CLASS TEST

S.No.: 01SK_ECEE_JKLMN_130825

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NETWORK THEORY

EC-EE

Date of Test : 13/08/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (b)

Since the network is passive, current I is due to the two sources V_1 and V_2.
By principle of superposition,

$$I = K_1V_1 + K_2V_2$$
$$1 = 4K_1 + 0$$
$$K_1 = 0.25$$

and
$$-1 = 0 + 5K_2$$
$$K_2 = \frac{-1}{5} = -0.2$$

Given,
$$V_1 = 10 \text{ V}$$

and
$$V_2 = 5 \text{ V}$$

$$\text{Current, } I = (10 \times 0.25) + (5 \times -0.2)$$
$$I = 2.5 - 1 = 1.5 \text{ A}$$

2. (a)

We have:
$$\vec{I}_3 = \vec{I}_1 - \vec{I}_2$$
$$= 6 \angle 30° - 2 \angle 20°$$
$$= 4.045 \angle 34.92° \text{A}$$

$\therefore$
$$I_{3\ max} = \sqrt{2} \times I_{rms}$$
$$= \sqrt{2} \times 4.045 = 5.72 \text{ A}$$

Here,
$$\phi = 34.92°$$

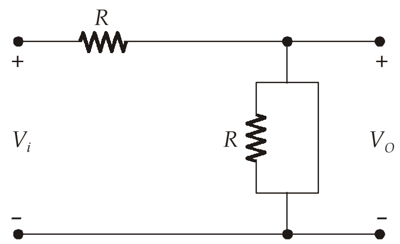
and
$$\omega = 2\pi f = 2\pi \times 60 = 377 \text{ rad/sec}$$

$\therefore$ Instantaneous current

$$i_3 = 5.72 \sin(377t + 34.92°) \text{ A}$$

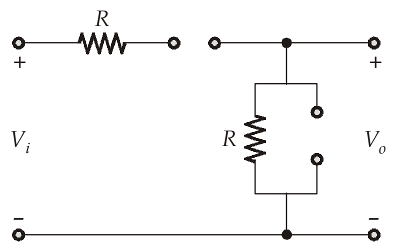
3. (c)

At $\omega \to \infty$, Capacitor $\to$ short circuited
Circuit looks like,



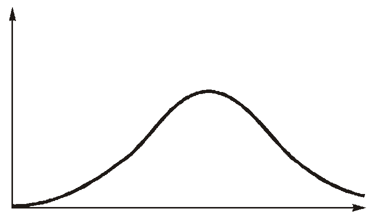
$$\frac{V_o}{V_i} = 0$$

At $\omega \to 0$, Capacitor $\to$ open circuited
Circuit looks like



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

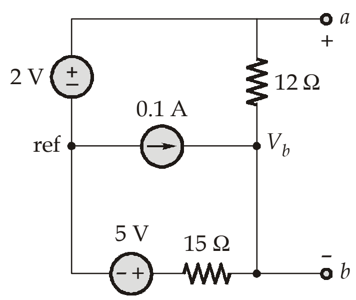
So frequency response of the circuit will be,



So the circuit is Band pass filter

4. (a)

Removing terminal C the circuit can be rearranged as,



V_{Th} is the voltage dropped by 12 Ω resistor

$$V_{\text{Th}} = V_a - V_b = 2 - V_b$$

Apply KCL at node b

$$\frac{V_b - V_a}{12} - 0.1 + \frac{V_b - 5}{15} = 0$$

By solving, we get

$$V_b = 4 \text{ V}$$

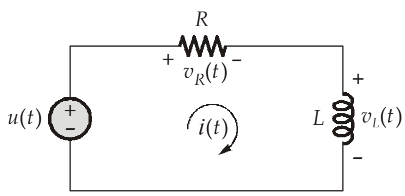
$$V_{\text{Th}} = -2 \text{ V}$$

$$R_{\text{Th}} = \frac{12 \times 15}{12 + 15} = 6.667\ \Omega$$

and

$$I_N = \frac{V_{Th}}{R_{Th}} = -0.3 \text{ A}$$

5. (a)



$$i(t) = 1 - e^{-t/\tau}$$

where, $$\tau = \frac{L}{R}$$

$$v_R(t) = i(t) \cdot R$$

$$v_R(t) = (1 - e^{-t/\tau})R$$

$$v_L(t) = L\frac{di}{dt} = L \cdot \frac{1}{\tau}e^{-t/\tau}$$

$$v_L(t) = Re^{-t/\tau}$$

Let $t = t_1$ when $v_R(t) = v_L(t)$

$\Rightarrow$ $$\left(1 - e^{-t_1/\tau}\right)R = \text{Re}^{-t_1/\tau}$$

$\Rightarrow$ $$2e^{-t_1/\tau} = 1$$

$\Rightarrow$ $$e^{-t_1/\tau} = \frac{1}{2}$$

$\Rightarrow$ $$-\frac{t_1}{\tau} = \ln\frac{1}{2} = -\ln 2$$

$\Rightarrow$ $$t_1 = \tau \ln 2$$

6. (c)

We apply KVL in the loop,

$$-12 + 4i + 2V_0 - 4 + 6i = 0$$

Put, $$V_0 = -6i$$

$$-12 + 4i - 12i - 4 + 6i = 0$$

$$-2i = 16$$

$$i = -8 \text{ A}$$

$$V_0 = -6 \times -8 = 48 \text{ V}$$

7. (c)

Current in a capacitor leads voltage by 90°,

Voltage across capacitor, $V_c = 10 \sin 2\pi t$

$$\text{Capacitor current} = \frac{V_c}{X_c} = \frac{10}{X_c}\sin\left(2\pi t + \frac{\pi}{2}\right)$$

$$= \frac{10}{X_c}\cos 2\pi t$$

$$\text{Power in capacitor} = V_c(t)\, i_c(t)$$

$$\text{Energy stores in capacitor} = \int_0^{0.5} V_c(t) i_c(t)\, dt$$

$$E_C = \int_0^{0.5} \frac{100}{X_C}\sin 2\pi t \cos 2\pi t$$

$$= \frac{50}{X_C}\int_0^{0.5} \sin 4\pi t\, dt = \frac{50}{X_C}\left[\frac{-\cos 4\pi t}{4\pi}\right]_0^{0.5}$$

$$E_C = \frac{50}{4\pi X_C}[-\cos 2\pi + \cos 0] = 0 \text{ J}$$

8. (a)

Here, Line voltage, V_L = 1100 V

Line current, I_L = 80 A

Power supplied, P = 100 kW

∴ power factor of the circuit,

$$\cos\phi = \frac{P}{\sqrt{3}V_L I_1} = \frac{100\times 10^3}{\sqrt{3}\times 1100\times 80} = 0.656 \text{ leading}$$

Impedance of the load per phase,

$$Z = \frac{V_{ph}}{I_{ph}} = \frac{\frac{V_L}{\sqrt{3}}}{I_1} = \frac{\frac{1100}{\sqrt{3}}}{80} = 7.94\ \Omega$$

Resistance of the load per phase,

$$R = Z\cos\phi = 7.94 \times 0.656 = 5.208\ \Omega \approx 5.21\ \Omega$$

Reactance of the load per phase,

$$X_C = \sqrt{Z^2 - R^2} = \sqrt{(7.94)^2 - (5.21)^2} = 5.99\ \Omega$$

Capacitance of the load per phase,

$$C = \frac{1}{2\pi f X_C}$$

$$\frac{1}{2\pi\times 50\times 5.99} = 531.4\ \mu\text{F}$$

9. (c)

The transfer function is,

$$H(s) = \frac{V_0(s)}{V_i(s)} = \frac{R\,\|\,\frac{1}{sC}}{sL + R\,\|\,\frac{1}{sC}} = \frac{R}{s^2RLC + sL + R}$$

or
$$H(j\omega) = \frac{R}{-\omega^2 RLC + j\omega L + R}$$

Since $H(0) = 1$ and $H(\infty) = 0$

∴ The circuit is a second-order low pass filter.

10. (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,

$$P = 2\left(\frac{V_L}{2}\right)^2 \times \frac{1}{R} = \frac{V_L^2}{2R}$$

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

11. (d)

Applying KVL in primary and secondary loops,

$$V_1 = I_1 j\omega L_1 - I_2 j\omega M \quad \text{...(i)}$$

$$0 = -I_1 j\omega M + I_2 (100 + j\omega L_2) \quad \text{...(ii)}$$

$$\text{Input impedance} = Z_{in} = \frac{V_1}{I_1} = j\omega L_1 - \frac{I_2}{I_1} j\omega M$$

From equation (ii), we get

$$\frac{I_2}{I_1} = \frac{j\omega M}{100 + j\omega L_2}$$

Substituting the above expression in equation (i), we get

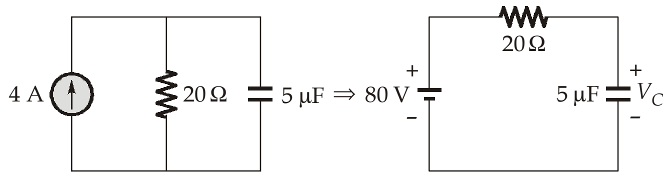
$$Z_{in} = j\omega L_1 - \frac{(j\omega M)^2}{100 + j\omega L_2}$$

$$= (j1000) + \frac{(1000)^2 \times 4}{100 + j4000} \quad [\because M^2 = L_1 L_2]$$

$$Z_{in} = 25\angle 1.43° \ \Omega$$

12. (d)

The circuit that exists for $t < 0$ is,



$$V = IR = 4 \times 20 = 80 \text{ V}$$

$$\therefore \quad V_c(0^+) = V_c(0^-) = 80 \text{ V}$$

$$\text{Time constant, } \tau = RC = 20 \times 5 \times 10^{-6} = 10^{-4} \ s$$

After $t = 0$,

$$V_c(t) = V_\infty - (V_\infty - V_0)\, e^{-t/\tau}$$

$$= 0 - (0 - 80)\, e^{-t/\tau}$$

$$V_c(t) = 80 e^{-10^4 t}$$

The half of initial voltage,

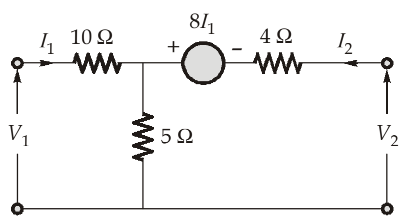
$$\frac{80}{2} = 40 \text{ V}$$

$$\therefore \quad 40 = 80 e^{-10^4 t}$$

$$0.5 = e^{-10^4 t}$$

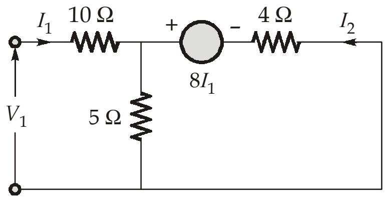
$$\text{Time, } t = 69.3 \ \mu s$$

13. (a)



$$I_1 = Y_{11} V_1 + Y_{12} V_2$$

Short-circuiting port-2 i.e. $V_2 = 0$, we get



Applying KVL in both loops, we get

$$V_1 = 10I_1 + 5I_1 + 5I_2 \quad \text{...(i)}$$

and $$4I_2 + 5I_2 + 5I_1 - 8I_1 = 0$$

$$\Rightarrow \quad 9I_2 = 3I_1$$

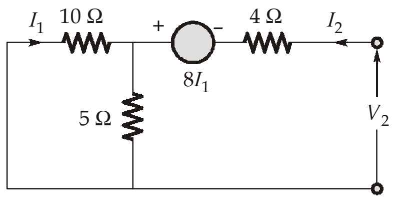
$$\Rightarrow \quad I_2 = \frac{I_1}{3} \quad \text{...(ii)}$$

From equations (i) and (ii); we get

$$V_1 = 10I_1 + 5I_1 + \frac{5I_1}{3} = 15I_1 + \frac{5I_1}{3} = \frac{50I_1}{3}$$

$$\Rightarrow \quad \left.\frac{I_1}{V_1}\right|_{V_2=0} = Y_{11} = \frac{3}{50}\text{ mho}$$

Short circuiting port-1; i.e. $V_1 = 0$, we get



Applying KVL in both loops; we have

$$10I_1 + 5I_1 + 5I_2 = 0$$

$$15I_1 = -5I_2$$

$$\Rightarrow \quad I_2 = -3I_1 \quad \text{...(iii)}$$

and $$V_2 = 4I_2 - 8I_1 + 5I_1 + 5I_2$$

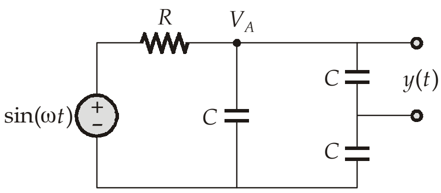
$$\Rightarrow \quad V_2 = 9I_2 - 3I_1$$

$$\Rightarrow \quad V_2 = 9(-3I_1) - 3I_1 \quad \text{[Using equation (iii)]}$$

$$\Rightarrow \quad V_2 = -30I_1$$

$$\therefore \quad \left.\frac{I_1}{V_2}\right|_{V_1=0} = Y_{12} = -\frac{1}{30}\text{ mho}$$

14. (b)



Applying KCL at node A, we get

$$\frac{V_A - \sin\omega t}{R} + \frac{V_A}{\frac{1}{j\omega C}} + \frac{V_A}{\frac{2}{j\omega C}} = 0 \quad \text{...(i)}$$

$$V_A\left[\frac{1}{R}+j\omega C+\frac{j\omega C}{2}\right] = \frac{\sin\omega t}{R}=\frac{1\angle 0^\circ}{R}$$

$$V_A = \frac{2}{2+3RC\cdot j\omega} \quad \text{...(ii)}$$

Also $$Y = \frac{V_A}{2}=\frac{1}{2+3j\omega RC} \quad \text{...(iii)}$$

$\because$ $$|A(\omega)| = \frac{1}{4} = 0.25$$

$\therefore$ $$\frac{1}{4} = \frac{1}{\sqrt{4+9\omega^2(RC)^2}}$$

or, $$\omega = \frac{2}{\sqrt{3}\,RC}$$

15. (c)

rms value of the waveform,

$$= \sqrt{\frac{1}{T}\int_0^T x(t)^2\,dt} = \sqrt{\frac{1}{T}\int_0^T\left[\left(\frac{10}{T}\right)t\right]^2 dt}$$

Since the line passing through origin is,

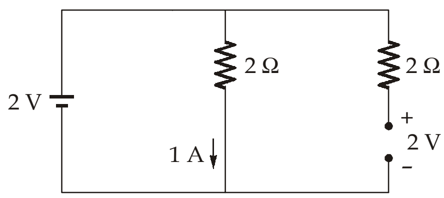
$$y = mx$$

$$y = \left(\frac{10-0}{T}\right)t$$

$$\text{RMS} = \sqrt{\frac{10^2}{T^3}\left[\frac{t^3}{3}\bigg|_0^T\right]} = \frac{10}{\sqrt{3}} = 5.77$$

16. (d)

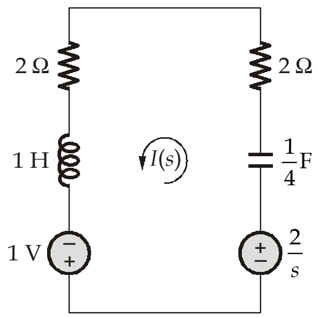
The circuit in the steady state with switch 's' is closed

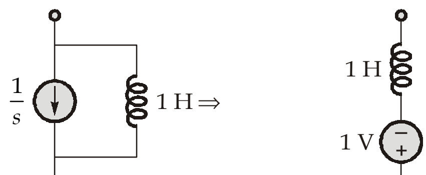


$$i(0^+) = i(0^-) = 1\text{ A}$$

and $$V_c(0^+) = V_c(0^-) = 2\text{ V}$$

Changing the circuit in s-domain





Source transformation

$$V = \frac{1}{S} \times SL(s) = 1 \times 1 = 1 \text{ V}$$

KVL in the loop gives:

$$\frac{2}{s} + 1 = \left(\frac{4}{s} + 4 + s\right) I(s)$$

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

Taking inverse laplace, we get

$$i(t) = e^{-2t}$$

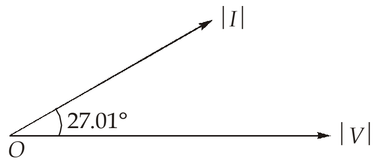
17. (d)

$$Y_{eq} = \frac{1}{50} + \frac{1}{j(2\pi \times 50 \times 0.15)} + j(2\pi \times 50 \times 100 \times 10^{-6})$$

$$Y_{eq} = 0.0224\angle 27.01° \ ℧$$

$$Z_{eq} = 44.64\angle -27.01° \ \Omega$$

$$I = \frac{100\angle 0°}{44.64\angle -27.01°} = 2.24\angle 27.01° \text{ A}$$



The input power factor $= \cos(27.01°) = 0.89$ leading

18. (b)

When the switch is at position 1,

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

Voltage across capacitor at $t > 0$

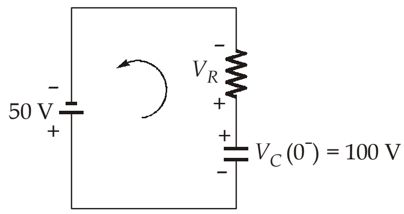
$$V_C = V_\infty - (V_\infty - V_0)e^{-t/\tau}$$

Where, $\tau = RC = 5000 \times 1 \times 10^{-6} = 5$ msec

$$V_C = (-50) - (-50 - 100)e^{-200t}$$

$$V_C = (150\, e^{-200t} - 50) \text{ V}$$

Applying KVL in the loop

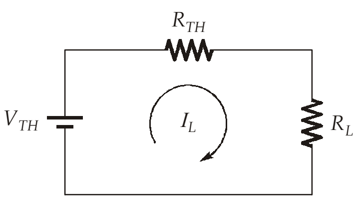


$$-V_C + V_R - 50 = 0$$

$$V_R = V_C + 50 = 150\, e^{-200t} - 50 + 50$$

$$V_R = 150\, e^{-200t} \text{ V}$$

19. (a)



For first case,

$$P = 20 \text{ kW and } R_L = 50\ \Omega$$

Power, $P = I_L^2 R_L$

or, $20 \times 10^3 = I_L^2 \times 50$

or, $I_L = 20$ A

and $V_{TH} = 20.\, R_{TH} + 1000$ ... (i)

For second case

Power, $P = 20$ kW and $R_L = 200\ \Omega$

$$\therefore \quad I_L = \sqrt{\frac{P_L}{R_L}} = \sqrt{\frac{20 \times 10^3}{200}} = 10\,\text{A}$$

and $V_{TH} = 10\, R_{TH} + 2000$ ... (ii)

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

$V_{TH} = 3000$ V and $R_{TH} = 100\ \Omega$

Thus, the maximum power transfer to the load

$$P_L = \frac{V_{TH}^2}{4R_{TH}} = \frac{(3000)^2}{4 \times 100} = 22.5\ \text{kW}$$

20. (a)

$$V_{ab} = V_{\text{Th}}$$

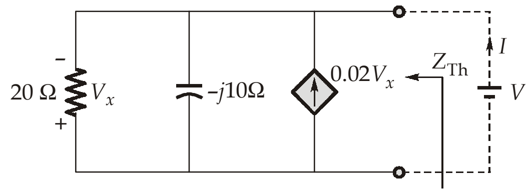
By applying KCL,

$$\frac{V_{Th} - 100}{20} + \frac{V_{Th}}{-j10} = 0.02\, V_x$$

Where, $V_x = 100 - V_{\text{Th}}$

$$\frac{V_{Th} - 100}{20} + \frac{V_{Th}}{-j10} = 0.02(100 - V_{Th})$$

$$V_{\text{Th}} = \frac{7}{0.07 + j0.1} = 57.34\angle{-55°}\ \text{V}$$



$$Z_{\text{Th}} = \frac{V}{I}$$

By apply KCL in the circuit gives,

$$\frac{V}{20} + \frac{V}{-j10} - 0.02V_x = I$$

and, $V_x = -V$

$$\therefore \quad \frac{V}{20} + \frac{V}{-j10} + 0.02V = I$$

$$Z_{\text{Th}} = \frac{V}{I} = \left[\frac{1}{\frac{1}{20} + \frac{1}{-j10} + 0.02}\right]$$

$$= (4.7 - j6.7)\Omega$$

21. (a)

Given,

$$V_1 = 4V_2 - 20I_2 \quad ...(i)$$

$$I_1 = 0.1\ V_2 - 2I_2 \quad ...(ii)$$

We need to find the Thevenin impedance Z_{th}

At the input port, $V_1 = -10I_1$ ...(iii)

(For Thevenin impedance calculation voltage source is replaced by short circuit)

Put equation (iii) in equation (i),

$$-10I_1 = 4V_2 - 20I_2$$

$$I_1 = -0.4\ V_2 + 2I_2 \quad ...(iv)$$

Equating equation (ii) and (iv),

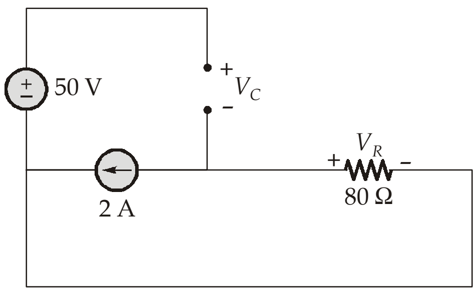
$$0.1\ V_2 - 2I_2 = -0.4\ V_2 + 2I_2$$

$$0.5\ V_2 = 4I_2$$

$$Z_{th} = \frac{V_2}{I_2} = 8\ \Omega$$

22. (b)

For $t < 0$;



$$V_R\ (0^-) = -160\ \text{V}$$

$$V_{2A} = 160\ \text{V}$$

$$V_C(0^+) = 210\ \text{V}$$

and $V_C(0^-) = V_C(0^+) = 210$ V

23. (a)

Total impedance is

$$Z = Z_3 + (Z_1 \,||\, Z_2)$$

$$= (30 + jX) + \left(\frac{(20 + j10)(10 - j30)}{20 + j10 + 10 - j30}\right)$$

$$= 30 + jX + \frac{500 - j500}{30 - j20}$$

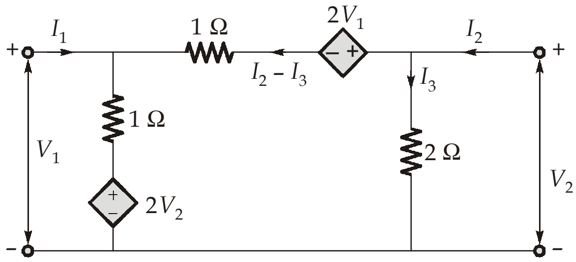
$$= 30 + jX + 19.23 - 3.846\ i$$

At resonance, the imaginary part is zero

$\therefore$ $X = 3.846\ \Omega \approx 3.85\ \Omega$

24. (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,

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

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

Also,

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

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

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

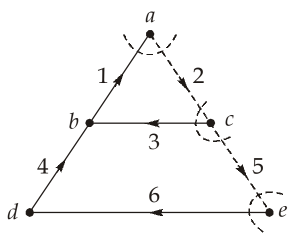
$$5V_2 + 3I_1 + 4I_2 - 4I_3 = 0$$

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

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

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

25. (c)

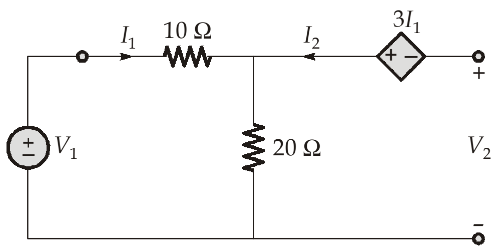


$C_1(1, 2)$: This separates the node-a and direction of both branch is opposite to each other.

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

26. (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.



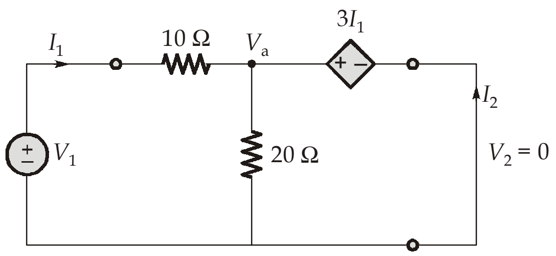
$$V_1 = (10 + 20)I_1 = 30I_1$$
$$V_2 = 20I_1 - 3I_1 = 17I_1$$

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

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

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

27. (b)

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

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

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,

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

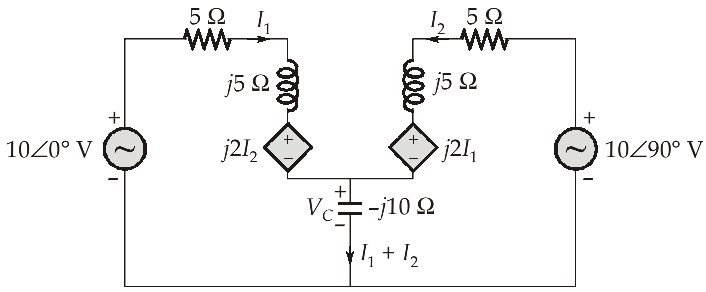
The maximum average power absorbed by R_L is

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

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

28. (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),

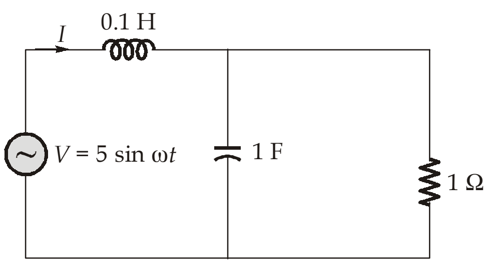
$$10 + j10 = I_1(5 - j13) + I_2(5 - j13)$$

$$I_1 + I_2 = \frac{10 + j10}{5 - j13}$$

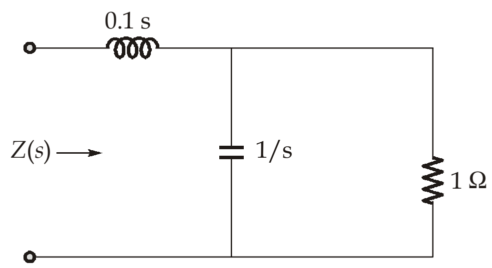
$$V_C = -jX_C(I_1 + I_2)$$

$$= -j10 \times \frac{10 + j10}{5 - j13} = 10.15\angle 24° \text{ V}$$

29. (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,

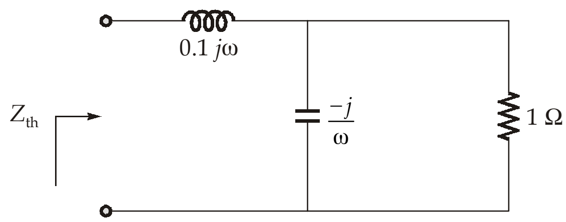
$$0.9\,\omega - 0.1\,\omega^3 = 0$$

$$\omega^2 = 9$$

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

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

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

30. (c)

$$M = K\sqrt{L_1 L_2} = 0.5\sqrt{36}$$
$$= 3 \text{ H}$$

The total energy stored in the system,

$$W(t) = \frac{1}{2}L_1[i_1(t)]^2 + \frac{1}{2}L_2[i_2(t)]^2 - M[i_1(t)i_2(t)]$$

$$= \frac{1}{2}\times 4[5\cos(50t - 30°)]^2 + \frac{1}{2}\times 9[2\cos(50t - 30°)]^2$$
$$-3\ [5\ \cos(50t - 30°) \times 2\ \cos(50t - 30°)]$$

at $t = 0$,

$$W(t) = 28.5 \text{ J}$$

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