Code: 23EC3201

I B.Tech - II Semester – Regular / Supplementary Examinations
MAY 2025

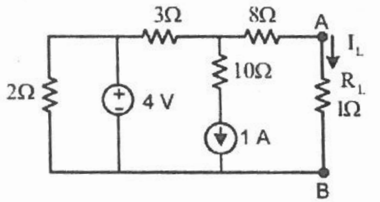
NETWORK ANALYSIS
(ELECTRONICS & COMMUNICATION ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

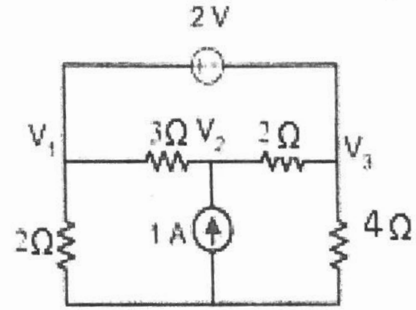
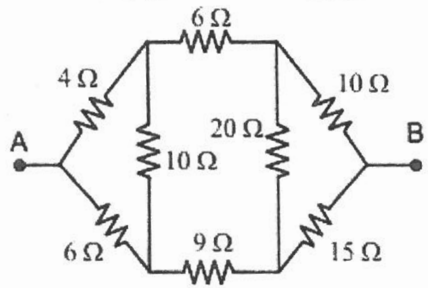
BL – Blooms Level CO – Course Outcome

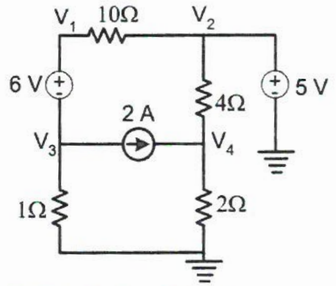
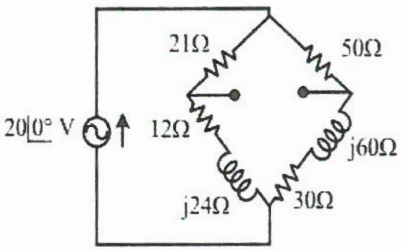
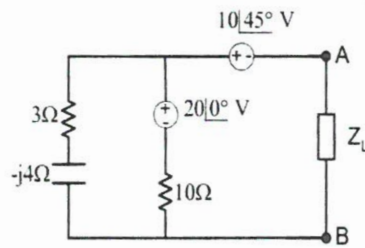
PART – A

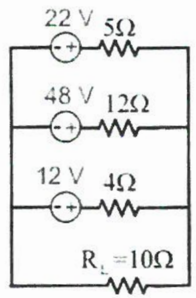
		BL	CO
1.a)	Explain dependent sources with an example.	L2	CO1
b)	Explain Independent sources with an example.	L2	CO1
c)	Draw the phasor diagram of a series RC circuit.	L2	CO3
d)	State Thevenin's theorem.	L2	CO2
e)	Find I_L using source Transformation. 	L2	CO2
f)	In a series RLC circuit, R=60kΩ, L = 20mH, C=245μ F. Find the resonant frequency.	L2	CO4
g)	What are the conditions to be fulfilled for Symmetry of a two-port network?	L2	CO5
h)	Give the comparison between Series and Parallel resonance.	L2	CO4

i)	State any two properties of Laplace transform.	L1	CO3
j)	Define Y-parameters and g-parameters.	L1	CO5

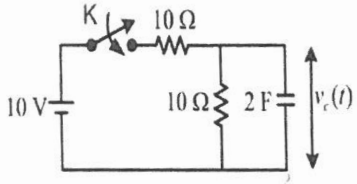
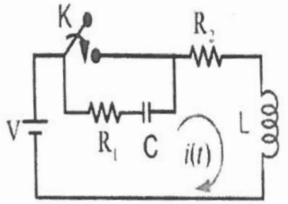
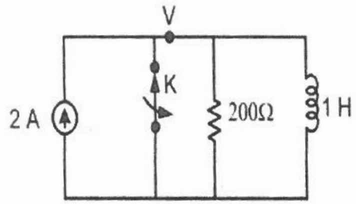
PART – B

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Determine all the node voltages using nodal analysis for the network shown in the fig. 	L3	CO2	5 M
	b)	Determine the equivalent resistance between terminals A and B for the circuit shown in fig. 	L3	CO1	5 M
		OR			

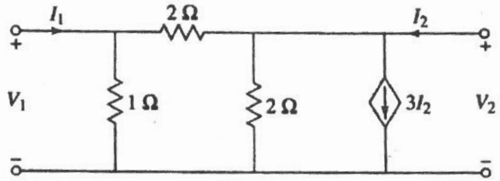
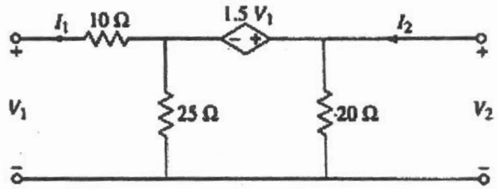
3	a)	Determine all the node voltages using nodal analysis. 	L3	CO2	5 M
	b)	Explain Super node concept with an example.	L2	CO2	5 M
		UNIT-II			
4		Obtain the Thevenin's equivalent network for the circuit shown in Figure. 	L3	CO2	10 M
		OR			
5	a)	Find the value of Z_L for which maximum power is transfer occurs in the circuit shown in Figure. 	L3	CO2	5 M

	b)	For the circuit shown in Figure, using superposition theorem find the current flowing through a load resistance $R_L = 10\Omega$. 	L3	CO2	5 M
		UNIT-III			
6	a)	Derive the expression for resonant frequency of a series RLC Circuit.	L3	CO4	5 M
	b)	Two coils with a coefficient of coupling of 0.4 between them are connected in series so as to magnetize in (a) same direction and b) opposite direction. The total inductance in the same direction is 1.8 H and in the opposite direction is 0.8H. Find the self-inductance of the coils.	L3	CO4	5 M
		OR			
7		An RLC series circuit with a resistance of 100, inductance of 0.2H and a capacitance of 40μF is supplied with a 100V supply at Variable frequency. Find the following parameters for the series resonant circuit. (i) Frequency of which resonance takes place (ii) current (iii) power (iv) power factor (v) Quality factor (g) half-power frequencies.	L3	CO4	10 M

UNIT-IV

8	a)	Explain the procedure for obtaining the transient response using Laplace transform.	L2	CO3	5 M
	b)	The switch in the network shown in Figure is closed at t = 0. Determine the voltage across the capacitor. 	L4	CO3	5 M
		OR			
9	a)	Consider an RLC series circuit as shown figure. Let us assume that the capacitor and inductor are initially uncharged, that is, at t=0, there is no charge on L or C. Develop an expression for current in the circuit when switch K is closed at t = 0. 	L3	CO3	5 M
	b)	For the circuit shown in figure, Analyse the circuit after switch is closed at t=0 and find the transient current for t>0. 	L4	CO3	5 M

UNIT-V

10	a)	For the network shown in Figure, Find Y parameters. 	L3	CO5	5 M
	b)	Express h parameters in terms of ABCD parameters.	L3	CO5	5 M
		OR			
11		For the network shown in figure Find Z and T parameters. 	L3	CO5	10 M

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MAY' 2025

NETWORK ANALYSIS (23EC3201)

(ELECTRONICS & COMMUNICATION ENGINEERING)

PART — A

1.a) Explain dependent sources with an example.

Definition with one example ----- 2Marks

b) Explain Independent sources with an example.

Definition with one example ----- 2Marks

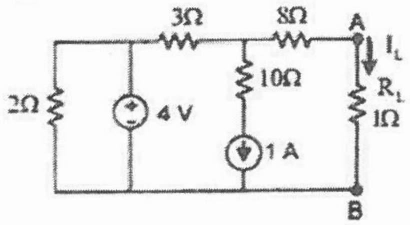
c) Draw the phasor diagram of a series RC circuit.

Phasor diagram ----- 2Marks

d) State Thevenin's theorem.

Statement for Thevenin's theorem ----- 2Marks

e) Find I_L using source Transformation.



Calculation of I_L----- 2Marks

f) In a series RLC circuit, R=60KΩ, L = 20mH, C=245μF. Find the resonant frequency.

Formula ------- 1Mark

Calculation ------- 1Mark

g) What are the conditions to be fulfilled for Symmetry of a two- port network?

Condition for Symmetry of a two- port network ------- 2Marks

h) Give the comparison between Series and Parallel resonance.

Any Two comparisons between Series and Parallel resonance ------- 2Marks

i) State any two properties of Laplace transform.

Any two properties of Laplace transform ------- 2Marks

j) Define Y-parameters and g-parameters.

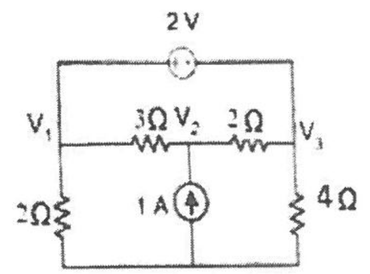
Y-parameters ------- 1 Mark

g-parameters ------- 1 Mark

PART — B

UNIT-I

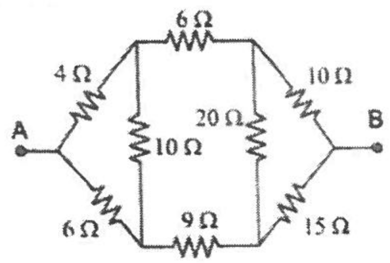
2. a) Determine all the node voltages using nodal analysis for the network shown in the fig.



Node Equations -------3 Marks

Solving Equations ------2 Marks

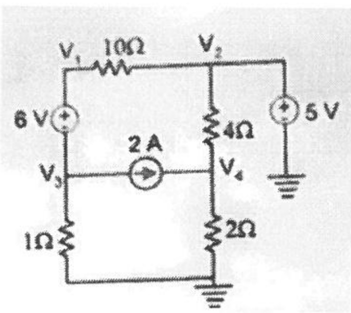
b) Determine the equivalent resistance between terminals A and B for the circuit shown in fig.



Delta to star conversion -------- 3 Marks

Solving the network -------- 2 Marks

3. a) Determine all the node voltages using nodal analysis.



Node Equations -------3 Marks

Solving Equations ------2 Marks

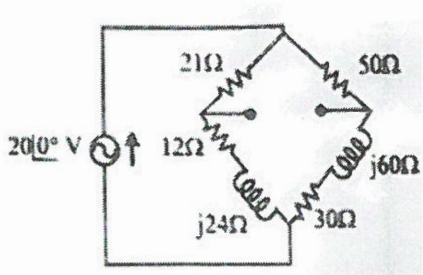
b) Explain Super node concept with an example.

Super node concept -------2 Marks

Example -------3 Marks

UNIT-II

4. Obtain the Thevenin's equivalent network for the circuit shown in Figure.

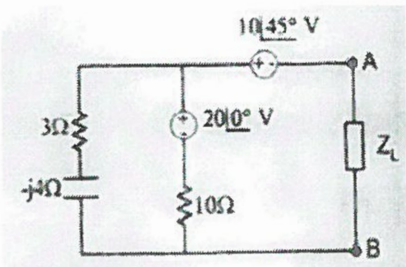


Calculation of V_{Th} -------4 Marks

Calculation of Z_{Th} -------4 Marks

Thevenin's Equivalent Network -------2 Marks

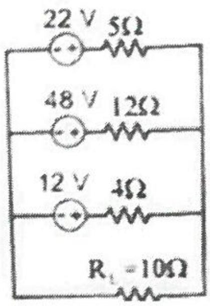
5. a) Find the value of Z_L for which maximum power is transfer occurs in the circuit shown in Figure.



Calculation of Z_{Th}: ------- 4 Marks

Condition for Maximum Power Transfer ------- 1Mark

b) For the circuit Shown in Figure, using superposition theorem find the current flowing through a load resistance $R_L = 10\Omega$.



Each Case ------- 1.5 Marks = 3×1.5 = 4.5Marks

Calculation of I_L------- 0.5 Marks

6. a) Derive the expression for resonant frequency of a series RLC Circuit.

    Series RLC Circuit Diagram ------ 2Marks

    Derivation for resonant frequency ------- 3Marks

  b) Two coils with a coefficient of coupling of 0.4 between them are connected in series so as to magnetize in (a) same direction and b) opposite direction. The total inductance in the same direction is 1.8 H and in the opposite direction is 0.8H. Find the self-inductance of the coils.

    Formulas ------- 3Marks

    Calculations ------- 2Marks

7. An RLC series circuit with a resistance of 100, inductance of 0.2H and a capacitance of 40μF is supplied with a l00V supply at Variable frequency. Find the following parameters for the series resonant circuit. (i) Frequency of which resonance takes place (ii) current (iii) power (iv) power factor (v) Quality factor (g) half-power frequencies.

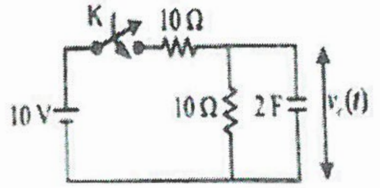
    Formulas ------- 6Marks

    Calculations ------- 4Marks

8. a) Explain the procedure for obtaining the transient response using Laplace Transform.

    Procedure ------- 5Marks

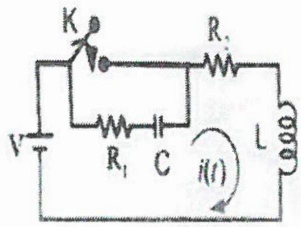
  b) The switch in the network shown in figure is closed at t=0. Determine the voltage across the capacitor.



Mesh equations & Laplace transform ------- 3Marks

Calculation of voltage across the capacitor ------- 2Marks

9. a) Consider an RLC series circuit as shown figure. Let us assume that the capacitor and inductor are initially uncharged, that is, at t=0, there is no charge on L or C. Develop an expression for current in the circuit when switch K is closed at t = 0.

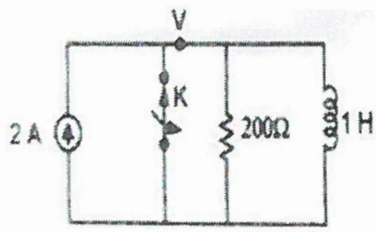


Circuit Analysis at $t=0^-$ ------- 1Mark

Circuit Analysis at $t=0^+$ ------- 2Marks

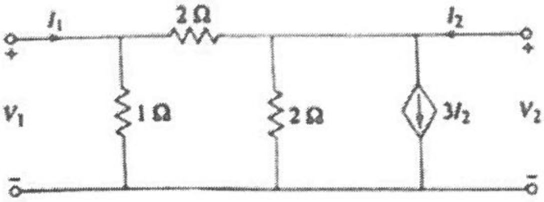
Circuit Analysis at t >0 ------- 2Marks

b) For the circuit shown in figure, Analyse the circuit after switch is closed at t=0 and find the transient current for t >0.



Calculation of transient current------- 5Marks

10. a) For the network shown in Figure, Find Y parameters.



Nodal Equations ------- 3Marks

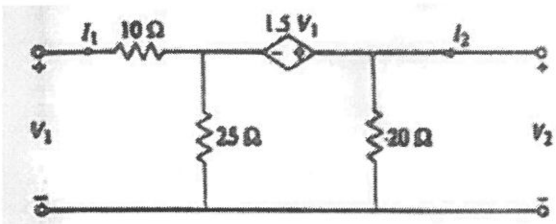
Calculation of Y parameters ------- 2Marks

b) Express h parameters in terms of ABCD parameters.

h parameters & ABCD parameters equations ------- 2Marks

h parameters in terms of ABCD parameters ------- 3Marks

11. For the network shown in figure Find Z and T parameters.



Z and T parameters equations ------- 2Marks

Calculation of Z parameters ------- 4Marks

Calculation of T parameters ------- 4Marks

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NETWORK ANALYSIS (23EC3201)

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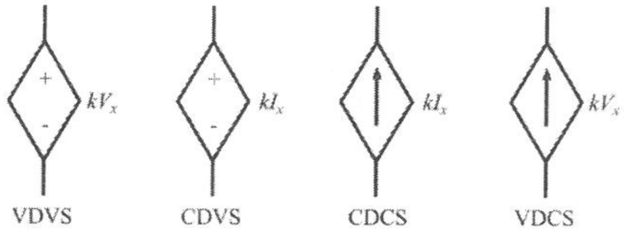
PART — A

1.a) Explain dependent sources with an example.

If the voltage or current of a source **depends** upon some other voltage or current, it is called as **dependent or controlled source**.



b) Explain Independent sources with an example.

If the voltage or current of a source **does not depends** upon some other voltage or current, it is called as **independent source**.

Independent Voltage Source

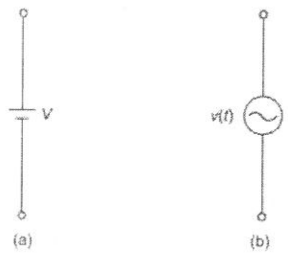


Fig. 1.1 Independent voltage source

Independent Current Source

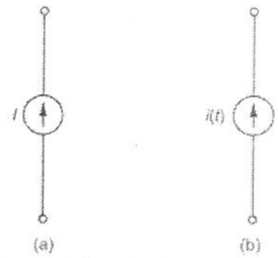
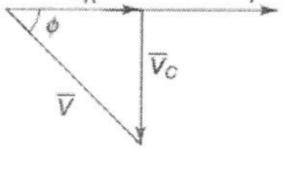


Fig. 1.2 Independent current source

c) Draw the phasor diagram of a series RC circuit.



The phasor diagram for RC circuit is shown in Fig below.

Where V is the applied voltage.

V_R is the Potential difference across the resistor.

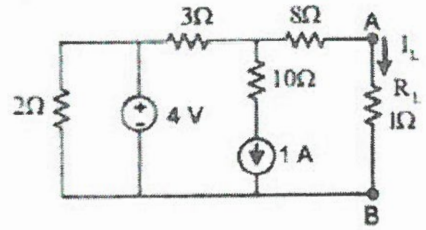
V_C is the Potential difference across the capacitor.

d) State Thevenin's theorem.

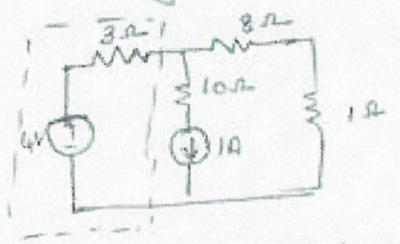
Thevenin's theorem states that "Any two terminal linear network having a number of voltage current sources and resistances can be replaced by a equivalent circuit consisting of a single voltage source in series with a resistance."

where the value of the voltage source is equal to the open-circuit voltage across the two terminals of the network, and resistance is equal to the equivalent resistance measured between the terminals with all the energy sources are replaced by their internal resistances.

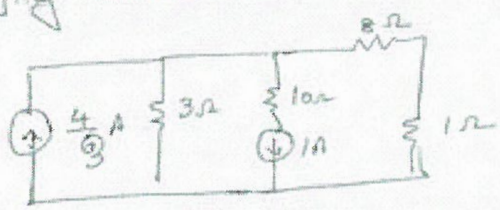
e) Find I_L using source Transformation.

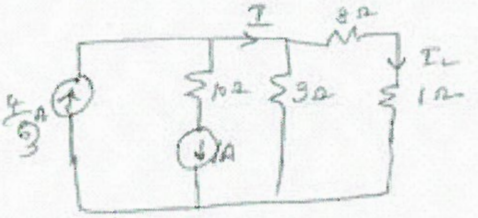


As the voltage across 2Ω is also 4V neglecting 2Ω



Applying Source transformation





$$I = \frac{4}{3} - 1 = \frac{1}{3}\,A$$

Applying current Division

$$I_L = \frac{1}{3} \times \frac{3}{3+9}$$

$$= \frac{1}{12} = 83.33\,mA$$

$$\boxed{I_L = 83.33\,mA}$$

f) In a series RLC circuit, R=60KΩ, L = 20mH, C=245μF. Find the resonant frequency.

For a series RLC circuit **resonant frequency** f_0 is given by $f_0 = \frac{1}{2\pi\sqrt{LC}}$

$L=20mH=20\times10^{-3}H$

$C=245\mu F=245\times10^{-6}\,F$

$$f_0 = \frac{1}{2\pi\sqrt{(20\times10^{-3})(245\times10^{-6})}}$$

$$\mathbf{f_0 = 71.9Hz}$$

g) What are the conditions to be fulfilled for Symmetry of a two- port network?

For a network to be symmetrical, the voltage-to-current ratio at one port should be the same as the voltage to- current ratio at the other port with one of the ports open-circuited.

h) Give the comparison between Series and Parallel resonance.

Comparison between Series and Parallel resonance:

Parameter	Series Circuit	Parallel Circuit
Current at resonance	$I = \frac{V}{R}$ and is maximum	$I = \frac{VCR}{L}$ and is minimum
Impedance at resonance	$Z = R$ and is minimum	$Z = \frac{L}{CR}$ and is maximum
Power factor at resonance	Unity	Unity
Resonant frequency	$f_0 = \frac{1}{2\pi\sqrt{LC}}$	$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$
Q-factor	$Q = \frac{2\pi f_0 L}{R}$	$Q = \frac{2\pi f_0 L}{R}$
It magnifies	Voltage across L and C	Current through L and C

i) State any two properties of Laplace transform.

Properties of Laplace Transform:

1. **Linearity:**

If $L\{f_1(t)\} = F_1(s)$ and $L\{f_2(t)\} = F_2(s)$ then $L\{af_1(t) + bf_2(t)\} = aF_1(s) + bF_2(s)$ where a and b are constants.

2. **Time Scaling:**

If $L\{f(t)\} = F(s)$ then $L\{f(at)\} = \frac{1}{a}F\left(\frac{s}{a}\right)$

j) Define Y-parameters and g-parameters.

Y-parameters:

The Y parameters of a two-port network may be defined by expressing the two-port currents I_1 and I_2 in terms of the two-port voltages V_1 and V_2.

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$
$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

g-parameters:

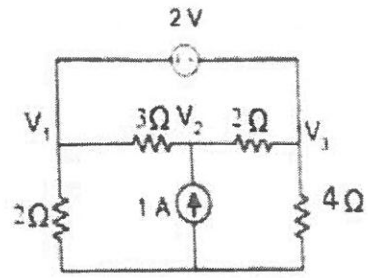
The g parameters of a two-port network are defined by expressing the current of the input port I_1 and voltage of the output port V_2 in terms of the voltage of the input port V_1 and the current of the output port I_2.

$$I_1 = g_{11} V_1 + g_{12} I_2$$
$$V_2 = g_{21} V_1 + g_{22} I_2$$

PART — B

UNIT-I

2. a) Determine all the node voltages using nodal analysis for the network shown in the fig.



In the above figure as 2V voltage source is connected between Nodes 1 & 3, Node1 & 3 will form a Super Node.

Applying KVL to super node:

$$V_1 - V_3 = 2V \quad \text{------ 1}$$

Applying KCL to super node:

$$\frac{V_1}{2} + \frac{V_1 - V_2}{3} + \frac{V_3 - V_2}{2} + \frac{V_3}{4} = 0 \quad \text{---------2}$$

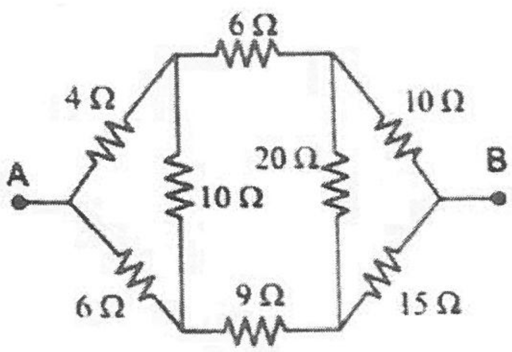
Applying KCL to V_2:

$$\frac{V_2 - V_1}{3} + \frac{V_2 - V_3}{2} - 1 = 0 \quad \text{---------3}$$

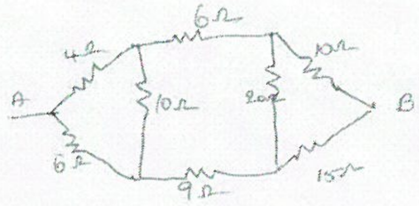
Solving Equ's 1, 2 & 3

V_1= 2V, V_2= 2V, V_3= 0V

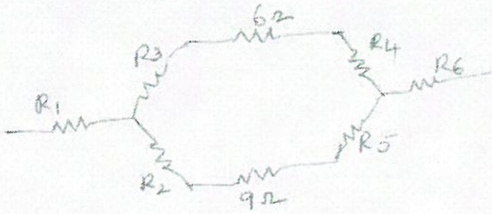
b) Determine the equivalent resistance between terminals A and B for the circuit shown in fig.



2 b'



Solu: Converting 2 delta's into equivalent star network.



$R_1 = \frac{4 \times 6}{4+6+10} = \frac{24}{20} = 1.2\,\Omega$

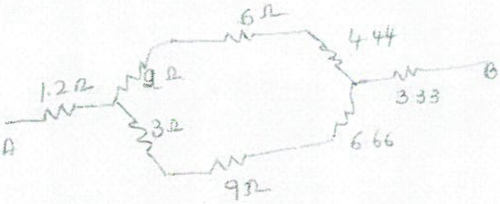
$R_2 = \frac{6 \times 10}{4+6+10} = \frac{60}{20} = 3\,\Omega$

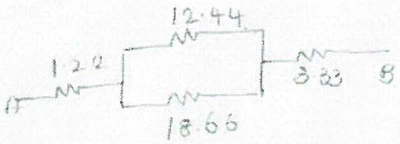
$R_3 = \frac{4 \times 10}{4+6+10} = \frac{40}{20} = 2\,\Omega$

$R_4 = \frac{20 \times 10}{20+10+15} = \frac{200}{45} = 4.44\,\Omega$

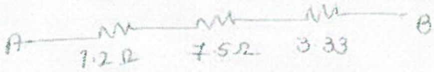
$R_5 = \frac{15 \times 20}{15+20+10} = \frac{300}{45} = 6.66\,\Omega$

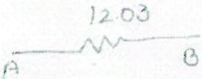
$R_6 = \frac{10 \times 15}{15+20+10} = \frac{150}{45} = 3.33\,\Omega$





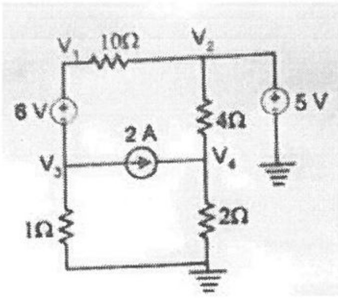
$12.44 \| 18.66 = \frac{12.44 \times 18.66}{12.44 + 18.66} = \frac{232.13}{31.1} = 7.5\,\Omega$



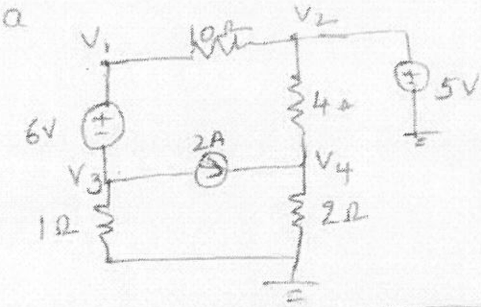


$R_{AB} = 12.03\,\Omega$

3. a) Determine all the node voltages using nodal analysis.



3.a



From the diagram $\boxed{V_2 = 5V}$ — (1)

V_1 & V_3 are forming Super node

$\boxed{V_1 - V_3 = 6V}$ — (2)

Applying KCL to supernode

$$\frac{V_3}{1} + 2 + \frac{V_1 - V_2}{10} = 0 \quad — (3)$$

Applying KCL to node V_4

$$\frac{V_4}{2} + \frac{V_4 - V_2}{4} - 2 = 0 \quad — (4)$$

Solving Equations 1, 2, 3 &4

$$V_1 = 4V$$

$$V_2 = 5V$$

$$V_3 = -1.91V$$

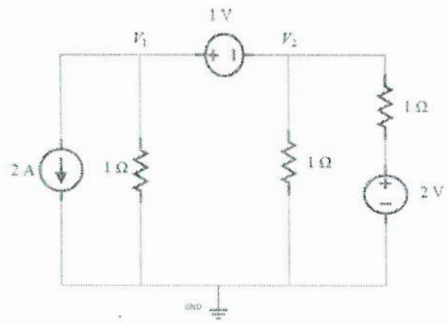
$$V_4 = 4.33V$$

b) Explain Super node concept with an example.

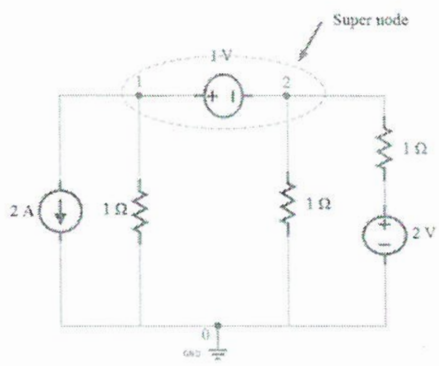
Supernode Analysis:

Nodes that are connected to each other by voltage sources, but not to the reference node by a path of voltage sources, form a super node. A super node requires one node voltage equation, that is, a KVL equation. The remaining node voltage equations are KCL equations.

Example: To find the nodal voltages V_1 and V_2 in the network shown in Fig.



In the above figure as 1V voltage source is connected between Nodes 1 & 2, Node1 & 2 will form a Super Node.



Applying KVL to super node:

$$V_1 - V_2 = 1V \quad ------ \ 1$$

Applying KCL to super node:

$$2 + \frac{(V_1-0)}{1} + \frac{(V_2-0)}{1} + \frac{(V_2-2)}{1} = 0 \quad \text{------ 2}$$

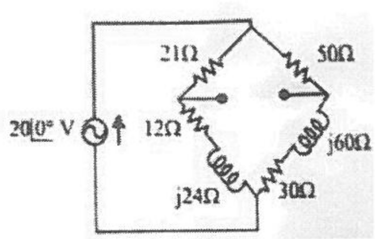
Solving Eq's 1 & 2

V_1 = 2/3= 1.5V

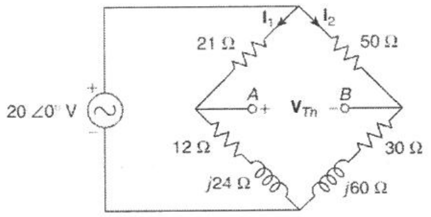
V_2 = -1/3= 0.33V

UNIT-II

4. Obtain the Thevenin's equivalent network for the circuit shown in Figure.



Calculation of V_{Th}:

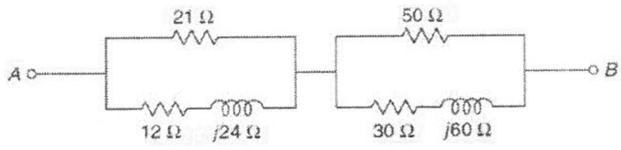


$$I_1 = \frac{20\angle 0^\circ}{21+12+j24} = 0.49\angle -36.02^\circ \text{ A}$$

$$I_2 = \frac{20\angle 0^\circ}{80+j60} = 0.2\angle -36.86^\circ \text{ A}$$

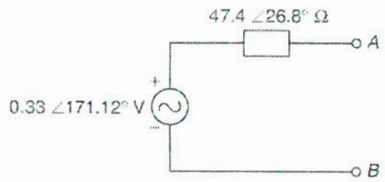
$$V_{Th} = (12+j24)\, I_1 - (30+j60)\, I_2$$
$$= (26.83\ \angle 63.43^\circ)(0.49\ \angle -36.02^\circ) - (67.08\ \angle 63.43^\circ)(0.2\ \angle -36.86^\circ)$$
$$= 0.33\ \angle 171.12^\circ \text{ V}$$

Calculation of Z_{Th}:

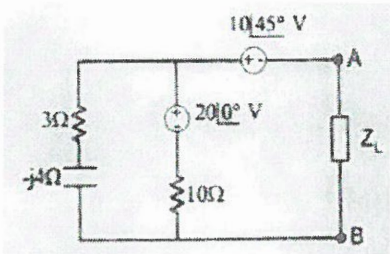


$$Z_{Th} = \frac{21(12+j24)}{33+j24} + \frac{50(30+j60)}{80+j60} = 47.4\angle 26.8^\circ\ \Omega$$

Thevenin's Equivalent Network:



5. a) Find the value of Z_L for which maximum power is transfer occurs in the circuit shown in Figure.



The Thevenin's impedance is:

$$Z_{th} = ((3 - j4)||(10))$$

$$Z_{th} = \frac{((3 - j4)(10))}{((3 - j4) + (10))} = \frac{30 - j40}{13 - j4}$$

$$Z_{th} = \frac{30 - j40}{13 - j4} \cdot \frac{13 + j4}{13 + j4}$$

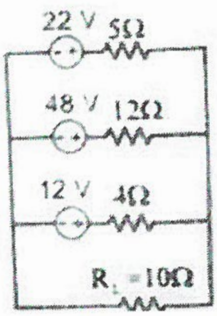
$$Z_{th} = \frac{550 - j400}{185}$$

$$Z_{th} = 2.97 - j2.16$$

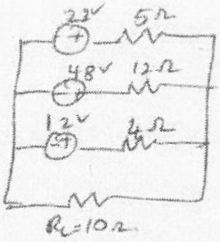
Condition for Maximum Power Transfer is $\mathbf{Z_L = Z_{th}^*}$

$$\boldsymbol{Z_{th} = Z_{th}^* = 2.97 + j2.16}$$

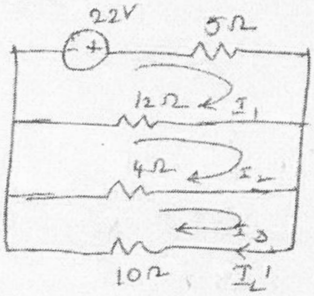
b) For the circuit Shown in Figure, using superposition theorem find the current flowing through a load resistance R_L = 10Ω.



5.b



Case I : 22V source is active



Mesh 1

$$17I_1 - 12I_2 = 22$$

Mesh 2

$$-12I_1 + 16I_2 - 4I_3 = 0$$

Mesh 3

$$-4I_2 + 14I_3 = 0$$

Solving above eq's

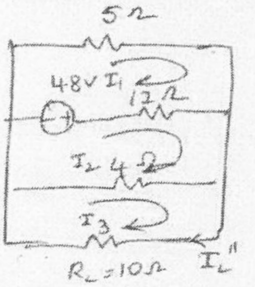
$I_1 = 3$ A

$I_2 = 2.43$ A

$I_3 = 0.69$A

$$\boxed{I_N' = I_3 = 0.69\text{ A}}$$

Case II : 48V Source is active



Mesh I

$$17I_1 - 12I_2 = -48$$

Mesh 2

$$-12I_1 + 16I_2 - 4I_3 = 48$$

Mesh 3

$$-4I_2 + 14I_3 = 0$$

Solving above eq's

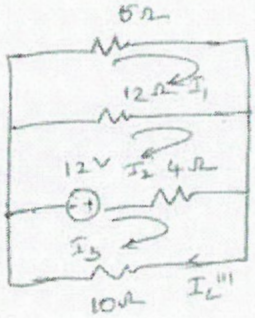
$I_1 = -1.26$A

$I_2 = 2.2$ A

$I_3 = 0.63$A

$$\boxed{I_L'' = I_3 = 0.63A}$$

Case III : 12V source is active



Mesh 1

$$17I_1 - 12I_2 = 0$$

Mesh 2

$$-12I_1 + 16I_2 - 4I_3 = -12$$

Mesh 3

$$-4I_2 + 14I_3 = 12$$

Solving above eq's

$I_1 = -0.95\ A$

$I_2 = -1.34\ A$

$I_3 = 0.47\ A$

$$I_L''' = I_3 = 0.47A$$

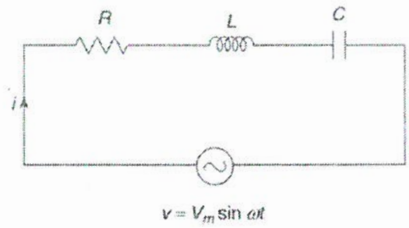
$$I_L = I_L' + I_L'' + I_L''' = 0.69 + 0.63 + 0.47$$

$$I_L = 1.79A$$

6. a) Derive the expression for resonant frequency of a series RLC Circuit.

Series Resonance:

Resonance: A circuit containing reactance is said to be in resonance **if the voltage across the circuit is in phase with the current through it**. At resonance, the circuit behaves as a pure resistor and the net reactance is zero.



➢ Consider the **series RLC circuit** shown in Fig

$$\mathbf{Z} = R + jX_L - jX_C = R + j(X_L - X_C)$$

At resonance, the circuit is purely resistive.

$$X_L - X_C = 0$$

$$X_L = X_C$$

$$\omega_0 L = \frac{1}{\omega_0 C}$$

$$\omega_0^2 = \frac{1}{LC}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

where f_0 is called the **resonant frequency** of the circuit.

b) Two coils with a coefficient of coupling of 0.4 between them are connected in series so as to magnetize in (a) same direction and b) opposite direction. The total inductance in the same direction is 1.8 H and in the opposite direction is 0.8H. Find the self-inductance of the coils.

The coefficient of coupling between the coils is k=0.4.

The total inductance when the coils are connected in series to magnetize in the same direction is

$$\mathbf{L_{same} = L1+L2+2M = 1.8H \quad ------ 1}$$

The total inductance when the coils are connected in series to magnetize in the opposite direction is

$$\mathbf{L_{opposite} = L1+L2-2M = 0.8H \quad -------2}$$

Solving Eq's 1 & 2

$$\mathbf{L1+L2 = 1.3 \quad ------ 3}$$

Substituting Eq 3 in Eq 1

$$L_{same} = L1+L2+2M = 1.8H$$

$$1.3+2M = 1.8H$$

$$2M=1.8-1.3$$
$$2M = 0.5$$
$$M = 0.25$$

The mutual inductance is

$$\boldsymbol{M = k\sqrt{L1\ L2}}$$

$$\sqrt{L1\ L2} = \frac{M}{k} = \frac{0.25}{0.4} = 0.625$$

L1 L2= 0.39 ------ **4**

Solving Eq's 3 & 4

L1 = 0.052, L2= 1.28

7. An RLC series circuit with a resistance of 100, inductance of 0.2H and a capacitance of 40μF is supplied with a l00V supply at Variable frequency. Find the following parameters for the series resonant circuit. (i) Frequency of which resonance takes place (ii) current (iii) power (iv) power factor (v) Quality factor (g) half-power frequencies.

Solution:

R = 100Ω, L = 0.2 H, C = 40μF, V = 100 V

(a) Resonant frequency:

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.2\times 40\times 10^{-6}}} = 56.3\ \text{Hz}$$

(b) Current:

$$I = \frac{V}{R} = \frac{100}{100} = 1A$$

(c) Power:

$$\mathrm{P_0 = I_0^2R = 1^2x100 = 100W}$$

(d) Power factor:

pf = 1

(e) Voltage across R, L, C:

$$\mathrm{V_R = RxI = 100x1 = 100V}$$

$$\mathrm{V_C} = X_C\mathrm{I} = \frac{1}{2\pi\mathrm{fC}}\mathrm{x\,I} = \frac{1}{2\pi X56.3X40^{-6}}\mathrm{x1 = 70.7V}$$

$$\mathrm{V_L} = X_L\mathrm{I} = \mathrm{2\pi fLx\,I = 2\pi fX0.2x\,1 = 70.7V}$$

(f) Quality factor:

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{0.2}{40^{-6}}} = 0.707$$

(g) Half-power points:

$$f_1 = f_0 - \frac{R}{4\pi L} = 56.3 - \frac{100}{4\pi 0.2} = 56.3 - 39.8 = 16.51\text{Hz}$$

$$f_2 = f_0 + \frac{R}{4\pi L} = 56.3 + \frac{100}{4\pi 0.2} 56.3 + 39.8 = 96\text{Hz}$$

8. a) Explain the procedure for obtaining the transient response using Laplace Transform.

1.Define the Circuit and Initial Conditions

- Identify all elements: resistors (R), capacitors (C), inductors (L), voltage and current sources.
- Note the **initial conditions.**

2. Transform the Circuit to s-Domain

- Replace energy-storing elements (L, C) with their **Laplace equivalents**.

Time-Domain Element	s-Domain Equivalent
Resistor R	R
Inductor L	sL
Capacitor C	1/sC

- Apply **initial conditions** as voltage or current sources in the transformed circuit.

3. Apply Circuit Analysis in s-Domain

- Use **Nodal or Mesh Analysis** to write algebraic equations.

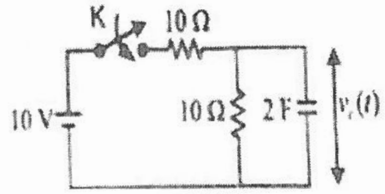
4. Solve for the Laplace-Domain Variable

- Simplify the algebraic equation to obtain the expression for the Laplace-domain response (e.g., current or voltage).

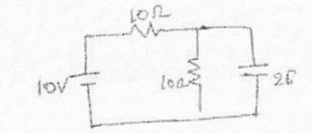
5. Apply Inverse Laplace Transform

- Use standard Laplace Transform tables or partial fraction decomposition to invert I(s) or V(s) back into the time domain **transient response** i(t) or v(t).

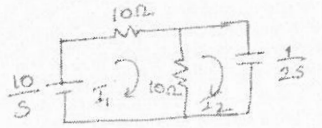
b) **The switch in the network shown in figure is closed at t=0. Determine the voltage across the capacitor.**



8.b. Switch is closed at t = 0



Using laplace transformation



Applying KVL to mesh (1)

$$20I_1(s) - 10I_2(s) = \frac{10}{s}$$

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

Applying KVL to mesh (2)

$$-10I_1(s) + 10I_2(s) + \frac{1}{2s}I_2(s) = 0$$

$$-10I_1(s) + \left[10 + \frac{1}{2s}\right]I_2(s) = 0$$

$$-10I_1(s) + \left[\frac{20s+1}{2s}\right]I_2(s) = 0$$

$$I_1(s) = \frac{\left[\frac{20s+1}{2s}\right]I_2(s)}{10}$$

$$I_1(s) = \left[\frac{20s+1}{20s}\right]I_2(s) \quad \text{— (2)}$$

Substituting eq (2) in eq (1) and solving for $I_2(s)$

$$I_2(s) = \frac{10}{1+10s}$$

$$I_2(s) = \frac{1}{s+\frac{1}{10}}$$

Applying Inverse Laplace transform

$$\boxed{i_2(t) = e^{-t/10}}$$

Voltage across capacitor

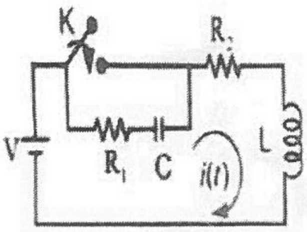
$$V_C(t) = \frac{1}{C}\int i_2(t)\,dt$$

$$V_C(t) = \frac{1}{2}\int e^{-t/10}\,dt$$

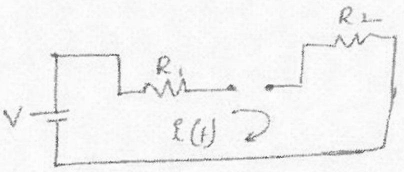
$$= \frac{1}{2}\left[\frac{e^{-t/10}}{-1/10}\right]$$

$$\boxed{V_C(t) = -5\,e^{-t/10}}$$

9. a) Consider an RLC series circuit as shown figure. Let us assume that the capacitor and inductor are initially uncharged, that is, at t=0, there is no charge on L or C. Develop an expression for current in the circuit when switch K is closed at t = 0.

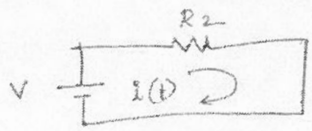


9 a At $t = 0^-$, Capacitor acts as open circuit & Inductor acts as short circuit. & switch is open



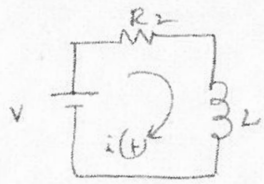
At $t = 0^-$, $i(t) = 0$

At $t = 0$, switch is closed



$$i(t) = \frac{V}{R_2}$$

For $t > 0$



$$V = i(t) R_2 + L \frac{di}{dt}$$

$$\frac{di}{dt} + \frac{R_2}{L} i = \frac{V}{L}$$

It is in the form of 1st order non homogeneous Equation

$$\frac{di}{dt} + Pi = Q$$

$$i(t) = e^{-Pt} \int Q e^{Pt} dt + ke^{-Pt}$$

$$i(t) = e^{-\frac{R_2}{L}t} \int \frac{V}{L} e^{\frac{R_2}{L}t} + k e^{-\frac{R_2}{L}t}$$

$$= e^{-\frac{R_2}{L}t} \frac{V}{L} \frac{e^{\frac{R_2 t}{L}}}{\frac{R_2}{L}} + k e^{-\frac{R_2}{L}t}$$

$$i(t) = \frac{V}{R_2} + k e^{-\frac{R_2}{L}t}$$

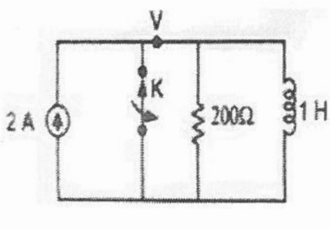
At $t = 0$

$$i(0) = \frac{V}{R_2} + k$$

$$k = 0$$

$$\therefore \; i(t) = \frac{V}{R_2}$$

b) For the circuit shown in figure, Analyse the circuit after switch is closed at t=0 and find the transient current for t>0.



At $t=0^-$, the switch is open. The inductor acts as a short circuit in steady state. The current source of 2A is therefore flowing through the inductor.

$$i(0^-) = 2A$$

Since the current through an inductor cannot change instantaneously,

$$i(0^+) = i(0^-) = 2A$$

Circuit for t> 0:

When the switch is closed at t= 0, the current source is shorted. The circuit is now a simple RL circuit. The inductor will discharge through the 200Ω resistor.

Differential Equation:

Apply KVL around the loop:

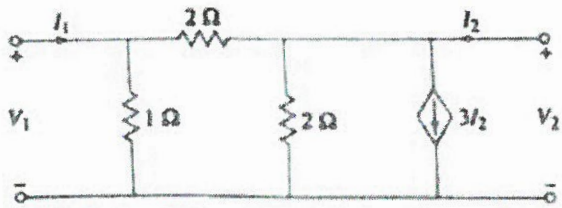
$$200i(t) + 1\frac{di(t)}{dt} = 0$$

$$\frac{di(t)}{dt} + 200i(t) = 0$$

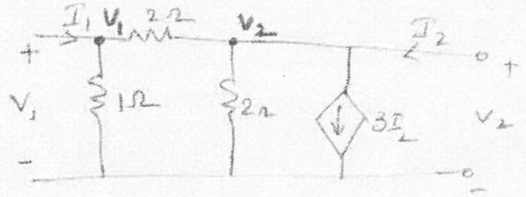
The solution to the differential equation is of the form

$i(t) = Ae^{-200t}$ Where A is a constant.

10. a) For the network shown in Figure, Find Y parameters.



10 a.



Applying KCL at node 1

$$-I_1 + \frac{V_1}{1} + \frac{V_1 - V_2}{2} = 0$$

$$V_1\left[1 + \frac{1}{2}\right] - \frac{V_2}{2} = I_1$$

$$V_1\left[\frac{3}{2}\right] + V_2\left[\frac{-1}{2}\right] = I_1 \quad \text{— (1)}$$

Applying KCL at node 2

$$\frac{V_2 - V_1}{2} + \frac{V_2}{2} + 3I_2 - I_2 = 0$$

$$V_1\left[-\frac{1}{2}\right] + V_2\left[\frac{1}{2} + \frac{1}{2}\right] = -2I_2$$

$$V_1\left[-\frac{1}{2}\right] + V_2 = -2I_2$$

$$V_1\left[\frac{1}{4}\right] + V_2\left[+\frac{1}{2}\right] = I_2 \quad \text{— (2)}$$

From eq (1) & (2)

$$I_1 = \frac{3}{2}V_1 - \frac{1}{2}V_2$$
$$I_2 = \frac{1}{4}V_1 + \frac{1}{2}V_2$$
$$\Rightarrow \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} \frac{3}{2} & -\frac{1}{2} \\ \frac{1}{4} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\therefore \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} \frac{3}{2} & -\frac{1}{2} \\ \frac{1}{4} & \frac{1}{2} \end{bmatrix}$$

b) Express h parameters in terms of ABCD parameters.

Hybrid Parameters in Terms of ABCD Parameters We know that

$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

Rewriting the second equation,

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

Comparing with $I_2 = h_{21} I_1 + h_{22} V_2$,

$$h_{21} = -\frac{1}{D}$$

$$h_{22} = \frac{C}{D}$$

Also,

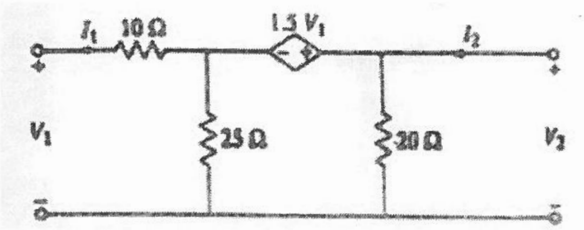
$$V_1 = AV_2 - B\left[-\frac{1}{D} I_1 + \frac{C}{D} V_2\right] = \frac{B}{D} I_1 + \left[\frac{AD - BC}{D}\right] V_2$$

Comparing with $V_1 = h_{11} I_1 + h_{12} V_2$,

$$h_{11} = \frac{B}{D}$$

$$h_{12} = \frac{AD - BC}{D} = \frac{\Delta T}{D}$$

11. For the network shown in figure Find Z and T parameters.



11. Z parameters:

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

T Parameters:

$$V_1 = A V_2 - B I_2$$

$$I_1 = C V_2 - D I_2$$

Applying KVL to mesh ①

$$V_1 = 10 I_1 + 25 I_1 - 25 I_3$$

$$\boxed{V_1 = 35 I_1 - 25 I_3} \quad \text{--- ①}$$

Applying KVL to mesh ②

$$V_2 = 20(I_2 + I_3)$$

$$\boxed{V_2 = 20 I_2 + 20 I_3} \quad \text{--- ②}$$

Applying KVL to mesh ③

$$25(I_3 - I_1) - 1.5 V_1 + 20(I_3 + I_2) = 0$$

$$-25 I_1 + 20 I_2 + 45 I_3 - 1.5 V_1 = 0 \quad \text{--- ③}$$

Substituting eq ① in eq ③

$$-25 I_1 + 20 I_2 + 45 I_3 - 1.5 [35 I_1 - 25 I_3] = 0$$

$$-25 I_1 + 20 I_2 + 45 I_3 - 52.5 I_1 + 37.5 I_3 = 0$$

$$-77.5 I_1 + 20 I_2 + 82.5 I_3 = 0$$

$$I_3 = \frac{77.5 I_1 - 20 I_2}{82.5}$$

$$\boxed{I_3 = 0.94 I_1 - 0.242 I_2} \quad \text{--- ④}$$

Substituting eq (4) in eq (1)

$$V_1 = 35I_1 - 25\left[0.94I_1 - 0.24I_2\right]$$

$$= 35I_1 - 23.5I_1 + 6I_2$$

$$\boxed{V_1 = 11.5I_1 + 6I_2} \quad \text{--- (5)}$$

Substituting eq (4) in eq (2)

$$V_2 = 20I_2 + 20\left[0.94I_1 - 0.24I_2\right]$$

$$= 20I_2 + 18.8I_1 - 4.8I_2$$

$$\boxed{V_2 = 18.8I_1 + 15.2I_2} \quad \text{--- (6)}$$

Z Parameters:

From eq (5) & (6)

$$\begin{bmatrix} 11.5 & 6 \\ 18.8 & 15.2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$\therefore \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 11.5 & 6 \\ 18.8 & 15.2 \end{bmatrix}$$

T parameters:

from eq (6)

$$I_1 = \frac{V_2 - 15.2 I_2}{18.8}$$

$$\boxed{I_1 = 0.053 V_2 - 0.81 I_2} \quad \text{——} \quad (7)$$

substituting eq (7) in (5)

$$V_1 = 11.5 \left[0.053 V_2 - 0.81 I_2\right] + 6 I_2$$

$$V_1 = 0.61 V_2 - 9.32 I_2 + 6 I_2$$

$$\boxed{V_1 = 0.61 V_2 - 3.32 I_2} \quad \text{——} \quad (8)$$

from eq (7) & (8)

$$\begin{bmatrix} 0.61 & -3.32 \\ 0.053 & -0.81 \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_1 \\ I_1 \end{bmatrix}$$

$$\therefore \begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 0.61 & -3.32 \\ 0.053 & -0.81 \end{bmatrix}$$