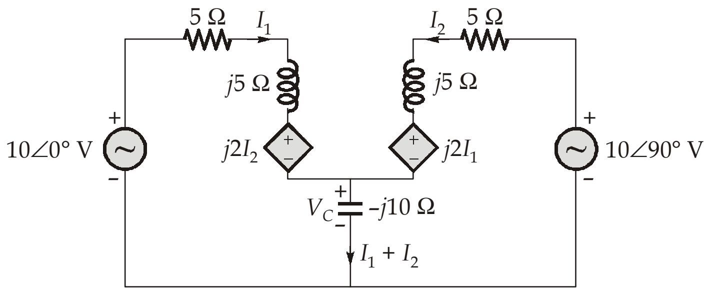
For V and I in phase, imaginary term = 0

Thus, $$\frac{-\omega}{1+\omega^2} + 0.1\omega = 0$$

$$\Rightarrow \quad \omega = 3 \text{ rad/s}$$

13. (b)

Using de-coupled technique,



Applying KVL in loop-1,

$$10\angle 0° = I_1(5 + j5 - j10) + I_2(j2 - j10)$$
$$= (5 - j5)I_1 + (-j8)I_2 \quad \text{...(i)}$$

Applying KVL in loop-2,

$$10\angle 90° = I_2(5 + j5 - j10) + I_1(j2 - j10)$$
$$10\angle 90° = I_2(5 - j5) + (-j8)I_1 \quad \text{...(ii)}$$

Now adding equation (i) and (ii),

$$10 + j10 = I_1(5 - j13) + I_2(5 - j13)$$
$$I_1 + I_2 = \frac{10 + j10}{5 - j13}$$
$$V_C = -jX_C(I_1 + I_2)$$
$$= -j10 \times \frac{10 + j10}{5 - j13} = 10.15\angle 24° \text{ V}$$

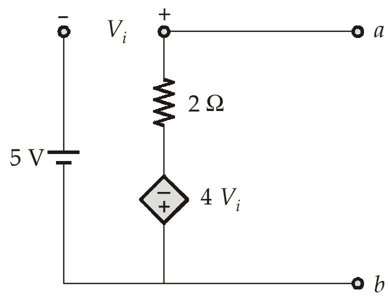
14. (c)

As we know that,

$$R_{th} = \frac{V_{OC}}{I_{SC}}$$

For V_{OC}

From the circuit, there is open voltage at terminal *ab*



$$V_{OC} = -4V_i$$

Where, $V_i = -4V_i - 5$

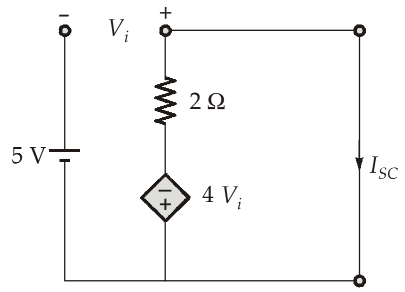
∴ $V_i = -1$

∴ $V_{OC} = -4 \times -1 = 4$ V

For I_{SC}

Short circuit current is determined by shorting terminals *a* and *b*,

Applying KVL,

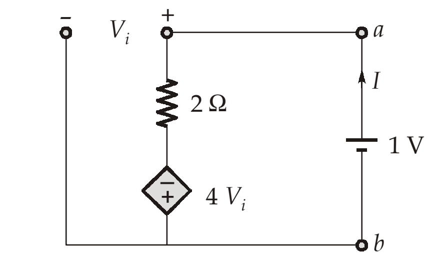


$$4V_i + 2\,I_{SC} = 0$$
$$2\,I_{SC} = -4\,V_i$$
$$I_{SC} = -2\,V_i$$
$$5 + V_i - 4V_i + 4V_i = 0$$
$$V_i = -5\text{ V}$$
$$I_{SC} = 10\text{ A}$$

$\therefore$ $$R_{th} = \frac{V_{OC}}{I_{SC}} = \frac{4}{10} = 0.4\ \Omega$$

Alternative Solution:

Let, V_{dc} = 1 V applied across a-b terminals



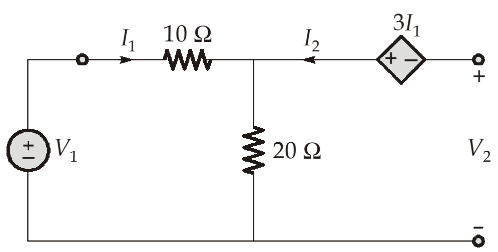
Applying KVL:

$$-1 + V_i = 0$$
$\Rightarrow$ $$V_i = 1$$
$$-1 + 2I - 4V_i = 0$$
$\Rightarrow$ $$-1 + 2I - 4 = 0$$
$\Rightarrow$ $$I = \frac{5}{2}\text{A}$$

Hence, $$R_{th} = R_{ab} = \frac{1}{I} = \frac{2}{5} = 0.4\,\Omega$$

15. (a)

To determine A and C, we leave the output port open as in figure. So that $I_2 = 0$ and place a voltage source V_1 at the input port.



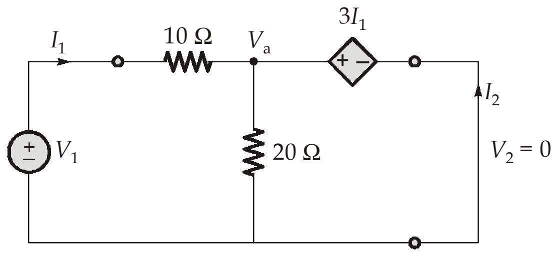
$$V_1 = (10 + 20)I_1 = 30I_1$$
$$V_2 = 20I_1 - 3I_1 = 17I_1$$

Thus,

$$A = \frac{V_1}{V_2} = \frac{30I_1}{17I_1} = 1.765$$

$$C = \frac{I_1}{V_2} = \frac{I_1}{17I_1} = 0.0588\ S$$

To obtain B and D, we short circuit the output port so that,



But, $$V_a = 3I_1$$

and $$I_1 = \frac{(V_1 - V_a)}{10}$$

$$V_1 = 13I_1$$

Applying KCL at node a,

$$I_1 - \frac{3I_1}{20} + I_2 = 0$$

$$\frac{17}{20}I_1 = -I_2$$

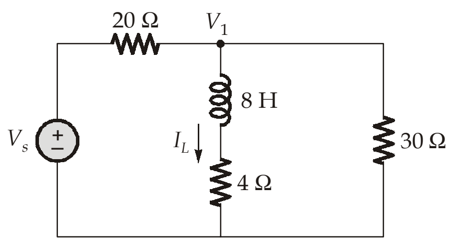
Therefore, $$B = -\frac{V_1}{I_2} = \frac{-13I_1}{\left(-\frac{17}{20}\right)I_1} = 15.29\ \Omega$$

$$D = \frac{20}{17} = 1.176$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1.765 & 15.29 \\ 0.0588 & 1.176 \end{bmatrix}$$

16. (a)

$$V_S(s) = \frac{-5}{s} + \frac{12}{s} + 3 = \left(\frac{7}{s} + 3\right)$$



$$\frac{(V_1 - V_s)}{20} + \frac{V_1}{8s+4} + \frac{V_1}{30} = 0$$

$$V_1\left(\frac{1}{20}+\frac{1}{8s+4}+\frac{1}{30}\right) = \frac{1}{20}\left(\frac{7+3s}{s}\right)$$

$$V_1\left(\frac{24s+12+60+16s+8}{60(8s+4)}\right) = \frac{1}{20s}(7+3s)$$

$$V_1 = \frac{7+3s}{20s}\times\frac{60(8s+4)}{(40s+80)}$$

$$= \frac{3}{s}\frac{(7+3s)(8s+4)}{(40s+80)}$$

$$I_L = \frac{3}{s}\frac{(7+3s)(8s+4)}{(40s+80)(8s+4)} = \frac{3}{s}\times\frac{(7+3s)}{40(s+2)}$$

$$I_L = \frac{3}{40}\left[\frac{7}{2s}+\frac{-1}{2(s+2)}\right]$$

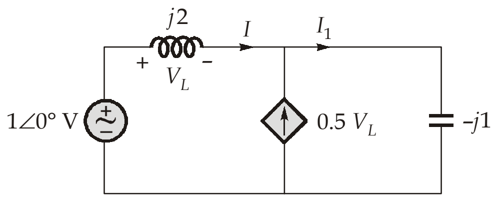
$$i_L(t) = \frac{3}{40}\left(\frac{7}{2}-\frac{1e^{-2t}}{2}\right)u(t)$$

$$i_L(t) = \left(\frac{21}{80}-\frac{3}{80}e^{-2t}\right)u(t)$$

17. (c)

$$X_L = \omega L = 2$$

$$X_C = \frac{1}{1} = 1$$



$$I = 0.5\,V_L + I_1$$

$$= -0.5\times(j2)I + I_1$$

$$I = -jI + I_1$$

$$I(1+j) = \frac{(1-j2I)}{-j1}$$

$$I(-j+1) = (1-j2I)$$

$$I(1+j) = 1$$

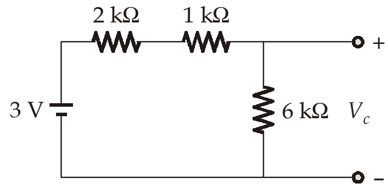
$$I = \left(\frac{1}{2}-\frac{j}{2}\right)$$

$$Y_{in} = I\times 1 = \left(\frac{1}{2}+\frac{1}{j2}\right)s$$

$$R = 2\,\Omega,\ L = 2\text{ H}$$

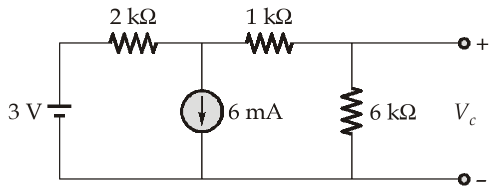
18. (a)

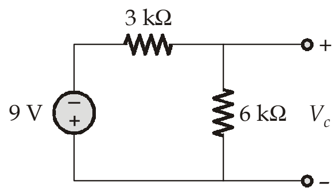
At $t < 0$,



$$V_c(0^-) = 3\times\frac{6}{(6+3)} = \frac{18}{9} = 2\text{ V}$$

At $t > 0$,





$$v_c(\infty) = \frac{6}{9}\times(-9) = -6\text{ V}$$

$$v_c(t) = -6 + (2+6)e^{-t/\tau}$$

$$\tau = \frac{18}{9}\times 1 = 2\ \mu\text{s}$$

$$V_c(t) = -6+8e^{-\frac{t}{2}}$$

$$V_c(2\ \mu\text{s}) = -6 + 8e^{-1} = -3.06\text{ V}$$

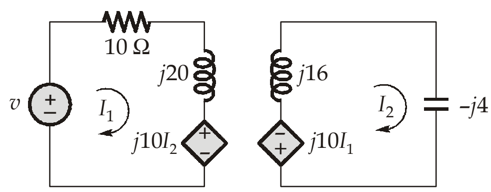
19. (a)

$$X_{L1} = j\omega L = j4\times 5 = j20\ \Omega$$

$$X_{L2} = j\omega L_2 = j4\times 4 = j16\ \Omega$$

$$X_C = \frac{1}{j\omega C} = \frac{16}{j4\times 1} = -j4\Omega$$

$$X_m = j\omega M = j\times 4\times 2.5 = j10\ \Omega$$



$$-60\angle 30° + (10+20j)I_1 + j10I_2 = 0 \qquad \text{...(i)}$$

$$(j16 - j4)I_2 + j10I_1 = 0$$

$$I_1 = -1.2I_2 \qquad \text{...(ii)}$$

$$-(10 + j20) \times 1.2I_2 + j10I_2 = 60\angle 30°$$
$$I_2 = 3.25\angle 160.6 \text{ A}$$
$$I_2 = 3.25 \cos(4t + 160.6°)$$
$$I_1 = 3.9 \cos(4t - 19.4°)$$

At $t = 1$ sec,
$$4t = 4 \text{ rad} = 229.18°$$
$$I_2 = 2.82 \text{ A}$$
$$I_1 = -3.38 \text{ A}$$

Total energy stored in the coupled inductor is

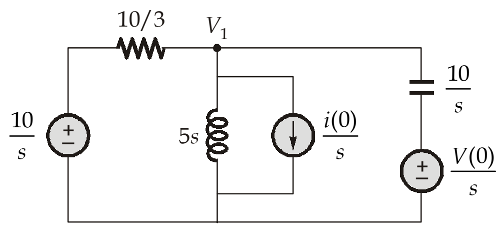
$$E = \frac{1}{2}L_i I_i^2 + \frac{1}{2}L_2 I_2^2 + MI_1I_2$$

$$E = \frac{1}{2}\times 5\times(-3.38)^2 + \frac{1}{2}\times 4\times(2.82)^2 - 2.5\times 3.38\times 2.82 = 20.5 \text{ J}$$

20. (d)

$$i(0) = -1 \text{ A}$$
$$V(0) = 5 \text{ V}$$

Apply node analysis



$$\frac{\left(V_1 - \frac{10}{s}\right)}{\frac{10}{3}} + \frac{V_1}{5s} - \frac{1}{s} + \frac{\left(V_1 - \frac{5}{s}\right)}{\left(\frac{10}{s}\right)} = 0$$

$$V_1\left(\frac{3}{10} + \frac{1}{5s} + \frac{s}{10}\right) - \frac{10\times 3}{s\times 10} - \frac{1}{s} - \frac{5}{s}\times\frac{s}{10} = 0$$

$$V_1\left(\frac{3s + 2 + s^2}{10s}\right) = \left(\frac{3}{s} + \frac{1}{s} + \frac{0.5s}{s}\right)$$

$$V_1 = \frac{10s}{(s^2 + 3s + 2)} \times \frac{(0.5s + 4)}{s}$$

$$V_1 = \frac{(5s + 40)}{s^2 + 3s + 2} = \frac{5(s + 8)}{(s + 1)(s + 2)}$$

$$V_1 = 5\left(\frac{7}{s + 1} - \frac{6}{s + 2}\right)$$

$$v_1(t) = \left(35e^{-t} - 30e^{-2t}\right)u(t)$$

21. (c)

Let the instantaneous voltage across the capacitor at any time t is,

$$v = V_m \cos \omega_o t$$

$\therefore$ Energy stored by the capacitor, $E_C = \frac{1}{2} C V_m^2 \cos^2 \omega_o t$ ...(i)

Similarly, the instantaneous current through the inductor at any time t will be,

$$i = \frac{1}{L}\int_0^t v\,dt = \frac{V_m}{\omega_0 L}\sin\omega_0 t = I_m \sin\omega_0 t$$

Where, $I_m = \frac{V_m}{\omega_o L}$ and $\omega_o = \frac{1}{\sqrt{LC}}$

$$i = I_m \sin \omega_o t$$

$\therefore$ Energy stored by the inductor,

$$E_L = \frac{1}{2} L I_m^2 \sin^2 \omega_o t = \frac{L}{2} \times \frac{V_m^2}{\frac{1}{LC} \times L^2} \sin^2 \omega_o t = \frac{1}{2} C V_m^2 \sin^2 \omega_o t$$

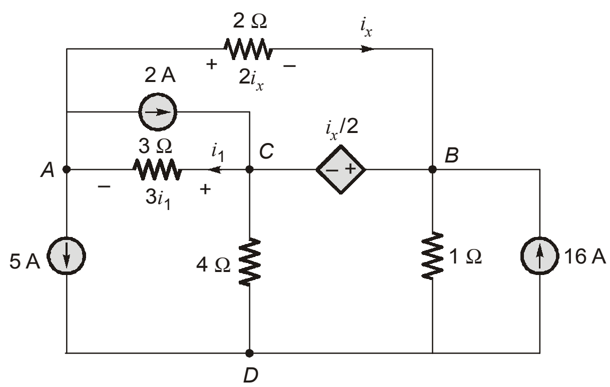
$\therefore$ Total energy $= E = E_C + E_L$

$$E = \frac{1}{2} C V_m^2 \left[\cos^2 \omega_o t + \sin^2 \omega_o t\right]$$

$$= \frac{1}{2} C V_m^2$$

22. (c)

Redrawing the given circuit, we get,



By KCL at node A, we get,

$$i_1 = 2 + 5 + i_x = 7 + i_x$$

By KVL in $ABCA$, we get,

$$2i_x + \frac{i_x}{2} + 3i_1 = 0$$

$$\frac{5i_x}{2} + 3(7 + i_x) = 0$$

$$\frac{5i_x}{2} + 21 + 3i_x = 0$$

$$\frac{11 i_x}{2} = -21$$

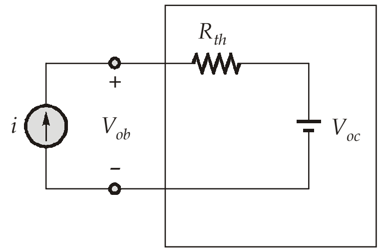
$$i_x = -\frac{42}{11} = -3.818 \text{ A}$$

23. **(b)**

The equation for the input can be written as

$$V_{ab} = i R_{th} + V_{oc}$$

Assume the equivalent network to be replaced by a Thevenin's equivalent.



Network N

Substituting the given values we get

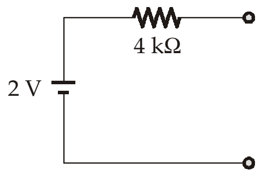
$$6 = 10^{-3} R_{th} + V_{oc} \quad \text{...(i)}$$

and
$$10 = 2 \times 10^{-3} R_{th} + V_{oc} \quad \text{...(ii)}$$

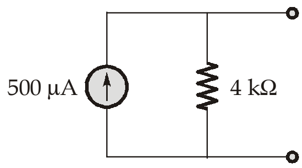
solving the two equations we get

$$V_{oc} = 2 \text{ V}$$
$$R_{th} = 4 \text{ k}\Omega$$

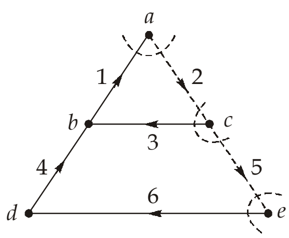
thus, the equivalent circuit can be drawn as



The equivalent Norton circuit can be drawn as



24. **(c)**



$C_1(1, 2)$: This separates the node-a and direction of both branch is opposite to each other.

$C_2(2, 3, 5)$: This separates node-C and direction of branch - 2 is opposite to branch - 3 and branch - 5.

25. (a)

$$[Z_a] = \begin{bmatrix} 25 & 20 \\ 5 & 10 \end{bmatrix}$$

$$\therefore \quad \Delta Z_a = 250 - 100 = 150$$

$$[Z_b] = \begin{bmatrix} 50 & 25 \\ 25 & 30 \end{bmatrix}$$

$$\Delta Z_b = 1500 - 625 = 875$$

$$[g] = \begin{bmatrix} \dfrac{1}{Z_{11}} & \dfrac{-Z_{12}}{Z_{11}} \\ \dfrac{Z_{21}}{Z_{11}} & \dfrac{\Delta Z}{Z_{11}} \end{bmatrix}$$

$$[g_a] = \begin{bmatrix} 0.04 & -0.8 \\ 0.2 & 6 \end{bmatrix}$$

$$[g_b] = \begin{bmatrix} 0.02 & -0.5 \\ 0.5 & 17.5 \end{bmatrix}$$

$$\therefore \quad [g] = [g_a] + [g_b]$$

$$= \begin{bmatrix} 60\text{ mS} & -1.3 \\ 0.7 & 23.5\ \Omega \end{bmatrix}$$

26. (c)

From Z-parameter model, we have

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

where,
$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \quad \text{...(i)}$$

Similarly from Y-parameter model, we have

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \quad \text{...(ii)}$$

Considering the above two conditions for transmission parameter model, we get,

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

By keeping $I_2 = 0$,
$$A = \frac{V_1}{V_2} \quad \text{and} \quad C = \frac{I_1}{V_2}$$

or,
$$\frac{V_1}{I_1} = \frac{A}{C} = Z_{11} \quad \text{...(iii)}$$

and by keeping $V_2 = 0$,
$$B = -\frac{V_1}{I_2} \quad \text{and} \quad D = -\frac{I_1}{I_2}$$

or $$\frac{I_1}{V_1} = \frac{D}{B} = Y_{11} \qquad \text{...(iv)}$$

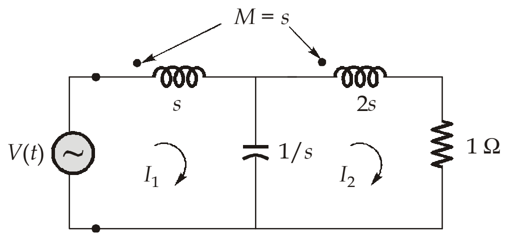
$\because$ $$Z_{11} = \frac{1}{Y_{11}} \qquad \text{(Given in the question)}$$

From equations (iii) and (iv), we get,

$$\frac{A}{C} = \frac{B}{D}$$

or $$AD - BC = 0$$

27. (b)



Applying laplace transform and KVL in loop 1.

$$V(s) = sI_1(s) + sI_2(s) + \frac{I_1(s) - I_2(s)}{s} \qquad \text{...(i)}$$

Applying KVL in loop 2.

$$0 = sI_1(s) + (2s+1)I_2(s) + \frac{I_2(s) - I_1(s)}{s} \qquad \text{...(ii)}$$

$\therefore$ $$\frac{I_1(s)}{s} - sI_1(s) = \left(2s + 1 + \frac{1}{s}\right) I_2(s)$$

$$\left(\frac{1}{s} - s\right) I_1(s) = \left(2s + 1 + \frac{1}{s}\right) I_2(s)$$

substituting the value of I_2 in eqn. (i) we get

$$Y_1(s) = \frac{I_1(s)}{V(s)} = \frac{2s^2 + s + 1}{s^3 + s^2 + 5s + 1}$$

substituting ω = 1 rad we get

$$Y_1(j\omega) = \frac{1+j}{4} = \frac{\sqrt{2}\angle 45°}{4}$$

$$I_1(j\omega) = Y_1(j\omega) V_1(j\omega)$$

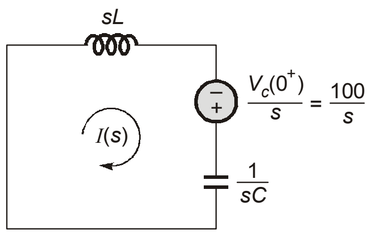
$\therefore$ $$i(t) = \cos(\omega t + 45°)\text{A}$$

28. (c)

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

$$v_c(0^-) = v_c(0^+) = 100 \text{ V}$$

The circuit can be redrawn in s-domain as,



or
$$I(s) = \frac{\left(\frac{100}{s}\right)}{\left(sL + \frac{1}{sC}\right)} = \frac{100}{L}\left(\frac{1}{s^2 + \frac{1}{LC}}\right)$$
$$= 100\sqrt{\frac{C}{L}}\left(\frac{\frac{1}{\sqrt{LC}}}{s^2 + \left(\frac{1}{\sqrt{LC}}\right)^2}\right)$$

Taking inverse Laplace transform of the above equation, we get,
$$i(t) = 100\sqrt{\frac{C}{L}}\sin\frac{1}{\sqrt{LC}}t$$

Now by putting the values of L and C, we get,
$$i(t) = 100\sqrt{\frac{10\times 10^{-6}}{1\times 10^{-3}}}\sin\frac{t}{\sqrt{10\times 1\times 10^{-9}}} = (10\sin 10^4 t)\text{ A}$$

29. (b)

From transmission parameter model,
$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$
∴
$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0}$$

From *h*-parameter model,
$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$
By keeping $I_2 = 0$,
$$\frac{I_1}{V_2} = \frac{-h_{22}}{h_{21}} = C$$

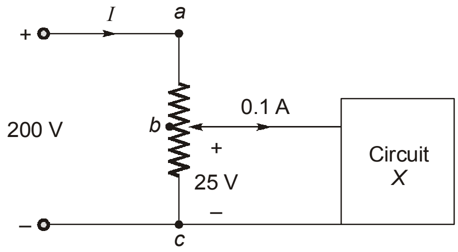
From *Z*-parameter model,
$$V_1 = Z_{11} I_1 + Z_{12} I_2$$
$$V_2 = Z_{21} I_1 + Z_{22} I_2$$
By keeping $I_2 = 0$,
$$\frac{I_1}{V_2} = \frac{1}{Z_{21}} = C$$

From *Y*-parameter model,
$$I_1 = Y_{11} V_1 + Y_{12} V_2$$
$$I_2 = Y_{21} V_1 + Y_{22} V_2$$
By keeping $I_2 = 0$,
$$V_1 = \frac{-Y_{22}}{Y_{21}} V_2$$
and
$$I_1 = \left[\frac{-Y_{22} Y_{11}}{Y_{21}} + Y_{12}\right] V_2$$
or
$$\frac{I_1}{V_2} = \left(Y_{12} - \frac{Y_{11} Y_{22}}{Y_{21}}\right) = C$$

Thus, only option (b) satisfies the condition.

30. (c)

By redrawing the circuit, we get,



Let us assume the tap position at 'b'

$\because \quad R_{ac} = 500\ \Omega$ (given)

Let, $\quad R_{bc} = x\ \Omega$

$\therefore \quad R_{ab} = (500 - x)\Omega$

Also, $\quad V_{ab} = 200 - 25 = 175$ V

The circuit current, $\quad I = \dfrac{25}{x} + 0.1$

We can also write, $\quad V_{ab} = I \times (500 - x) = \left(\dfrac{25}{x} + 0.1\right)(500 - x)$

or $\quad 0.1x^2 + 150x - 12500 = 0$

By solving, we get,

$$x = 79.16\ \Omega \quad \text{and} \quad -1579.16\ \Omega$$

By considering $x = 79.16\ \Omega$,

$$I = \frac{25V}{x} + 0.1\ A = 0.416\ A$$

Total power supplied = 200 V × I = 200 V × 0.416 A = 83.2 W

■■■■