Paper 1, TDC Part-1
Chapter– 3, Mesh and Node Analysis
Nodal Analysis -3

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Mesh and Nodal Analysis in Passive Circuits

In this lecture we will discuss problem based on dependent source.

As we already know that there are 4 types of dependent source and these are :-

Voltage dependent voltage source

Current dependent voltage source

Current dependent current source

Voltage dependent current source

Now let us look how to analyze circuit with dependent source through problem.

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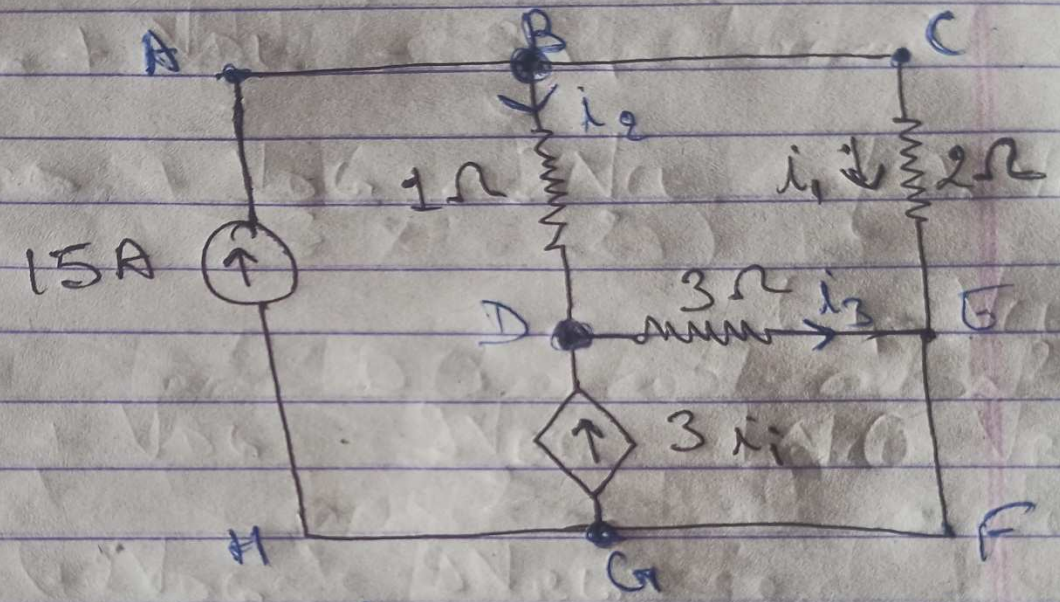
Q1) Determine the power supplied by dependent source in the circuit shown in figure below.



Soln: In the given problem circuit we find that there is one dependent source and this is a current source whose values depends on the current flowing through the resistor 2Ω.

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Now let use solve the problem through nodal analysis method.

First we identify the nodes for which we will suppose the voltage. In this circuit there are 3 nodes with more than 2 circuit elements ~~at~~ ends are connected. These nodes are B, D, & G

So $n = 3$ and hence no. of eqn. will be required $n - 1 = 2$.

But there are 3 unknowns so we require 3 equations to solve.

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Let the voltage at node B is V_B & D is V_D and since G is grounded so $V_G = 0$ V. We will consider G as reference node.

Also let the currents flowing through branch BD & DE are i_2 & i_3 respectively as shown in the problem figure

Now applying KCL at node B we can write,

$$15\text{ A} - i_2 - i_1 = 0$$

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or $i_1 + i_2 = 15\ A$

or $\frac{V_{CE}}{2} + \frac{V_{BD}}{1\Omega} = 15\ A$

$\frac{V_{BG}}{2} + \frac{V_{BD}}{1} = 15$ [As, $V_B = V_C$ & $V_G = V_E$]

$V_{BG} + 2V_{BD} = 30$ ——— (i)

Now applying KCL at node D we have

$i_2 + 3i_1 - i_3 = 0$ [$3i_1$ is current due to current dependent current source]

or $-\frac{V_{BD}}{1} + \frac{V_{DE}}{3} = 3i_1$

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or $\quad \dfrac{-V_B}{1} + \dfrac{V_{DG}}{3} = \dfrac{3V_{CE}}{2}$ $\quad$ [As $V_E = V_G$ & $i_1 = \dfrac{V_{CE}}{2}$]

As $\quad -3V_{BD} + V_{DG} = \dfrac{9V_{BG}}{2}$ $\quad$ [$V_{CE} = V_{BG}$]

or $\quad -6V_{BD} + 2V_{DG} = 9V_{BG}$

$\quad -6V_B + 6V_D + 2V_D = 9V_B$

or $\quad \cancel{-6V_B + 18V_D + 2V_D - 2V_G = 9V_B - 9V_G}$

or

or $\quad 8V_D = 15V_B$ $\quad$ [$\because V_G = 0$]

$\cancel{V_D = \dfrac{25}{20} V_B}$ $\quad V_D = \dfrac{15}{8} V_B$

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Now eqn. (1), can be written as

$$V_B - V_G + 2V_B - 2V_D = 30$$

putting value of $V_D = \frac{15}{8} V_B$ & $V_G = 0$

$$3V_B - \frac{2 \times 27}{10} V_B = 30$$

$$\Rightarrow 30 V_B - 27 V_B = 300$$

$$3V_B - 2V_D = 30$$

$$3V_B - \frac{2 \times 15}{8} V_B = 30 \qquad \left[V_D = \frac{15}{8} V_B \right.$$

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or, $\frac{24 - 30V_B}{8} = 30$

or, $V_B = -\frac{\cancel{30}^{5} \times 8}{\cancel{6}} = -40V$

So,

$$V_D = \frac{15}{\cancel{8}} \times \cancel{-40}^{-5} V = -75V$$

As per question we have to find the power supplied by the dependent source i.e.

Power due to $3i$ is product of ~~current~~ current supplied by dependent source and voltage across it.

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Current supplied $= 3i_1 = 3 \times \frac{V_B}{2}$ $\left[i_1 = \frac{V_B}{2}\right]$

$= \frac{3 \times \cancel{-40}}{\cancel{2}} -20$ $\left[V_B = -40\right]$

$= -60\,A$

Voltage across the dependent source is

$V_{DG} = V_D - V_G$

$= -75 - 0\,V$

$= -75\,V$

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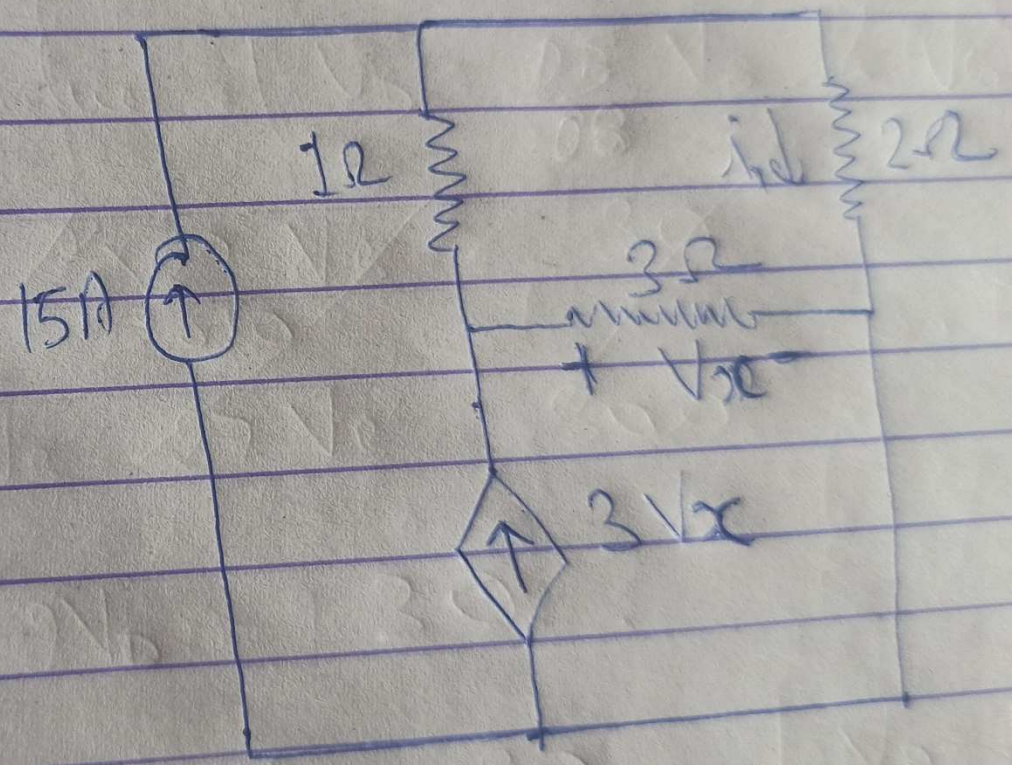
So power supplied by the dependent source is,

$$P = (-75 \times -60)\ W$$

$$= 4500 = 4.5\ kW$$

We see that the presence of ~~of~~ a dependent source will create the need for an additional equation in our analysis if the controlling quantity is not a nodal voltage.

Assignment (b) Find the power supplied by the dependent source of the circuit shown in below figure



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For any query contact- 9771474020

Thank You