Q1-1 (a)

1> $Q(s) = s^5 + s^3 + s$

Solution:- Since the given Polynomial contains odd funcions only, it is not Possible to Perform CFE

$$Q'(s) = \frac{d}{ds} Q(s) = 5s^4 + 3s^2 + 1$$

By CFE

$$5s^4 + 3s^2 + 1 \,)\, s^5 + s^3 + s \,(\tfrac{1}{5}s$$

$$s^5 + \tfrac{3}{5}s^3 + \tfrac{1}{5}s$$

$$- \quad - \quad -$$

$$\tfrac{2}{5}s^3 + \tfrac{4}{5}s \,)\, 5s^4 + 3s^2 + 1 \,(\tfrac{25}{2}s$$

$$5s^4 + 10s^2$$

$$- \quad -$$

$$-7s^2 + 1 \,)\, \tfrac{2}{5}s^3 + \tfrac{4}{5}s \,(-\tfrac{2}{35}s$$

Since quotient term is negative, Q(s) is not hurwitz

2> $Q(s) = s^4 + 6s^3 + 8s^2 + 10$

In the given Polynomial, the term s is missing and it is neither an even nor an odd Polynomial. Hence, it is not hurwitz

d. Y-Parameter interms of Z-Parameter

we know that,

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

By Cramer's Rule,

$$I_1 = \frac{\begin{vmatrix} V_1 & Z_{12} \\ V_2 & Z_{22} \end{vmatrix}}{\begin{vmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{vmatrix}} = \frac{Z_{22} V_1 - Z_{12} V_2}{Z_{11} Z_{22} - Z_{12} Z_{21}} = \frac{Z_{22}}{\Delta Z} V_1 - \frac{Z_{12}}{\Delta Z} V_2$$

where $\Delta Z = Z_{11} Z_{22} - Z_{12} Z_{21}$

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

$$Y_{11} = \frac{Z_{22}}{\Delta Z} \quad \& \quad Y_{12} = \frac{-Z_{12}}{\Delta Z}$$

Also,

$$I_2 = \frac{\begin{vmatrix} Z_{11} & V_1 \\ Z_{21} & V_2 \end{vmatrix}}{\Delta Z} = \frac{Z_{11} V_2 - Z_{12} V_1}{\Delta Z} = -\frac{Z_{21}}{\Delta Z} V_1 + \frac{Z_{11}}{\Delta Z} V_2$$

Comparing with $I_2 = Y_{21} V_1 + Y_{22} V_2$

$$Y_{21} = -\frac{Z_{21}}{\Delta Z} \quad Y_{22} = \frac{Z_{11}}{\Delta Z}$$

Q1-2

(a) $Z(s) = \dfrac{3(s+2)(s+4)}{s(s+3)}$

$$Z(s) = \frac{3[s^2+6s+8]}{s^2+3s} = \frac{3s^2+18s+24}{s^2+3s}$$

$$
\begin{array}{r|l}
s^2+3s & 3s^2+18s+24 \;(3 \\
 & \underline{3s^2+9s} \\
 & \quad 9s+24
\end{array}
$$

$$Z(s) = \underbrace{3}_{Z_1(s)} + \underbrace{\frac{9s+24}{s(s+3)}}_{Z_2(s)}$$

$$Z_2(s) = \frac{9s+24}{s(s+3)}$$

$$\frac{9s+24}{s(s+3)} = \frac{A}{s} + \frac{B}{s+3}$$

$9s+24 = A(s+3) + Bs$

Put $s = 0$

$24 = A(3)$

$\boxed{A = 8}$

Put $s = -3$

$-27+24 = -3B$

$-3 = -3B$

$\boxed{B = 1}$

$$Z_2(s) = \frac{8}{s} + \frac{1}{s+3}$$

$$Z(s) = \underbrace{3}_{Z_1} + \underbrace{\frac{8}{s}}_{Z_2} + \underbrace{\frac{1}{s+3}}_{Z_3}$$

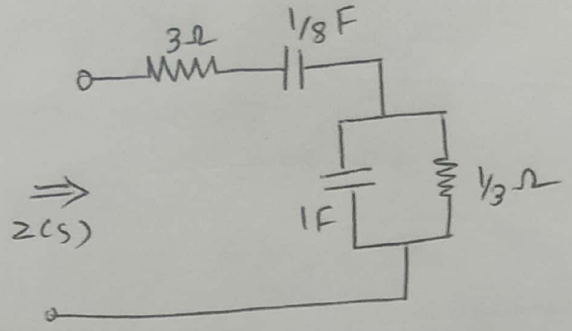
$Z_1 = 3 \rightarrow R = 3\Omega$

$Z_2 = \frac{8}{s} \rightarrow \frac{1}{Cs} \Rightarrow C = \frac{1}{8} F$

$Z_3 = \frac{1}{s+3} \Rightarrow Y_3 = s+3$

$\downarrow$ Cs, $C = 1F$

$\downarrow$ $R = \frac{1}{3}\Omega$



Foster:- II

$$Y(s) = \frac{s^2+3s}{3s^2+18s+24}$$

$$3s^2+18s+24 \,\big)\, s^2+3s \,\big(\, 1/3$$
$$s^2+6s+8$$
$$- \quad - \quad -$$
$$-3s-8$$

$$\frac{Y(s)}{s} = \frac{\cancel{s}(s+3)}{3\cancel{s}(s+2)(s+4)}$$

$$\frac{Y(s)}{s} = \frac{1}{3}\left[\frac{A}{(s+2)} + \frac{B}{s+4}\right]$$

$$\frac{\cancel{s}(s+3)}{\cancel{s}\cancel{3}(s+2)(s+4)} = \frac{1}{3}\left[\frac{A}{s+2} + \frac{B}{s+4}\right]$$

$$\frac{s+3}{(s+2)(s+4)} = \frac{A}{s+2} + \frac{B}{s+4}$$

$$s+3 = A(s+4) + B(s+2)$$

Put $s = -4$

$$-1 = B(-2)$$

$$\boxed{B = 1/2}$$

Put $s = -2$

$$1 = A(2)$$

$$\boxed{A = 1/2}$$

$$\frac{Y(s)}{s} = \frac{1}{3}\left[\frac{1/2}{s+2} + \frac{1/2}{s+4}\right]$$

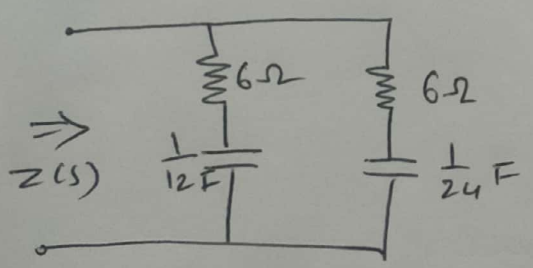
$$\frac{Y(s)}{s} = \frac{1}{6}\left[\frac{1}{s+2} + \frac{1}{s+4}\right]$$

$$Y(s) = \underbrace{\frac{s}{6(s+2)}}_{Y_1} + \underbrace{\frac{s}{6(s+4)}}_{Y_2}$$

$$Y_1 = \frac{s}{6s+12} \Rightarrow Z_1 = \frac{6s+12}{s} = \underbrace{6}_{R = 6\Omega} + \underbrace{\frac{12}{s}}_{\frac{1}{Cs} = C \Rightarrow \frac{1}{12}F}$$

$$Y_2 = \frac{s}{6s+24} \Rightarrow Z_2 = \frac{6s+24}{s} \Rightarrow \underbrace{6}_{R = 6\Omega} + \underbrace{\frac{24}{s}}_{\frac{1}{Cs} = C = \frac{1}{24}F}$$

Foster II :-



(b) $Z(s) = \dfrac{(s+1)(s+3)}{s(s+2)}$

Cauer - I

$$Z(s) = \frac{s^2+4s+3}{s^2+2s}$$

By CFE

$s^2+2s \,)\, s^2+4s+3 \,(\, 1 \rightarrow Z = 1\Omega$

$\quad -s^2 - 2s$

$\quad 2s+3 \,)\, s^2+2s \,(\, \frac{s}{2} \rightarrow Y = Cs \Rightarrow C = \frac{1}{2}F$

$\quad\quad -\cancel{s^2} - \frac{3}{2}s$

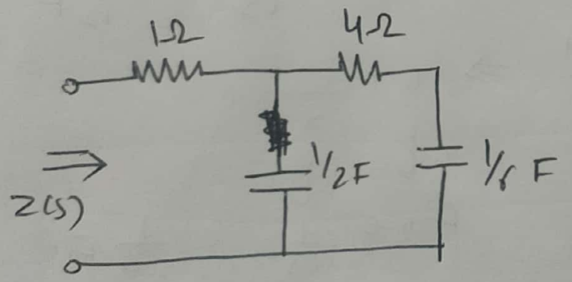
$\quad\quad \frac{1}{2}s \,)\, 2s+3 \,(\, 4 \rightarrow Z = 4\Omega$

$\quad\quad\quad -2s$

$\quad\quad\quad 3 \,)\, \frac{1}{2}s \,(\, \frac{s}{6} \rightarrow Y = Cs = C = \frac{1}{6}F$

$\quad\quad\quad\quad -\frac{1}{2}s$

$\quad\quad\quad\quad 0$



Cauer II :-

$$Z(s) = \frac{3+4s+s^2}{2s+s^2}$$

$2s+s^2 \,)\, \cancel{3} + 4s + s^2 \,\left(\, \frac{3}{2s} \longrightarrow Z \Rightarrow \frac{1}{Cs} \Rightarrow C = \frac{2}{3}F\right.$

$\cancel{3} + \frac{3}{2}s$

$- \quad -$

$\frac{5}{2}s + s^2 \,)\, 2s + s^2 \,\left(\, \frac{4}{5} \longrightarrow Y = \frac{1}{R} \Rightarrow R = \frac{5}{4}\,\Omega\right.$

$2s + \frac{4}{5}s^2$

$- \quad -$

$\frac{1}{5}s^2 \,)\, \frac{5}{2}\cancel{s} + s^2 \,\left(\, \frac{25}{2s} \rightarrow Z \Rightarrow \frac{1}{Cs} \Rightarrow C = \frac{2}{25}F\right.$

$\frac{5}{2}\cancel{s}$

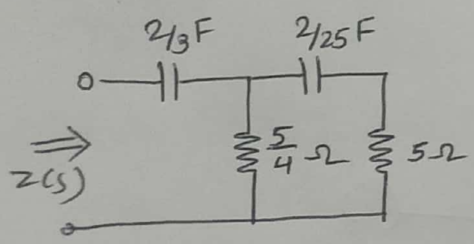
$-$

$s^2 \,)\, \frac{1}{5}s^2 \,\left(\, \frac{1}{5} \rightarrow Y = \frac{1}{R} \Rightarrow R = 5\,\Omega\right.$

$\frac{1}{5}s^2$

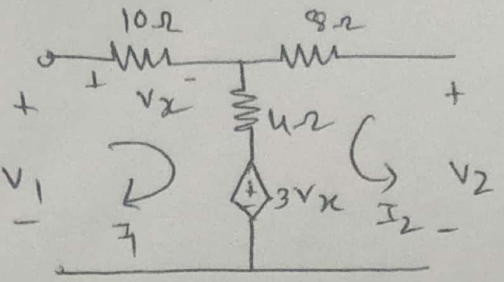
$-$

0



Q:-3

(a) For N_1



$V_x = 10 I_1$

KVL to loop 1

$V_1 - 10 I_1 - 4(I_1 + I_2) - 3V_x = 0$

$V_1 = 44 I_1 + 4 I_2$ ——— (1)

KVL to loop 2

$V_2 - 8I_2 - 4(I_2 + I_1) - 3V_x = 0$

$V_2 = 34 I_1 + 12 I_2$ ——— (2)

$12 I_2 = -34 I_1 + V_2$

$I_2 = -\frac{34}{12} I_1 + \frac{1}{12} V_2$

$I_2 = -2.83 I_1 + 0.0833 V_2$ ——— (i)

$\boxed{h_{21} = -2.83 \qquad h_{22} = 0.0833}$

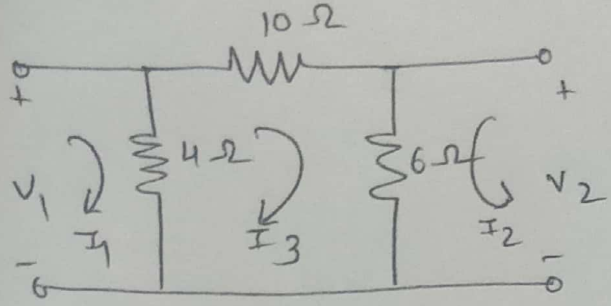
$V_1 = 44 I_1 + 4[-2.83 I_1 + 0.0833 V_2]$

$V_1 = 32.68 I_1 + 0.33 V_2$

$\boxed{h_{11} = 32.68 \qquad h_{12} = 0.33}$

$h_1 = \begin{bmatrix} 32.68 & 0.33 \\ -2.83 & 0.0833 \end{bmatrix}$

For N_2



loop 1

$V_1 - 4(I_1 - I_3) = 0$

$V_1 = 4I_1 - 4I_3$ —— (i)

loop 2

$V_2 - 6(I_2 + I_3) = 0$

$V_2 = 6I_2 + 6I_3$ —— (ii)

loop 3

$-10I_3 - 6(I_3 + I_2) - 4(I_3 - I_1) = 0$

$-10I_3 - 6I_3 - 6I_2 - 4I_3 + 4I_1 = 0$

$4I_1 - 6I_2 - 20I_3 = 0$

$20I_3 = 4I_1 - 6I_2$

$I_3 = \frac{I_1}{5} - \frac{3}{10} I_2$

$V_1 = 4I_1 - 4\left[\frac{I_1}{5} - \frac{3}{10} I_2\right]$

$V_1 = \frac{16}{5} I_1 + \frac{6}{5} I_2$ —— (1)

$V_2 = 6I_2 + 6\left[\frac{I_1}{5} - \frac{3}{10} I_2\right]$

$V_2 = \frac{6}{5} I_1 + \frac{21}{5} I_2$ —— (2)

Rearrange eqn (2)

$$\frac{21}{5} I_2 = V_2 - \frac{6}{5} I_1$$

$$\boxed{I_2 = -\frac{2}{7} I_1 + \frac{5}{21} V_2}$$

$$\boxed{h_{21} = -\frac{2}{7} \qquad h_{22} = \frac{5}{21}}$$

$$V_1 = \frac{16}{5} I_1 + \frac{6}{5}\left(-\frac{2}{7} I_1 + \frac{5}{21} V_2\right)$$

$$\boxed{V_1 = \frac{20}{7} I_1 + \frac{2}{7} V_2}$$

$$\boxed{h_{11} = \frac{20}{7} \qquad h_{12} = \frac{2}{7}}$$

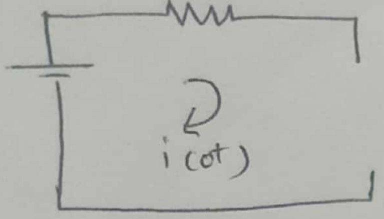
N_1

$$\begin{bmatrix} 32.68 & 0.33 \\ -2.83 & 0.0833 \end{bmatrix} + \begin{bmatrix} \frac{20}{7} & \frac{2}{7} \\ -2/7 & \frac{5}{21} \end{bmatrix} = \begin{bmatrix} 35.53\,\Omega & 0.616 \\ -3.116 & 0.3212 \end{bmatrix}$$

(b) At $t = 0^-$, No current flowing thro the inducter

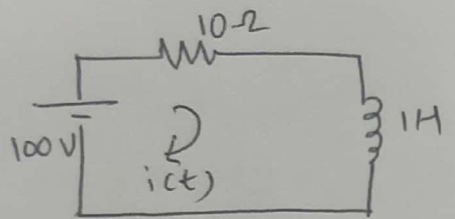
$$i(0^-) = 0$$

At $t = 0^+$



$$i(0^+) = 0$$

For $t > 0$ the network is shown.



$$100 - 10\,i(t) - 1\frac{di}{dt} = 0 \quad \text{—— (1)}$$

$$\frac{di}{dt} = 100 - 10\,i(t) \quad \text{—— (2)}$$

At $t = 0^+$

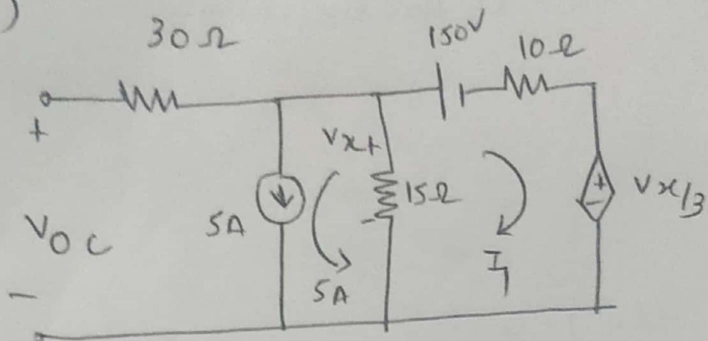
$$\boxed{\frac{di}{dt}(0^+) = 100 \text{ A/s}}$$

Differentiating equation 2

$$\frac{d^2 i}{dt^2} = -10\frac{di}{dt}$$

$$\boxed{\frac{d^2 i}{dt^2} = -10(100) = -1000 \text{ A/s}^2}$$

Q:- 4
(a)



Step :- I

$V_x = -15(5+I_1)$

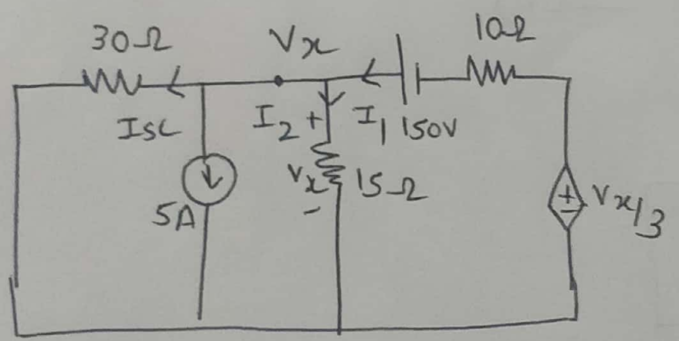
$-150 + 10I_1 - \frac{V_x}{3} - 15(I_1+5) = 0$

$I_1 = -10\,Amp$

$V_{OC} = V_x = -15(5-10)$

$\boxed{V_{OC} = 75\,V}$

Step :- II Find I_{SC}



Applying KCL at node V_x

$I_1 = I_2 + 5 + I_{SC}$

$$\frac{\frac{V_x}{3} + 150 - V_x}{10} = \frac{V_x}{15} + 5 + \frac{V_x}{30}$$

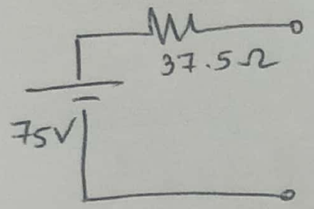
$\boxed{V_x = 60V}$

$I_{SC} = \frac{V_x}{30} = 2\,Amp.$

Step III :-

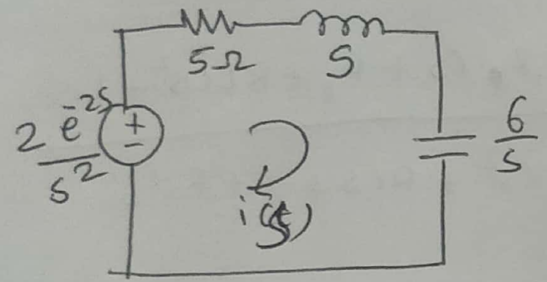
$$R_{TH} = \frac{V_{OC}}{I_{SC}} = \frac{75}{2} = 37.5\Omega$$

Step IV :-



(b) solution :-

In s-domain



$$\frac{2e^{-2s}}{s^2} - 5I(s) - sI(s) - \frac{6}{s}I(s) = 0$$

$$\frac{2e^{-2s}}{s^2} = I(s)\left[5+s+\frac{6}{s}\right]$$

$$I(s) = \frac{2e^{-2s}}{s(s^2+5s+6)} = \frac{2e^{-2s}}{s(s+3)(s+2)}$$

By P.F

$$\frac{1}{s(s+3)(s+2)} = \frac{A}{s} + \frac{B}{s+3} + \frac{C}{s+2}$$

$$I(s) = 2e^{-2s}\left[\frac{1}{6s} + \frac{1}{3(s+3)} - \frac{1}{2(s+2)}\right]$$

$$I(s) = \frac{1}{3}\frac{e^{-2s}}{s} - \frac{e^{-2s}}{s+2} + \frac{2}{3}\frac{e^{-2s}}{s+3}$$

$$\boxed{i(t) = \frac{1}{3}u(t-2) - e^{-2(t-2)}u(t-2) + \frac{2}{3}e^{-3(t-2)}u(t-2)}$$

Q! 5

(a)

$$Z(s) = \frac{(R_1+Ls)\cdot(R+1/Cs)}{R_1+Ls+R+\frac{1}{Cs}} = \frac{\frac{R_1 R + \frac{R_1}{Cs} + RLs + \frac{L}{C}}{}}{\frac{R_1Cs + LCs^2 + RCs + 1}{Cs}}$$

$$= \frac{R_1R\,Cs + R_1 + RLCs^2 + Ls}{LCs^2 + RCs + 1 + R_1Cs}$$

$$= \frac{RLCs^2 + s[R_1RC + L] + R_1}{LCs^2 + s[RC + R_1C] + 1}$$

$$Z(s) = H\cdot\frac{(s+1)(s+3)}{(s+1+\sqrt{5}j)(s+1-\sqrt{5}j)}$$

$$= \frac{H(s+1)(s+3)}{(s+1)^2 - (j\sqrt{5})^2}$$

$$= \frac{H[s^2+4s+3]}{s^2+2s+1+6} = \frac{H[s^2+4s+3]}{s^2+2s+6}$$

$$Z(0) = H\left[\frac{3}{6}\right] \qquad \therefore H = 2 \qquad Z(s) = 2\frac{[s^2+4s+3]}{s^2+2s+6}$$

$$1 = \frac{H}{2}$$

$$= \frac{RLC\left[s^2 + s\left[\frac{R_1RC+L}{RLC}\right] + \frac{R_1}{RLC}\right]}{LC\left[s^2+s\left[\frac{RC+R_1C}{LC}\right] + \frac{1}{LC}\right]}$$

$$= \frac{R\left[s^2+s\left[\frac{R_1}{L} + \frac{1}{RC}\right] + \frac{R_1}{RLC}\right]}{s^2+s\left[\frac{R}{L}+\frac{R_1}{L}\right] + \frac{1}{LC}}$$

$\boxed{R = 2\,\Omega}$

$\frac{R_1}{L} + \frac{1}{RC} = 4$

$\frac{R_1}{RLC} = 3$

$\frac{R+R_1}{L} = 2$

$\frac{1}{LC} = 6$

$\boxed{\begin{array}{l} R = 2\Omega \\ R_1 = 1\Omega \\ L = \frac{3}{2}H \\ C = \frac{3}{20}F \end{array}}$

$\frac{R_1}{L} + \frac{1}{2C} = 4$

$\frac{R_1}{2LC} = 3$

$\boxed{\frac{R_1}{LC} = 6}$

$\frac{2+R_1}{L} = 2$

$2 + R_1 = 2L$

$R_1 \cdot 6 = 6$

$\boxed{R_1 = 1\,\Omega}$

$\frac{1}{L} + \frac{1}{2C} = 4$

$\frac{2+1}{L} = 2$

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

$\boxed{L = \frac{3}{2}H}$

$\frac{1}{\frac{3}{2}} + \frac{1}{2C} = 4$

$\frac{2}{3} + \frac{1}{2C} = 4$

$\frac{1}{2C} = 4 - \frac{2}{3}$

$\frac{1}{2C} = \frac{10}{3}$

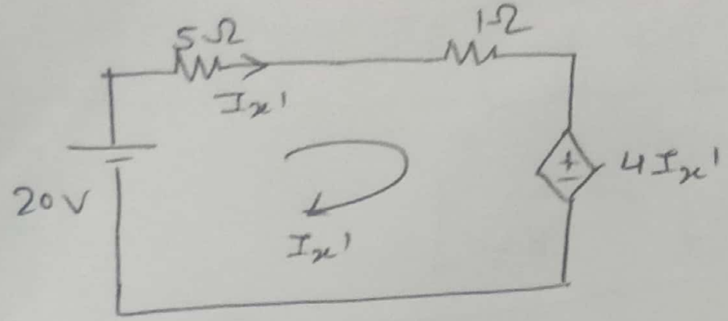
$\frac{1}{2} = \frac{10}{3}C$

$\boxed{\frac{3}{20} = C}$

$\boxed{C = \frac{3}{20}F}$

(b)

Step I:- considering only 20V

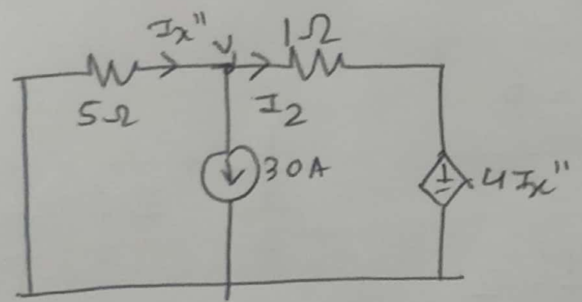


$$20 - 5I_x' - I_x' - 4I_x' = 0$$

$$20 = 10I_x'$$

$$\boxed{I_x' = 2A}$$

Step II:- considering only 30A



$$I_x'' = 30 + I_2$$

$$\frac{-V_1}{\cancel{5}} = 30 + \frac{V_1 - 4I_x''}{1}$$

$$I_x'' = 30 + V_1 - 4I_x''$$

$$5I_x'' = 30 + V_1$$

$$\cancel{5}\left[\frac{-V_1}{\cancel{5}}\right] = 30 + V_1$$

$$-30 = 2V_1$$

$$\boxed{V_1 = -15V}$$

$$I_x'' = -\frac{V_1}{5} = 3A$$

$$I_x = I_x' + I_x''$$

$$= 2 + 3$$

$$\boxed{I_x = 5A}$$

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Q1-6

(a) $F(s) = \dfrac{2s^4 + 7s^3 + 11s^2 + 12s + 4}{s^4 + 5s^3 + 9s^2 + 11s + 6}$

Step I:-

$Z(s) = 2s^4 + 7s^3 + 11s^2 + 12s + 4$

s^4	2	11	4
s^3	7	12	0
s^2	$\frac{53}{7}$	4	0
s	$440/53$	0	
s^0	4		

$Z(s) = s^4 + 5s^3 + 9s^2 + 11s + 6$

s^4	1	9	6
s^3	5	11	0
s^2	$34/5$	6	0
s	$\frac{112}{17}$	0	
s^0	6		

1st condition is satisfied.

step II:-

$N(s) = 2s^4 + 7s^3 + 11s^2 + 12s + 4$

$(s+2)(s+0.5)(s+0.5+j1.323)(s+0.5-j1.323)$

$D(s) = s^4 + 5s^3 + 9s^2 + 11s + 6$

$(s+3)(s+1)(s+0.5-j1.323)(s+0.5+j1.323)$

No poles on jw axis

residue test not require

2nd condition satisfied.

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Step 3:-

$$A(\omega^2) = m_1 m_2 - n_1 n_2 \Big|_{s=j\omega}$$

$m_1 = 2s^4 + 11s^2 + 4$ $\quad n_1 = 7s^3 + 12s$

$m_2 \; s^4 + 9s^2 + 6$ $\quad n_2 = 5s^3 + 11s$

$$A(\omega^2) = (2s^4 + 11s^2 + 4)(s^4 + 9s^2 + 6) - (7s^3 + 12s)(5s^3 + 11s)$$

$$= 2s^8 + 18s^6 + 12s^4 + 11s^6 + 99s^4 + 66s^2 + 4s^4 + 36s^2 + 24$$

$$- [35s^6 + 77s^4 + 60s^4 + 23s^2]$$

$=$ for all values of $\omega \geq 0$

$A(\omega^2) \geq 0$

$\therefore$ Third condition satisfied

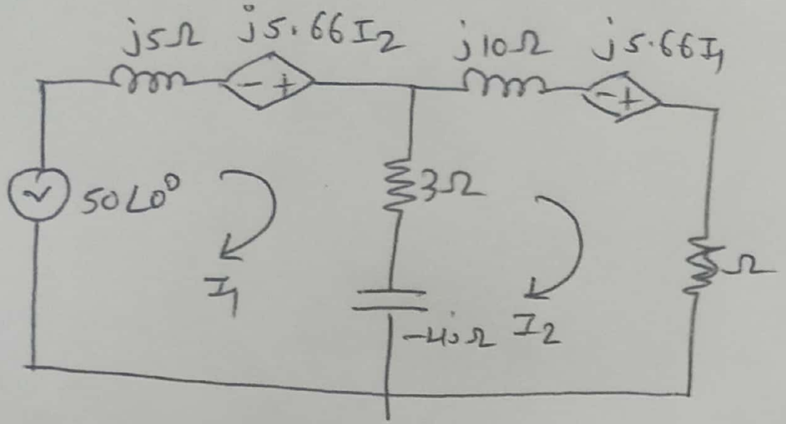
$\therefore$ given function is PRF

(b) For magnetically coupled circuit

$$X_m = K\sqrt{X_{L_1} X_{L_2}}$$

$$= 0.8\sqrt{(5)(10)}$$

$$= 5.66\,\Omega$$



KVL to mesh 1

$$50\angle 0^\circ - j5I_1 + j5.66 I_2 - (3-4j)(I_1 - I_2) = 0$$

$$(3+j)I_1 - (3+j1.66)I_2 = 50\angle 0^\circ \quad \text{——} \; (1)$$

KVL to mesh 2

$$-(3-4j)(I_2 - I_1) - j10 I_2 + j5.66 I_1 - 5I_2 = 0$$

$$-(3+j1.66)I_1 + (8+6j)I_2 = 0$$

$$\begin{bmatrix} 3+j & -(3+j1.66) \\ -(3+j1.66) & 8+6j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 50\angle 0 \\ 0 \end{bmatrix}$$

$$I_2 = \frac{\begin{vmatrix} 3+j & 50\angle 0 \\ -(3+j1.66) & 0 \end{vmatrix}}{\begin{vmatrix} 3+j & -(3+j1.66) \\ -(3+j1.66) & 8+6j \end{vmatrix}} = 8.62\angle -24.79$$

$$\boxed{V_{5\Omega} = 5I_2 = 43.1\angle -24.79^\circ \text{ A}}$$