Corrected

EE200 2018

Assignment 3

1 We now introduce a new concept, a *dependent source.* It can be a current source or a voltage source, which one it is is easily understood from its notation in the schematic. In the circuit it acts as a source, but its value depends on the value of some variable elsewhere in the circuit - either a current or a voltage. The dependence is given in the form of a function, and we confine ourselves to linear functions. A dependent source is to be treated just as any other source when you first write out KCL or KVL equations in a circuit. But after writing the equation, we use its dependency expression to replace the term containing the source with a term that contains the controlling variable. Write the KVL equations for the three meshes 1, 2, 3 in the circuit shown in Fig.1, when $V_2 = -3I + V\underline{/90^\circ}$.

2 For the circuit in Fig.2, write the two KCL equations at nodes 1, 2 when $I_2 = -5V + I\underline{/30^\circ}$.

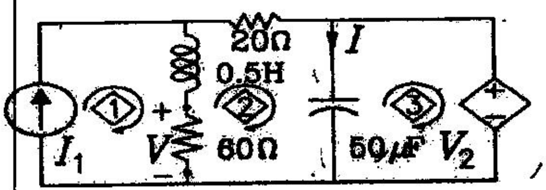


Fig.1

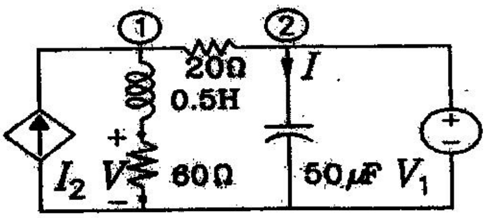


Fig.2

3 For the circuit in Fig.3, write the KVL equations for the three meshes 1, 2, 3. $M = 0.1\,\mathrm{H}$.

4 Examine the two network graphs shown in Fig.4, and follow the given vertex and edge labeling given.

(*a*) Write the full node incidence matrix $\mathbf{A}_a$.

(*b*) Sketch two different trees for each graph. The branches in the graph other than the tree branches are also called nontree branches or *link* branches.

(*c*) For each graph given, choose a particular tree. Number the tree branches as $1, 2, n_t - 1$. Remove one tree branch at a time (erase it). When this is done, each time, the tree falls apart into two separate parts. List, for each such case, the set of all branches in the original graph that connect any node in one part to a node in the other. This set will always contain exactly one tree branch (the one you removed): the rest are link branches. Together, they are called the *cut set* associated with the removed tree branch.

(*d*) What is the number of cut sets associated with a given graph? Is there an formula for the number of link branches too, in terms of the number of vertices n_t and total number of branches b?

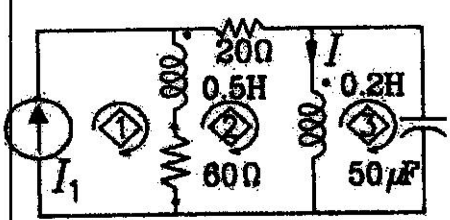


Fig.3

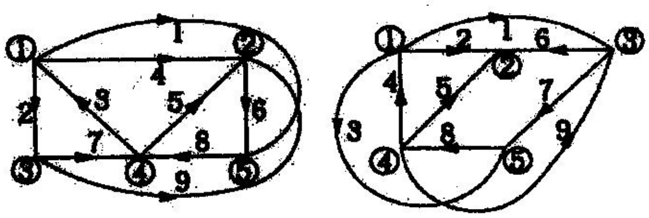


Fig.4

Q1

Mesh ① : I_1 is given

Mesh ② : $(I_1 - I_2)(60 + j\omega L) + I_2(20) + (I_2 - I_3)\frac{1}{j\omega C} = 0$

$$(60 + j\omega L) I_1 + \left(-40 + \frac{1}{j\omega C} - j\omega L\right) I_2 - \frac{1}{j\omega C} I_3 = 0$$

$$\Rightarrow \left(40 + j\omega L - \frac{1}{j\omega C}\right) I_2 + \frac{1}{j\omega C} I_3 = (60 + j\omega L) I_1$$

Mesh ③ :

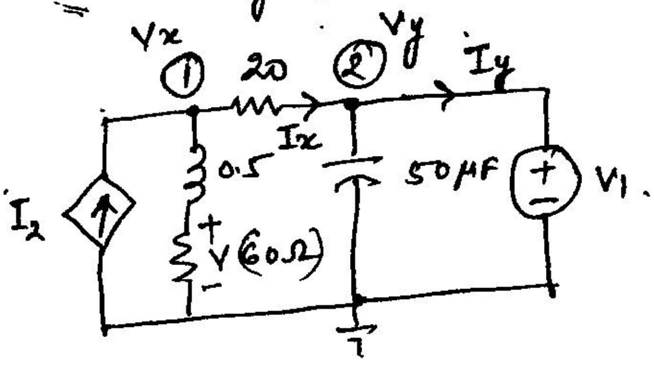
$$+(I_3 - I_2)\frac{1}{j\omega C} + V_2 = 0$$

$$\Rightarrow (I_3 - I_2)\frac{1}{j\omega C} - 3I + V\angle 90^\circ = 0$$

$$\Rightarrow (I_3 - I_2)\frac{1}{j\omega C} - 3(I_2 - I_3) + ((I_1 - I_2)60)\angle 90^\circ = 0$$

$$\Rightarrow \left(-\frac{1}{j\omega C} - 3 - 60\angle 90^\circ\right) I_2 + \left(\frac{1}{j\omega C} + 3\right) I_3 = -(60\angle 90^\circ) I_1$$

Q2.



Node 1 : Applying KCL

$$-I_2 + \frac{V_x}{(j\omega L + 60)} + \frac{V_x - V_y}{20} = 0 \quad \text{—— ①}$$

$$V_x\left(\frac{1}{20} + \frac{1}{j\omega L + 60}\right) - \frac{V_y}{20} = I_2.$$

Node 2 :- $\frac{V_y - V_x}{20} + \frac{V_y}{1/j\omega C} + I_y = 0.$ —— ②

where $I_y = I_x + \frac{V_y}{1/j\omega C} = \frac{V_x - V_y}{20} + (j\omega C)V_y$

$$\boxed{V_y = V_1}$$

$\therefore \quad I_2 = -5V + I\angle 30^\circ$

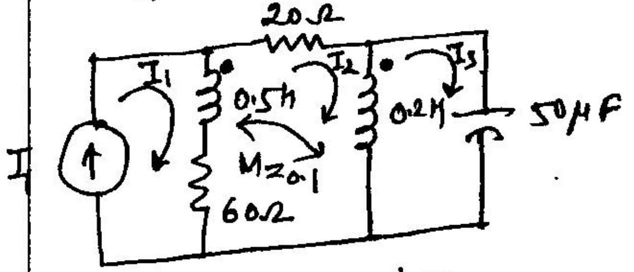
where $V = \dfrac{V_x}{(60+j\omega L)} \times 60$

$I = \dfrac{V_y}{1/j\omega C}$

substituting in eq. ①, we get

$$V_x\left(\frac{1}{20}+\frac{1}{60+j\omega L}\right) - \frac{V_y}{20} = -5\left(\frac{60V_x}{60+j\omega L}\right) + V_y(j\omega C)\angle 30^\circ$$

Q3.



Mesh 1 :- I_1 is given

Mesh 2 :- ~~$20I_2$~~

$$0 = (I_2-I_1)(60+j\omega 0.5) + 20I_2 - (I_2-I_3)j\omega(0.1) + (I_2-I_3)j\omega(0.2) + (I_1-I_2)j\omega 0.1 \quad \text{——①}$$

$$I_2(60+j0.5\omega + 20 - j0.1\omega + j\omega 0.2 - j0.1\omega) + I_3(\cancel{0+j\omega}\ j0.1\omega - j0.2\omega) = I_1(60+j0.5\omega - j0.1\omega)$$

$$\Rightarrow (80+j0.5\omega)I_2 - (j0.1\omega)I_3 = I_1(60+j0.4\omega)$$

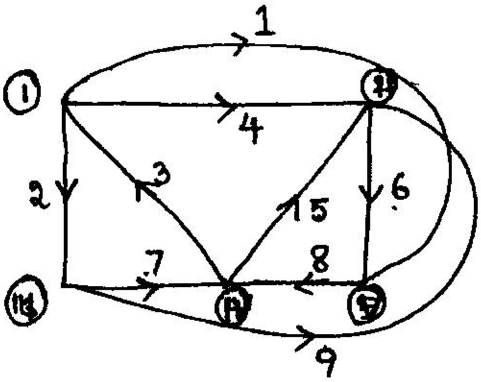
Mesh 3 :- $0 = (I_3-I_2)j\omega(0.2) + (I_2-I_1)j\omega(0.1) + \dfrac{1}{j\omega(50\times 10^{-6})}I_3$

$$\Rightarrow (-j0.1\omega)I_2 + I_3\left(j0.2\omega + \frac{1}{j\omega\times 50\times 10^{-6}}\right) = j\omega(0.1)I_1 \quad \text{——②}$$

Assignment-3.

(4A) (a) Incidence matrix A_a.

fig. 1



Let I, II, III, IV, V be given nodes for a given graph and 1, 2, 3 . . . 9 are the branches.

In a incidence matrix, if a branch current is going away from a node then its element is $\boxed{1}$.

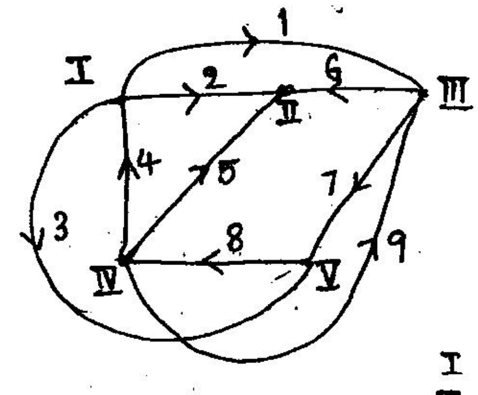
if branch current is coming towards a node then it is $\boxed{-1}$

& if it is not connected then it is zero..

Accordingly for fig 1, incidence matrix will become

$$A_a = \text{nodes} \begin{array}{c} \\ \text{I} \\ \text{II} \\ \text{III} \\ \text{IV} \\ \text{V} \end{array} \begin{array}{c} \begin{array}{ccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \end{array} \rightarrow \text{branches} \\ \begin{bmatrix} 1 & 1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & -1 & 1 & 0 & 0 & -1 \\ 0 & -1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & -1 & -1 & 0 \\ -1 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 \end{bmatrix}_{5\times 9} \end{array}$$

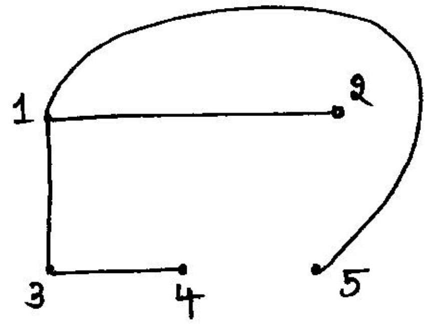
fig 2:

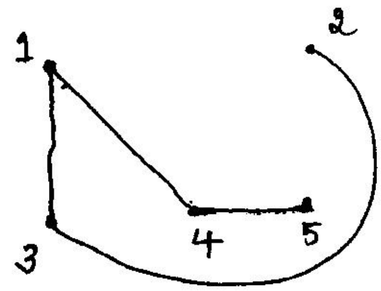


$$A_a = \begin{array}{c} \\ \text{I} \\ \text{II} \\ \text{III} \\ \text{IV} \\ \text{V} \end{array} \begin{array}{c} \begin{array}{ccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \end{array} \rightarrow \text{branches} \\ \begin{bmatrix} 1 & 1 & 1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & -1 & -1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & -1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & -1 & 1 \\ 0 & 0 & -1 & 0 & 0 & 0 & -1 & 1 & 0 \end{bmatrix} \end{array}$$

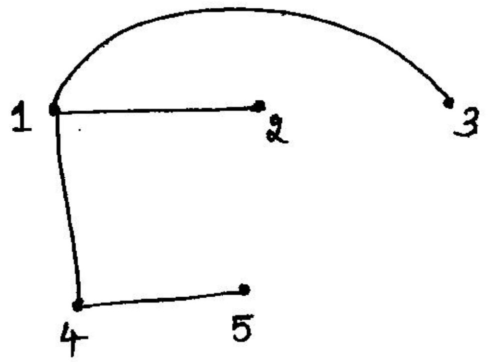
(b). Tree is a connected subgraph, which connects all the nodes without any closed loop.

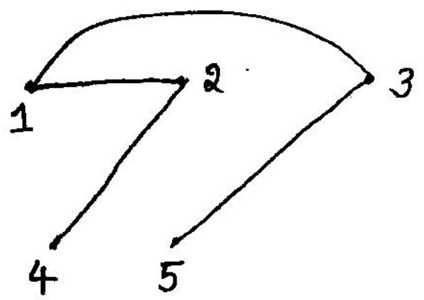
For fig 1, two possible Trees are





for fig 2, two possible trees are

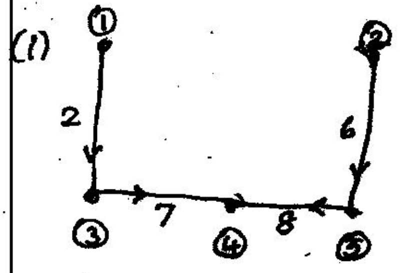




4 (c)

Cut Set Tables

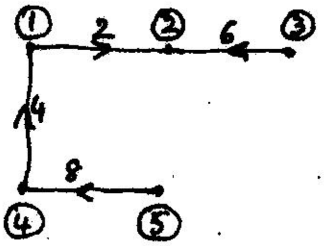
(i)



Chosen Tree.

TREE BRANCH	CUTSET
2	1234
6	4569
7	14379
8	14589

(ii)



Chosen Tree

TREE BRANCH	CUT SET
2	12579
4	34579
6	1679
8	378

?

(d) What is the no. of cut sets associated with a given graph?

Cut-set corresponding to a given tree are equal to number of branches of tree.

Formula for number of link branches in terms of vertices n_t and total no. of branches b?

Given a graph;

Total No. of branches $= b$.

Total No. of Twigs of associated tree $= n_t - 1$.

$$\boxed{\text{Total No. of Links of associated co-tree} = b - (n_t - 1)}$$

$n_t \rightarrow$ No. of Nodes.