Network Analysis, May/June 2006

SET 2

1. (a) For the given network (Fig. Set 2.1), draw the oriented graph and choose one possible tree and construct the basic cutest schedule. Write down the network Equations from the above matrix.

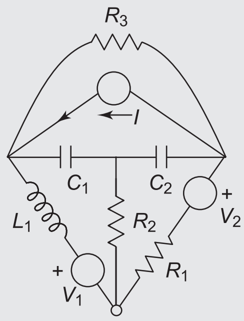


Fig. Set 2.1

Solution:

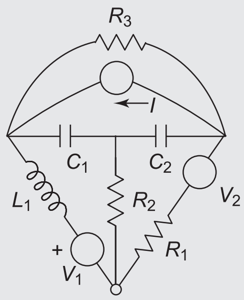


Fig. Set 2.2

The oriented graph for the given network can be as shown in Fig. Set 2.3

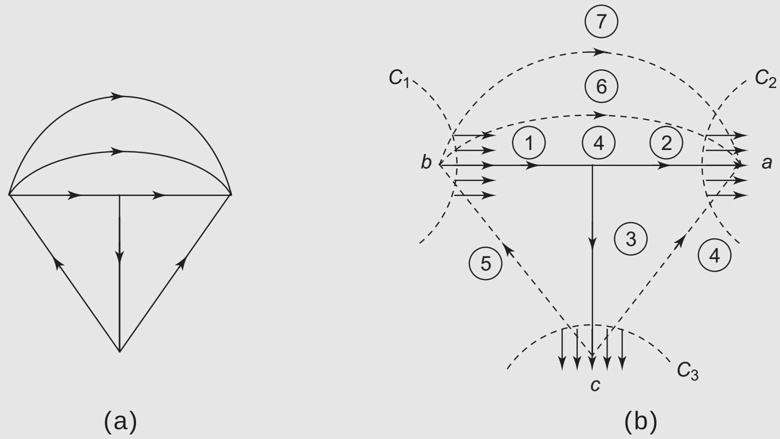


Fig. Set 2.3

$$C_1\!: i_1 - i_5 + i_6 + i_7 = 0$$

$$C_2\!: i_2 - i_4 + i_6 + i_7 = 0$$

$$C_3\!: i_3 + i_4 - i_5 = 0$$

$$\begin{array}{rl} & \text{branches} \\ f-\text{cutsets} & \begin{array}{ccccccc}1 & 2 & 3 & 4 & 5 & 6 & 7\end{array} \\ \begin{array}{r}[7, 6, \bar{2}, 4]\ \ a \\ [7, 6, \bar{1}, 4]\ \ b \\ [3, 4, \bar{5}]\ \ c\end{array} & \begin{bmatrix} 0 & 1 & 0 & -1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & -1 & 1 & 1 \\ 0 & 0 & 1 & 1 & -1 & 0 & 0 \end{bmatrix}\end{array}$$

1. (b) For the network shown (Fig. Set 2.4), determine the node Voltages V_1 and V_2. Determine the power dissipated in each resistor.

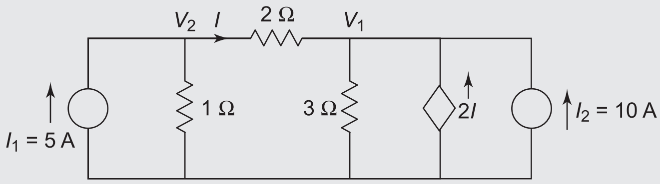


Fig. Set 2.4

Solution:

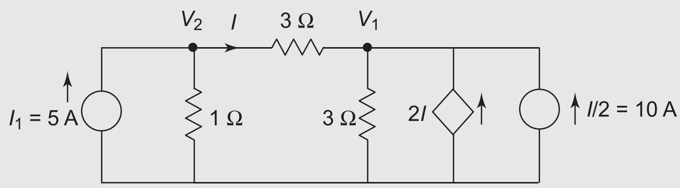


Fig. Set 2.5

Applying KCL

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

$$3V_2 - V_1 = 10 \tag{1}$$

$$I = \frac{V_2 - V_1}{2} \tag{2}$$

$$\frac{V_1}{3} + \frac{V_1 - V_2}{2} = 10 + 2I = \frac{-V_2}{2} = 10 + 2\left(\frac{V_2 - V_1}{2}\right)$$

$$\Rightarrow \quad V_1\left(\frac{1}{2} + \frac{1}{3}\right) = 10 + V_2 - V_1$$

$$\therefore \quad 11V_1 - 9V_2 = 60 \tag{3}$$

Solving (1) and (3),

$$V_1 = 11.25 \text{ volts}$$

$$\text{and } V_2 = 7.083 \text{ volts}$$

$$\text{Power dissipated in } 1\ \Omega \text{ resistor} = VI = I^2R = \frac{V^2}{R} = \frac{V^2}{1} = (7.083)^2$$

$$= 50.17 \text{ watts}$$

$$\text{Power dissipated in } 2\ \Omega \text{ resistor} = \frac{V^2}{R} = \frac{(V_2 - V_1)^2}{2} = 8.682 \text{ watts}$$

$$\text{Power dissipated in } 3\ \Omega \text{ resistor} = \frac{V_1^2}{3} = \frac{(11.25)^2}{3} = 42.19 \text{ watts}$$

1. (c) Explain cleanly what you understand by "Duality" and "Dual network". Illustrate the procedure for drawing the dual of a given network.

Solution: Two circuits are duals, if the mesh equations that characterise one of them have the same mathematical form as the nodal equations that characterise other.

Then they are said to duals (OH) satisfy duality of property i.e., if each mesh equation of one circuit is numerically identical with the corresponding nodal equation of other.

Networks that satisfy duality property are called "Dual networks."

Dual pairs:

Resistance (R) → Conductance (G)
Inductance (L) → Capacitance (C)
Voltage (V) → Current (I)
Voltage Source → Current source
Node → Mesh
Series path → Parallel path
Open circuit → Short ckt
Thevenin → Norton

<u>Steps to construct a dual circuit:</u>

1. Place a node at the centre of each mesh of the given ckt. Place the reference node of the dual ckt outside the given ckt.
2. Draw dotted lines between the nodes such that each line crosses a network element by its dual.
3. A voltage source that produces a positive (clockwise) mesh current has it dual or current source whose reference direction is from ground to non-reference node.

∴ Two circuits are said to be dual if they are described by the same characterising equations with dual quantities interchanged.

2. (a) Explain the Dot Convention for mutually coupled coils.

Solution: *Dot Convention*

Mutual inductance is the ability of one inductor to induce voltage across the neighbouring inductor measured in Henrys (H).

The mutually induced emf $\frac{Mdi}{dt}$ may be positive (or) negative but M is always positive.

We apply dot convention to determine the polarity of the induced emf.

Place a dot at one end of coil (1) Assume that the current enters at the dotted end of the coil. Determine the direction of flux produced due to this current. Then place another dot at one of the ends of coil (2) such that the current entering at that dotted end in coil (2) produce flux in the same direction. Consider two coils (1) and (2) as shown.

1. Place a dot at one end of coil (1) and assume that the current enters at that dotted end in coil (1).
2. Place another dot at one of the ends of coil (2) such that the current entering at that end in coil (2) establishes magnetic flux in the same direction.

In order that the flux produced by I_2 flowing in coil (2) produce flux in the same upward direction it should enter at lower end of coil (2). Hence place a dot at that end of coil (2).

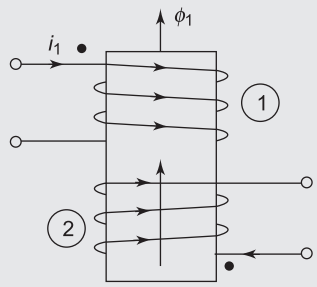


Fig. Set 2.6

2. (b) Derive the Expression for coefficient coupling between pair of magnetically coupled coils.

Solution: *Coefficient of Coupling*: It is a measure of the flux linkages between the two coils.

The coefficient of coupling is defined as the fraction of the total flux produced by one coil linking with another and it is denoted by 'k'.

Let $\phi_1 \rightarrow$ flux produced by coil–1

$\phi_2 \rightarrow$ flux produced by coil–2

$\phi_{12} \rightarrow$ flux produced by coil–1 linking with coil–2

$\phi_{21} \rightarrow$ flux produced by coil–2 linking with coil–1

$$\therefore \quad \text{Coefficient of coupling } k = \frac{\phi_{12}}{\phi_1} = \frac{\phi_{21}}{\phi_2}$$

k value lies between 0 and 1.

We know that $M_{12} = \dfrac{M_2\ \phi_{12}}{i_1}$, $M_{21} = \dfrac{M_1\ \phi_{21}}{i_2}$

$$M_{12} \times M_{21} = \frac{M_2\ \phi_{12} \times M_1\ \phi_{21}}{i_1\ i_2}$$

$$M^2 = \frac{M_2 \times k\phi_1}{i_1} \times \frac{M_1 \times k\ \phi_2}{i_2}$$

$$M^2 = k^2\ \frac{M_1\ \phi_1}{i_1} \times \frac{M_2\ \phi_2}{i_2} = k^2\ L_1\ L_2$$

$$\Rightarrow \qquad \boxed{k = \frac{M}{\sqrt{L_1 L_2}}}$$

2. (c) Write the Loop Equations for the Coupled circuit shown in Fig. Set 2.7.

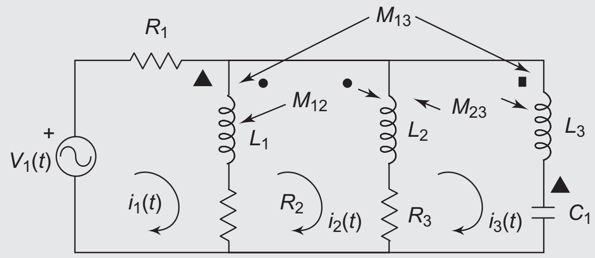
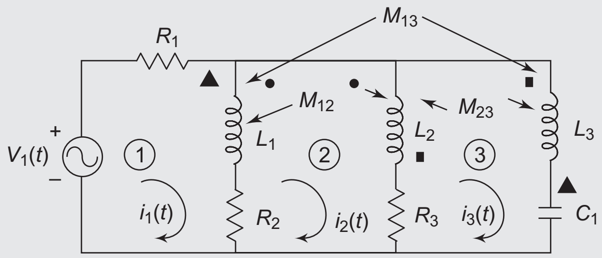


Fig. Set 2.7

Solution:



$i_1(f) \rightarrow i_1$
$i_2(f) \rightarrow i_2$
$i_3(f) \rightarrow i_3$

Fig. Set 2.8

Loop Equations: (By Dot Rule Convention)

(1) $\Rightarrow$ $V_1(t) = R_1\ i_1(t) + L_1 \left(\dfrac{d\,i_1(t)}{d\,t} - \dfrac{d\,i}{d\,t} \right) + M_{12}$

$$\left(\frac{d\,i_2(t)}{d\,t} - \frac{d\,i_3(t)}{d\,t} - M_{13}\ \frac{di_3(t)}{d\,t} \right) + R_2\ (i_1(t) - i_2(t) = 0$$

$$\Rightarrow V_1(t) = i_1(t)\,(R_1 + R_2) + L_1 \frac{d\,i_1(t)}{d\,t} - i_2(t)\,R_2 + M_{12} \frac{d\,i_2(t)}{d\,t} -$$

$$M_{13} \frac{d\,i_3(t)}{d\,t} - L_1 \frac{d\,i_2(t)}{d\,t} - M_{12} \frac{d\,i_3(t)}{d\,t}$$

(2) $$\Rightarrow R_2\,(i_2(t) - i_1(t)) + L_1 \left(\frac{d\,i_2(t)}{d\,t} - \frac{d\,i_1(t)}{d\,t}\right) - M_{12}\left(\frac{d\,i_2(t)}{d\,t} - \frac{d\,i_3}{d\,t}\right) +$$

$$M_{13} \frac{d\,i_3}{d\,t} + L_2 \left(\frac{d\,i_2}{d\,t} - \frac{d\,i_3}{d\,t}\right) - M_{12}\left(\frac{d\,i_2}{d\,t} - \frac{d\,i_1}{d\,t}\right) - M_{23}\frac{d\,i_3}{d\,t} +$$

$$R_3\,(i_2 - i_3) = 0$$

(3) $$\Rightarrow R_3\,(i_3 - i_2) + L_2 \left(\frac{d\,i_3}{d\,t} - \frac{d\,i_2}{d\,t}\right) - M_{12}\left(\frac{d\,i_1}{d\,t} - \frac{d\,i_2}{d\,t}\right) + M_{23}\frac{d\,i_3}{d\,t}$$

$$+ L_3 \frac{d\,i_3}{d\,t} - M_{13}\left(\frac{d\,i_1}{d\,t} - \frac{d\,i_2}{d\,t}\right) + M_{23}\left(\frac{d\,i_3}{d\,t} - \frac{d\,i_2}{d\,t}\right) + \frac{1}{C_1}\int i_3\,dt = 0.$$

3. (a) What are initial conditions? Why do you need them?

Solution: *Initial Conditions:*

Initial conditions *are those conditions that exist in the circuit immediately after switching operation.*

At $t = 0$, one-or more switches are operated which disturb the equilibrium of the circuit. We assume that the switch is operated in zero time. To distinguish time immediately before and immediately after the operation of the switch we use $t = 0^-$ and $t = 0^+$. *The initial conditions will depend on the post history of the network* before time instant $t = 0^-$. The initial conditions are given in terms of capacitor voltage and inductor current.

Necessity: After switching, $t = 0^+$, the new voltages and currents may appear in the network, as the result of initial capacitor voltages and inductor currents or because of the sources. The elevation of currents, voltages and their derivative at $t = 0^+$ constitutes the evaluation of initial conditions.

3. (b) The switch is closed at $t = 0$. Find the initial conditions at $t = 0^+$ for i_1, i_2, V_C, di_1/dt, di_2/dt. (Fig. Set 2.9)

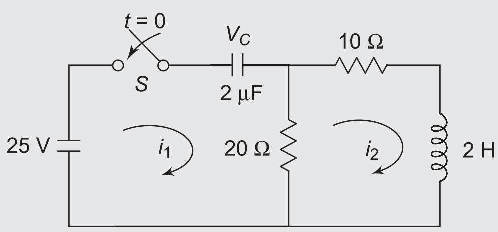


Fig. Set 2.10

Solution: Capacitor doesn't allow sudden changes in voltage.

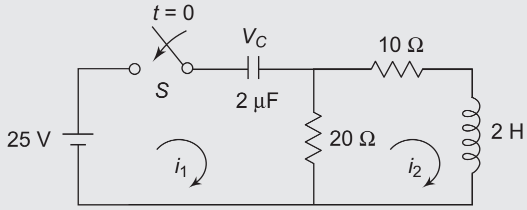


Fig. Set 2.11

Inductor doesn't allow sudden changes in current.
Since no sources are present initially (at $t = 0^-$) $VC = 0$ V and $i_2 = 0$A

$\therefore$ At $t = 0^+$, 'C' $\rightarrow$ Shoot circuit

'L' $\rightarrow$ Open circuit

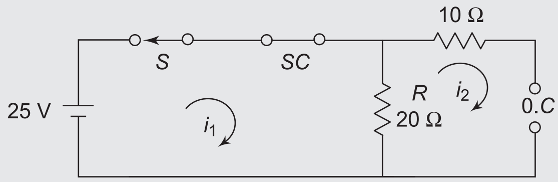


Fig. Set 2.12

At $t = 0^+$, $20i_1 = 25$ and $i_2|_{t=0^+} = 0$A

$$\Rightarrow \quad i_1\big|_{t=0^+} = 1.25 \text{ A}$$

$$V_C\big|_{t=0^+} = 0 \text{ But } V_C = \frac{1}{C}\int_0^t i_1\, dt$$

$$\Rightarrow \quad \frac{dV_C}{dt} = \frac{i_1}{C}$$

Applying KVL,

$$25 = V_C + 20i_R$$

Differentiating

$$0 = \frac{dV_C}{d\,t} + 20\,\frac{di_R}{d\,t}$$

$$\Rightarrow \quad 20\,\frac{di_R}{d\,t} + \frac{i_1}{C} = 0$$

$$\text{At } t = 0^+,\ 20\,\frac{di_R}{d\,t}\bigg|_{t=0^+} + \frac{i_1}{C}\bigg|_{t=0^+} = 0 \quad \Rightarrow \frac{di_R}{d\,t} = -\frac{1.25}{2\mu \times 20}$$

$$\therefore \quad \left.\frac{di_R}{d\,t}\right|_{t=0^+} = -\,31{,}250 \text{ A/S}$$

Also, $10i_2 + 2\,\dfrac{di_2}{dt} = 25 \qquad \Rightarrow 10i_2|_{t=0^+} + 2\left.\dfrac{di_2}{dt}\right|_{t=0^+} = 23$

$$\Rightarrow \quad \left.\frac{di_2}{dt}\right|_{t=0^+} = 12.5 \text{ A/S} \qquad (\text{Since } i_2|_{t=0^+} = 0)$$

$$\therefore \quad \left.\frac{di_1}{dt}\right|_{t=0^+} = \left.\frac{di_R}{dt}\right|_{t=0^+} + \frac{di_2(t)}{dt} = -\,31237.5 \text{ A/S}$$

3. (c) A current of 5A flows through a non-inductive resistance in series with a chocking coil when supplied at 250v, 50 Hz. If the voltage across the non inductive resistance is 125 V and that across that coil 200 V, calculate the Impedance, Reactance and Resistance of the coil, power absorbed by the coil and the total power draw the phasor diagram.

Solution:

Given $|V_R| = 125$ V

$|V_L| = 200$ V

$|I| = 5$ A

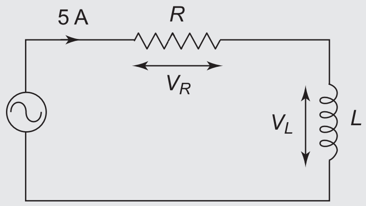


Fig. Set 2.13

$|V_R| = |I|R = 125$ V $\quad \Rightarrow \quad R = \dfrac{125}{5} = 25\ \Omega \quad (\because I = 5 \text{ A})$

$|V_L| = |I|X_L = |I|(j\omega L) \quad \therefore \quad |V_L| = 200$ V

$\Rightarrow \quad |X_L| = 40 \quad \Rightarrow \quad 5(2\pi \times 50)L = 200$

$$\Rightarrow \quad L = \frac{200}{500\pi} = 127.3 \text{ mH}$$

$$Z = 25 + j40 = 47.16\ \underline{|57.99^\circ}$$

Power absorbed by coil $= \dfrac{1}{2}\,LI^2$

$= \dfrac{1}{2} \times 0.1273 \times 25$

$= 1.59$ watts

True power $P_{av} = VI\cos\theta = 250 \times 5 \times \cos 57.99^\circ$

$= 662.58$ watts

Phasor diagram:

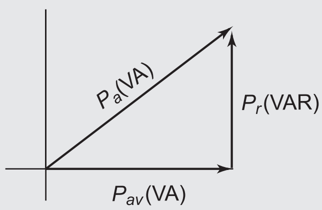


Fig. Set 2.14

$$\text{Reactive power, } P_r = I^2 X_L = 25 \times 40 = 1000 \text{ VAR}$$

$$\text{Apparent power, } P_a = I^2 Z = 25 \times 47.16 = 1179 \text{ VA}$$

4. (a) Determine $V_C(t)$ and $i_L(t)$ in the circuit shown in the Fig. Set 2.15. Assume Zero initial conditions. Use Laplace Transform method.

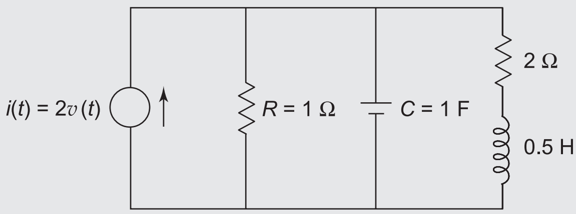


Fig. Set 2.15

Solution: (a) Applying Nodal analysis,

$$2u(t) = \frac{V_C}{R} + C\frac{dV_C}{dt} + i_L$$

$$\text{But } i_L = \frac{V_C}{2 + j0.5}$$

Applying Laplace Transform on both sides,

$$\frac{2}{5} = \frac{V_C(S)}{R} + \frac{1}{SC}(SV_C(S) - V_C(0)) + \frac{V_C(S)}{2 + 0.5S}$$

Assuming zero initial conditions, $V_C(0) = 0$

$$\Rightarrow \quad V_C(S)\left(1 + \frac{S}{S} + \frac{1}{2 + S(0.5)}\right) = \frac{2}{5}.$$

$$\Rightarrow \quad V_C(S)\left(2 + \frac{1}{2 + 5/2}\right) = \frac{2}{5}$$

$$\Rightarrow \quad V_C(S)\left(1 + \frac{1}{4 + 5}\right) = \frac{1}{5} \quad \Rightarrow \quad V_C(S) = \frac{S + 4}{S(S + 5)}$$

$$\therefore \quad i_L(S) = \frac{V_C(S)}{2 + 0.5S} = \frac{2}{S(S + 5)}$$

Applying inverse Laplace Transform for

$$V_C(S) = \frac{S + 4}{S(S + 5)} = \frac{4/5}{5} + \frac{1/5}{S + 5}$$

$$\therefore \quad V_C(t) = \frac{4}{5}u(t) + \frac{1}{5}e^{-5t}u(t)$$

$$\Rightarrow \qquad V_C(t) = \frac{1}{5}\ (4 + e^{-5t})\ u(t)$$

Similarly $$i_e(S) = \frac{2}{S\,(S+5)} - \frac{2/5}{5} - \frac{2/5}{S+5}$$

Applying inverse Laplace Transform

$$\boxed{i_L(t) = \frac{2}{5}\ u(t) - \frac{2}{5}\ e^{-5t}\ u(t)}$$

4. (b) Obtain the S-Domain Equivalent for the following elements

i. Resistance R ii. Inductance with initial current-I_0

iii. Capacitors

iv. Capacitors with initial Voltage V_0 give the relevant equations.

Solution: *S-Domain Equivalent for the elements*

(i) Resistor, R

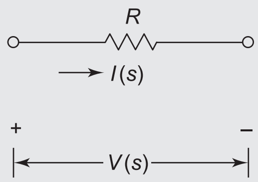


Fig. Set 2.16

$$V(S) = I(S)R$$

The ratio of $V(S)$ to $I(S)$ is called transform impedance, $Z(S)$.

$$Z(S) = \frac{V(S)}{I(S)} = R$$

$\therefore$ S-Domain equivalent is also = 'R'.

(ii)

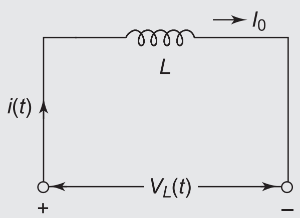


Fig. Set 2.17

$$V_i(t) = L\frac{di}{dt} \tag{1}$$

$$i(t) = \frac{1}{L}\int V_L(t)\ dt \tag{2}$$

Applying Laplace Transform to (1) and (2)

$$V_L(S) = L[SI(S) - I(0^-)] \qquad (1')$$

$$I(S) = \frac{1}{SL}\, V(S) + \frac{i(0^+)}{S} \qquad (2')$$

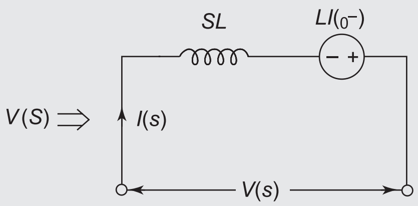


Fig. Set 2.18

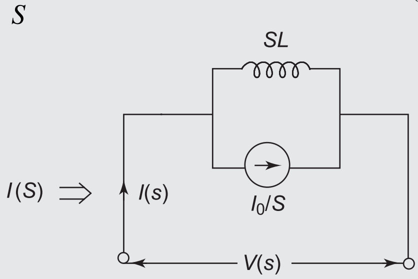


Fig. Set 2.19

(iii)

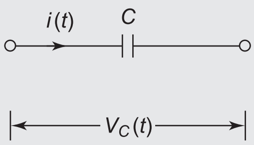


Fig. Set 2.20

$$V_C(t) = \frac{1}{C}\int i(t)\, dt \qquad (1)$$

$$i(t) = C\,\frac{dV_C}{dt} \qquad (2)$$

Apply Laplace Transform to (1)

$$V_C(S) = \frac{1}{SC}\, I(S) + \frac{V(0)}{S} \qquad (V(0) = 0)$$

Assuming initial conditions = 0

$$V_C(S) = \frac{1}{SC}\, I(S)$$

$$\therefore \quad Z(S) = \frac{1}{SC}$$

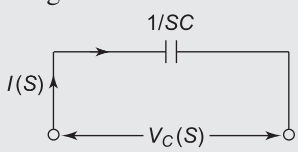


Fig. Set 2.21

S-domain equivalent of capacitor with no initial voltage.

(iv) Capacitor with initial voltage from (1) and (2) of the above problem.

$$V_C(S) = \frac{1}{C_S}\, I(S) + \frac{V(0)}{S} \qquad (1')$$

$$I(S) = C[SV_C(S) - V(0^-)] \qquad (2')$$

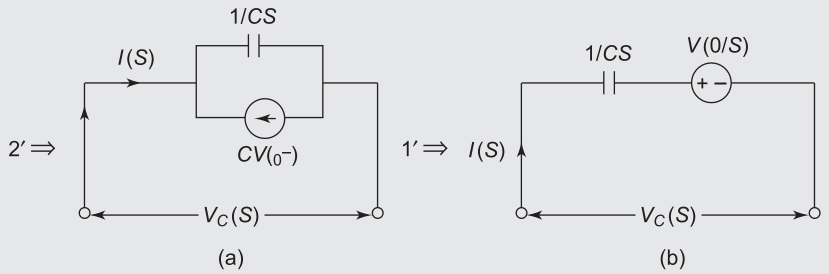


Fig. Set 2.22

5. (a) Verify Tellegen's theorem in the network shown in the Fig. Set 2.23.

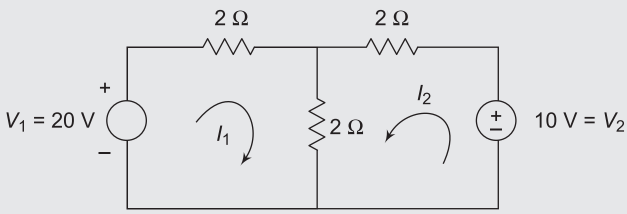


Fig. Set 2.23

Solution: Tellegens theorem states that in any arbitrary lumped network, the algebraic sum of the powers in all the branches at any instant is zero and all the branch currents and voltages must satisfy Kirchoff's law.

Verifying Tellegens theorem for the above ckt.

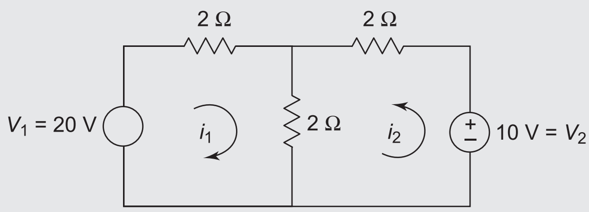


Fig. Set 2.24

There are 5 elements in the above circuit.

Applying mesh equations.

$$4i_1 + 2i_2 = 20$$

$$\Rightarrow 2i_1 + i_2 = 10 \quad (1)$$

$$2i_1 + 4i_2 = 10$$

$$i_1 + 2i_2 = 5 \quad (2)$$

Solving (1) and (2)

$$i_1 = 5, \qquad i_2 = 0$$

$$\sum_{k=1}^{5} V_k I_k \text{ for this circuit is}$$

$$-100 + 50 + 50 + (0)^2 (2) - (0)(10) = 0$$

Hence, verified.

5. (b) Verify reciprocity theorem for the network shown in Fig. Set 2.25.

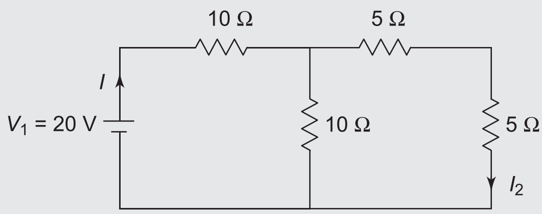


Fig. Set 2.25

Solution: Reciprocity theorem states that in any passive linear bilateral single source network interchanging the positions of ideal voltage source and an ideal ammeter does not after the ammeter reading (current) and interchanging then positions of current source and ideal voltmeter does not after voltmeter reading (voltage).

Verifying theorem for the above ckt

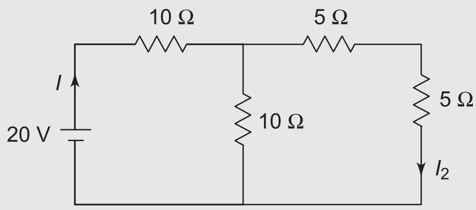


Fig. Set 2.26

$$I = \frac{20}{10+5} = \frac{4}{3} \qquad \therefore \quad I_2 = \frac{2}{3}$$

(Current divider rule)

Interchanging the voltage source.

$$I = \frac{20}{15} = \frac{4}{3}$$

$$\Rightarrow \qquad I_1 = \frac{2}{3}$$

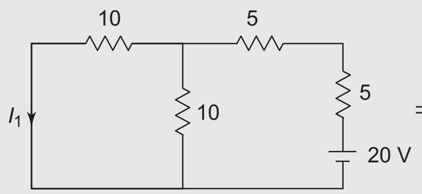


Fig. Set 2.27

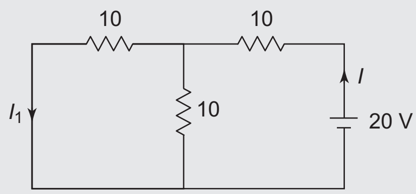


Fig. Set 2.28

$\therefore$ The ratio of excitation to response when only one excitation is applied is constant when positions of excitation and response are interchanged. Hence reciprocity theorem is verified.

6. (a) A typical two-port network is characterised by the equation $2V_1 + 4I_2 = I_1$ and $V_2 + 6V_1 = 8I_2$. Determine the values of

i. y_{11} ii. z_{21} and iii. h_{21}

Solution: A typical two-port network is characterised by the equation

$$2V_1 + 4I_2 = I_1 \qquad (1) \text{ and}$$

$$V_2 + 6V_1 = 8I_2 \qquad (2)$$

$$6V_1 + 12I_2 = 3I_1 \quad (1) \times 3$$

$$6V_1 + V_2 = 8I_2 \qquad (2)$$

$$12I_2 - V_2 = 3I_1 - 8I_2$$

$$3I_1 - 20I_2 = -V_2 \qquad (3)$$

$$V_2 = -3I_1 + 20I_2$$

$$V_1 = \frac{I_1}{2} - 2I_2 \qquad \text{(from (2) and (3))}$$

$$\therefore \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} = \begin{pmatrix} \frac{1}{2} & -2 \\ -3 & 20 \end{pmatrix}$$

(i) $Y_{11} = \dfrac{Z_{22}}{\Delta Z}$ $(\Delta Z = 10 - 6 = 4) = \dfrac{-20}{4} = 5$

(ii) $Z_{21} = -3$

(iii) $h_{21} = \dfrac{-Z_{21}}{Z_{22}} = \dfrac{3}{20}$.

6. (b) Obtain the input and output impedances of an amplifier having $h_{11} = 2\Omega$; $h_{12} = 1\Omega$; $h_{21} = 5$ and $h_{22} = 2\Omega$, if it is driven by a source having an internal resistance of 4Ω and is terminated through a load which draws maximum power from the amplifier.

Solution:

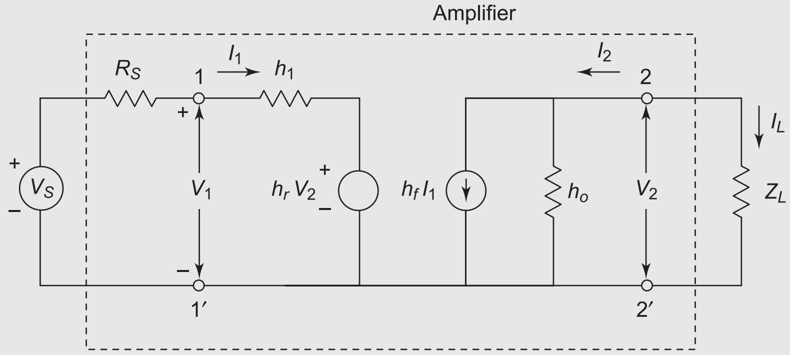


Fig. Set 2.29

Given $h_{11} = 2\ \Omega$, $h_{12} = 1\Omega$, $h_{21} = 5\ \Omega$, $h_{22} = 2\ \Omega$
(h_i) (h_r) (h_f) (h_o)

$R_S = 4\ \Omega$

Load draws maximum power when

$Z_L = Z_{TH}$. (More power Transform Theorem)

To find Z_{TH} (Remove Z_L) | Output admittance

$$Z_L = \frac{V_2}{-I_2} = \frac{-1}{Y_o} \quad \Bigg| \quad Y_o = \frac{I_2}{V_2}.\text{ with } V_S = and\ R_L = \infty$$

$$I_2 = h_f I_1 + h_0 V_2 = t$$

$$\Rightarrow \qquad y_0 = h_f \frac{I_1}{V_2} + h_0 \qquad (1)$$

From Fig. $R_S I_1 + h_i I_1 + hr V_2 = 0$ (or) $\dfrac{I_1}{V_2} = -\dfrac{h_r}{h_i + R_S}$ (2)

$$(2) \text{ in } (1) \Rightarrow Y_0 = h_0 \frac{h_f h_r}{h_i + R_S}$$

$$\therefore \qquad Y_0 = 2 - \frac{5}{2+4} = 2 - \frac{5}{6} = \frac{7}{6} = 1.167\ \Omega$$

$$Z_{TH} = 0.857\ \Omega$$

$$Z_L Y_L = Z_{TH} = 0.857\ \Omega$$

$$Z_i = \frac{V_1}{I_1} \quad V_1 = h_i I_1 + h_r V_2$$

Hence

$$Z_i = \frac{hi\,I_1 + h_r V_2}{I_1} = h_i + h_r\,\frac{V_2}{I_1}$$

Substituting,

$$V_2 = -\,I_2\,Z_L = A_I\,I_1\,Z_L$$

$$A_I = \frac{I_2}{I_1} = \frac{-h_f}{1 + h_0 Z_L} \qquad \left(\therefore I_2 = h_f\,I_1 + h_0\,V_2 \text{ and } A_I - \frac{I_L}{I_1}\right)$$

$$Z_i = h_i + h_r\,A_I\,Z_L = h_i - \frac{h_f\,h_r}{Y_L + h_0}$$

$$= 2 - \frac{5}{1.167 + 2} = 0.421\ \Omega$$

$$\therefore \quad \text{O/P impedance} = \frac{1}{Y_0}\bigg\|\ Z_L = \frac{0.857}{2} = 0.418\ \Omega$$

I/P impedance = 0.421 Ω

7. (a) Draw the circuit of an asymmetrical L-attenuator working between tow equal impedances with a given loss. Derive the design equations for the circuit elements in terms of
   i. the iterative resistance R_i, and
   ii. the current ratio N.

Solution: *L-Type Attenuator:*

An L-type asymmetrical attenuator is connected between a source with source resistance $R_S = R_i$ and load resistance $R_L = R_i$
(P-707 in Network Theory) filters and Attenuators.
Simply replace $R_0 \rightarrow$ by 'R_i' (iterative resistance).

7. (b) Design an asymmetrical L-attenuator to operate into a resistance of 300 Ω and to provide attenuation of 30 DB.

Solution: $N = \text{Antilog}\,\dfrac{dB}{20} = \text{Antilog}\,\dfrac{30}{20} = 31.62$

The series erm of the attenuator

$$R_1 = R_\mathrm{i}\left(\frac{N-1}{N}\right) = 300\left(\frac{31.62 - 1}{31.62}\right) = 290.51\ \Omega$$

The shunt erm of the attenuator

$$R_2 = \frac{R_i}{N-1} = \frac{300}{31.62 - 1} = 9.79\ \Omega$$

The desired configuration of L-attenuator is

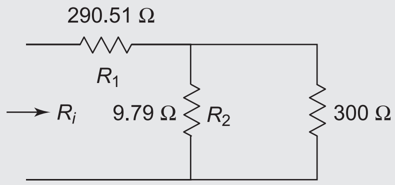


Fig. Set 2.30

8. (a) Explain the variation of Attenuation, phase shift and characteristic impedance of m derived high pass filter?

Solution: (a) In P-689 in Network Theory (Filters and Attenuators).

8. (b) Draw the circuit diagram for T and Π section of m-derived high pass filter.

Solution: With both T and Π sections shown in P-688 in Network Theory.