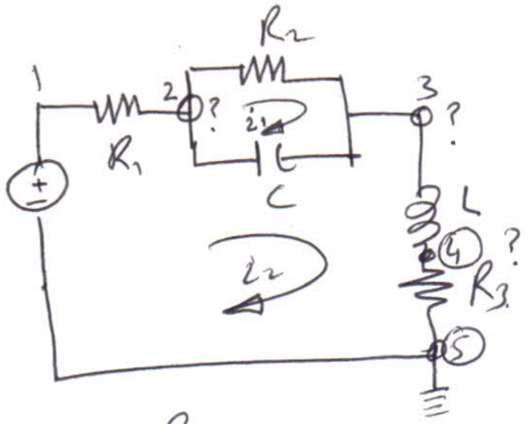
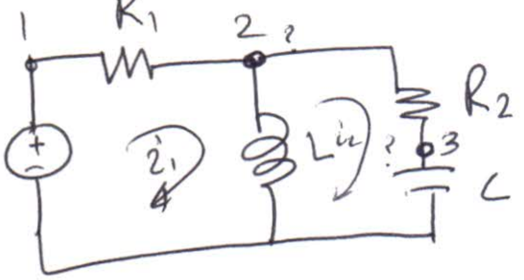
(a)



No. of Loops = 2

No. of node Voltages = 3

(b)



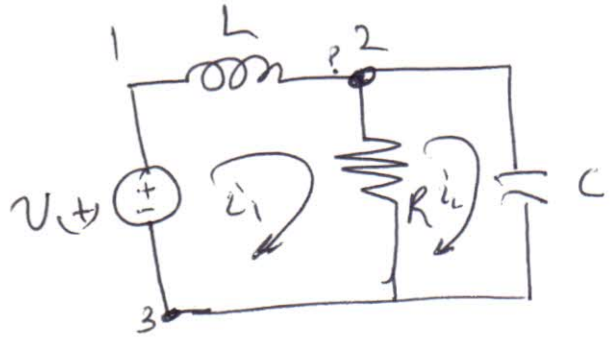
$i_1 = ?$, $i_2 = ?$

$v_2 = ?$ $v_3 = ?$

no. of Loops = 2

no. of Nodes Voltages = 2

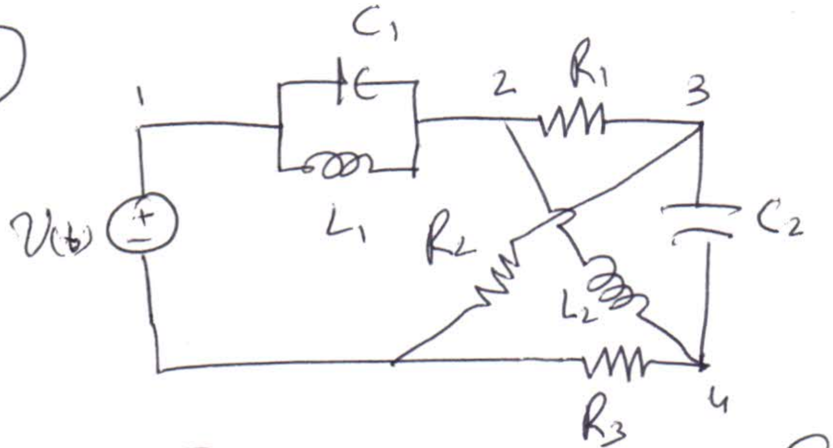
(c)



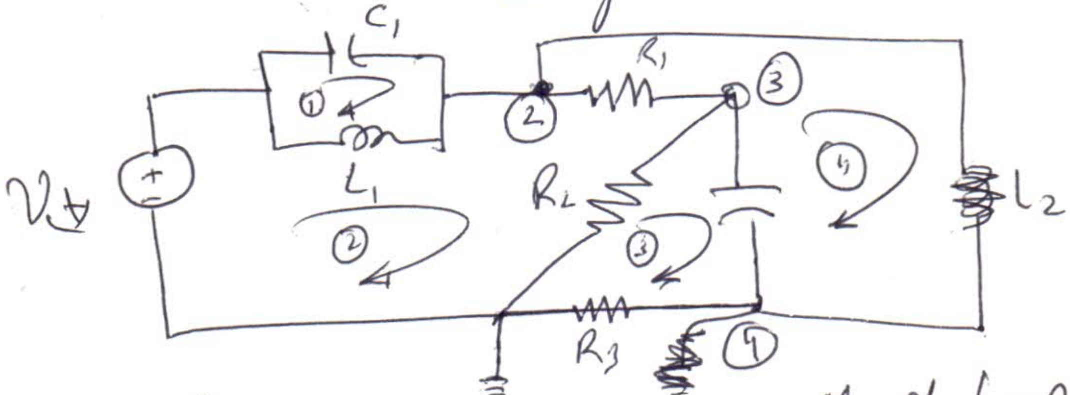
no. of Loops = 2

no. of node voltages = 1.

(d)



The above diagram Can be Re-drawn

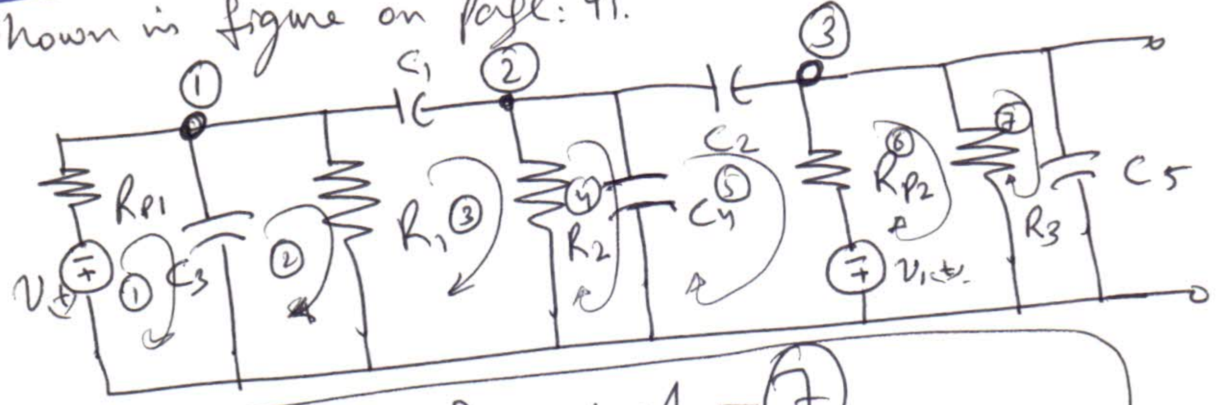


No. of loops = 4

No. of node-voltages = 3

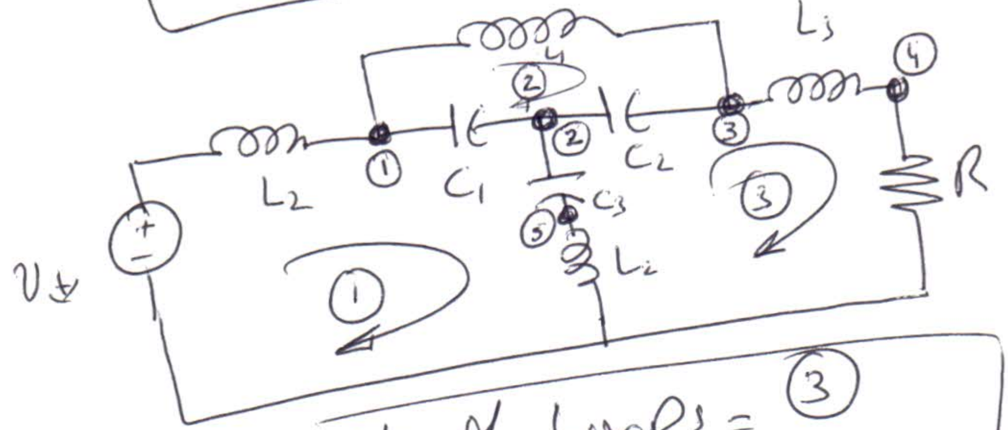
178

Prob: 3.18 Repeat Prob: 3.17 for each of the 4-network shown in figure on page: 91.



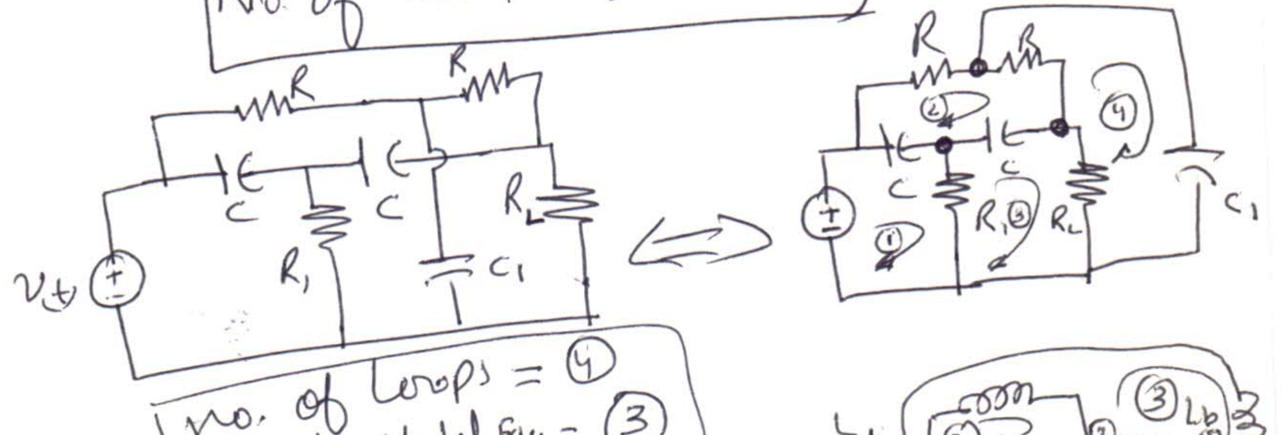
Loops Required = 7
nodal equations Required = 3

(b)



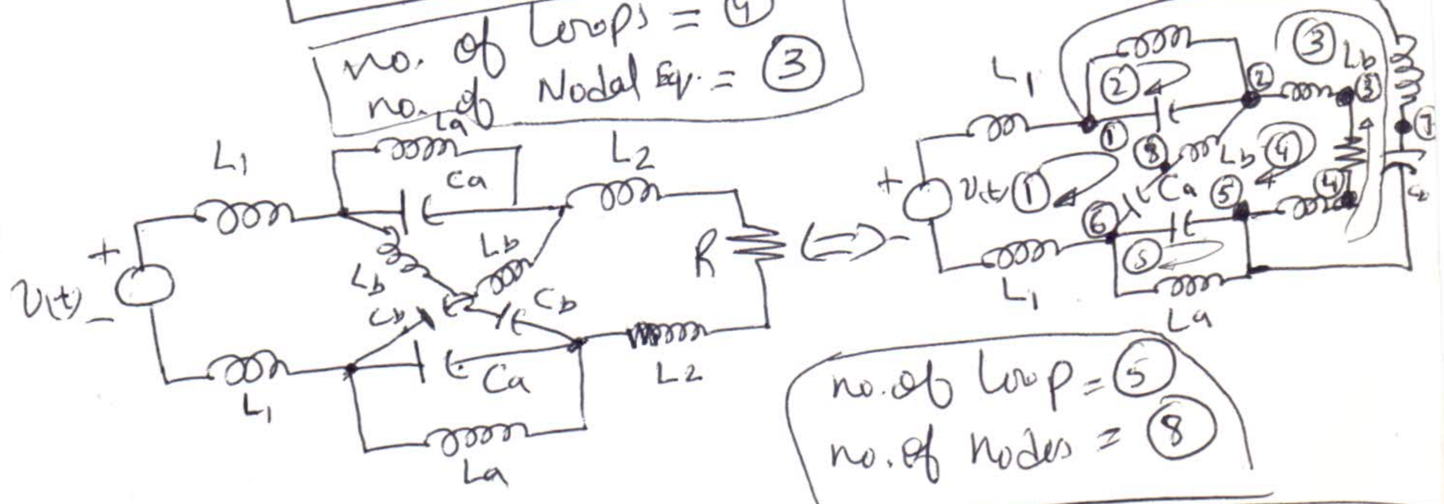
No. of Loops = 3
No. of nodal Voltages = 5

(c)



no. of Loops = 4
no. of Nodal Eq. = 3

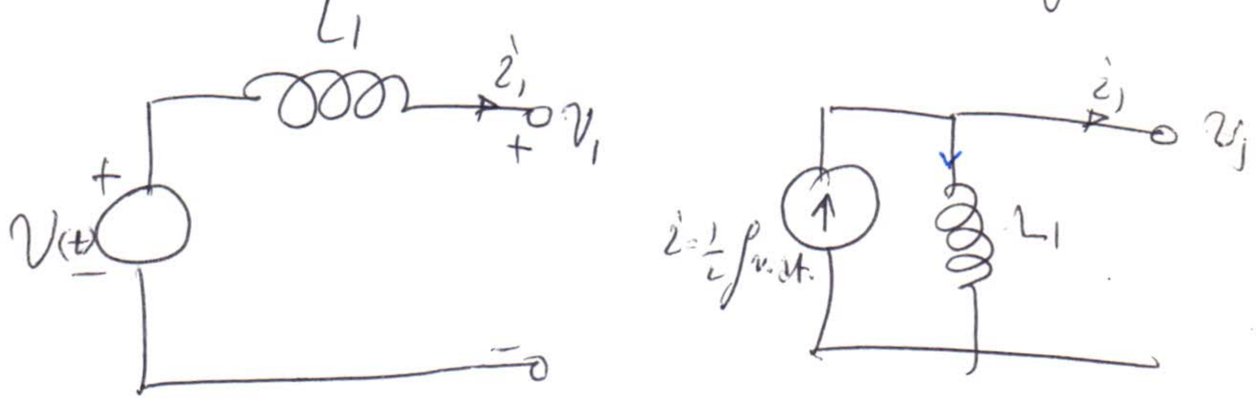
(d)



no. of Loop = 5
no. of nodes = 8

Demonstrate the equivalence of networks (179) shown in Fig. 3.17 and so establish a rule for converting a voltage source in series with an inductor into an equivalent network containing a current source.

Sol.



from figure we can see

$$V(t) = L_1 \frac{di_1}{dt} + v_1.$$

$$\frac{di_1}{dt} = \frac{V}{L_1} - \frac{v_1}{L_1}$$

Integrate above equation

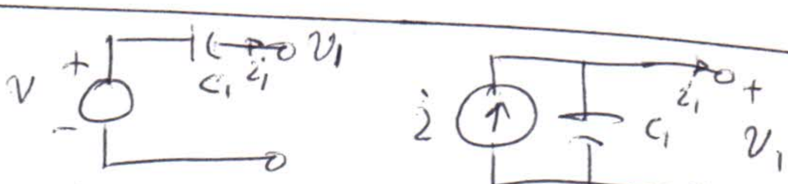
$$i_1 = \frac{1}{L_1}\int_{-\infty}^{t} V \cdot dt - \frac{1}{L_1}\int_{-\infty}^{t} v_1 \cdot dt$$

$$i_1 = i - \frac{1}{L}\int v_1 \cdot dt$$

or

$$\boxed{i = i_1 + \frac{1}{L_1}\int v_1 \cdot dt}$$

3.20



$$V = \frac{1}{C_1}\int i_1 \cdot dt + v_1$$

$$\frac{dV}{dt} = \frac{i_1}{C_1} + \frac{dv_1}{dt} \Rightarrow \boxed{i = i_1 + C_1 \frac{dv_1}{dt}}$$

manipulate

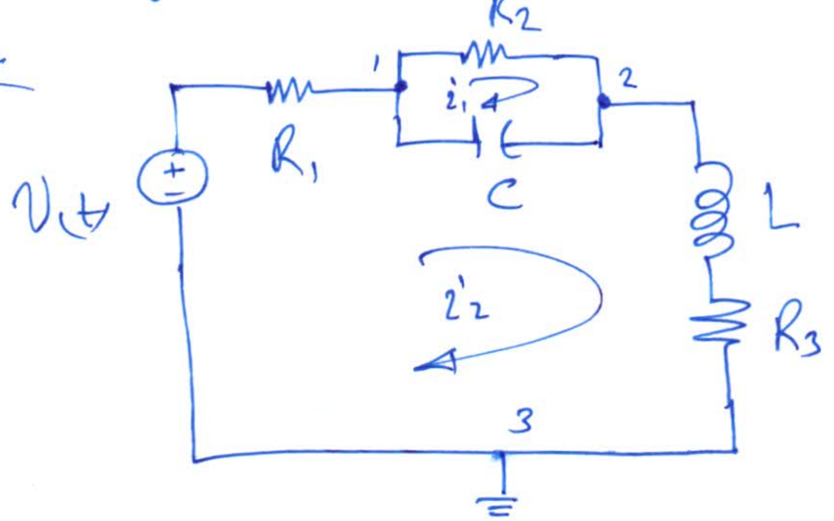
3.20 New book: Demonstrate that the two networks shown in figure 3.18 are Equivalent.

Ans: Out of all ⓐ, ⓑ, ⓒ and ⓓ parts (network) are observed but none of them found equivalent of the other.

3.21 Write a set of equations using the Kirchhoff's voltage law in terms of appropriate Loop current variables for the 4-networks of Prob: 3.17.

Sol.

ⓐ



No of branches
$b = 4$
$n = 3$
No. of eq: $= b-n+1$
$= 2$

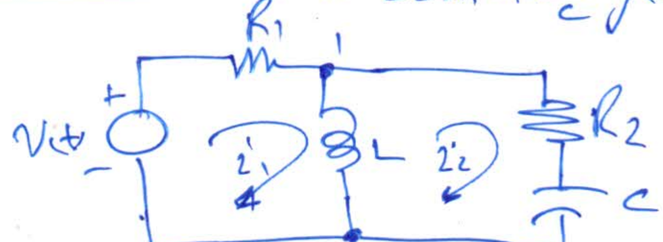
Loop_1

$$i_1 R_2 + \frac{1}{C}\int (i_1 - i_2).dt = 0$$

Loop_2

$$V(t) = i_2 R_1 + \frac{1}{C}\int (i_2 - i_1)\,dt + L\frac{di_2}{dt} + i_2 . R_3$$

ⓑ



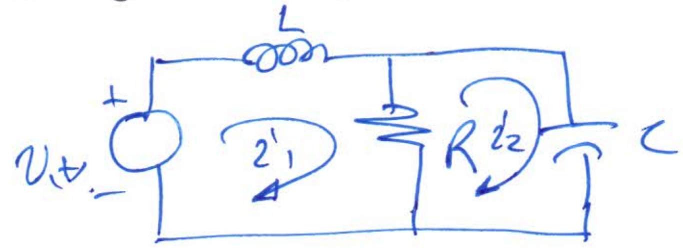
$b = m = 3$
$n = 2$
no. of eq. $= b - n + 1 = 3 - 2 + 1 = 2$

Loop_1 $\quad V(t) = i_1 R_1 + L\frac{d}{dt}(i_1 - i_2)$

Loop_2 $\quad 0 = i_2 R_2 + \frac{1}{C}\int i_2 . dt.$

P_ 3.21 (Contd.)

(c)



$b = m = 3$

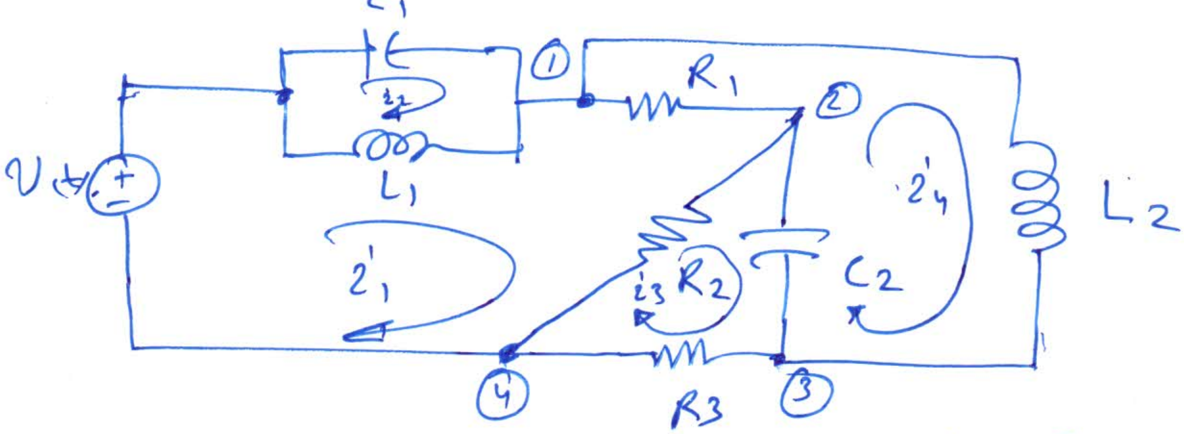
$n = 2$

No. of eq $= b - n + 1 = 2$

Loop-1 $\quad V(t) = L\dfrac{di_1}{dt} + (i_1 - i_2)R$

Loop-2 $\quad 0 = (i_2 - i_1)\cdot R + \dfrac{1}{C}\int i_2 \cdot dt$

(d)



$b = 7$

$n = 4.$

No. of equation $= 7 - 4 + 1 = 4$

Loop_1

$$V(t) = L_1\frac{d}{dt}(i_1 - i_2) + (i_1 - i_4)R_1 + (i_1 - i_3)R_2 ..$$

Loop_2

$$0 = L_1\frac{d}{dt}(i_2 - i_1) + \frac{1}{C_1}\int i_2 \cdot dt$$

Loop_3

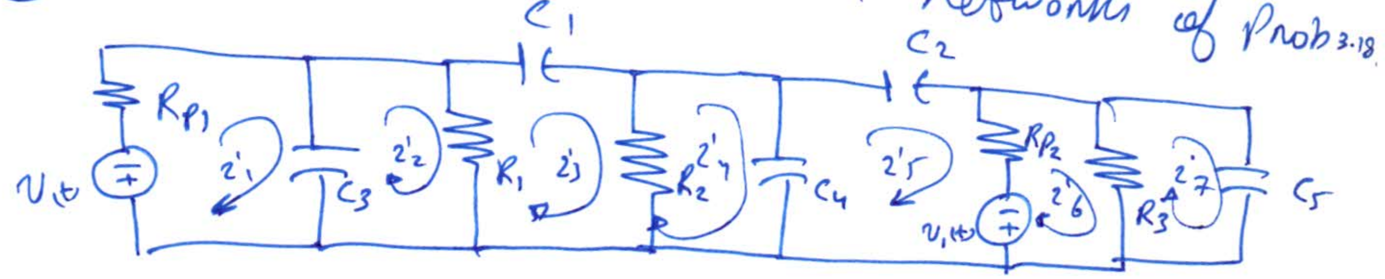
$$0 = (i_3 - i_2)R_2 + i_3 \cdot R_3 + \frac{1}{C_2}\int (i_3 - i_4)\cdot dt$$

Loop_4

$$0 = (i_4 - i_1)R_1 + \frac{1}{C_2}\int (i_4 - i_3)\cdot dt + L_2\frac{di_4}{dt}$$

on Loop – basis for the 4 – networks of Prob 3.18 to write equation

Sol. (a)



$b = 10$, $n = 4$, no. of equation $= 10 - 4 + 1 = 7$

Loop – 1

$$-V(t) = i_1 R_{P_1} + \frac{1}{C_3}\int (i_1 - i_2)\cdot dt$$

Loop – 2

$$0 = (i_2 - i_3) R_1 + \frac{1}{C_3}\int (i_2 - i_1)\cdot dt$$

Loop – 3

$$0 = (i_3 - i_2)\cdot R_1 + \frac{1}{C_1}\int i_3 \cdot dt + (i_3 - i_4) R_2$$

Loop – 4

$$0 = (i_4 - i_3) R_2 + \frac{1}{C_4}\int (i_4 - i_5)\cdot dt$$

Loop – 5

$$V_1(t) = (i_5 - i_6) R_{P_2} + \frac{1}{C_2}\cdot\int i_5 \cdot dt + \frac{1}{C_4}\int (i_5 - i_4)\cdot dt$$

Loop – 6

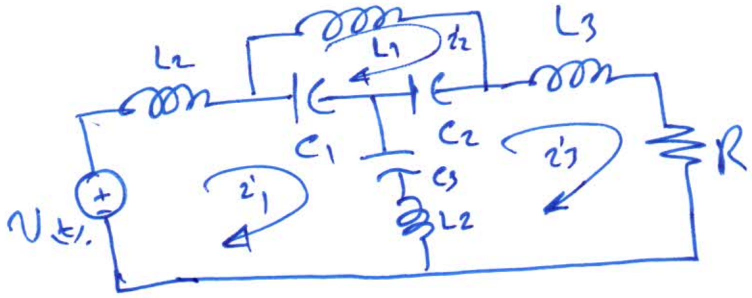
$$-V_1(t) = (i_6 - i_5) R_{P_2} + (i_6 - i_7)\cdot R_3$$

Loop – 7

$$0 = (i_7 - i_6) R_3 + \frac{1}{C_5}\cdot\int i_7 \cdot dt$$

(P.T.O)

(b)



Loop-1 $v(t) = L_2 \cdot \frac{di_1}{dt} + \frac{1}{C_1}\int (i_1 - i_2)\cdot dt + \frac{1}{C_3}\cdot \int (i_1 - i_3)\, dt + L_2 \frac{d}{dt}(i_1 - i_3)$

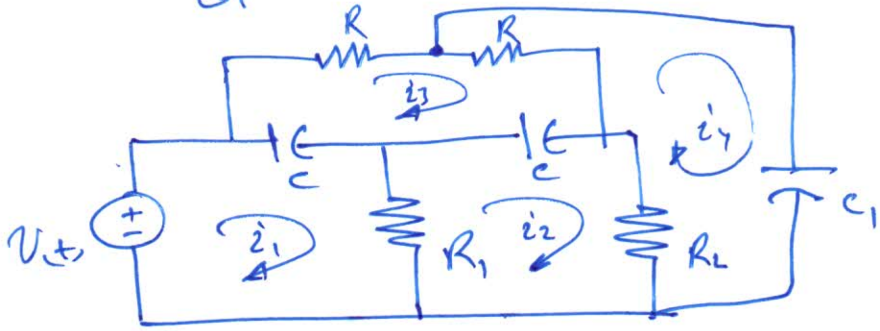
Loop-2

$$0 = L_1 \frac{di_2}{dt} + \frac{1}{C_1}\int (i_2 - i_1)\cdot dt + \frac{1}{C_2}\int (i_2 - i_3)\cdot dt$$

Loop-3

$$0 = L_3 \cdot \frac{di_3}{dt} + i_3 \cdot R + \frac{1}{C_2}\cdot \int (i_3 - i_2)\cdot dt + \frac{1}{C_3}\int (i_3 - i_1)\cdot dt + L_2 \frac{d(i_3 - i_1)}{dt}$$

(c)



Loop-1 $v(t) = (i_1 - i_2) R_1 + \frac{1}{C}\int (i_1 - i_3)\cdot dt$

Loop-2

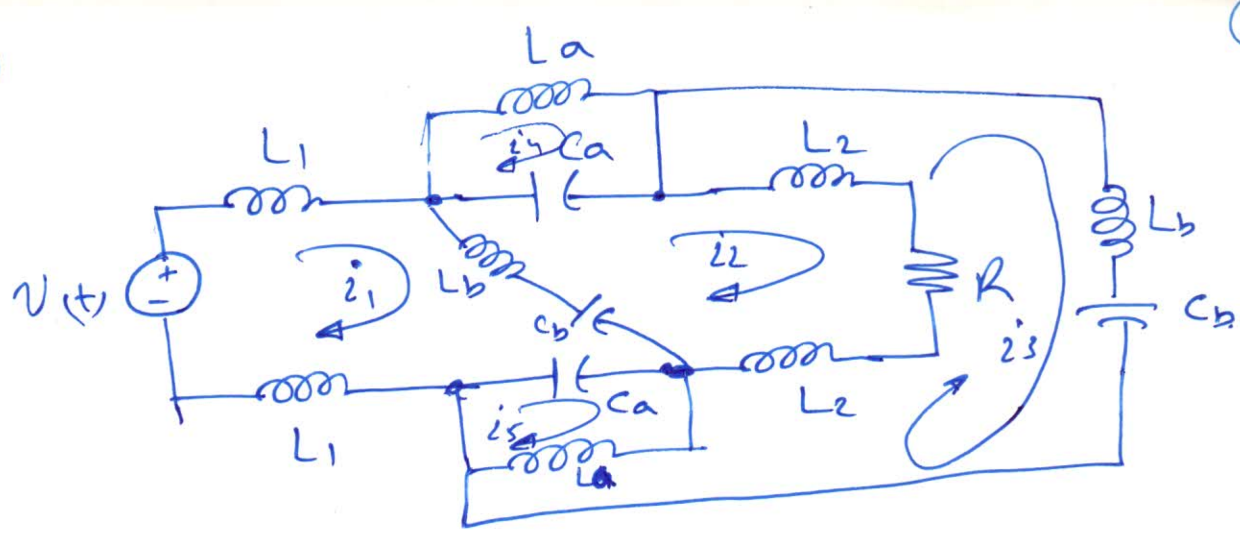
$$0 = (i_2 - i_1) R_1 + \frac{1}{C}\int (i_2 - i_3)\, dt + R_2 (i_2 - i_4)$$

Loop-3 $0 = i_3 R + (i_3 - i_4) R + \frac{1}{C}\int (i_3 - i_1)\cdot dt + \frac{1}{C}\int (i_3 - i_2)\cdot dt$

Loop-4 $0 = (i_4 - i_3) R + (i_4 - i_2) R_2 + \frac{1}{C_1}\int i_4 \cdot dt$

P. S. N. P

(d)



Loop-①

$$v(t) = L_1\frac{di_1}{dt} + L_1\frac{di_1}{dt} + L_b\frac{d(i_1-i_2)}{dt} + \frac{1}{C_b}\int(i_1-i_2)\cdot dt + \frac{1}{C_a}\int(i_1-i_5)\cdot dt$$

Loop-②

$$0 = L_b\frac{d(i_2-i_1)}{dt} + \frac{1}{C_b}\cdot\int(i_2-i_1)\cdot dt + \frac{1}{C_a}\int(i_2-i_4)\cdot dt + L_2\frac{d(i_2-i_3)}{dt} + L_2\frac{d(i_2-i_3)}{dt} + (i_2-i_3)R$$

Loop-③

$$0 = L_2\frac{d(i_3-i_2)}{dt} + L_b\frac{di_3}{dt} + \frac{1}{C_b}\int i_3\cdot dt + L_a\frac{d(i_3-i_5)}{dt} + L_2\frac{d}{dt}(i_3-i_2) + (i_3-i_2)R$$

Loop-4

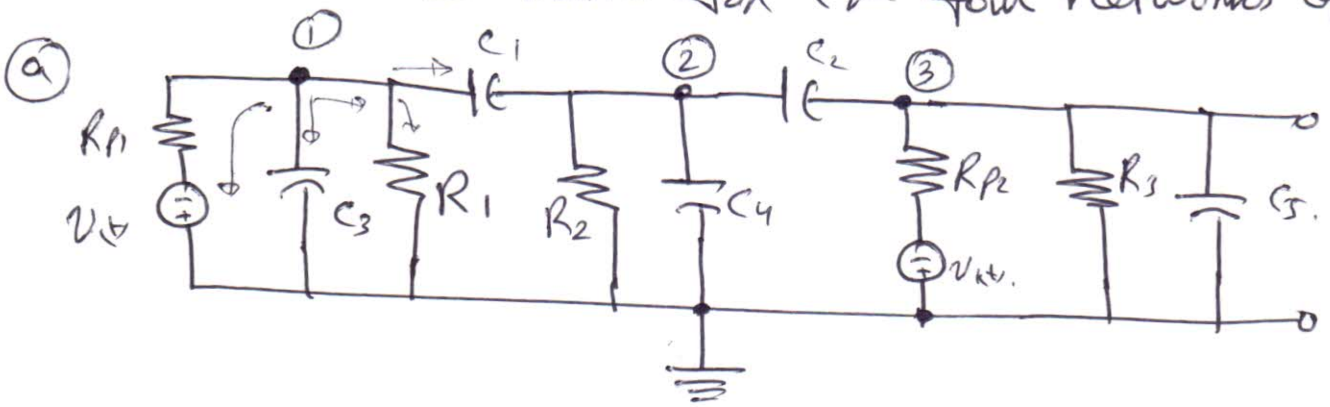
$$0 = L_a\cdot\frac{di_4}{dt} + \frac{1}{C_a}\cdot\int(i_4-i_2)\cdot dt$$

Loop 5

$$0 = \frac{1}{C_a}\int(i_5-i_1)\cdot dt + L_a\cdot\frac{d(i_5-i_3)}{dt}$$

Prob: 3.29 Making use of K.C-Law, Write equations on node-basis for the four networks of Prob. 3.18.

(a)



Node-1

$$\frac{V_1 + V_{(t)}}{R_{P_1}} + C_3 \frac{dV_1}{dt} + \frac{V_1}{R_1} + C_1 \frac{d}{dt}(V_1 - V_2) = 0$$

or

$$\frac{V_1}{R_1} + \frac{V_1}{R_{P_1}} + C_3 \frac{dV_1}{dt} + C_1 \frac{d}{dt}(V_1 - V_2) = -\frac{V_{(t)}}{R_{P_1}}$$

Node-2

$$\frac{V_2}{R_2} + C_4 \frac{dV_2}{dt} + C_1 \frac{d(V_2 - V_1)}{dt} + C_2 \frac{d(V_2 - V_3)}{dt} = 0$$

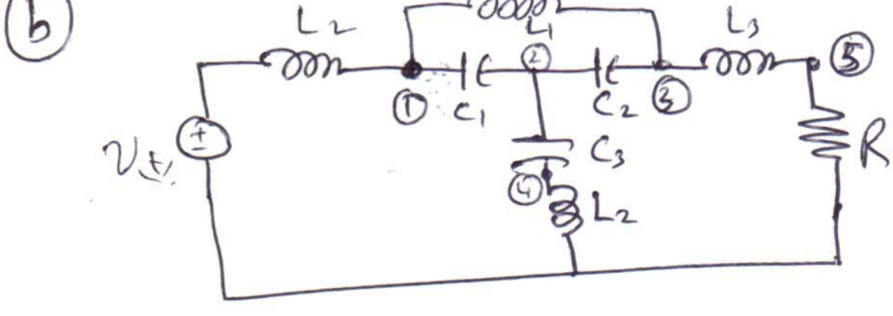
Node-3

$$\frac{V_3 + V_{(t)}}{R_{P_2}} + C_2 \frac{d(V_3 - V_2)}{dt} + \frac{V_3}{R_3} + C_5 \frac{dV_3}{dt} = 0$$

or

$$\frac{V_3}{R_{P_2}} + \frac{V_3}{R_3} + C_2 \cdot \frac{d(V_3 - V_2)}{dt} + C_5 \cdot \frac{dV_3}{dt} = -\frac{V_{(t)}}{R_{P_2}}$$

(b)



Node-1

$$\frac{1}{L_2} \int (V_1 - V_{(t)}) \cdot dt + \frac{1}{L_1} \int (V_1 - V_3)\, dt + C_1 \frac{d(V_1 - V_2)}{dt} = 0$$

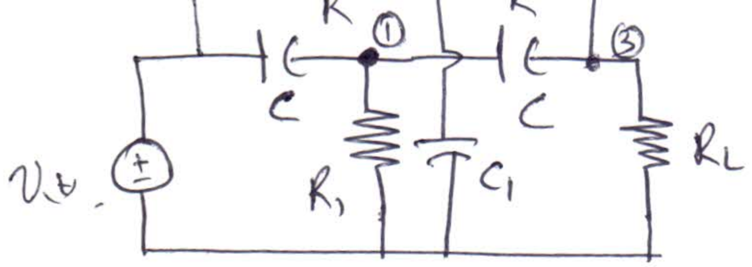
or

$$\frac{1}{L_2} \int V_1 \cdot dt + \frac{1}{L_1} \int (V_1 - V_3)\, dt + C_1 \frac{d(V_1 - V_2)}{dt} = \frac{1}{L_2} \int V_{(t)} \cdot dt$$

Node-2

$$C_1 \frac{d(V_2 - V_1)}{dt} + C_3 \frac{d(V_2 - V_4)}{dt} + C_2 \frac{d}{dt}(V_2 - V_3) = 0$$

(c)



Node-1

$$C\frac{d(V_1-V_{(t)})}{dt}+\frac{V_1}{R_1}+C\frac{d(V_1-V_3)}{dt}=0.$$

$$C\frac{dV_1}{dt}+\frac{V_1}{R_1}+C\frac{d(V_1-V_3)}{dt}=C\cdot\frac{dV_{(t)}}{dt}.$$

Node-2

$$\frac{V_2-V_{(t)}}{R}+\frac{V_2-V_3}{R}+C_1\frac{dV_2}{dt}=0$$

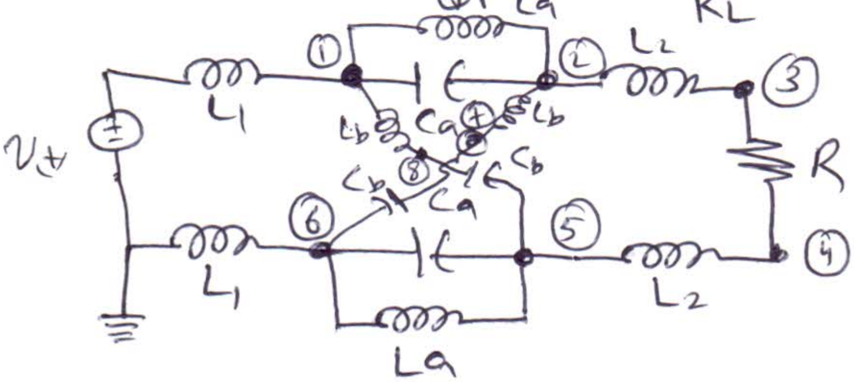
$$\frac{V_2}{R}+\frac{V_2}{R}-\frac{V_3}{R}+C_1\frac{dV_2}{dt}=\frac{V_{(t)}}{R}.$$

Node-3

$$\frac{V_3-V_2}{R}+C\frac{d(V_3-V_1)}{dt}+\frac{V_3}{R_L}=0$$

~~Node~~

(d)



Node-1

$$\frac{1}{L_1}\int(V_1-V_{(t)})\cdot dt+\frac{1}{L_a}\cdot\int(V_1-V_2)\cdot dt+\frac{1}{L_b}\int(V_1-V_8)\cdot dt$$
$$+C_a\frac{d(V_1-V_2)}{dt}=0.$$

(which can be further manipulated)

Node-2

$$C_a\cdot\frac{d(V_2-V_1)}{dt}+\frac{1}{L_a}\int(V_2-V_1)\cdot dt+\frac{1}{L_b}\int(V_2-V_7)\cdot dt+\frac{1}{L_2}\int(V_2-V_3)\,dt=0$$

Node-3

$$\frac{1}{L_2}\int(V_3-V_2)\cdot dt+\frac{V_3-V_4}{R}=0$$

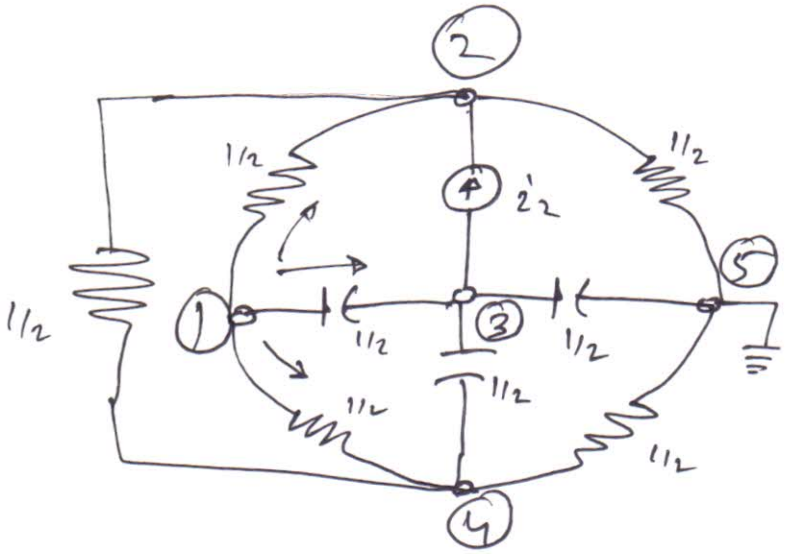
Node-4

$$\frac{V_4-V_3}{R}+\frac{1}{L_2}\int(V_4-V_5)\cdot dt=0$$

Node-5

... network, Write the node-basis equations using the node to datum voltages as variables. Collect terms in your formulation so that the equations have the general form of Eq: 3.59.

$$\sum_{j=1}^{N} b_{kj} V_j = i_k \qquad k = 1, 2, \ldots, N.$$



All $R = \frac{1}{2}\,\Omega$
All $C = \frac{1}{2}\,F$

At Node-1

$$2(V_1 - V_2) + 2(V_1 - V_4) + \frac{1}{2}\frac{d}{dt}(V_1 - V_3) = 0$$

or

$$\left(4 + \frac{1}{2}\frac{d}{dt}\right)V_1 + (-2)V_2 + (0)V_3 + (-2)V_4 = 0$$

At Node-2

$$2(V_2 - V_4) + 2(V_2 - V_1) + 2(V_2) - i_2 = 0$$

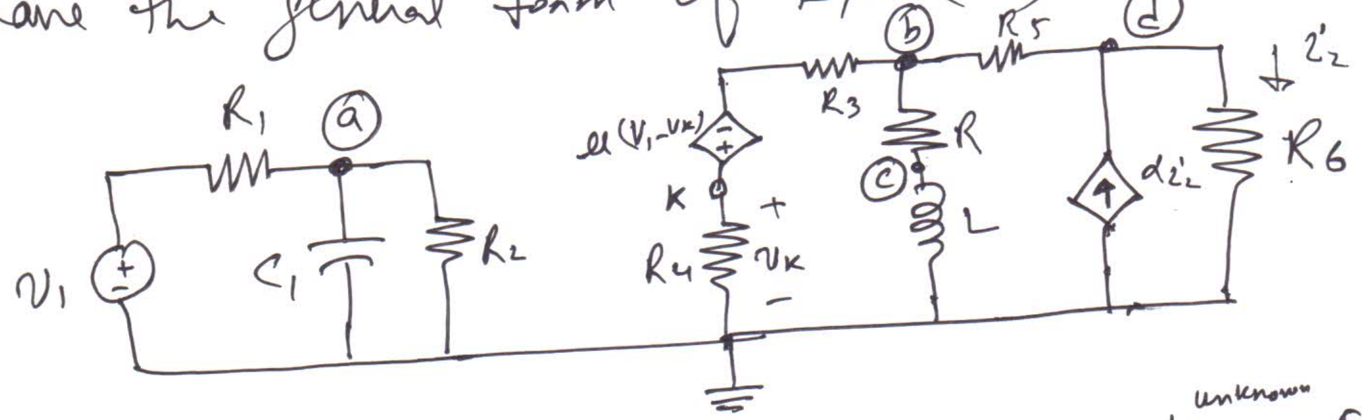
$$(-2)V_1 + (6+0)V_2 + (0)V_3 + (-2)V_4 = i_2$$

At Node-3

$$\frac{1}{2}\frac{d}{dt}(V_3 - V_4) + \frac{1}{2}\frac{dV_3}{dt} + \frac{1}{2}\frac{d}{dt}(V_3 - V_1) + i_2 = 0$$

$$\ldots V_2(0) + \left(-\frac{1}{2}\frac{d}{dt}\right)V_4 = -i_2$$

Prob: 3.31. The network in fig. contains one independent voltage source and 2 – controlled sources. Using K.C. Law, write node-basis equations. Collect terms in the formulation so that the equations have the general form of Eqs. (3.89).



Variables will be V_a, V_b, V_c, V_d, V_K. (No. of unknown node voltages = 5)

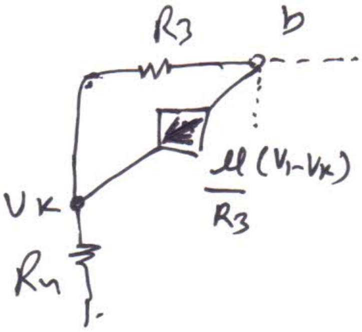
Equations at node a

$$\frac{V_a - V_1}{R_1} + C_1\frac{dV_a}{dt} + \frac{V_a}{R_2} = 0$$

$$\left(\frac{1}{R_1} + \frac{1}{R_2} + C_1\frac{d}{dt}\right)V_a + \left(-\frac{1}{R_1}\right)V_1 = 0$$

$$\left(\frac{1}{R_1} + \frac{1}{R_2} + C_1\frac{d}{dt}\right)V_a + (0)V_b + (0)V_c + (0)V_d = \frac{V_1}{R_1} \rightarrow (1)$$

Equation at node - b



$$\frac{V_b - V_K}{R_3} + \frac{V_b - V_d}{R_5} + \frac{V_b - V_c}{R} + \frac{\mu(V_1 - V_K)}{R_3} = 0$$

OR

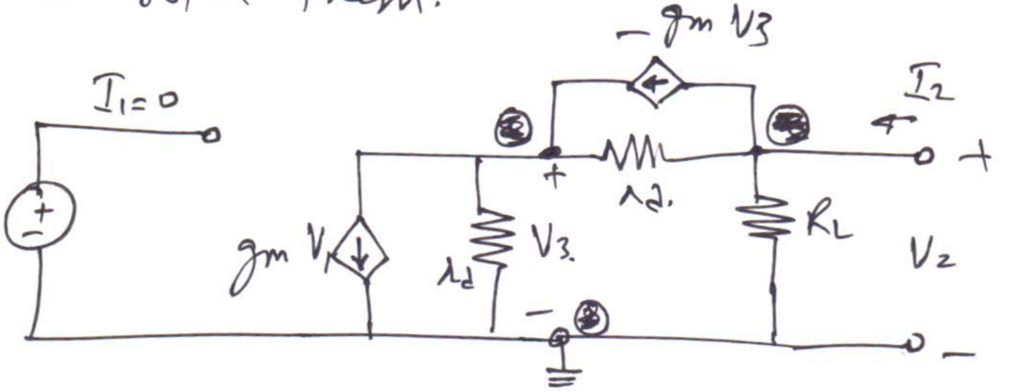
$$V_a(0) + \left(\frac{1}{\ } + \frac{1}{\ } + \frac{1}{\ }\right)V_b + \left(-\frac{1}{\ }\right)V_c + \left(-\frac{1}{\ }\right)V_d + \left(-\frac{\mu}{R_3}\right)V_K$$

$$\frac{V_d - V_b}{R_5} - \alpha i_2 + \frac{V_d}{R_6} = 0 \qquad i_2 = \frac{V_d}{R_6}.$$

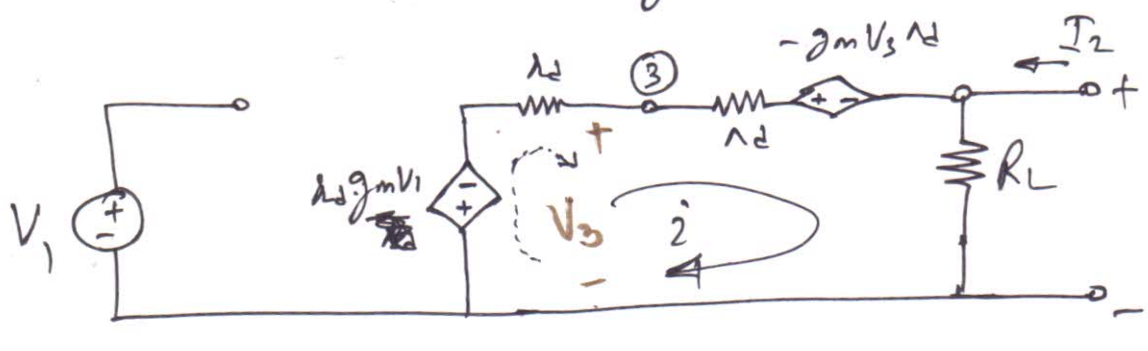
$$(0)V_a + \left(-\frac{1}{R_5}\right)V_b + (0)\,V_c + \left(-\frac{\alpha}{R_6} + \frac{1}{R_6}\right)V_d = 0$$

Equation at node - V = ?

Prob: 3.32 The network of the figure is a model suitable for "mid band" operation of the "Cascode-Connected" MOS transistor amplifier. Analyze the network on (a) the Loop basis and (b) the node basis. Write the resulting equations in matrix form, but do not solve them.



(a) In order to analyze this network on Loop basis, Convert all current sources in to their equivalent Voltage source.



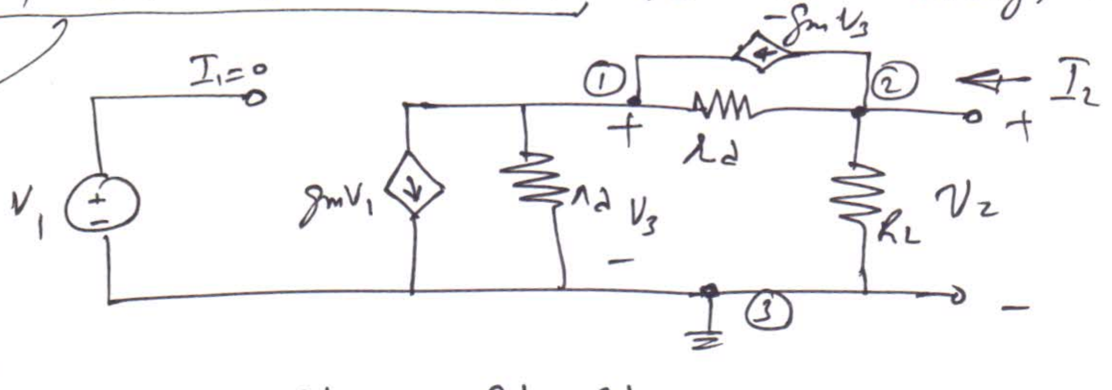
$$r_d g_m V_1 + (-g_m V_3 r_d) + i\, r_d + i \cdot r_d + R_L i = 0$$

i ... V_2 (V_1 = given value)

$$i = -\frac{(\ldots g_m V_1 + g_m r_d \; V_1)}{(g_m \cdot r_d^2 + 2 r_d + R_L)}$$

(3) 2-nodes are selected and 3rd node is datum/reference node.

Equation at node-1 in the original diagram



$$g_m V_1 + \frac{V_1}{r_d} + \frac{V_1 - V_2}{r_d} - (-g_m V_3) = 0$$

$$V_1 = V_3$$

$$g_m V_1 + g_m V_1 + \frac{2V_1}{r_d} - \frac{V_2}{r_d} = 0$$

$$V_1 \left(g_m + \frac{2}{r_d}\right) + V_2 \left(-\frac{1}{r_d}\right) = -g_m V_1 \rightarrow (1)$$

Equation at node-2

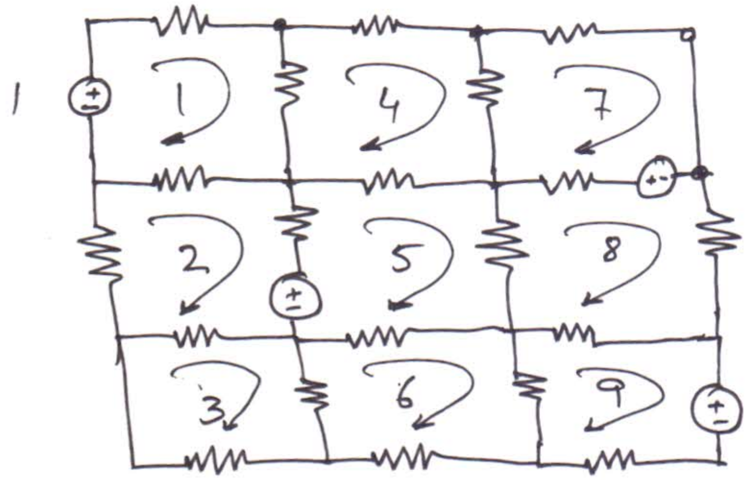
$$-g_m V_3 + \frac{V_2 - V_1}{r_d} + \frac{V_2}{R_L} = 0$$

$$-g_m V_3 + V_1 \left(-\frac{1}{r_d}\right) + V_2 \left(\frac{1}{R_L} + \frac{1}{r_d}\right) = \cancel{g_m V_3}\ 0 \longrightarrow (2)$$

$$V_1 \left(-\frac{1}{r_d} + g_m\right) + V_2 \left(\frac{1}{R_L} + \frac{1}{r_d}\right) \quad \cancel{V}_1$$

$$\Big[(\ldots) \quad \left(-\frac{1}{\ldots}\right) \Big] \begin{bmatrix} V_1 \\ \ldots \end{bmatrix} = \begin{bmatrix} -g_m V_1 \\ \ldots \end{bmatrix}$$

Prob: 3.33 In the network of the fig, each branch contains a 1-Ω resistor, and four branches contain a 1-V, voltage source. Analyze the network on loop basis and organize the resulting equations in the form of a chart as in Example: 11. Do not solve the equations. (195)



$R = 1\Omega$

$V = 1\text{-Volt.}$

Loop-1

$$1 = (3)i_1 + (-1)i_2 + (0)i_3 + (-1)i_4 + (0)i_5 + (0)i_6 + (0)i_7 + 0i_8 + 0i_9$$

Loop-2

$$-1 = (-1)i_1 + (4)i_2 + (-1)i_3 + (0)i_4 + (-1)i_5 + (0)i_6 + (0)i_7 + (0)i_8 + (0)i_9$$

Loop-3

$$0 = (0)i_1 + (-1)i_2 + (3)i_3 + (0)i_4 + (0)i_5 + (-1)i_6 + (0)i_7 + (0)i_8 + (0)i_9$$

Loop-4

$$0 = (-1)i_1 + (0)i_2 + (0)i_3 + (4)i_4 + (-1)i_5 + (0)i_6 + (-1)i_7 + (0)i_8 + (0)i_9$$

Loop-5

$$1 = (0)i_1 + (-1)i_2 + (0)i_3 + (-1)i_4 + (4)i_5 + (-1)i_6 + (0)i_7 + (-1)i_8 + (0)i_9$$

Loop-6

$$0 = (0)i_1 + (0)i_2 + (-1)i_3 + (0)i_4 + (-1)i_5 + (4)i_6 + (0)i_7 + (0)i_8 + (-1)i_9$$

Loop-7

$$1 = (0)i_1 + (0)i_2 + (0)i_3 + (-1)i_4 + (0)i_5 + (0)i_6 + (3)i_7 + (-1)i_8 + (0)i_9$$

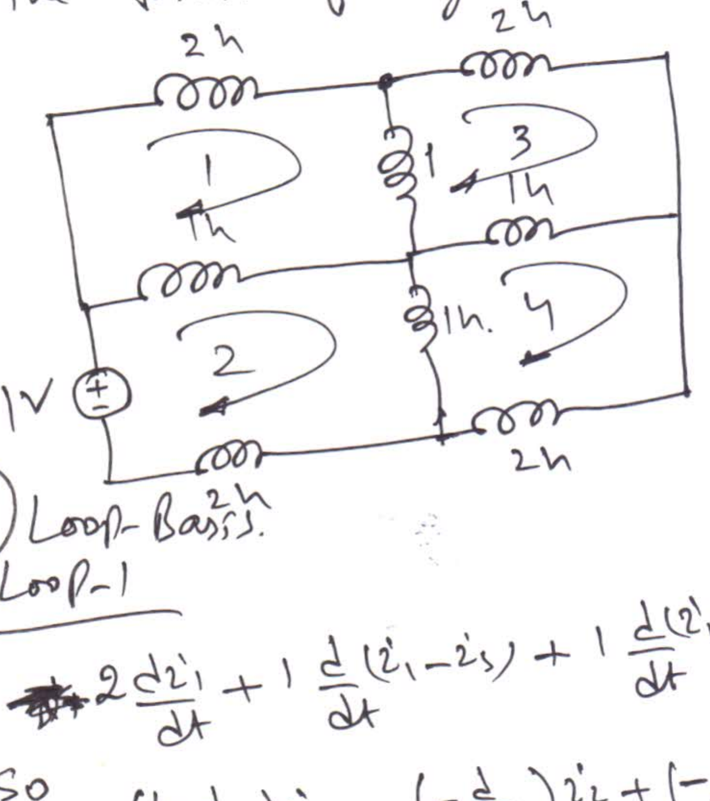
Loop-8

$$1 = (0)i_1 + (0)i_2 + (0)i_3 + (0)i_4 + (-1)i_5 + (0)i_6 + (-1)i_7 + (4)i_8 + (-1)i_9$$

$$
\begin{array}{c}
1\\2\\3\\4\\5\\6\\7\\8\\9
\end{array}
\begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \\ 1 \\ 0 \\ 1 \\ -1 \\ -1 \end{bmatrix}
=
\begin{array}{c|c}
 & \begin{array}{ccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \end{array} \\
\begin{array}{c}1\\2\\3\\4\\5\\6\\7\\8\\9\end{array} &
\begin{bmatrix}
3 & -1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\
-1 & 4 & -1 & 0 & -1 & 0 & 0 & 0 & 0 \\
0 & -1 & 3 & 0 & 0 & -1 & 0 & 0 & 0 \\
-1 & 0 & 0 & 4 & -1 & 0 & -1 & 0 & 0 \\
0 & -1 & 0 & -1 & 4 & -1 & 0 & -1 & 0 \\
0 & 0 & -1 & 0 & -1 & 4 & 0 & 0 & -1 \\
0 & 0 & 0 & -1 & 0 & 0 & 3 & -1 & 0 \\
0 & 0 & 0 & 0 & -1 & 0 & -1 & 4 & -1 \\
0 & 0 & 0 & 0 & 0 & -1 & 0 & -1 & 3
\end{bmatrix}
\end{array}
\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \\ i_7 \\ i_8 \\ i_9 \end{bmatrix}
$$

.Chart FoRM.

Prob: 3.34 Repeat problem P3.33 for the network of the accompanying figure. In addition, write equations on the node-basis, and arrange the equations in the form of ~~figure~~ the chart of Example-13



(a) Loop-Basis.

Loop-1

$$2\frac{di_1}{dt} + 1\frac{d}{dt}(i_1 - i_3) + 1\frac{d}{dt}(i_1 - i_2) = 0$$

So
$$\left(4\frac{d}{dt}\right)i_1 + \left(-\frac{d}{dt}\right)i_2 + \left(-\frac{d}{dt}\right)i_3 + (0)i_4 = 0$$

Loop-2

$$(-1) + 1\cdot\frac{d(i_2 - i_1)}{dt} + 1\frac{d}{dt}(i_2 - i_4) + 2\frac{d}{dt}i_2 = 0$$

$$\left(-\frac{d}{dt}\right)i_1 + (3d)\,i_2 + (0)\,i_3 + \left(-\frac{d}{dt}\right)i_4 = (1)$$

Loop – 4

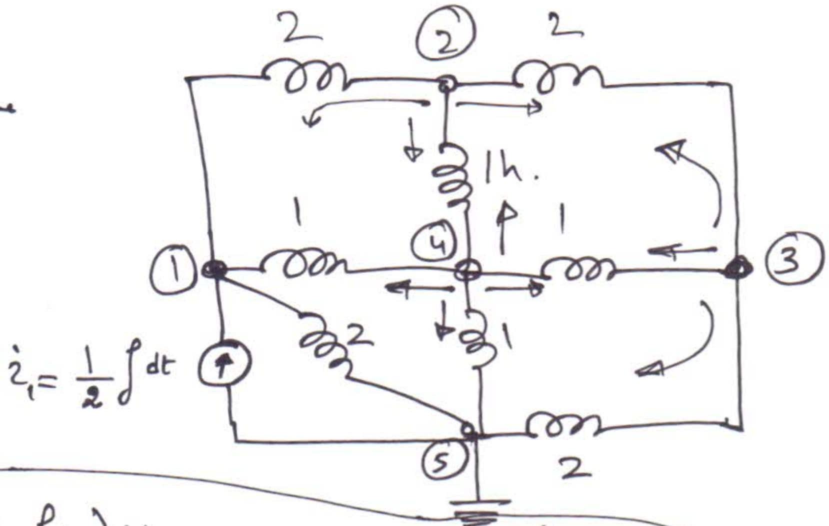
$$2\cdot\frac{d}{dt}i_4 + 1\cdot\frac{d}{dt}(i_4-i_3) + 1\cdot\frac{d}{dt}(i_4-i_2) = 0$$

$$(0)\,i_1 + \left(-\frac{d}{dt}\right) i_2 + \left(-\frac{d}{dt}\right) i_3 + \left(4\cdot\frac{d}{dt}\right) i_4 = 0$$

Chart form

$$\begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 4\frac{d}{dt} & -\frac{d}{dt} & -\frac{d}{dt} & 0 \\ -\frac{d}{dt} & 3\frac{d}{dt} & 0 & -\frac{d}{dt} \\ -\frac{d}{dt} & 0 & 4\cdot\frac{d}{dt} & -\frac{d}{dt} \\ 0 & -\frac{d}{dt} & -\frac{d}{dt} & 4\cdot\frac{d}{dt} \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix}$$

(b) Node – Basis



Node – 1

$$-i_1 + \frac{1}{2}\int V_1\cdot dt + \frac{1}{1}\int (V_1 - V_4)dt + \frac{1}{2}\int (V_1 - V_2)\cdot dt = 0$$

$$i_1 = \frac{1}{2}\int dt = \left(2\cdot 0\int dt\right)V_1 + \left(-\frac{1}{2}\int dt\right)V_2 + (0)\,V_3 + \left(-\int dt\right)V_4$$

Node – 2

$$\frac{1}{2}\int (V_2 - V_1)\cdot dt + \frac{1}{2}\int (V_2 - V_3)\,dt + \frac{1}{1}\int (V_2 - V_4)\cdot dt = 0$$

$$\left(-\frac{1}{2}\int dt\right)V_1 + \left(2\cdot 0\int dt\right)V_2 + \left(-\frac{1}{2}\int dt\right)V_3 + \left(-1\int dt\right)V_4 = 0$$

Node – 3

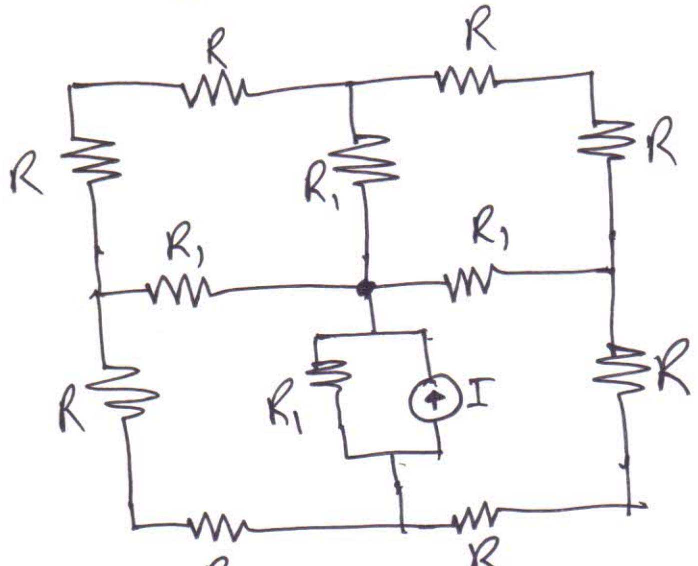
$$\frac{1}{2}\int (V_3 - V_2)\cdot dt + \frac{1}{1}\int (V_3 - V_4)\cdot dt + \frac{1}{2}\int V_3\cdot dt = 0$$

$$(0)\,V_1 + \left(-\frac{1}{2}\int dt\right)V_2 + \left(2\cdot 0\times\int dt\right)V_3 + \left(-\int dt\right)V_4 = 0$$

In Matrix Form;

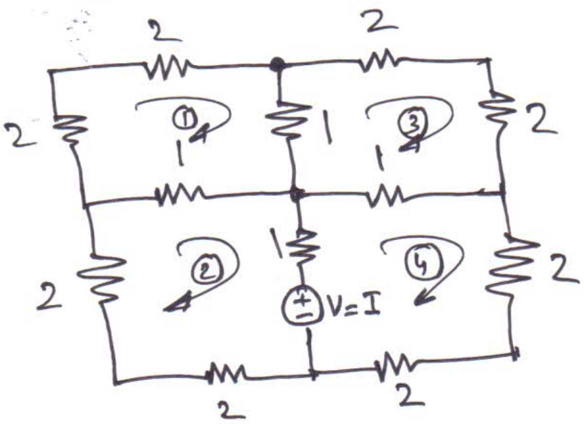
$$\begin{array}{c|cccc|} & 1 & 2 & 3 & 4 \\ \hline 1 & 2\int dt & -\frac{1}{2}\int dt & -\frac{1}{2}\int dt & -\int dt \\ 2 & -\frac{1}{2}\int dt & 2\int dt & -\frac{1}{2}\int dt & -1\int dt \\ 3 & 0 & -\frac{1}{2}\int dt & 2\int dt & -\int dt \\ 4 & -1\int dt & -1\int dt & -1\int dt & 4\int dt \end{array} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} +\frac{1}{2}\int dt \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad i_1$$

Prob: 3.35 In the network of Figure: $R = 2\Omega$ $R_1 = 1\Omega$. Write equations on (a) the loop basis, and (b) the node-basis, and simplify the equations to the form of Chart used in Example-11 and 13.



Solution

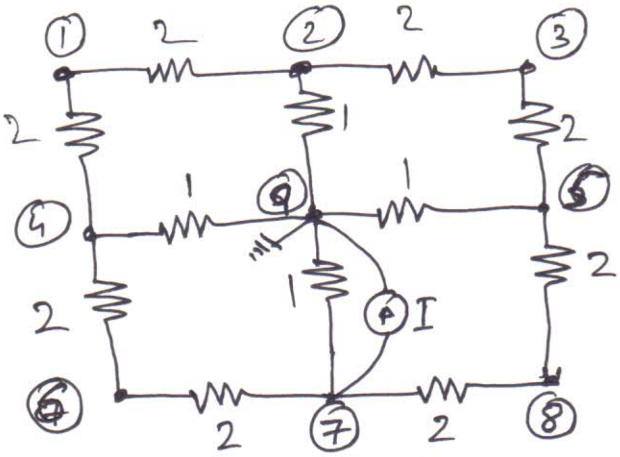
Loop Analysis



Equation: in Matrix form:

$$\begin{array}{c|cccc|} & 1 & 2 & 3 & 4 \\ \hline 1 & 6 & -1 & -1 & 0 \\ 2 & -1 & 5 & 0 & -1 \end{array} \begin{array}{c} 1 \\ 2 \end{array} \begin{bmatrix} i_1 \\ i_2 \\ \vdots \end{bmatrix} = \begin{bmatrix} 0 \\ -I \\ 0 \end{bmatrix}$$

Node_Analysis

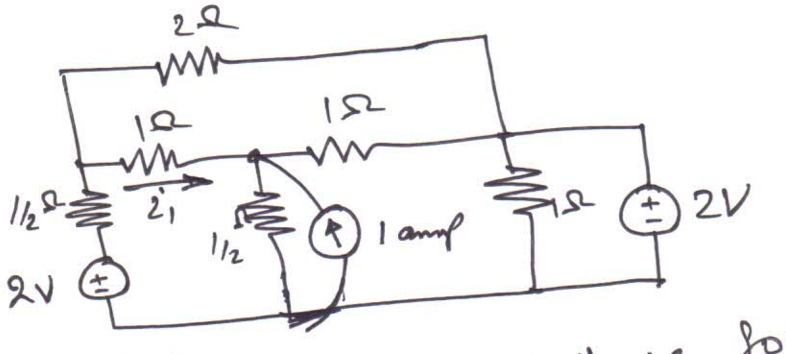


Node:

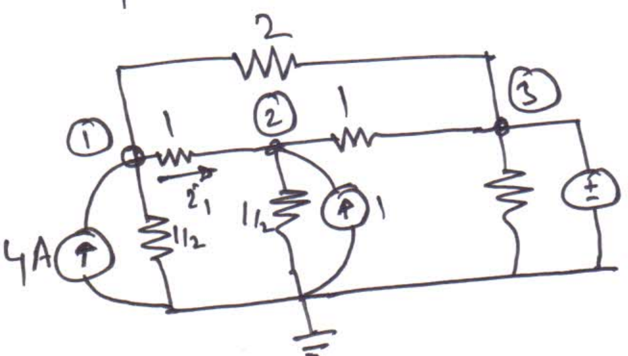
> Node-9 = datum Node.

	1	2	3	4	5	6	7	8					
1	1.0	-1/2	0	-1/2	0	0	0	0	1	V_1		1	0
2	-1/2	1.5	-1/2	0	0	0	0	0	2	V_2		2	0
3	0	-1/2	1.0	0	-1/2	0	0	0	3	V_3		3	0
4	-1/2	0	0	2.0	0	-1/2	0	0	4	V_4	=	4	0
5	0	0	-1/2	0	2.0	0	0	-1/2	5	V_5		5	0
6	0	0	0	-1/2	0	1.0	-1/2	0	6	V_6		6	0
7	0	0	0	0	0	-1/2	2.0	-1/2	7	V_7		7	-I
8	0	0	0	0	-1/2	0	-1/2	1.0	8	V_8		8	0

Prob: 3.36 For the network shown in the figure, determine the numerical value of the branch current i_1. All sources in the network are time invariant.



Apply Node Analysis, Convert Voltage source 2V, in series with 1/2 Ω in to equivalent Current source



> No-Need to write equation for node-3, as $V_3 = 2$ Volt.

At Node-1

$$-4 + \frac{(V_1 - V_2)}{1} + \frac{V_1}{1/2} + \frac{V_1 - 2}{2} = 0$$

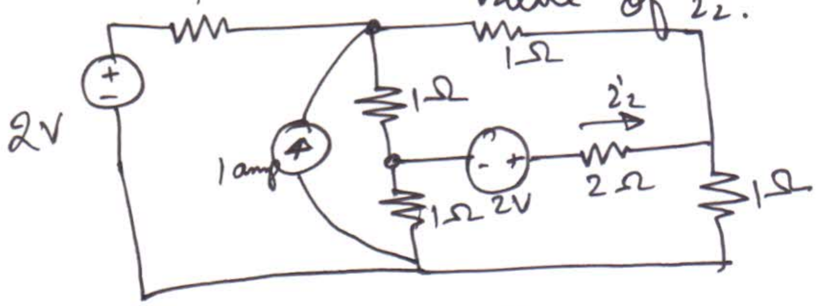
$$\begin{bmatrix} 3.5 & -1 \\ -1 & 4.0 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$

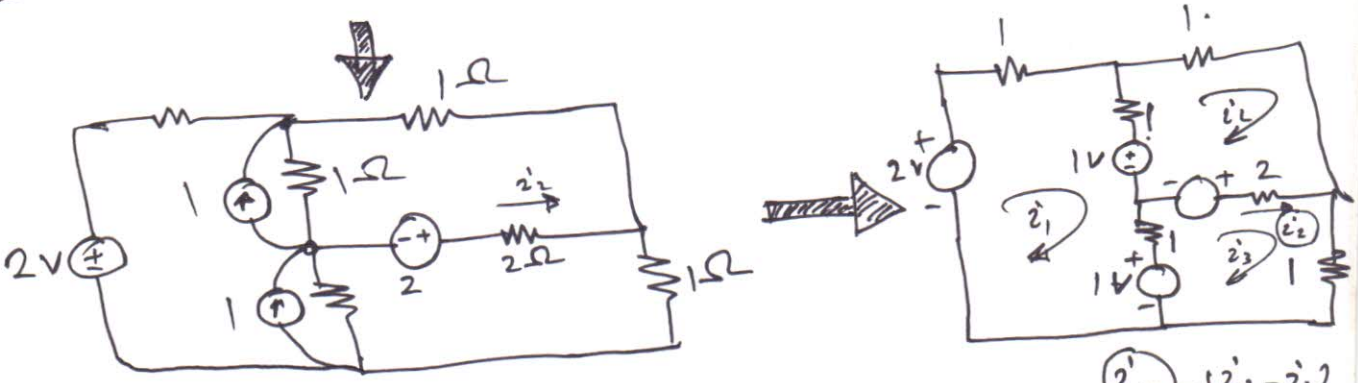
$$\Delta_2 = \begin{vmatrix} 3.5 & 5 \\ -1 & 3 \end{vmatrix} = 3.5\times 3 - (-1)\times 5 = 10.5 + 5 = 15.5.$$ (200)

$$V_2 = \frac{\Delta_2}{\Delta} = \frac{15.5}{13} \text{ Volts.}$$

$$i_1 = \frac{V_1 - V_2}{1} = \frac{23}{13} - \frac{15.5}{13} = \frac{23 - 15.5}{13} = 7.5 \text{ Amp.}$$

Prob: 3.37 In the network of the figure, all sources are time invariant. Determine the numerical value of i_2.





$$(i_2) = (i_3 - i_2)$$

$$\begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline 1 & 3 & -1 & -1 \\ 2 & -1 & 4 & -2 \\ 3 & -1 & -2 & 4 \end{array} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \\ 3 \end{bmatrix}$$

We are only interested in (i_2) and (i_3) loop current

$$i_2 = \frac{\Delta_2}{\Delta}, \quad i_3 = \frac{\Delta_3}{\Delta}.$$

$$\Delta = \begin{vmatrix} 3 & -1 & -1 \\ -1 & 4 & -2 \\ -1 & -2 & 4 \end{vmatrix} = 3\begin{vmatrix} 4 & -2 \\ -2 & 4 \end{vmatrix} + \begin{vmatrix} -1 & -2 \\ -1 & 4 \end{vmatrix} + (-1)\begin{vmatrix} -1 & 4 \\ -1 & -2 \end{vmatrix}$$

$$= 3(16-4) + (-4+2) + (-1)(+2-4)$$

$$\ldots + (-1)(-4) = 36 - 2 + 4$$

$$\Delta_3 = \begin{vmatrix} 3 & -1 & 0 \\ -1 & 4 & -1 \\ -1 & -2 & 3 \end{vmatrix} = 3\begin{vmatrix} 4 & -1 \\ -2 & 3 \end{vmatrix} + 1\begin{vmatrix} -1 & -1 \\ -1 & 3 \end{vmatrix} + 0$$

$$= 3(12-2) + 1(-3-1)$$

$$= 3(10) + (-4) = 30 - 4 = 26$$

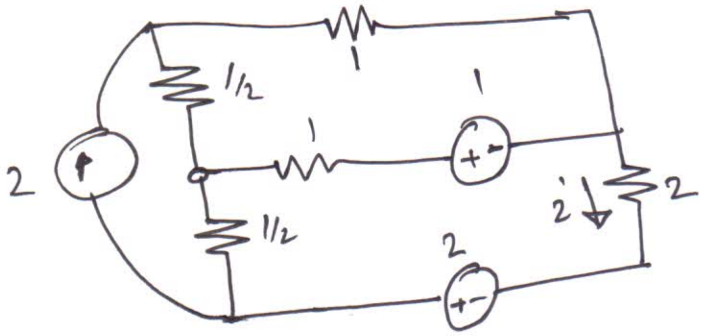
$$i_2 = \frac{\Delta_2}{\Delta} = \frac{9}{38}$$

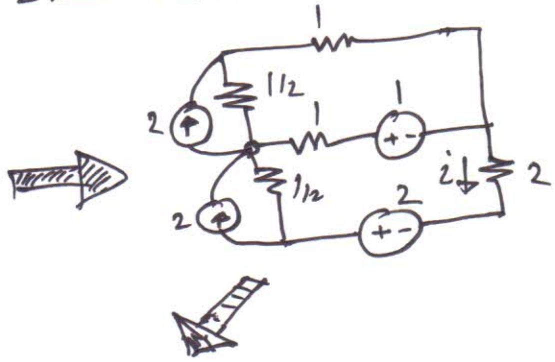
$$i_3 = \frac{\Delta_3}{\Delta} = \frac{26}{38}$$

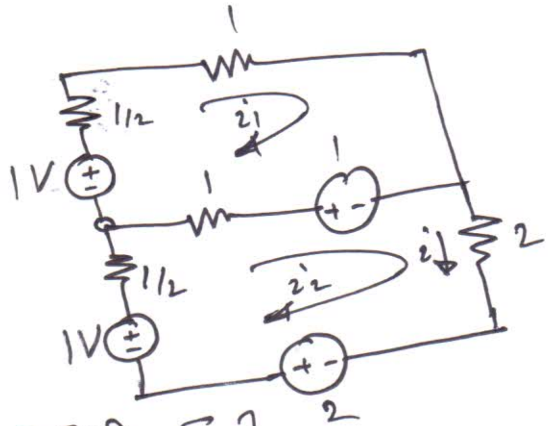
$$i_2 \text{ (Require)} = i_3 - i_2 = \frac{26}{38} - \frac{9}{38} = \frac{17}{38}$$

$$\boxed{i_2 = \frac{17}{38}}$$

Prob: 3.38 In the given network, all sources are time invariant. Determine the branch current in the 2 Ω resistor.







$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

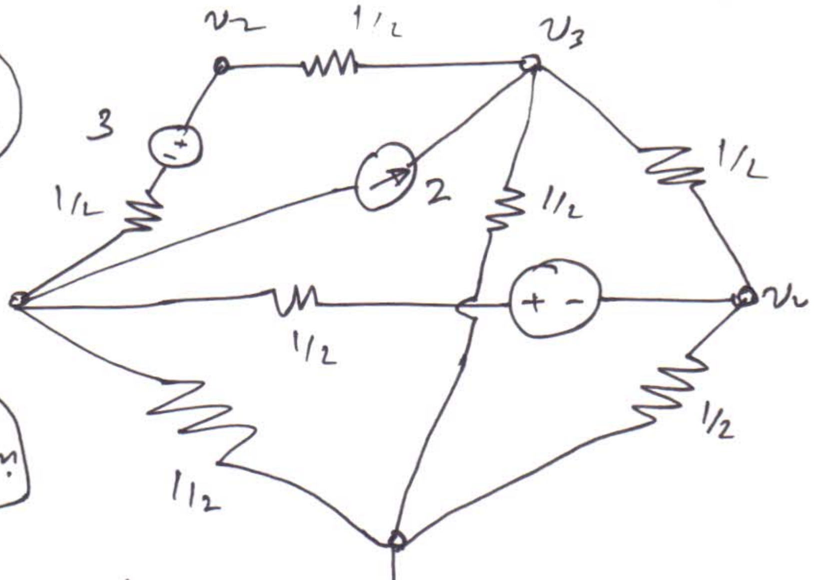
$$\Delta = \begin{vmatrix} 2.5 & -1 \\ -1 & 3.5 \end{vmatrix}$$

$$\Delta_1 = \begin{vmatrix} +2 & -1 \\ +3 & 3.5 \end{vmatrix}$$

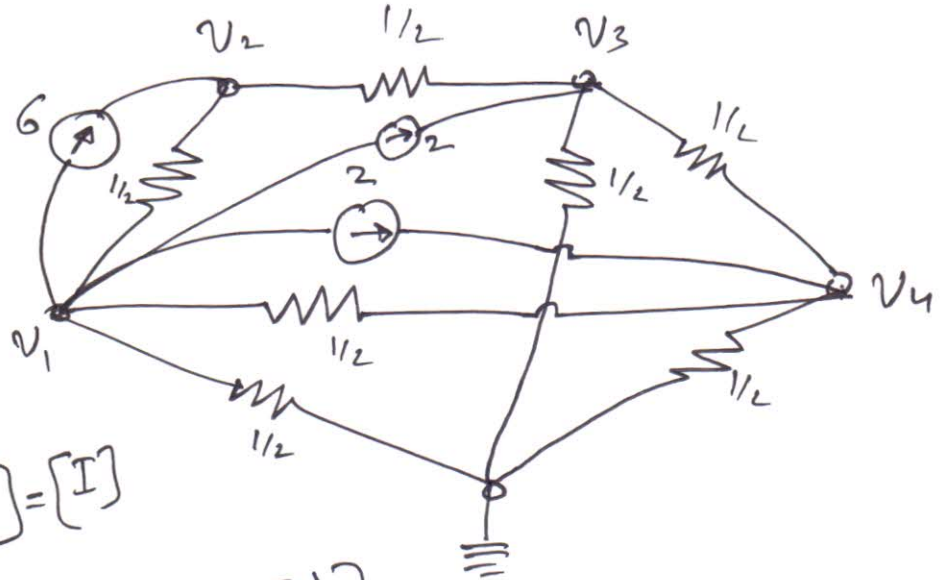
$i_1 = \frac{\Delta_1}{\Delta}$ Not-Required

Prob: 3.39

In the network, voltage and current sources are time invariant.
All $R = 1/2\,\Omega$.
Solve for the four node-to datum



Preferably Convert Voltage Sources into Current Source.



$$[B][V] = [I]$$

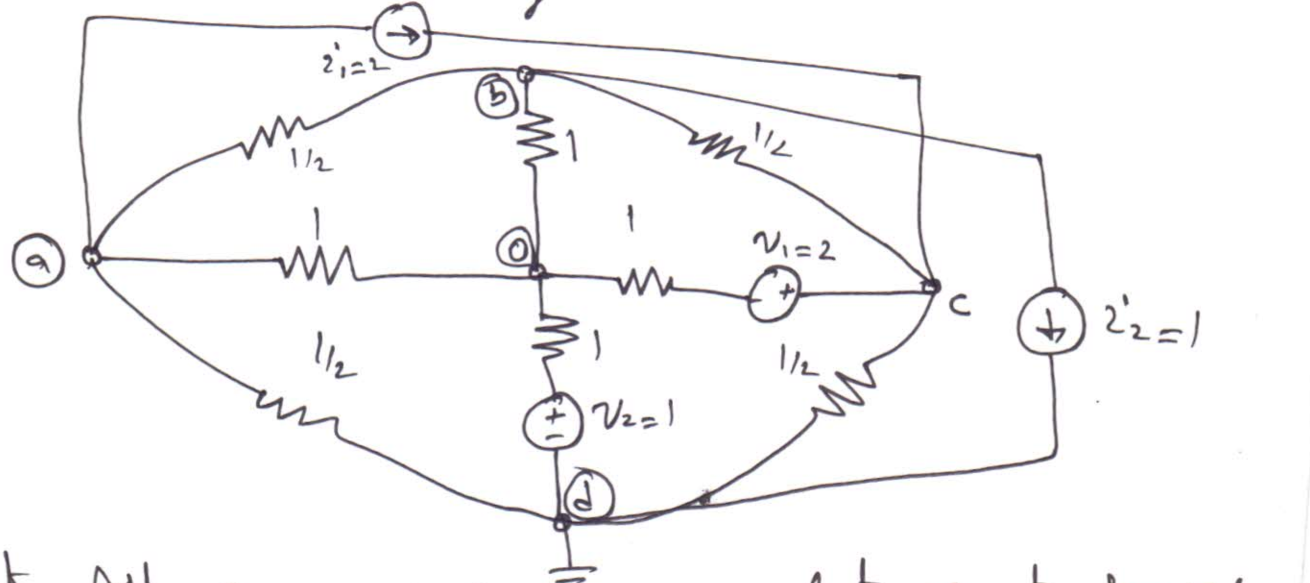
$$\begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix}$$

$$\begin{array}{c|cccc} & 1 & 2 & 3 & 4 \\ \hline 1 & 6 & -2 & 0 & -2 \\ 2 & -2 & 4 & -2 & 0 \\ 3 & 0 & -2 & 6 & -2 \\ 4 & -2 & 0 & -2 & 8 \end{array} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} = \begin{bmatrix} -10 \\ 6 \\ 2 \\ 2 \end{bmatrix}$$

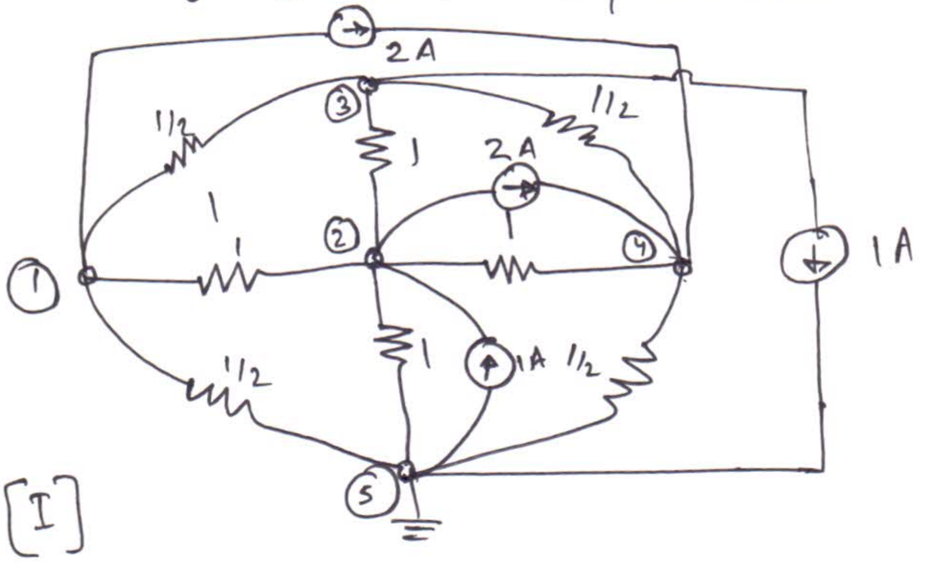
Now we can solve for

$$v_1 = \frac{\Delta_1}{\Delta}, \quad v_2 = \frac{\Delta_2}{\Delta}, \quad v_3 = \frac{\Delta_3}{\Delta}, \quad v_4 = \frac{\Delta_4}{\Delta}.$$

... node – d is selected as datum node. For the specified elements and source values determine values for the four node-to-datum voltages.



Convert All sources into equivalent current sources



$B = Y$

↓

$$[B][V] = [I]$$

$$\begin{bmatrix} B_{11} & B_{12} & B_{13} & B_{14} \\ B_{21} & B_{22} & B_{23} & B_{24} \\ B_{31} & B_{32} & B_{33} & B_{34} \\ B_{41} & B_{42} & B_{43} & B_{44} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix}$$

$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 3 & -1 & -2 & 0 \\ -1 & 4 & -1 & -2 \\ -2 & -1 & 5 & -2 \\ 0 & -1 & -2 & 5 \end{bmatrix} \end{array} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} -2 \\ -1 \\ -1 \\ 4 \end{bmatrix} \begin{array}{l} \\ \text{--- } (1-2) \\ \\ \\ \end{array}$$