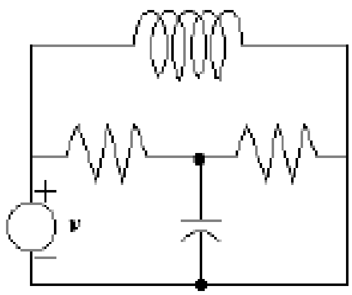
Q2 (a) For the circuit shown in Fig.2, determine (i) its graph (ii) its oriented graph (iii) trees.



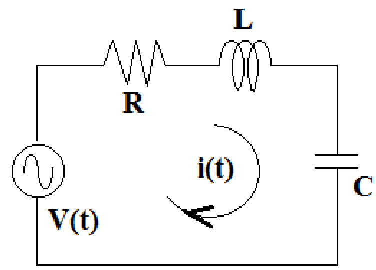
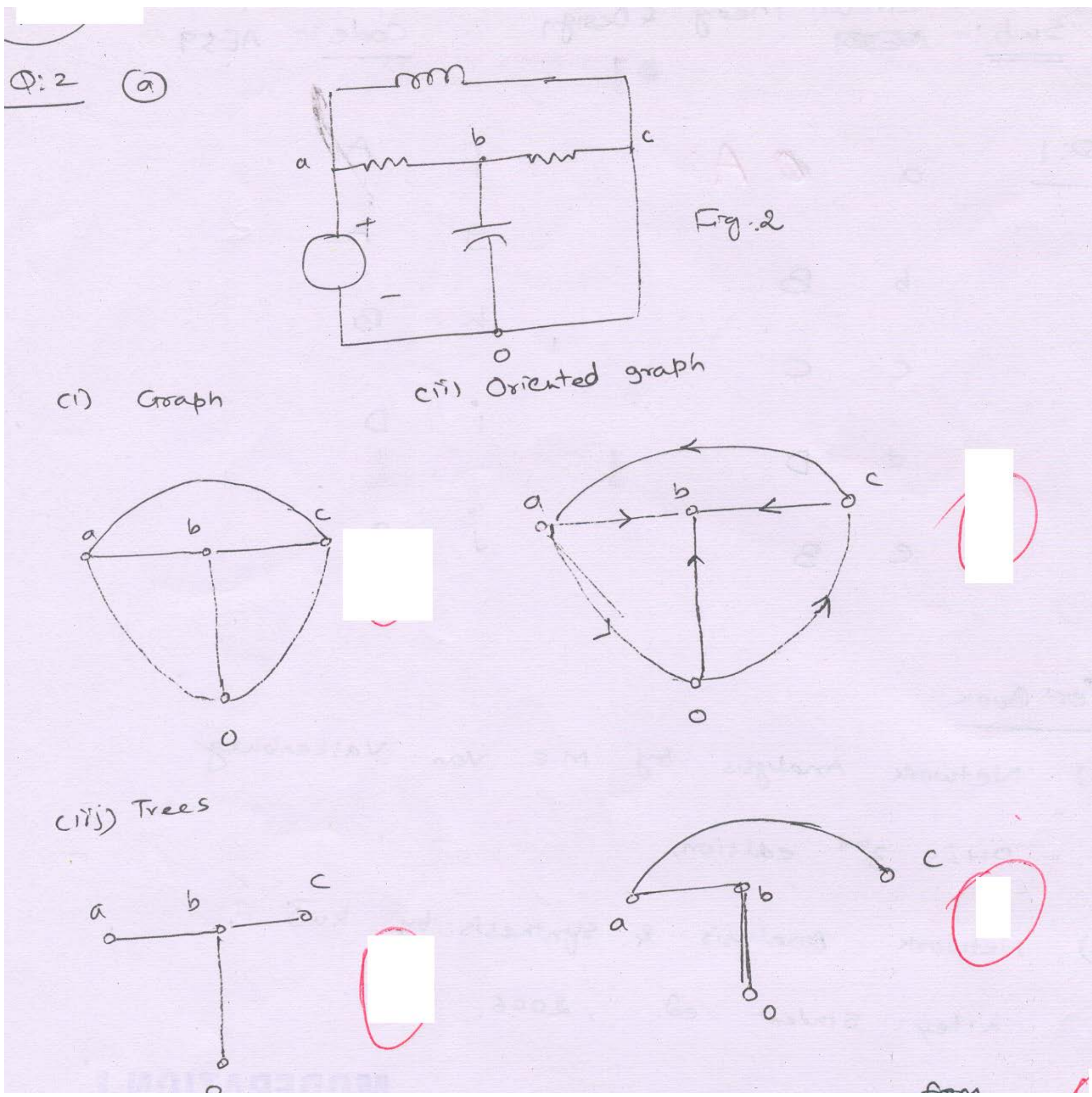


Fig.3

Answer



Q2 (b) Define duality. Obtain dual of network shown in Fig.3. Write integro-differential equation for both.

Answer

(b) Duality :- The process of converting a network from loop basis to node basis for the purpose of analysis.

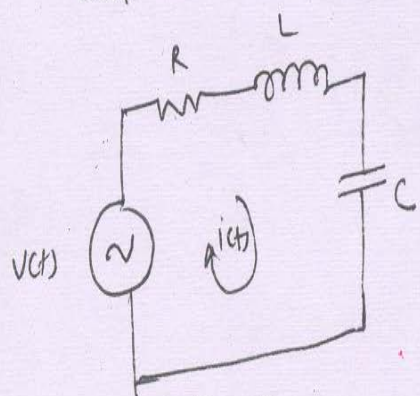
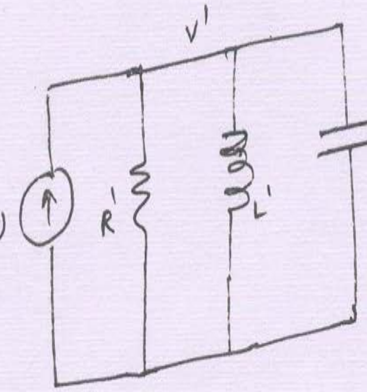


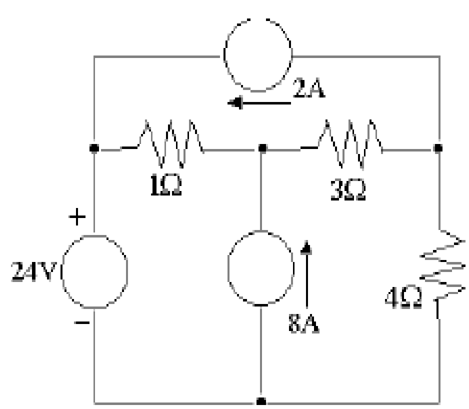
Fig.3



$$L\frac{di}{dt} + Ri + \frac{1}{C}\int i\,dt = v(t)$$

$$C'\frac{dv'}{dt} + G'v' + \frac{1}{L'}\int v'\,dt = i'(t)$$

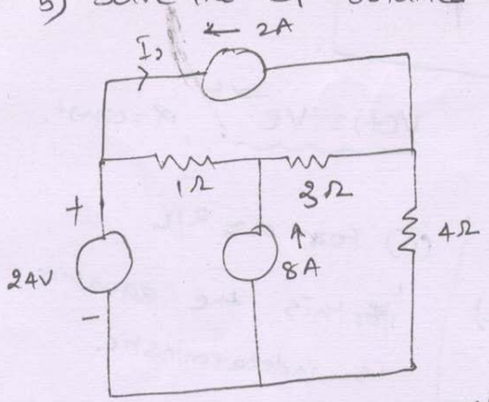
Q2 (c) Write various steps involved for loop analysis. Find the power dissipated in the 4Ω resistor in the circuit shown in Fig.4 using loop analysis.



Answer

3 (*) Loop analysis steps:-

1) Select the various loops.
2) Show the various loop currents & the polarities of the associated voltage drops.
3) Search for any current source, before applying KVL to the loops.
4) Apply KVL to the loops that do not consist current source. Follow sign convention.
5) Solve the eq^s obtained in steps 3 and 4 simultaneously, to obtain the required unknowns.



Writing KVL to super mesh

$$-24 + 4I_3 + 3(I_3 - I_2) + 1(I_1 - I_2) = 0.$$

$$I_1 - 4I_2 + 7I_3 = 24. \quad -(1)$$

For Branches having sources

$$I_2 = -2 \qquad I_3 - I_1 = 8 \quad -(2)$$

From eq. (1) $\quad I_1 + 8I_2 + 7I_3 = 8 \quad -(3)$

From eq (2) & (3). $\quad I_3 = 3$ Amp.

Power dissipated in 4Ω resistor $= I_3^2 R = 9 \times 4 = 36$ Watts. Ans.

Q3 **(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?**

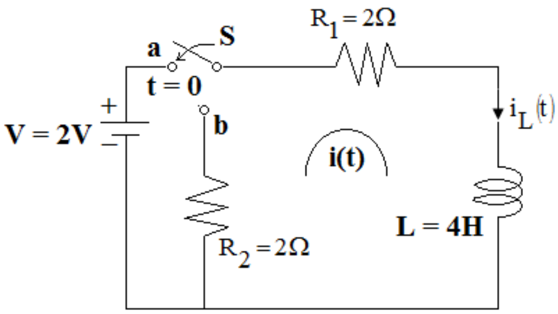


Fig.5

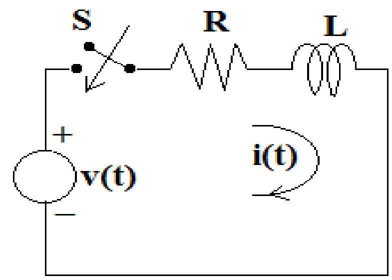


Fig.6

Answer

Q:3

(a)

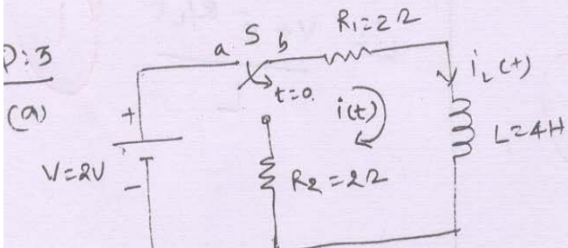


Fig 5

Writing KVL eq, when switch S is open

$$L\frac{di}{dt} + R_1 i + R_2 i = 0.$$

$$4\frac{di}{dt} + 2i + 2i = 0$$ (on substituting values)

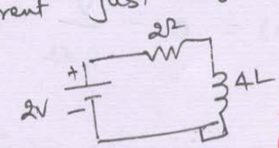
$$\therefore \frac{di}{dt} + i = 0. \quad -(1)$$

By applying Laplace Transform to eq (1)

$$sI(s) - i(0^+) + I(s) = 0.$$

$$\therefore I(s)\,(s+1) = i(0^+)$$

As the current just before switching



$$i(0) = \frac{V}{R} = \frac{2}{2} = 1 \text{ Amp.}$$

After switching to position 'b', current $i(0^+) = 1$ Amp due to L. in the ckt.

$$\therefore I(s)\,(s+1) = 1 \Rightarrow I(s) = \frac{1}{s+1}$$

By taking Inverse LT $i(t) = e^{-t}$

After t=4 sec,

$$i(t) = e^{-4} = \quad \text{Amp.}$$

Q3 (b) In the given network of Fig.6, the switch S is closed at t=0. The voltage source follows the law $v(t) = Ve^{-\alpha t}$, where α is a constant. Solve for the current assuming that (i) $\alpha \neq R/L$ (ii) $\alpha = R/L$.

Answer

Q:3 (b)

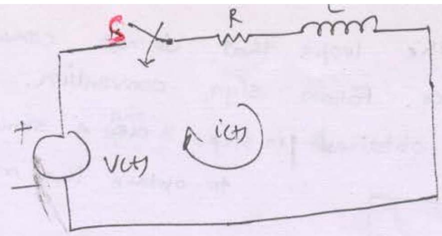


Fig.6

switch S is closed at t=0. $V(t) = Ve^{-\alpha t}$, α = const.

(i) $\alpha \neq R/L$

$V(t) = L\frac{di}{dt} + Ri$ (By writing KVL)

$\therefore Ve^{-\alpha t} = L\frac{di}{dt} + Ri$

$\therefore \frac{di}{dt} + \frac{R}{L} i = \frac{V}{L} e^{-\alpha t}$.

By integrating factor $e^{+R/L\, t}$

$e^{R/L\, t}\frac{di}{dt} + \frac{R}{L} i \cdot e^{\frac{R}{L}t} = \frac{V}{L} e^{(\frac{R}{L}\alpha)t}$

$i e^{R/L\, t} = \frac{Ve^{(R/L - \alpha)t}}{(\frac{R}{L} - \alpha L)} + K$.

$i = \frac{Ve^{-\alpha t}}{R - \alpha L} + Ke^{-R/L\, t}$

$i(0) = 0 - \frac{V}{R - \alpha L} + K$

hence $i = \frac{V}{(R - \alpha L)}\left(e^{-\alpha t} - e^{-\frac{R}{L}t}\right)$

(ii) for $\alpha = R/L$

for this the equation is indeterministic.

Using L'Hospital's Rule

$i e^{+R/L\, t} = \frac{Vt}{L} + K$

$i = \frac{Vt\, e^{-R/L\, t}}{L} + Ke^{-R/L\, t}$

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

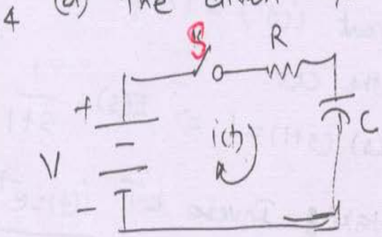
hence

$i = \frac{Vt\, e^{-R/L\, t}}{L}$

Q4 (a) At t = 0, a switch is closed, connecting a voltage source V to a series RC circuit. Find the expression for current by using method of Laplace transform. Assume capacitor has no initial charge.

Answer

Q: 4 (a) The Given n/w will be



switch S is closed at $t=0$.

i.e ⇒ Voltage expression $= V\,u(t)$

By writing the voltage exp.

$$\frac{1}{C}\int_{-\infty}^{t} i\,dt + Ri = V u(t).$$

By Taking Laplace Transform

$$\frac{1}{C}\left[\frac{I(s)}{s} + \frac{q(0^-)}{s}\right] + RI(s) = \frac{V}{s}$$

Now $q(0^-)$ is the charge on capacitor at $t=0^-$.

If the capacitor is initially uncharged $q(0^-)=0$.

$$I(s)\left(\frac{1}{Cs} + R\right) = \frac{V}{s}$$

By rearranging

$$I(s) = \frac{V/R}{\left(s + 1/RC\right)}$$

Taking Inverse Laplace

$$\mathcal{L}^{-1}\{I(s)\} = \mathcal{L}^{-1}\left\{\frac{V/R}{(s+1/RC)}\right\}$$

$$\therefore\ i(t) = \frac{V}{R}e^{-t/RC} \qquad t \geq 0$$

$$i(t) = 0 \qquad t < 0$$

— Ans.

Q4 (b) State and prove initial value theorem and final value theorem for Laplace transform. Obtain initial value for the function F(s) = 2(s+1) / s^2+2s+5

Answer

(b) For initial & final value Th of Laplace Transform

Topic. 8.4 Ref(I)

1

$$F(s) = \frac{2(s+1)}{s^2+2s+5}$$ Find the initial value.

$$f(0^+) = \lim_{t\to 0^+} f(t) = \lim_{s\to\infty} s\cdot F(s) = \lim_{s\to\infty} \frac{2(s+1)\,s}{s^2+2s+5} =$$

2

or

By writing

$$F(s) = \frac{2(s+1)}{(s+1)^2+2^2} \Rightarrow f(t) = 2e^{-t}\cos 2t$$

hence for

$$f(0^+) = \frac{2e^0}{1}\,\frac{\cos 0}{1} = 2$$

Ans.

Q5 (a) State and prove reciprocity theorem. Write its application.

Answer

Reciprocity Theorem, Topic 9.4 of Text Book I

Q5 (b) Obtain the transform impedance representation for a capacitor and an inductor. For initial conditions in the network, how they are transformed?

Answer

Transformation of Capacitor & Inductor, Topic 9.2 of Text Book I

Q6 (a) Discuss the time domain behaviour from the pole and zero plot.

Answer

Topic 10.7 of Text book I

Q6 (b) Determine whether the polynomial are Hurwitz or not.

(i) $F(s)= s^3+ 2s^2 + s + 2$

(ii) $F(s) = s^4 + s^3 +2s^2 +2s+1 = 0$

Answer

(b) Hurwitz or not ?

(i) $F(s) = s^3 + 2s^2 + s + 2$

~~using con~~ $m(s) = 2s^2+2$ - even Part

$n(s) = s^3+s$ - odd

continued Fraction Expansion $= \frac{n(s)}{m(s)}$

$$2s^2+2 \,\overline{)\, s^3+s\,}\ \left(\tfrac{1}{2}s\right.$$
$$s^3+s$$
$$\overline{\quad 0 \quad}$$

By taking ratio of

$$\frac{n(s)}{m(s)} = \frac{s^3+s}{2s^2+2} = \frac{s(s^2+1)}{2(s^2+1)}$$

Hence $F(s) = \underline{(2s^2+2)}\left(\tfrac{1}{2}s+1\right)$

Hurtwiz Hurtwiz

Hence F(s) Hurwitz Ans.

(ii) $F(s) = s^4+s^3+2s^2+2s+1=0$

Using Routh's array

s^4	1	2	1
s^3	1	2	0
s^2	$0(\epsilon)$	1	0
s^1	$\frac{2\epsilon-1}{\epsilon}$	0	
s^0	1		

one sign change (between s^3 and s^2 rows)

one sign change (between s^1 and s^0 rows)

Two changes in sign implying than F(s) has two roots with positive real parts.

Hence F(s) is not a Hurwitz polynomial.

Q7 (a) State the condition of two port network to be reciprocal and symmetrical interms of Z, h , ABCD & Y parameters.

Answer

Q:7 (a)

Parameter	Conditional for Reciprocal network	Symmetrical n/w
i) Z	$Z_{12} = Z_{21}$	$Z_{11} = Z_{22}$
ii) h	$h_{12} = -h_{21}$	$h_{11} h_{22} - h_{12} h_{21} = 1$
iii) ABCD	$AD - BC = 1$	$A = D$
iv) Y	$y_{12} = y_{21}$	$y_{11} = y_{22}$

Q7 (b) Explain twin –T network.

Answer

Twin T-n/w, Topic 11.7 of Text Book I

Q7 (c) For the circuit as shown in Fig.7, find the Y-parameters.

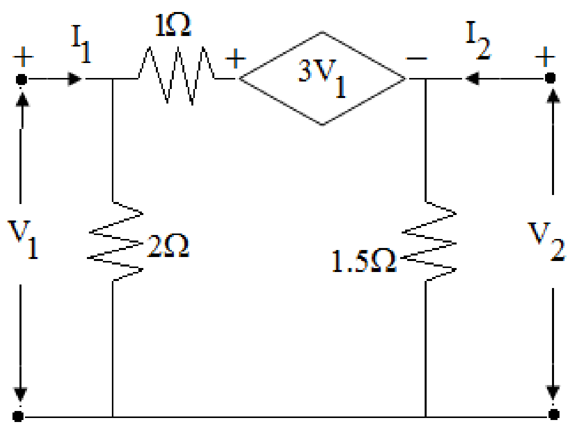
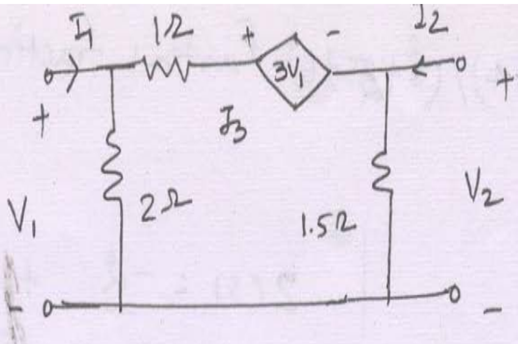


Fig.7

Answer

Q:7 (b)



Y-Parameter

7/11

Let I_3 be the current in middle loop.

By ~~KVL~~ applying KVL,

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

$$2(I_3 - I_1) + 1 I_3 + 3V_1 + 1.5(I_3 + I_2) = 0$$

i.e. $4.5 I_3 = 2I_1 - 1.5 I_2 - 3V_1$

and

$$V_2 = 1.5(I_2 + I_3)$$

using above eqs.

$$V_1 = 0.476 I_1 - 0.285 I_2$$

$$V_2 = 0.19 I_1 + 1.285 I_2$$

$$Z = \begin{bmatrix} 0.476 & 0.285 \\ 0.19 & 1.285 \end{bmatrix}$$

$$Y = [Z]^{-1} = \begin{bmatrix} 0.476 & 0.285 \\ 0.19 & 1.285 \end{bmatrix}^{-1}$$

$$Y = \begin{bmatrix} -1.285 & -0.285 \\ 0.19 & -0.476 \end{bmatrix}$$

Ans.

Q8 (a) Obtain (i) Foster –I form realization and (ii) Cauer –II form realization for

$$Z(s) = 2(s+1)(s+3) / s(s+2)$$

Answer

Q:8 (a) $Z(s) = \dfrac{2(s+1)(s+3)}{s(s+2)}$

Poles: 0, −2 & zeros −1, −3.

Foster-I form.

$F(s) = \dfrac{2s^2+8s+6}{s^2+2s} = 2 + \dfrac{4s+6}{s(s+2)}$

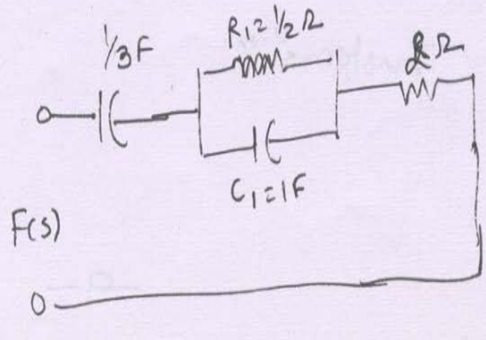
$= Z(\infty) + F_1(s)$

$F_1(s) = \dfrac{4s+6}{s(s+2)} = \dfrac{A}{s} + \dfrac{B}{s+2}$

On solving $A = 3$ $B = 1$

hence

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



Cauer-II form.

$F(s) = \dfrac{6+8s+2s^2}{2s+s^2}$

using continued fraction expansion

$2s+s^2 \,)\, 6+8s+2s^2 \,(\, \dfrac{3}{s}$

$\quad 6+3s$

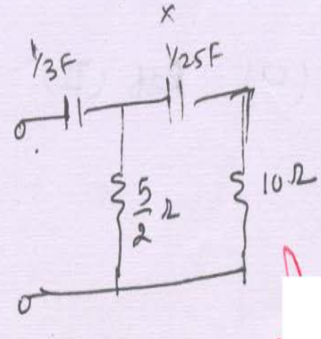
$\quad 5s+2s^2 \,(\, \dfrac{2}{5}$

$\quad 2s+\dfrac{4}{5}s^2$

$\quad \dfrac{1}{5}s^2 \,(\, \dfrac{25}{5}$

$\quad -\dfrac{1}{5}s^2 \,\} \, \dfrac{1}{10}$

$\quad x$



Q8 (b) Synthesize $Z(s) = (s^2 + 5s + 4) / (s^2 + 5s + 6)$ using partial fraction expansion method.

Answer

Q.8

(b) $Z(s) = (s^2+5s+4)/(s^2+5s+6)$ Partial fraction Exp.

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

$$= \frac{K_0}{s} + \frac{K_1}{s+2} + \frac{K_2}{s+3} + K_\infty$$

$$K_0 = s \cdot Z(s) \big|_{s\to 0} = 0.$$

Z/s 8.

$$K_1 = (s+2)(Z(s))\big|_{s\to -2}$$

$$= \frac{(s+1)(s+3)}{(s+3)}\Bigg|_{s\to -2}$$

$$= -2$$

$$K_2 = (s+3)Z(s)\big|_{s\to -3}$$

$$= 2$$

$$K_\infty \quad Z(s)\big|_{s\to\infty}$$

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

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

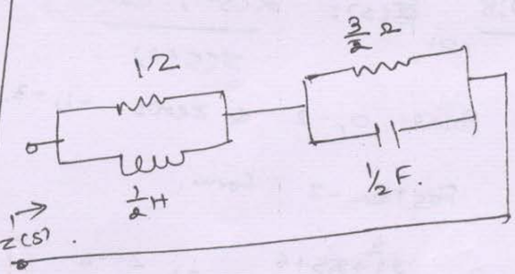
$$= 1$$

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

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

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

$$= \frac{1}{1+\frac{1}{\frac{1}{2}s}} + \frac{1}{\frac{1}{2}s+\frac{3}{2}}$$



Q9 (a) Discuss how the element change in Frequency Transformations used for filter design.

Answer

Frequency Transformation of Text Book II

Q9 (b) Realise H(s) = s / {s^3 +s^2 +3s+1} as a network terminated by 1Ω resistor.

Answer

Q:9 (b)

$$H(s) = \frac{s}{(s^3+s^2+3s+1)}$$ } n/w terminated by 1Ω resistor

$$\therefore H(s) = \frac{s}{(s^2+1)+(s^3+3s)}$$

$$\therefore H(s) = \frac{s/(s^2+1)}{1+\frac{s^3+3s}{(s^2+1)}}$$

$$Y_{12}(s) = \frac{s}{s^2+1} \quad \&$$

$$Y_{22}(s) = \frac{s^3+3s}{s^2+1}$$

ZoT at s=0 & s=∞ for H(s).

n=1 m=3

ZoT at s=0 are n=1

ZoT at s=∞ are m−n=2.

using continued fraction

$$1+s^2 \,\big|\, 3s+s^3 \,\big|\, 3s$$
$$3s+3s^3$$
$$-2s^3.$$

$$Z_{22}(s) = \frac{1}{Y_{22}(s)} = \frac{s^2+1}{3s+s^3}$$

using cauer-II form:

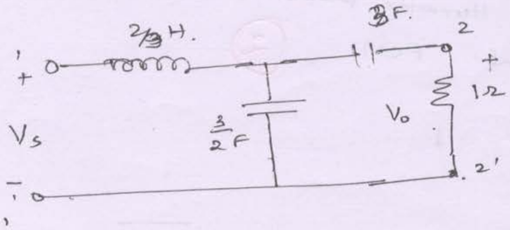
$$3s+s^3 \,\big|\, 1+s^2 \,\big(\, \tfrac{1}{3s} = \tfrac{1}{C_1 s}$$
$$1+\tfrac{1}{3}s^2$$

$$\tfrac{2}{3}s^2 \,)\, 3s+s^3$$

using cauer-I form

$$\tfrac{2}{3}s^2 \,(\, s^3+3s \,(\, \tfrac{3}{2}s \leftarrow C_2 s$$

$$3s \,)\, s^3 \,(\, \tfrac{2}{9}s \leftarrow L_3 s$$
$$\tfrac{2}{3}s^2$$
$$-\tfrac{2}{3}s^2$$
$$0.$$



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

