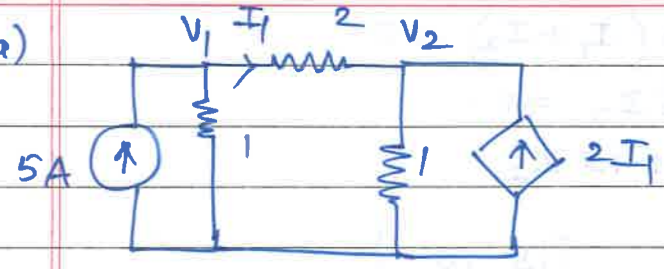
QP code: 24950

Q1 a)



$5 = \frac{V_1}{1} + \frac{V_1 - V_2}{2} \Rightarrow 5 = V_1\left(1+\frac{1}{2}\right) - \frac{V_2}{2}$

$5 = V_1(3/2) - \frac{V_2}{2}$

$2I_1 + I_1 = \frac{V_2}{1}$

$3I_1 = V_2/1 \Rightarrow 3\left(\frac{V_1 - V_2}{2}\right) = \frac{V_2}{1}$

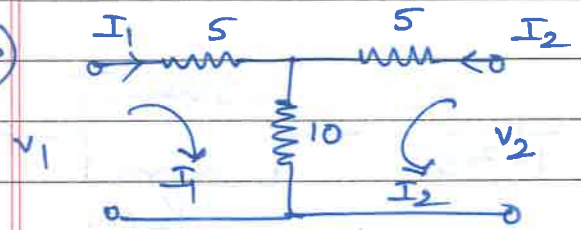
$\frac{3}{2}V_1 - V_2\left(\frac{3}{2}+\frac{1}{2}\right) = 0$

$\frac{3}{2}V_1 - V_2(5/2) = 0$

$V_1 = 4.167$

$V_2 = 2.5$

b)



KVL equations

$V_1 - 5I_1 - 10(I_1 + I_2) = 0$

$V_1 - 15I_1 - 10I_2 = 0$

$V_1 = 15I_1 + 10I_2$

classmate

Date

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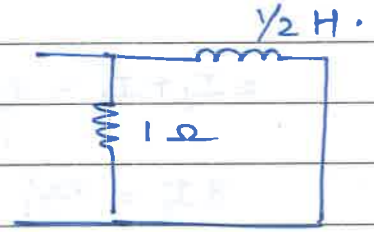
$V_2 - 5I_2 - 10(I_1 + I_2) = 0$

$V_2 - 10I_1 - 15I_2 = 0.$

$V_2 = 10I_1 + 15I_2$

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 15 & 10 \\ 10 & 15 \end{bmatrix}.$$

c) $y(s) = \frac{s+2}{s}$

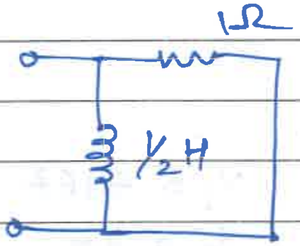


Cauer ~~Foster~~ I $\rightarrow$ $s)\, s+2\, (1 \leftarrow y$

$\underline{s}$

$2)\, s\, (s/2 \leftarrow z$

Cauer II $\quad y(s) = \frac{2+s}{s}$



$s)\, 2+s\, (2/s$

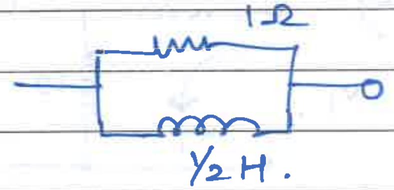
$\underline{2}$

$s)\, s\, (1$

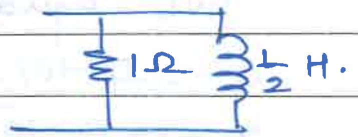
$\underline{s}$

0

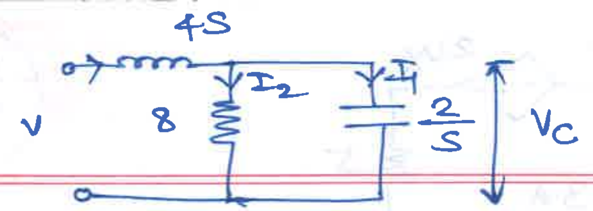
Foster I $-$ $z = \frac{s}{s+2} = \frac{1}{1+2/s}$



Foster II $-$ $y(s) = \frac{s+2}{s} = 1 + \frac{2}{s}$



d)



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$$= 4s + \left(8 \,//\, 2/s\right)$$

$$= 4s + \left(\frac{8 \times \frac{2}{s}}{8 + \frac{2}{s}}\right)$$

$$= 4s + \left(\frac{16}{8s+2}\right)$$

$$= \frac{4(s)(8s+2) + 16}{8s+2}$$

$$= \frac{32s^2 + 8s + 16}{8s+2}$$

$$Z = \frac{\cancel{2}(16s^2 + 4s + 8)}{\cancel{2}\,4s+1}$$

$$V = IZ$$

$$V_C = I_1 (2/s)$$

$$I_1 = I\left(\frac{8}{8+2/s}\right) = I\left(\frac{8s}{8s+2}\right)$$

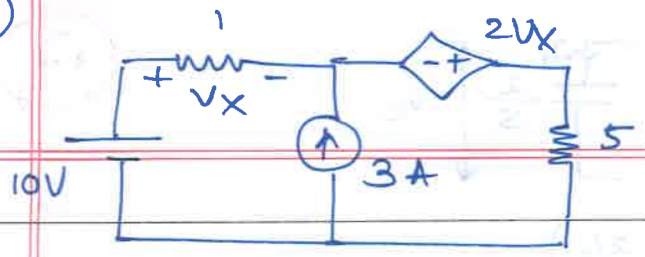
$$\frac{V}{V_C} = \frac{IZs}{I_1(2)}$$

$$= \frac{\cancel{I_1}\frac{(8s+2)}{8s}\left[\frac{16s^2+4s+8}{4s+1}\right]s}{\cancel{I_1}(2)}$$

$$= \frac{\cancel{2}(4s+1)\left[16s^2+4s+8\right]\cancel{s}}{4\,\cancel{8s}\left[\cancel{4s+1}\right]}$$

$$\frac{V}{V_C} = \frac{16s^2+4s+8}{4} = (4s^2+s+2)$$

Q2 a)



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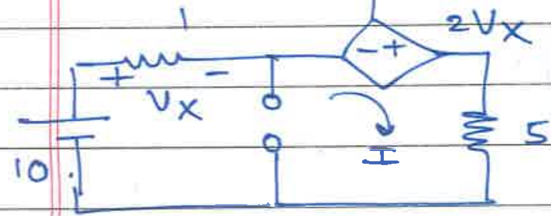
10 V acting



$-I + 2V_x - 5I + 10 = 0.$

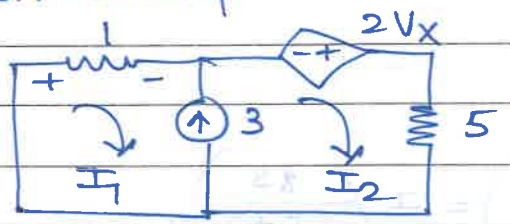
$V_x = I$

$-I + 2I - 5I + 10 = 0$

$-4I = -10$

$I = 10/4 \downarrow.$

3A acting



$I_2 - I_1 = 3.$

$-I_1 + 2V_x - 5I_2 = 0$

$V_x = I_1$

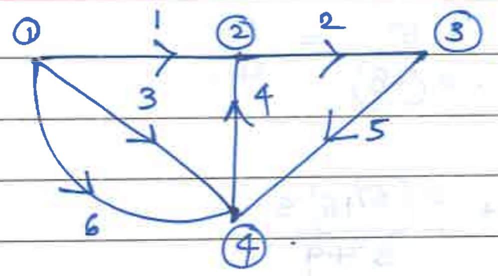
$-I_1 + 2I_1 - 5I_2 = 0 \Rightarrow I_1 - 5I_2 = 0.$

$I_1 = -3.75$

$I_2 = -0.75 \downarrow.$

$\therefore I_{5\Omega} = 2.5 - 0.75 = 1.75$ Amp.

b)



$$A_a = \begin{array}{c|cccccc} \text{Node} & 1 & 2 & 3 & 4 & 5 & 6 \\ \hline 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 2 & -1 & 1 & 0 & -1 & 0 & 0 \\ 3 & 0 & -1 & 0 & 0 & 1 & 0 \\ 4 & 0 & 0 & -1 & 1 & -1 & -1 \end{array}$$

c). Condition for symmetry $Z_{11} = Z_{22}$

" " reciprocity $Z_{12} = Z_{21}$

Q 3 a) $z(s) = \dfrac{s(s^2+4)}{(s^2+1)(s^2+9)}$

Foster I.

$$z(s) = \frac{2AS}{(s^2+1)} + \frac{2BS}{(s^2+9)}$$

$$A = \frac{z(s)\,(s^2+1)}{2S}\bigg|_{s^2=-1}$$

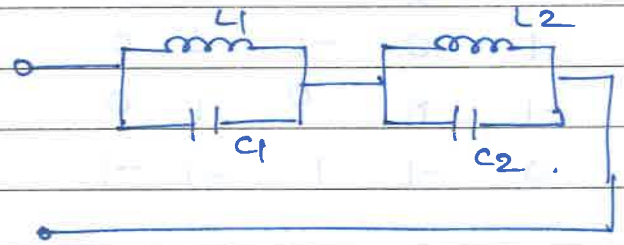
$$= \cancel{(-1)}\frac{(-1+4)}{2(-1+9)} = \frac{3}{2(8)} = \frac{3}{16}.$$

$$B = \frac{z(s)\,(s^2+9)}{2S}\bigg|_{s^2=-9}$$

$$B = \frac{(-9+4)}{2(-9+1)} = \frac{-5}{2(-8)} = \frac{5}{16}.$$

$$\therefore z(s) = \frac{2\left(3/16\right)s}{s^2+1} + \frac{2\left(5/16\right)s}{s^2+9}$$

$$z(s) = \frac{3/8\,s}{s^2+1} + \frac{5/8\,s}{s^2+9}.$$



$C_1 = 8/3$ F $\quad L_1 = 3/8$ H

$C_2 = 8/5$ F $\quad L_2 = 5/72$ H.

Foster II.

$$Y(s) = \frac{(s^2+1)(s^2+9)}{s(s^2+4)} = \frac{s^4+10s^2+9}{s^3+4s}.$$

$$s^3+4s\,)\ s^4+10s^2+9\ (\ s.$$
$$\cancel{s^4}+4s^2$$
$$6s^2+9$$

$$\therefore Y(s) = s + \frac{6s^2+9}{s(s^2+4)}$$

$$= s + \frac{A}{s} + \frac{2Bs}{s^2+4}.$$

$$A = Y(s)s\Big|_{s=0}$$

$$A = \frac{9}{4}$$

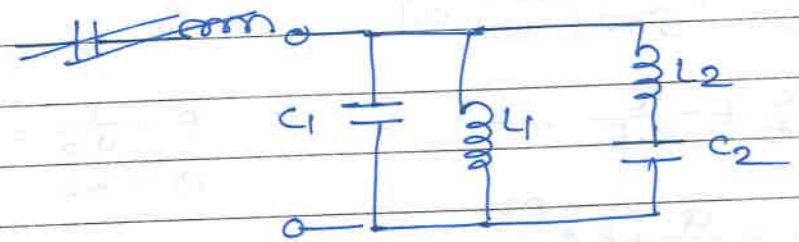
$$B = Y(s)\,\frac{(s^2+4)}{2s}\Bigg|_{s^2=-4}$$

$$= \frac{6(-4)+9}{2(-4)}$$

$$= \frac{-24+9}{-8} = 15/8$$

$$\therefore Y(s) = s + \frac{9/4}{s} + \frac{2(15/8)\,s}{s^2+4}$$

$$= s + \frac{9/4}{s} + \frac{15/4\,s}{s^2+4}$$



$C_1 = 1\ F$

$L_1 = 4/9\ H.$

$L_2 = 4/15\ H$

$C_2 = 15/16\ F.$

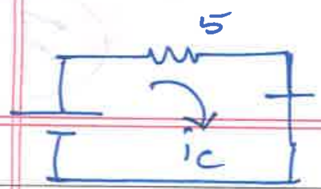
b) $t = 0^-$

$v_C(0^-) = 0.$

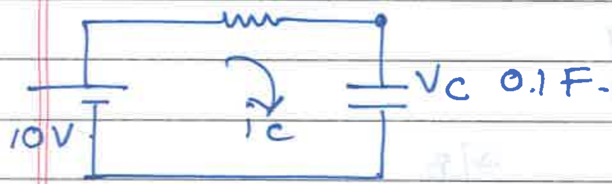
$I_C(0^-) = 0$

At $t=0^+$. $v_c(0^+) = 0$

$i_c(0^+) = 10/5 = 2A$.



$t > 0$.



$$C\frac{dv_c}{dt} + \frac{v_c - 10}{5} = 0$$

$$\therefore \frac{dv_c}{dt} + \frac{v_c}{5C} = \frac{2}{C}$$

$$\frac{dv_c}{dt} + \frac{v_c}{5\times 0.1} = \frac{2}{0.1}$$

$$\frac{dv_c}{dt} + \frac{v_c}{0.5} = 20 \qquad \therefore P = \frac{1}{0.5} = 2$$

$$Q = 20$$

$$\therefore v_c = \frac{Q}{P} + k e^{-pt}$$

$$\boxed{v_c = \frac{20}{2} + k e^{-2t}}$$

at $t = 0$

$$0 = 10 + k.$$

$$\therefore k = -10$$

$$\therefore \left(v_c = 10 - 10 e^{-2t}\right)$$

$$i_c = C\frac{dv}{dt} = 0.1 \frac{d}{dt}\left(10 - 10 e^{-2t}\right)$$

$$= 0.1\left(-10(-2)\, e^{-2t}\right)$$

$$\boxed{i_c = 2 e^{-2t}}$$

c) i) $P(s) = s^4 + 7s^3 + 6s^2 + 21s + 8$

s^4	1	6	8
s^3	7	21	0
s^2	3	8	0
s^1	7/3	0	
s^0	8		

all elements in 1st column is positive
∴ polynomial is Hurwitz

ii) $P(s) = s^5 + s^3 + 5$

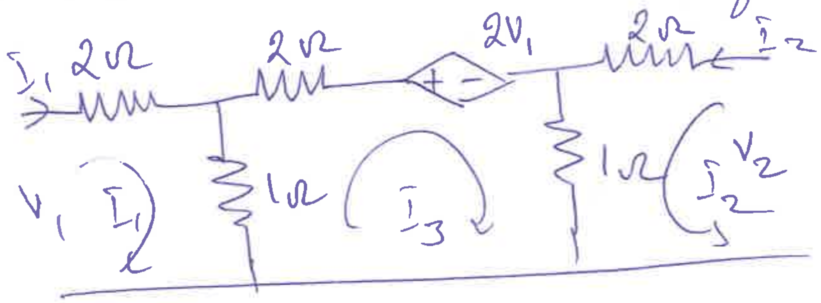
$P'(s) = 5s^4 + 3s^2$

$\therefore P_1(s) = s^5 + 5s^4 + s^3 + 3s^2 + 5.$

since s term is missing it is not hurwitz.

cop code: 24950

4(a) Find ABCD Parameters of the following n/w



$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

$V_1 = 3I_1 - I_3$

$V_2 = I_2 + I_3$

$0 = -I_1 + I_2 + 4I_3 + 2V_1$

$I_3 = (I_1 - I_2 - 2V_1) \times \frac{1}{4}$

$V_1 = 3I_1 - (I_1 - I_2 - 2V_1) \times \frac{1}{4}$

$V_1 - \frac{V_1}{2} = I_1\left(3 - \frac{1}{4}\right) + I_2 \times \frac{1}{4}$

$\frac{1}{2}V_1 = \frac{11}{4}I_1 + \frac{1}{4}I_2$

$V_1 = \frac{11}{2}I_1 + \frac{1}{2}I_2$ — (1)

$V_2 = I_2 + (I_1 - I_2 - 2V_1)\frac{1}{4}$

$V_2 = \frac{1}{4}I_1 + I_2\left(1 - \frac{1}{4}\right) - \frac{1}{2}V_1$

$V_2 = \frac{1}{4}I_1 + \frac{3}{4}I_2 - \frac{1}{2}V_1$

$= \frac{1}{4}I_1 + \frac{3}{4}I_2 - \frac{1}{2}\left(\frac{11}{2}I_1 + \frac{1}{2}I_2\right)$

$= \left(\frac{1}{4} - \frac{11}{4}\right)I_1 + \left(\frac{3}{4} - \frac{1}{4}\right)I_2$

$V_2 = -\frac{5}{2}I_1 + \frac{1}{2}I_2$

$\frac{5}{2}I_1 = -V_2 + \frac{1}{2}I_2$

$\boxed{I_1 = -\frac{2}{5}V_2 + \frac{1}{5}I_2}$ — (2)

Sub. ② in ①

$$V_1 = \frac{11}{2}\left(-\frac{2}{5}V_2 + \frac{1}{5}i_2\right) + \frac{1}{2}i_2$$

$$V_1 = -\frac{11}{5}V_2 + I_2\left(\frac{11}{10} + \frac{1}{2}\right)$$

$$V_1 = -\frac{11}{5}V_2 + \frac{16}{10}i_2$$

$$\boxed{V_1 = -\frac{11}{5}V_2 + \frac{8}{5}i_2}$$

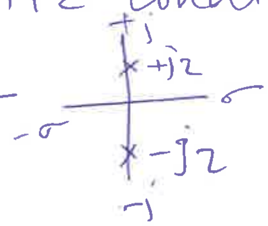
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \left\{ \cancel{-\frac{2}{5}} \quad \cancel{-\frac{1}{5}} \begin{bmatrix} -11/5 & -8/5 \\ -2/5 & -1/5 \end{bmatrix}\right.$$

ⓑ Test whether $F(S)$ is P.R.

$$F(s) = \frac{s^2+4}{(s^3+3s^2+3s+1)} =$$

I Testing for Hurwitz Condition.

$Nr_{N(s)}: s^2+4 \qquad s = \pm j2$



∴ Hurwitz.

or $N'(s) = 2s$

s^2	1	4
s	2	
s^0	4	

∴ Nr. HWZ.

Dn.

s^3	1	3
s^2	3	1
s	8/3	
s^0	1	

∴ Dn HWZ.

II Residue test is not required as ~~[illegible]~~ poles are not on $j\omega$ axis.

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$$F(s) = \frac{s^2+4}{(s+1)^3}$$

III $m_1 = s^2+4$ $n_1 = 0$

$m_2 = 3s^2+1$ $n_2 = s^3+3s$

$$m_1m_2 - n_1n_2 = (s^2+4)(3s^2+1) - 0$$
$$= 3s^4 + s^2 + 12s^2 + 4$$
$$= 3s^4 + 13s^2 + 4$$

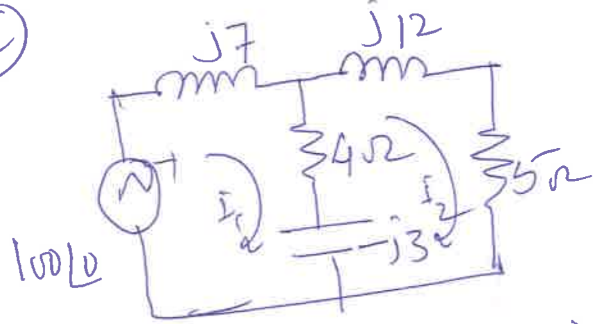
$s = j\omega$
$$= 3(j\omega)^4 + 13(j\omega)^2 + 4$$
$$= 3\omega^4 - 13\omega^2 + 4$$

$\omega = 0$ $= 4$

$\omega = 1$ $= 3 - 13 + 4$
$= -6$

$\therefore$ 3rd Test fails. $\therefore F(s)$ is not PR

(c)



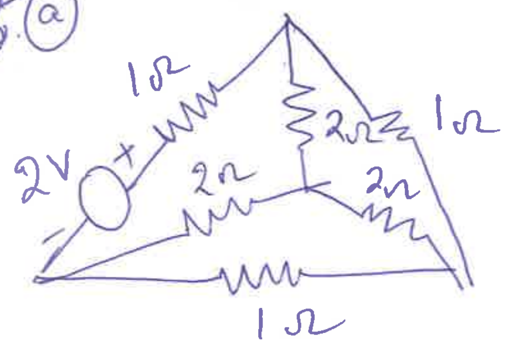
Find I_2

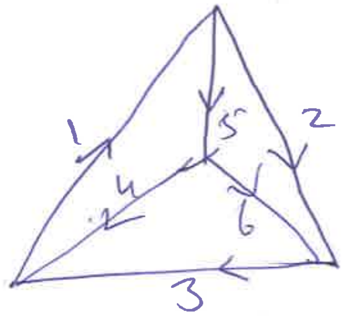
$$(4+4j)I_1 - (4-j3)I_2 = 100$$
$$-(4-j3)I_1 + (9+9j)I_2 = 0$$

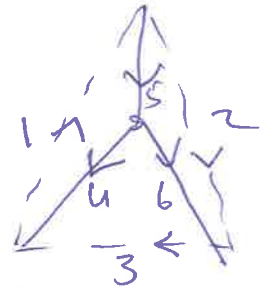
$$\begin{bmatrix} (4+4j) & -(4-j3) \\ -(4-j3) & (9+9j) \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \end{bmatrix}$$

Solving for I_2. $I_2 = (-3.41 - j3.92)$
$= 5\angle -2.246$

Q ~~5~~ (a)







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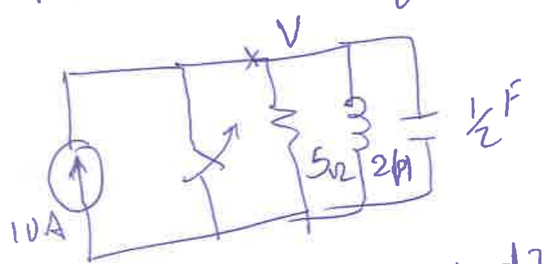
$$B = \begin{bmatrix} 1 & 0 & 0 & \cancel{0} & 1 & \cancel{0} \\ 0 & 1 & 0 & 0 & -1 & -1 \\ 0 & 0 & 1 & -1 & 0 & 1 \end{bmatrix} \qquad Z = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 \end{bmatrix}$$

KVL eq.

$$\begin{bmatrix} 5 & -2 & -2 \\ -2 & 5 & -2 \\ -2 & -2 & 5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix}$$

(b) Find $v(\cancel{0^+})$, $\frac{dv}{dt}$, $\frac{d^2v}{dt^2}$ @ 0^+



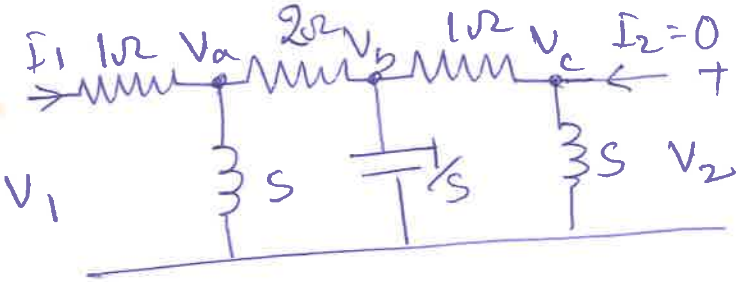
$v(0^+) = 0$

$$\frac{v}{5} + \frac{1}{2}\int v\,dt + \frac{1}{2}\frac{dv}{dt} = 10 \quad \text{— (1)}$$

at $t = 0^+$ $$\frac{0}{5} + \frac{1}{2}\underbrace{\int_{0^-}^{0^+} v\,dt}_{0} + \frac{1}{2}\frac{dv}{dt} = 10$$

$$\therefore \frac{dv}{dt} = 20\,V/s.$$

(14)

6. (a) 

Find V_1/V_2 & $\frac{V_2}{I_1}$

$$\frac{V_1}{V_2} = \left(\frac{3}{s^2} + \frac{7}{s} + 3s + 6\right)$$

$$= \left(\frac{3s^3 + 6s^2 + 7s + 3}{s^2}\right)$$

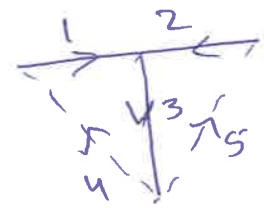
$$\frac{V_2}{I_1} = \frac{1}{\left(\frac{3}{s^2} + \frac{4}{s} + s + 3\right)}$$

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

(b) ~~Find~~ obtain Z parameters in terms of Y parameters.

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} \frac{Y_{22}}{\Delta Z} & -\frac{Y_{12}}{\Delta Y} \\ -\frac{Y_{21}}{\Delta Y} & \frac{Y_{11}}{\Delta Y} \end{bmatrix}$$

(c) obtain Tieset & fcutset matrix



$$B = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

$$Q = \begin{bmatrix} 1 & 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 & -1 \\ 0 & 0 & 1 & -1 & -1 \end{bmatrix}$$

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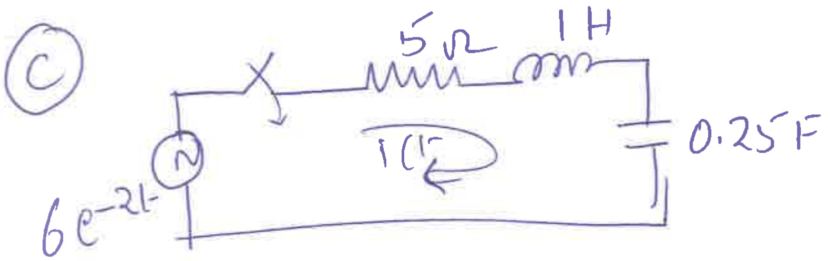
Diff. 1

$$\frac{1}{5}\frac{dv}{dt} + \frac{1}{2}v + \frac{1}{2}\frac{d^2v}{dt^2} = 0$$

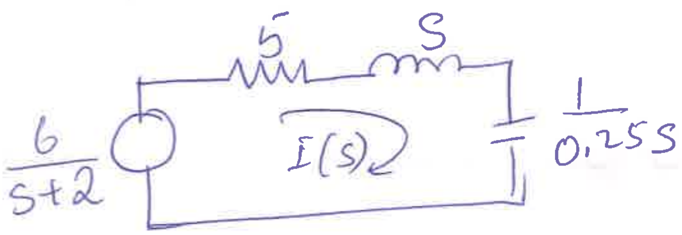
$$\frac{1}{5} \times 20^4 + 0 + \frac{1}{2}\frac{d^2v}{dt^2} = 0$$

$$\frac{d^2v}{dt^2} = -4 \times 2$$
$$= -8\ v/s^2$$

(c)



Transformed ckt.



$$I(S) = \frac{\frac{6}{S+2}}{5 + S + \frac{1}{0.25S}}$$

$$= \frac{6}{(S+2)\left(5+S+\frac{4}{S}\right)}$$

$$= \frac{6S}{(S^2+5S+4)(S+2)}$$

$$= \frac{6S}{(S+1)(S+4)(S+2)}$$

$$= \frac{A}{S+1} + \frac{B}{S+2} + \frac{C}{S+4}$$

$$= \frac{-2}{S+1} + \frac{6}{S+2} - \frac{4}{S+4}$$

Taking ILT $\boxed{i(t) = -2e^{-t} + 6e^{-2t} - 4e^{-4t}}$