Q.2a. Calculate the voltage V_{AB} across terminals A and B in the network, shown in Fig 3.

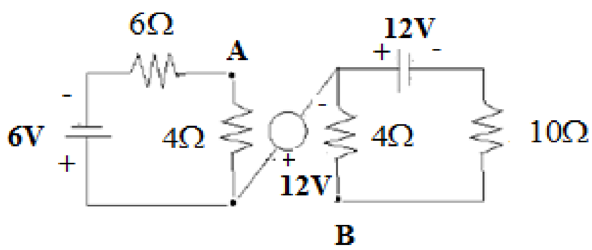


Fig.3

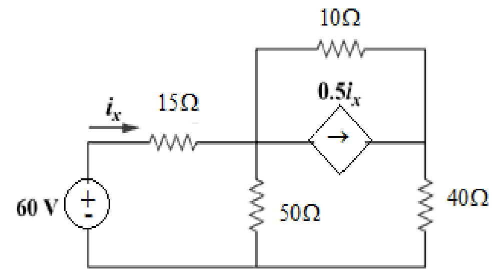


Fig.4

Fig. 2 B

Ans:

The circuit of Fig.2 can be redrawn as shown in Fig.2.1(a)

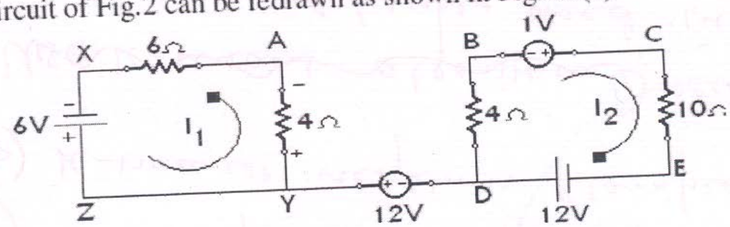


Fig.2.1(a)

In loop XAYZ, loop current I_1 as shown in Fig2.1(a) is

$$I_1 = \frac{6}{6+4} = \frac{6}{10} = 0.6A$$

In loop BCED, loop current I_2 as shown in Fig.2.1(a) is

$$I_2 = \frac{12}{4+10} = \frac{12}{14} = 0.86A$$

V_A = voltage drop across 4Ω resistor is

$$V_A = I_1 \times 4\Omega = 0.6 \times 4 = 2.4V$$

V_B = voltage drop across 4Ω resistor is

$$V_B = I_2 \times 4\Omega = 0.86 \times 4 = 3.44V$$

Therefore,

The voltage between points A and B is the sum of voltages as shown in Fig.2.1(b)

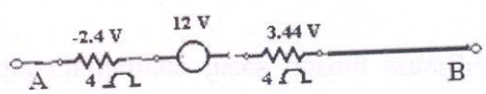


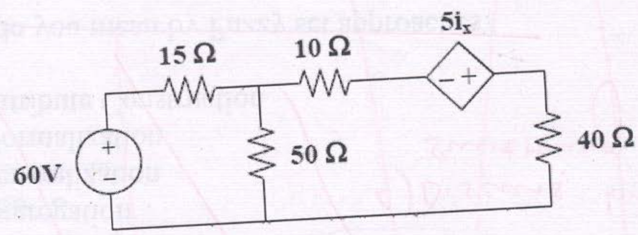
Fig.2.1(b)

Hence, $V_{AB} = -2.4 + 12 + 3.44 = 13.04V$

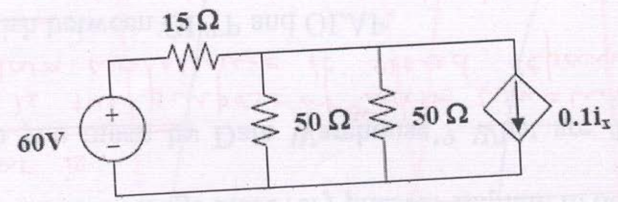
b. Using source transformation, calculate the current i_x flowing in the circuit shown in Fig 4.

Fig. 3

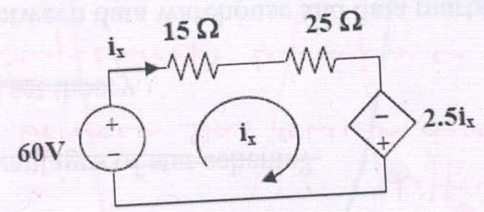
As shown in Fig. (a), we transform the dependent current source to a voltage source,



(a)



(b)



(c)

In Fig. (b), 50||50 = 25 ohms. Applying KVL in Fig. (c),

$-60 + 40i_x - 2.5i_x = 0$, or $i_x =$ **1.6 A**

Q.3 a. After steady-state current is established in the R-L circuit shown in Fig.5 with switch S in position 'a', the switch is moved to position 'b' at t = 0. Find $i_L(0+)$ and i(t) for t > 0.What will be the value of i(t) when t = 4 seconds?(8)

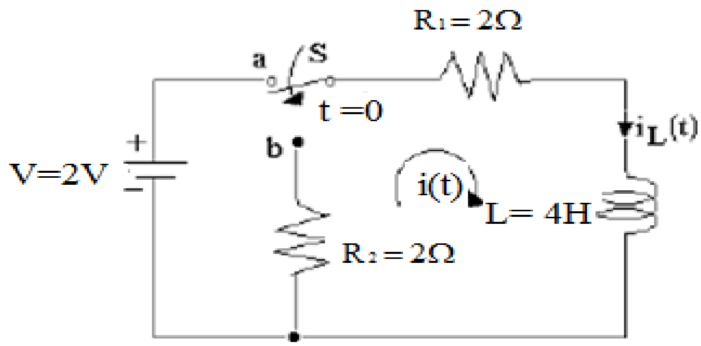


Fig.5

Ans:

When the switch 'S' is in position 'b', Kirchhoff's Voltage Law (KVL) gives

$$L\frac{di}{dt}+R_1 i+R_2 i=0 \quad \text{-------------------- (1)}$$

But from the Fig.7, $L=4H$, $R_1=2\Omega$ & $R_2=2\Omega$

By substituting these values in equation (1), we get

$$4\frac{di}{dt}+2i+2i=0$$

$$4\frac{di}{dt}+4i=0 \quad \Rightarrow \frac{di}{dt}+i=0 \quad \text{-------------------- (2)}$$

By applying Laplace Transform to the equation (2), we get

$$SI(s)-i(o^+)+I(s)=0$$

$$I(s)(s+1)=i(o^+) \quad \text{-------------------- (3)}$$

Now, the current just before switching to position 'b' is given by (shown in Fig.4.8)

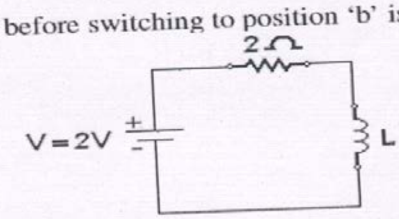


Fig.4.8

$$i(o^-)=\frac{V}{R}=\frac{2}{2}=1Amp$$

The current $i(o^+)$ after switching to position 'b' must also be 1amp, because of the presence of inductance L in the circuit. Therefore, the equation (3) will become

$$I(s)(s+1)=i(o^+)$$

$$I(s)(s+1)=1 \quad \Rightarrow I(s)=\frac{1}{s+1} \quad \text{-------------------- (4)}$$

On taking Laplace Transform to equation (4) , we get

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

<u>When t = 4 seconds, finding of i(t)</u> : the value of i(t) will be

$$i(t)=e^{-4}.$$

b. Determine the amplitude and phase for F(j2) from the pole-zero plot in s-plane for the network function $F(s)=\frac{4s}{(s^2+2s+2)}$

Ans:

The given network function is $F(s)=\frac{4s}{s^2+2s+2}$

In factored form, F(s) will become as

$$F(s)=\frac{4s}{(s+1+j1)(s+1-j1)}$$

F(s) has (i) Zero at s = 0

(ii) Poles are located at (-1+j1) & (-1-j1)

From the poles and zeros of F(s), draw vectors to the point jw = 2, as shown in Fig.5.1.

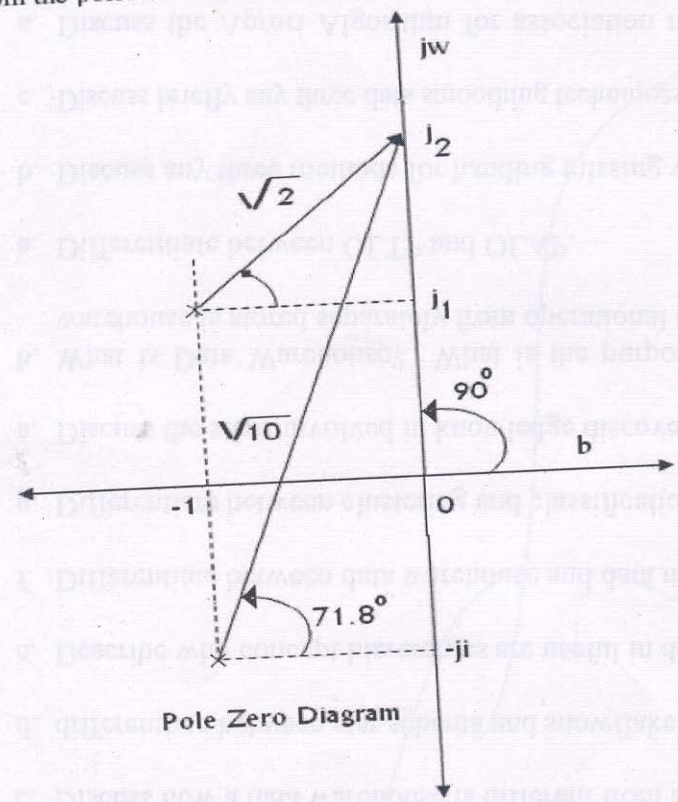


Fig.5.1. Pole-Zero Diagram

From the pole-zero diagram, it is clear that

Magnitude at F(j2) is calculated as

$$M(j2)=4\left(\frac{2}{\sqrt{2}\times\sqrt{10}}\right)=1.78 \quad \text{and}$$

Phase at F(j2) is calculated as

$$\phi(j2)=90^0-45^0-71.8^0=-26.8^0$$

Q.4 a. Switch K in the circuit shown in Fig.6 is opened at $t = 0^+$ Draw the Laplace transformed network for $t > 0^+$ and find the voltages V_1 (t) and V_2 (t), $t > 0^+$.

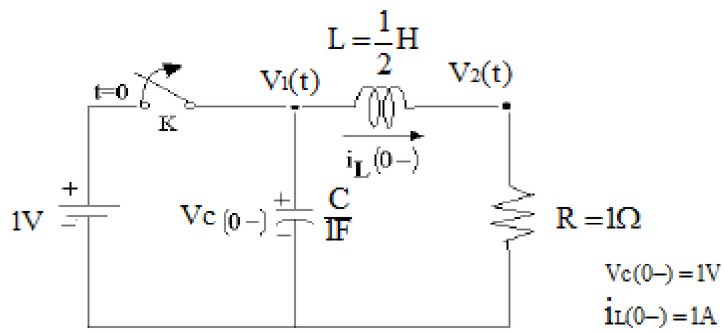
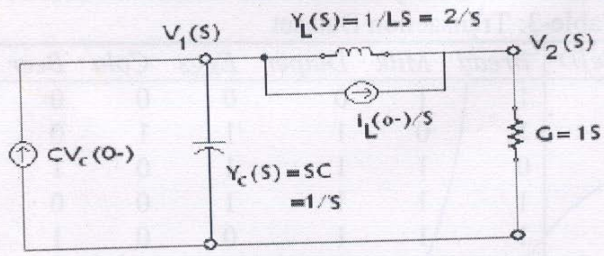


Fig.6

Ans:
The Laplace transformed network for t > 0+ is shown in Fig 5.



Node V_1:

$$\frac{-i_L(0^-)}{S}+CV_C(0^-)=\left(SC+\frac{1}{SL}\right)V_1(S)-\frac{1}{SL}V_2(S) \quad \text{---------------- (1)}$$

and Node V_2:

$$\frac{i_L(0^-)}{S}=-\frac{1}{SL}V_1(S)+\left(\frac{1}{SL}+G\right)+V_2(S) \quad \text{---------------- (2)}$$

Since prior to opening of switch the network has been in steady-state, then we have $V_C(0^-)=1V$ and $I_L(0^-)=1A$. By substituting the numerical values in eqns (1) & (2) we have

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

$$\frac{1}{S}=\frac{2}{S}V_1(S)+\left(\frac{2}{S}+1\right)V_2(S) \quad \text{---------------- (4)}$$

Solving the equations (3) & (4) for $V_1(S)$ & $V_2(S)$ we have

$$V_1(S)=\frac{S+1}{(S^2+2S+2)}=\frac{S+1}{(S+1)^2+1} \quad \text{---------------- (5)}$$

$$V_2(S)=\frac{S+2}{(S^2+2S+2)}=\frac{S+2}{(S+1)^2+1}$$

b. In the network shown in Fig. 7, the switch 'K' is moved from position 'a' to position 'b' at t=0, a steady state having previously been established at position 'a'. Solve the current i(t) using the Laplace transformation method (8)

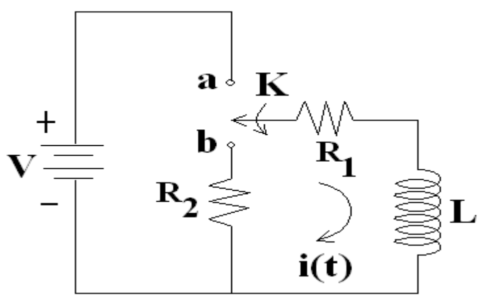


Fig.7

Ans:

KVL to loop of v and series R-L-C with i(t) $\Rightarrow V = L\frac{di}{dt} + Ri + \frac{1}{C}\int i dt$

Differentiation $\Rightarrow O = L\frac{d^2 i}{dt^2} + R\frac{di}{dt} + \frac{i}{C} LO = \left(s^2 L + Rs + \frac{1}{C}\right) I(s)$.

$\therefore$ Roots of $s^2 + \frac{R}{L}s + \frac{1}{LC} = 0 \Rightarrow s_{1,2} = -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}} = -\alpha \pm \beta$ (say).

Where $\alpha = \frac{R}{2L}, \omega_0^2 = \frac{1}{LC}$, and $\beta = \sqrt{\alpha^2 - \omega_0^2}$.

$\therefore$ Transient current

$i(t) = Ae^{s_1 t} + Be^{s_2 t}, A$ -------- (1) (A, B → constants, derived usint inital conditions)

Q.5 a. Determine the equivalent Norton network at the terminals a and b of the circuit shown in Fig.8 below.

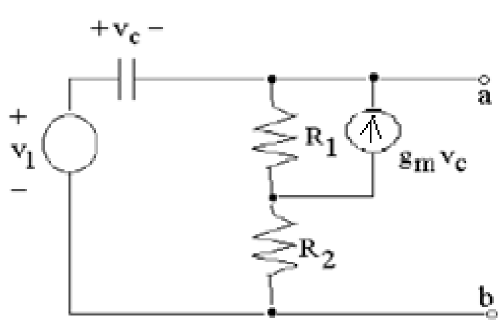


Fig.8

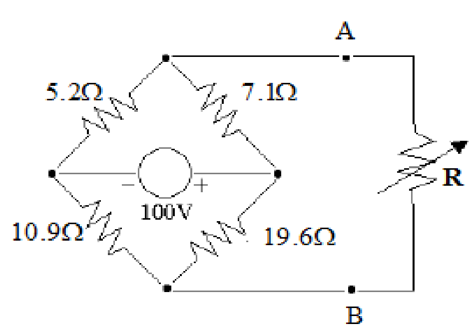
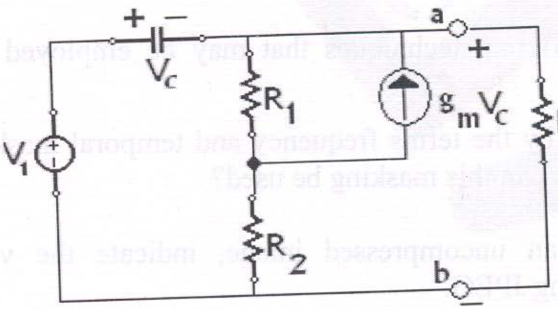
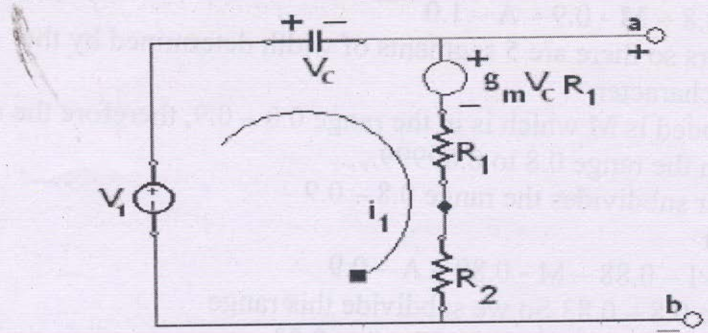


Fig.9

Ans:





By writing loop equations for the circuit shown

$-V_1 + V_c + g_m V_c R_1 + i_1(R_1 + R_2) = 0$

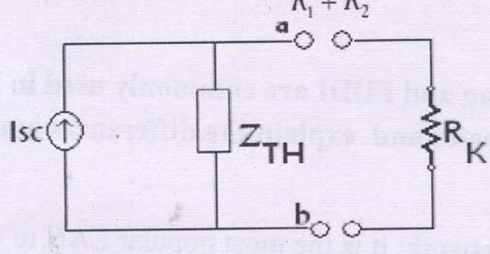
OR $i_1(R_1 + R_2) = V_1 - V_c(1 + g_m R_1)$

OR $i_1 = \dfrac{V_1 - V_c(1 + g_m R_1)}{(R_1 + R_2)}$

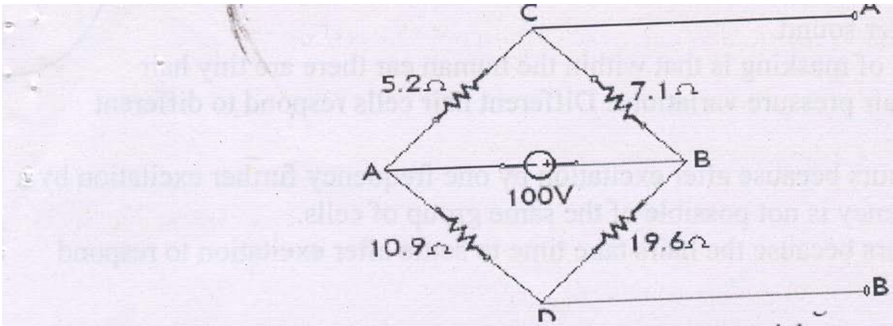
Thevenin's Impedance for the circuit is given by

$Z_{Th} = \dfrac{R_1 + R_2}{1 + SC(R_1 + R_2) + g_m R_1}$

OR $I_{SC} = V_1(S).\dfrac{[SC(R_1 + R_2) + g_m R_1]}{R_1 + R_2}$



b.Use the Thevenin equivalent of the network shown in Fig.9 to find the value of R which will receive maximum power. Find also this power.



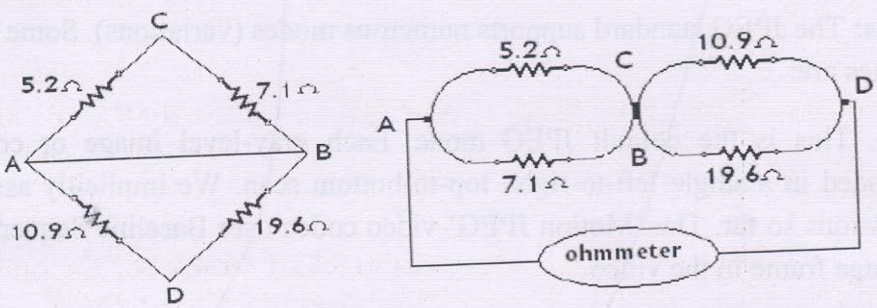
Consider the point A (the reference point) at ground potential,

$$V_A = \frac{5.2}{5.2+7.1}\times(100v) = \frac{5.2}{12.3}\times(100v) = 42.27\ volts$$

Similarly, $V_B = \frac{10.9}{10.9+19.6}\times(100v) = \frac{10.9}{30.5}\times(100v) = 35.73\ volts$

Therefore, $V_{Th} = V_{CD} = 42.27 - 35.73 = 6.53\ volts$

Now, apply the second step of Thevenin's Theorem, to find R_{Th}. For finding of R_{Th}, short the points C & D together, that is replace the voltage generator by its internal resistance (considered here as a short) and measure the resistance between points A and B. This is illustrated in Fig.



$$R_{Th} = (5.2 \parallel 7.1) + (10.9 \parallel 19.6)$$
$$= \frac{5.2\times 7.1}{5.2+7.1} + \frac{10.9\times 19.6}{10.9\times 19.6} = \frac{36.92}{12.3} + \frac{213.64}{30.5} = 10\Omega$$

The Maximum Power is

$$P_{R(Max)} = I_R^2 \cdot R = \frac{V_s^2}{4R^2}(R) = \frac{V_s^2}{4R} = \frac{(6.53)^2}{4\times 10} = 1.066\,W$$

Q.6a. Test the following polynomial for the Hurwitz property.

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

(i) The even part e(s) and odd part o(s) of the given F(s)

$e(S)=S^4+2S^2+2$

And $o(S)=S^3+3S$

Continued fraction expansion. $F_1(S)=\frac{e(S)}{o(S)}$ can be obtained by dividing e(S) by o(S) and then investing and dividing again as follows:-

$$\begin{array}{l} S^3+3S\,)\,S^4+2S^2+2\,(\,S \\ \quad\quad S^4+3S^2 \\ \quad\quad \overline{-S^2+2}\,)\,S^3+3S\,(\,-S \\ \quad\quad\quad\quad S^3-2S \\ \quad\quad\quad\quad \overline{5S}\,)\,-S^2+2\,(\,-\frac{S}{5} \\ \quad\quad\quad\quad\quad\quad -S^2 \\ \quad\quad\quad\quad\quad\quad \overline{2}\,)\,5S\,(\,\frac{5}{2}S \\ \quad\quad\quad\quad\quad\quad\quad\quad 5S \\ \quad\quad\quad\quad\quad\quad\quad\quad \times \end{array}$$

Hence continued expansion $F_1(S)$ is

$$F_1(S)=\frac{e(S)}{o(S)}=S+\cfrac{1}{-S+\cfrac{1}{-\frac{S}{5}+\cfrac{1}{\frac{5}{2}S}}}$$

Since two quotient terms -1 and $-\frac{1}{5}$ out of the total quotient terms 1, -1, $-\frac{1}{5}$ and $-\frac{5}{2}$ are negative. Therefore, $F_1(S)$ is not Hurwitz.

S^3+5S^2+9S+3 is Positive real function.(8)

b. Determine if the function F(s) = $\frac{s^3+5s^2+9s+3}{s^3+4s^2+7s+9}$ **is Positive real function.**

b. Determine if the function F(s) = $\frac{S^3+5S^2+9S+3}{S^3+4S^2+7S+9}$ is Positive real function.**(8)**

Ans:

The given function is $F(s)=\frac{s^3+5s^2+9s+3}{s^3+4s^2+7s+9}$

Now let us proceed with the testing of the function F(s) for positive realness:-

(i) Since all the coefficients in the numerator and denominator are having positive values, hence, for real value of S, Z(s) is real.

(ii) To find whether the poles are on the left half of the S-plane, let us apply the Hurwitz criterion to the denominator using continued fraction method.

Let $P(s)=s^3+4s^2+7s+9=M_2(s)+N_2(s)$

Where $M_2(s)=4s^2+9$ and $N_2(s)=s^3+7s$.

$$\varphi(s)=\frac{N_2(s)}{M_2(s)}=\frac{s^3+7s}{4s^2+9}$$

$$4s^2+9\ \big)\ s^3+7s\ \big(\ \frac{s}{4}$$
$$s^3+9\frac{s}{4}$$
$$\frac{19s}{4}\ \big)\ 4s^2+9\ \big(\ \frac{16}{19}s$$
$$4s^2$$
$$9\ \big)\ \frac{19s}{4}\ \big(\ \frac{19s}{4\times 9}$$
$$\frac{19s}{4}$$
$$0$$

Since all the quotients are positive in the continued fraction expansion, hence, the polynomial of Z(s) in the denominator is Hurwitz.

(iii) In order to find whether $R_e Z(j\omega)\geq 0$ for all ω, let us adopt slightly more mathematical manipulation.

Let $F(s)=\dfrac{M_1(s)+N_1(s)}{M_2(s)+N_2(s)}$ where

$M_1(s)=5s^2+3$; $N_1(s)=s^3+9s$;

$M_2(s)=4s^2+9$ and $N_2(s)=s^3+7s$

Rationalising,
$$F(s)=\frac{M_1+N_1}{M_2+N_2}\cdot\frac{M_2-N_1}{M_2-N_2}$$
$$=\frac{M_1M_2-N_1N_2}{M_2^2-N_2^2}+\frac{N_1M_2-M_1N_1}{M_2^2-N_2^2}$$

Here, even part of F(s) is $\dfrac{M_1M_2-N_1N_2}{M_2^2-N_2^2}$

$$\therefore \text{Real }F(j\omega)=\left.\frac{M_1M_2-N_1N_2}{M_2^2-N_2^2}\right|_{s=j\omega}=\frac{D(s)}{M_2^2-N_2^2}$$

Since, $\left(M_2^2-N_2^2\right)$ is always positive for $s=j\omega$, $F(j\omega)\geq 0$ provided $D(j\omega)\geq 0$ for any ω.

In this problem,

$D(s)=M_1M_2-N_1N_2=\left(5s^2+3\right)\left(4s^2+9\right)-\left(s^3+9s\right)\left(s^3+7s\right)$

Or $D(s)=20s^4+45s^2+12s^2+27-s^6-7s^4-9s^4-63s^2$

$=-s^6+4s^4-6s^2+27$

Therefore, $D(j\omega)=-(j\omega)^6+4(j\omega)^4-6(j\omega)^2+27$

Or $D(j\omega)=\omega^6+4\omega^4+6\omega^2+27$

i.e., $D(j\omega)>0$ for any value of ω. Thus, $Z(j\omega)\geq 0$ for any value of ω.

The above three ((i),(ii), & (iii)) tests certify that the given function F(s) is a PR function.

Q.7 a. Following short circuit currents and voltages are obtained experimentally for a two port network. Determine Y parameters.
(i) With output short circuited I_1=5mA, I_2 = - 0.3mA, V_1=25V
(ii) With input short circuited I_1 = - 5mA, I_2 = -10mA, V_2=30V

Ans:
The given short circuit currents and voltages, when the output is short-circuited i.e. when $V_2 = 0$ are

$I_1 = 5mA$

; $I_2 = -0.3mA$ and $V_1 = 25V\big|_{when\, V_2=0}$

And the given short circuit currents and voltages, when the inupt is short-circuited i.e., when $V_1 = 0$ are

$I_1 = -5mA$; $I_2 = 10mA$ and $V_2 = 30V\big|_{when\, V_1=0}$

Therefore, the Y-parameter equations are

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

$I_2 = Y_{21}.V_1 + Y_{22}.V_2$

$$\text{Hence } Y_{11} = \frac{I_1}{V_1}\bigg|_{V_2=0} = \frac{5mA}{25volts} = 0.2\times10^{-3}\text{ mho}$$

$$Y_{21} = \frac{I_2}{V_1}\bigg|_{V_2=0} = \frac{-0.3mA}{25volts} = -0.012\times10^{-3}\text{ mho}$$

$$Y_{22} = \frac{I_2}{V_2}\bigg|_{V_1=0} = \frac{10mA}{30volts} = 0.333\times10^{-3}\text{ mho}$$

$$Y_{12} = \frac{I_1}{V_2}\bigg|_{V_1=0} = \frac{-5mA}{30volts} = -0.166\times10^{-3}\text{ mho}$$

Therefore the Y-parameters are

$Y_{11} = 0.2\times10^{-3}$ mho; $Y_{22} = 0.333\times10^{-3}$ mho and

$Y_{21} = -0.012\times10^{-3}$ mho; $Y_{12} = -0.166\times10^{-3}$ mho

b. Derive the Relationship between Z and Y parameter.

Ans:

The Z-parameters of a two-port network are given by

$V_1 = Z_{11}I_1 + Z_{12}I_2$ ------------- (1) and

$V_2 = Z_{21}I_1 + Z_{22}I_2$ ------------- (2)

Where Z_{11}, Z_{12}, Z_{21}, Z_{22} are called Z-Parameters or impedance (z) parameters.

These parameters can be represented by matrix form as

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \quad \text{------------- (3)}$$

From equation (3), the current I_1 and I_2 in matrix

$$I_1 = \begin{bmatrix} V_1 & Z_{12} \\ V_2 & Z_{22} \end{bmatrix} \Big/ \Delta_Z \quad \text{------------- (4)}$$

$$I_2 = \begin{bmatrix} Z_{11} & V_1 \\ Z_{22} & V_2 \end{bmatrix} \Big/ \Delta_Z \quad \text{------------- (5)}$$

Where Δ_Z is the determinant of Z matrix given by

$$\Delta_Z = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \quad \text{------------- (6)}$$

From equations (4) and (5), we can write

$$I_1 = \frac{Z_{22}}{\Delta_Z}V_1 - \frac{Z_{12}}{\Delta_Z}V_2 \quad \text{------------- (7)}$$

$$I_2 = \frac{-Z_{21}}{\Delta_Z}V_1 + \frac{Z_{11}}{\Delta_Z}V_2 \quad \text{------------- (8)}$$

The Y-parameters of a two-port network are given as

$I_1 = Y_{11}V_1 + Y_{12}V_2$ ------------- (9)

$I_2 = Y_{21}V_1 + Y_{22}V_2$ ------------- (10)

Comparing equation (7) with equation (9), we have

$$Y_{11} = \frac{Z_{22}}{\Delta_Z}; \quad Y_{12} = \frac{-Z_{12}}{\Delta_Z} \quad \text{and}$$

Comparing equation (8) with equation (10), we have

$$Y_{21} = \frac{-Z_{21}}{\Delta_Z} \quad \text{and} \quad Y_{22} = \frac{Z_{11}}{\Delta_Z}$$

Q.8 a. Consider the system given by system function Z(s) = $\frac{2(s+1)(s+3)}{(s+2)(s+6)}$. Design a RC network.

The given impedance function given by

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

Design of R-C N/W :-

The partial fraction expansion of Z(s) will yield negative residues at poles s = -2 and s = -6.

Therefore, Z(s) have to expand as $\frac{Z(s)}{s}$ and latter multiply by s.

Hence,

$$\frac{Z(s)}{s}=\frac{a_1}{s}+\frac{a_2}{(s+2)}+\frac{a_3}{(s+6)}$$

Where,

$$a_1=\left.\frac{2(s+1)(s+3)}{(s+2)(s+6)}\right|_{s=0}=\frac{1}{2}$$

$$a_2=\left.\frac{2(s+1)(s+3)}{s(s+6)}\right|_{s=-2}=\frac{1}{4} \quad \text{and}$$

$$a_3=\left.\frac{2(s+1)(s+3)}{s(s+6)}\right|_{s=-6}=\frac{5}{4}$$

Therefore, $$\frac{Z(s)}{s}=\frac{1}{2s}+\frac{1}{4(s+2)}+\frac{5}{4(s+6)}$$

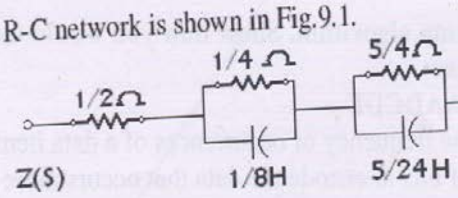
Now, it is clear that none of the residues are negative.

Multiplying both the sides by s, we have

$$Z(s)=\frac{1}{2}+\frac{s}{4(s+2)}+\frac{5s}{4(s+6)}$$

$$=\frac{1}{2}+\frac{1}{\frac{1}{1/4}+\frac{1}{s/3}}+\frac{1}{\frac{1}{5/4}+\frac{1}{5s/24}}$$

The resulting R-C network is shown in Fig.9.1.



b.Design a one-port RL network to realize the driving point admittance function F(s) = $\frac{3(s+2)(s+4)}{s(s+3)}$

$$F(s) = \frac{3(s+2)(s+4)}{s(s+3)} = \frac{3(s^2+4s+2s+8)}{s^2+3s}$$

$$\text{Or } F(s) = \frac{3(s^2+6s+8)}{s^2+3s} = \frac{3s^2+18s+24}{s^2+3s}$$

Therefore, the driving point function F(s) is realized by the continues fraction expansion i.e., (CAUER Form – I)

$s^2+3s \,)\, 3s^2+18s+24 \,(\, 3 \quad \leftarrow Y_1(s) = \frac{1}{3}\Omega$

$3s^2+9s$

$9s+24 \,)\, s^2+3s \,(\, \frac{1}{9}s \quad \leftarrow Z_2(s) = \frac{1}{9}H$

$s^2+\frac{8}{3}s$

$\frac{1}{3}s \,)\, 9s+24 \,(\, 27 \quad \leftarrow Y_3(s) = \frac{1}{27}\Omega$

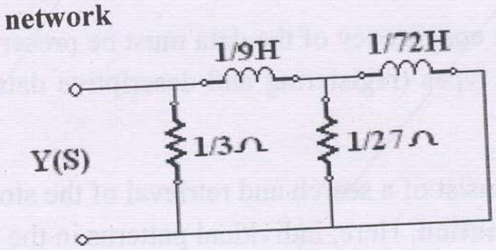
$9s$

$24 \,)\, \frac{1}{3}s \,(\, \frac{s}{72} \quad \leftarrow Z_4(s) = \frac{1}{72}H$

$\frac{1}{3}s$

$\times$

The synthesised RL network



Q.9 a. Synthesise the network that has a transfer impedance $Z_{21}(s) = \frac{2}{s^3+3s^2+4s+2}$ and 1Ω termination at the output.

Ans:

Given that $Z_{21}(s)=\dfrac{2}{s^3+3s^2+4s+2}$

$$Z_{21}(s)=\frac{P(s)}{Q(s)}=\frac{2}{s^3+3s^2+4s+2}$$

Here, all three zeros of transmission at $s=\infty$. Since the numerator P(s) is a constant 2 & $(3s^2+2)$ with the odd part of the denominator i.e. s^3+4s as

$$Z_{21}=\frac{2}{s^3+4s} \quad \text{and}$$

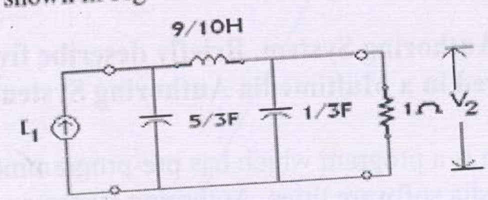
$$Z_{22}=\frac{3s^2+2}{s^3+4s}$$

b.Show that the filter described by the transfer function H(s)= $\dfrac{1}{(s^2+0.73536s+1)(s^2+1.84776s+1)}$ **is a low pass filter.**

Therefore Z_{21} and Z_{22} have the same poles. Synthesize Z_{22}, has the transmission zeros of Z_{21}. Synthesize Z_{22} to give LC network structure by the following continued fraction expansion of $\frac{1}{Z_{22}}$.

$$3s^2+2 \;\big)\; s^3+4s \;\big(\; \tfrac{1}{3}s \leftarrow Y$$
$$s^3+\tfrac{2}{3}s$$
$$\tfrac{10}{3}s \;\big)\; 3s^2+2 \;\big(\; \tfrac{9}{10}s \leftarrow Z$$
$$3s^2$$
$$2 \;\big)\; \tfrac{10}{3}s \;\big(\; \tfrac{5}{3}s \leftarrow Y$$
$$\tfrac{10}{3}s$$
$$0$$

Since Z_{22} is synthesized from the 1-Ω termination toward the input end, the final network takes the form shown in Fig.



b. Show that the filter described by the transfer function H(s)= $\frac{1}{(S^2+0.73536S+1)(S^2+1.84776S+1)}$ is a low pass filter. (6)

Ans:

The given transfer function H(s) is

$$H(s)=\frac{1}{(s^2+0.76536s+1)(s^2+1.84776s+1)}$$

In low-pass filter design, all the zeros of the system function are at infinity. Therefore, in the given transfer function H(s), the zeros in the numerator are at infinity. Hence the given transfer function H(s) is a Low Pass filter.

Text books

1. Network Analysis, M.E.Van Valkenberg, 3rd Edition, Prentice-Hall India, EEE 2006

2. Network Analysis and Synthesis, Franklin F Kuo, 2nd Edition, Wiley India Student Edition 2006