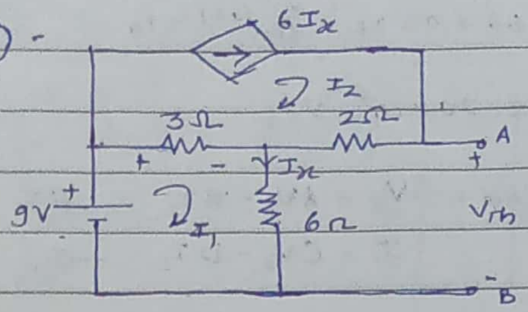
END SEM. EXAM. (R-24) SH 2025

Solution:

Branch: EXTC   Course: Network Theory

Year/Sem: SE/III. Course code: ETC-304   Marks: 80

Q 1) (A) -



Calculation of V_{Th}

from fig. $I_x = I_1$ --- (1)

Applying KVL to Mesh 1

$9 - 3(I_1 - I_2) - 6I_1 = 0$

$9I_1 - 3I_2 = 9$ --- (2)

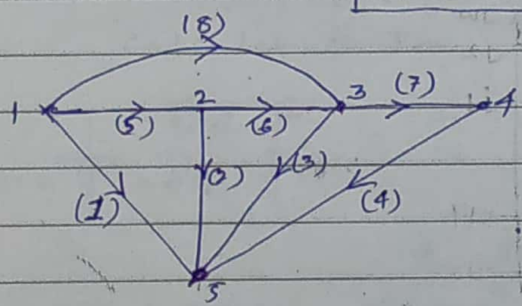
from Mesh 2: $I_2 = 6I_x = 6I_1$ $\therefore 6I_1 - I_2 = 0$ --- (3)

solving (2) & (3): $I_1 = -1\,A$ $I_2 = -6\,A$

Writing V_{Th} eq^n: $9 - 3(I_1 - I_2) + 2I_2 - V_{Th} = 0$

$\boxed{V_{Th} = -18\,V}$

(B)

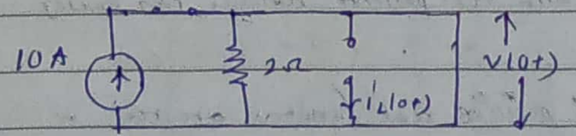


(C)

At $t=0^-$ no current flows through the inductor and there is no voltage across capacitor.

$i_L(0^-) = 0$; $v(0^-) = 0$

At $t = 0^+$,

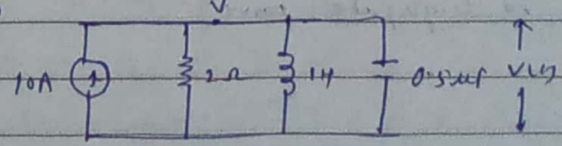


Inductor acts as open circuit

$i_L(0^+) = 0$

$v(0^+) = 0$

For $t > 0$



Writing KCL eq^n for $t>0$

$\frac{v}{2} + \frac{1}{1}\int v\,dt + 0.5\times10^{-6}\frac{dv}{dt} - 10 = 0$

At $t=0+$ $\quad \frac{V(0+)}{2} + 0 + 0.5\times10^{-6}\frac{dV}{dt}(0+) = 10$

$$\frac{dV(0+)}{dt} = 20\times10^{6}\ V/s$$

b) ABCD parameters are: $V_1 = AV_2 - BI_2$ — ①

$I_1 = CV_2 - DI_2$ — ②

Rewriting eqn ②

$$I_2 = -\frac{1}{D}I_1 + \frac{C}{D}V_2 \quad — ③$$

& $V_1 = AV_2 - BI_2$.

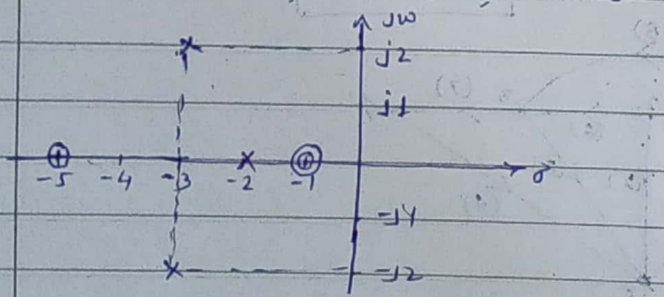
$$= AV_2 - B\left[-\frac{1}{D}I_1 + \frac{C}{D}V_2\right]$$

$$V_1 = \frac{B}{D}I_1 + \left[\frac{AD-BC}{D}\right]V_2 \quad — ④$$

Comparing eqn ③ & ④ with std. h parameters

$$h_{11} = \frac{B}{D},\ h_{12} = \frac{AD-BC}{D},\ h_{21} = -\frac{1}{D},\ h_{22} = \frac{C}{D}$$

c) Function F(s) has zero at $s=-1, -1$ & $s=-5$ and poles at $s=-2$, $s=-3+j2$, $s=-3-j2$



f) properties of positive real function:

i) If F(s) is positive real then $\frac{1}{F(s)}$ is also positive real

ii) Sum of two positive real function is positive real

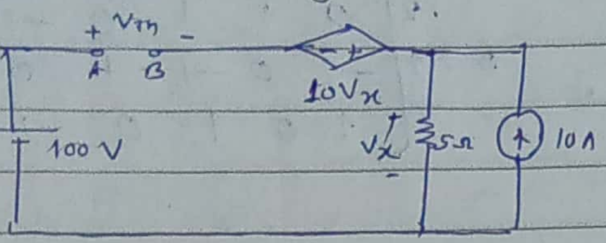
iii) poles & zeros of positive real function cannot have positive real parts ie they cannot be in right half of s plane

iv) Only simple poles with real positive residue can exists on jω axis.

v) poles and zeros of positive real function are real or occur in conjugate pairs

Q 2 A

Step 1: Calculation of V_{Th}:



from fig: $V_x = 10 \times 5 = 50V$

writing V_{Th} eqn

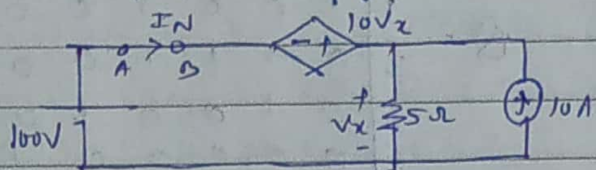
$100 - V_{Th} + 10V_x - V_x = 0$

$100 - V_{Th} + 9V_x = 0$

$100 - V_{Th} + 9(50) = 0$

$V_{Th} = 550$ Volt

Step 2: Calculation of I_N



from fig: $V_x = 5(I_N + 10)$

Apply KVL to Mesh (1)

$100 + 10V_x - V_x = 0$

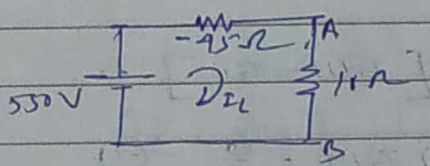
$V_x = \cancel{-100/9}$

$$\cancel{-100/9} = 5I_N + 50$$

$$I_N = -\frac{550}{45}\ A$$

Step III: Calculation of R_{Th}: $R_{Th} = \frac{V_{Th}}{I_N} = \frac{550}{\left(-\frac{550}{45}\right)} = -45\Omega$

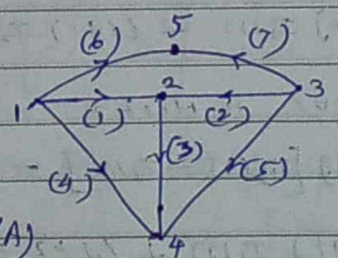
Step IV: Calculation of I_L



$$I_L = \frac{V_{Th}}{R_{Th} + R_L} = \frac{550}{-45+10} = -\frac{110}{7}\ A$$

B

Oriented graph:



Incidence Matrix (A)
(Aa)

Branches →

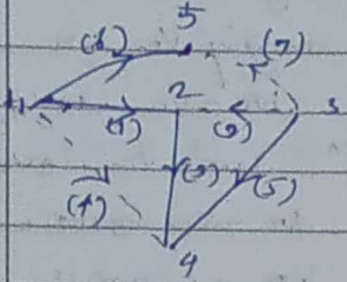
Nodes	1	2	3	4	5	6	7
1	1	0	0	1	0	1	0
2	-1	-1	1	0	0	0	0
3	0	1	0	0	1	0	1
4	0	0	-1	-1	-1	0	0
5	0	0	0	0	0	-1	-1

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

Reduced incidence matrix (A) while eliminating last row from matrix (Aa)

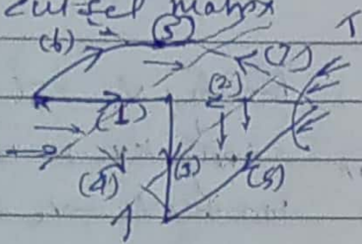
$$A = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 0 \\ -1 & -1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & -1 & -1 & -1 & 0 & 0 \end{bmatrix}$$

Tieset matrix (B)



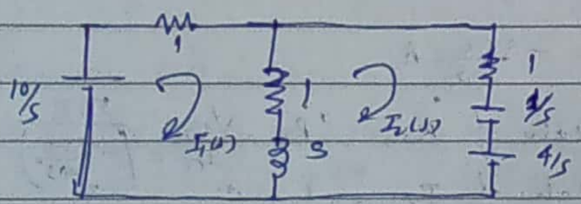
$$B = \begin{array}{c|ccccccc} & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ \hline 2 & 0 & 1 & 1 & 0 & -1 & 0 & 0 \\ 4 & -1 & 0 & -1 & 1 & 0 & 0 & 0 \\ 7 & 1 & 0 & 1 & 0 & -1 & -1 & 1 \end{array}$$

cutset matrix



$$Q = \begin{array}{c|ccccccc} & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ \hline 1 & 1 & 0 & 0 & 1 & 0 & 0 & -1 \\ 3 & 0 & -1 & 1 & 1 & 0 & 0 & -1 \\ 5 & 0 & 1 & 0 & 0 & 1 & 0 & +1 \\ 6 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \end{array}$$

e) for $t > 0$ transformed network



Apply KVL to Mesh 1

$$\frac{10}{s} - I_1(s) - (1+s)\left[I_1(s) - I_2(s)\right] = 0$$

$$(s+2)\, I_1(s) - (s+1)\, I_2(s) = \frac{10}{s} \quad —(1)$$

Apply KVL to Mesh 2

$$-(s+1)\left[I_2(s) - I_1(s)\right] - I_2(s) - \frac{1}{s} I_2(s) - \frac{4}{s} = 0$$

$$-(s+1)\, I_1(s) + \left(s+2+\frac{1}{s}\right) I_2(s) = 4/s \quad —(2)$$

By cramers rule

$$I_1(s) = \frac{\Delta_1}{\Delta} = \frac{\begin{vmatrix} \frac{10}{s} & -(s+1) \\ -4/s & s+2+\frac{1}{s} \end{vmatrix}}{\begin{vmatrix} s+2 & -(s+1) \\ -(s+1) & s+2+\frac{1}{s} \end{vmatrix}} = \frac{3s+5}{s(s+1)}$$

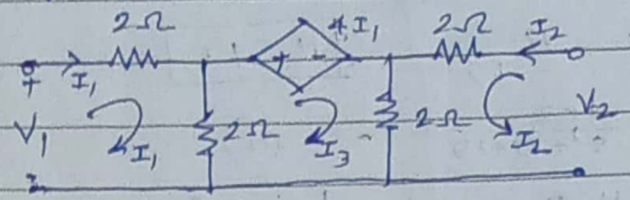
By partial fraction $I_1(s) = \frac{A}{s} + \frac{B}{s+1}$

$I_1(s) = \frac{5}{s} - \frac{2}{s+1}$. by inverse L.T. $i_1(t) = 5 - 2e^{-t}$

Similarly $I_2(s) = \frac{\Delta_2}{\Delta} = \frac{\begin{vmatrix} s+2 & 10/s \\ -(s+1) & -4/s \end{vmatrix}}{\begin{vmatrix} (s+2) & -(s+1) \\ -(s+1) & s+2+\frac{1}{s} \end{vmatrix}} = \frac{3}{s+1} - \frac{2}{(s+1)^2}$

By Inverse LT $\quad i_2(t) = 3e^{-t} - 2te^{-t}$

D]



Applying KVL to Mesh ①

$$V_1 = 2I_1 + 2(I_1 - I_3)$$

$$V_1 = 4I_1 - 2I_3 \quad \text{--- (i)}$$

Applying KVL to Mesh 2

$$V_2 = 2I_2 + 2(I_2 + I_3)$$

$$V_2 = 4I_2 + 2I_3 \quad \text{--- (ii)}$$

Applying KVL to Mesh 3

$$-2(I_3 - I_1) - 4I_1 - 2(I_3 + I_2) = 0$$

$$I_1 + I_2 = -2I_3 \quad \text{--- (iii)}$$

put eqⁿ (iii) in (i) & (ii)

$$V_1 = 4I_1 + I_1 + I_2 = 5I_1 + I_2 \quad \text{--- (v)}$$

& $\quad V_2 = 4I_2 - I_1 - I_2 = -I_1 + 3I_2 \quad \text{--- (iv)}$

Comparing (iv) & (v) with std Z parameter

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 5 & 1 \\ -1 & 3 \end{bmatrix}$$

To find h-parameter

$$\Delta Z = Z_{11}Z_{22} - Z_{12}Z_{21} = (5)(3) - (1)(-1) = 16$$

$$h_{11} = \frac{\Delta Z}{Z_{22}} = \frac{16}{3}\,\Omega, \quad h_{12} = \frac{Z_{12}}{Z_{22}} = \frac{1}{3}$$

$$h_{21} = -\frac{Z_{21}}{Z_{22}} = \frac{1}{3}. \quad h_{22} = \frac{1}{Z_{22}} = \frac{1}{3}\,℧$$

$$\begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} = \begin{bmatrix} 16/3 & 1/3 \\ 1/3 & 1/3 \end{bmatrix}$$

E]

$$Z(s) = \frac{(R+Ls)\frac{1}{Cs}}{R+Ls+\frac{1}{Cs}} = \frac{\frac{1}{C}(s+\frac{R}{L})}{s^2+\frac{R}{L}s+\frac{1}{LC}} \quad \text{--- (i)}$$

form pole zero diagram

zero is at $s = -2$ & poles are at $s = -1 \pm j4$.

$$Z(s) = H\frac{s+2}{(s+1+j4)(s+1-j4)} = H\frac{s+2}{(s+1)^2-(j4)^2} = H\frac{s+2}{s^2+2s+17}$$

At d.c, $2 = H\cdot\frac{2}{17}$ $\quad \therefore \boxed{H = 17}$

$$Z(s) = 17\cdot\frac{s+2}{s^2+2s+17} \quad \text{--- (ii)}$$

Comparing eq^n (ii) with (i) $\frac{1}{C} = 17$, $\frac{R}{L} = 2$, $\frac{1}{LC} = 17$

$\therefore C = \frac{1}{17}F$, $L = 1H$, $R = 2\Omega$

F] Cauer I form:

$$Z(s) = \frac{2(s+1)(s+3)}{(s+2)(s+6)} = \frac{2s^2+8s+6}{s^2+8s+12}$$

By Continued fraction expansion

$s^2+8s+12)\ 2s^2+8s+6\ (2 \leftarrow Z$

$2s^2+16s+24$

$-8s-18$

∵ negative result, Continued fraction expansion of Y(s) carried out

$$Y(s) = \frac{s^2+8s+12}{2s^2+8s+6}$$

By Continued fraction expansion

$2s^2+8s+6)\ s^2+8s+12\ (\frac{1}{2} \leftarrow Y$

s^2+4s+3

$4s+9)\ 2s^2+8s+6\ (\frac{1}{2}s+2$

$2s^2+\frac{9}{2}s$

$\frac{7}{2}s+6)\ 4s+9\ (\frac{8}{7} \leftarrow Y$

$4s+\frac{48}{7}$

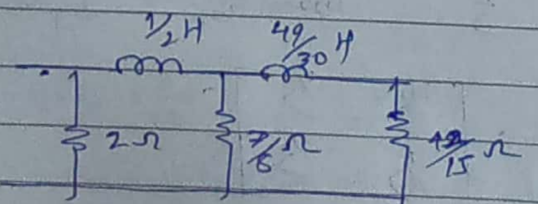
$\frac{15}{7})\ \frac{7}{2}s+6\ (\frac{49}{30} \leftarrow Z$

$\frac{7}{2}s$

$6)\ \frac{15}{7}\ (\frac{15}{42} \leftarrow Y$

$\frac{15}{7}$

0



Cauer I form

Cauer II form

Arranging Numerator & Denominator polynomials of Z(s) in ascending order of s.

Q2 (F) ~~Cauer II form~~

$Z(s) = \frac{6+8s+2s^2}{12+8s+s^2}$

By Continued ~~fraction~~ expansion

$12+8s+s^2 \,)\, 6+8s+2s^2 \,(\, \frac{1}{2} \leftarrow 2$

$6+4s+\frac{1}{2}s^2$

$4s+\frac{3}{2}s^2 \,)\, 12+8s+s^2 \,(\, \frac{3}{s} \leftarrow y$

$12+\frac{9}{2}s$

$\frac{7}{2}s+s^2 \,)\, 4s+\frac{3}{2}s^2 \,(\, \frac{8}{7} \leftarrow 2$

$4s+\frac{8}{7}s^2$

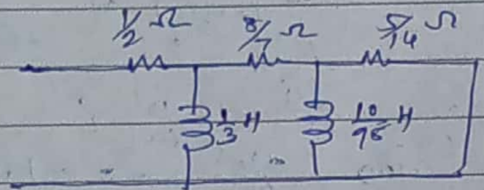
$\frac{5}{14}s^2 \,)\, \frac{7}{2}s+s^2 \,(\, \frac{98}{10s} \leftarrow y$

$\frac{7}{2}s$

$s^2 \,)\, \frac{5}{14}s^2 \,(\, \frac{5}{14} \leftarrow 2$

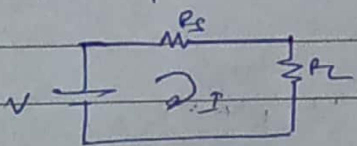
$\frac{5}{14}s^2$

0



Q3 (A) Maximum power Transfer theorem

· Max^m power is delivered from Source to load when $R_L = R_S$



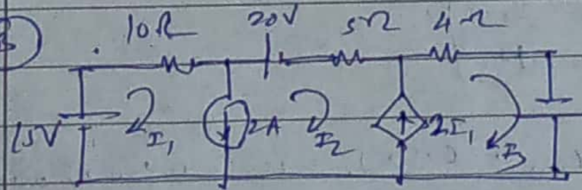
$I = \frac{V}{R_S+R_L}$

$P_L = I^2 R_L = \frac{V^2 R_L}{(R_S+R_L)^2}$

To determine value of R_L max^m power transferred to load.

$\frac{dP_L}{dR_L} = 0 \quad \frac{d}{dR_L}\left[\frac{V^2}{(R_S+R_L)^2} R_L\right] \quad \boxed{R_L = R_S}$

(B)



Mesh 1, 2, 3 will form supermesh

Writing Current eq^n for supermesh

$I_1 - I_2 = 2 \quad \text{(i)}$

$I_3 - I_2 = 2I_1 \quad \text{(ii)}$

$\therefore\ 2I_1 + I_2 - I_3 = 0$

Applying KVL to outer path of supermesh

$15 - 10I_1 - 20 - 5I_2 - 4I_3 + 40$

$10I_1 + 5I_2 + 4I_3 = 35 \quad \text{(iii)}$

Solving eq^n (i) (ii) & (iii)

$I_1 = 1.96A, \quad I_2 = -0.04A \quad I_3 = 3.87A$

$\boxed{I_{10\Omega} = I_1 = 1.96A}$