Solution

EE101 Winter 2019 Quiz #3

January 29, 2019

Name_____ Student ID_____

This Problem consists of two parts, Part A and Part B in solving for I_x.

*3.20 For the circuit in Fig. P3.20, determine the current I_x.

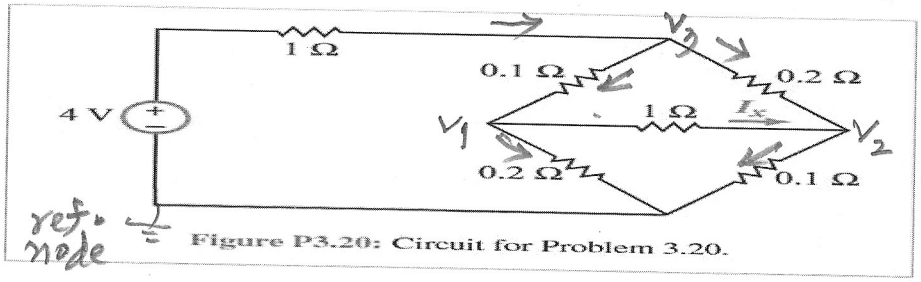

Figure P3.20: Circuit for Problem 3.20.

Part A (4 points) Let us solve for I_x as $I_x = \frac{V_1 - V_2}{1\,\Omega}$, where the two voltages are node voltages at both ends of the 1 Ω resistor through which I_x flows. Write down two KCL equations to solve for V_1, V_2.

KCL node 3 : $\frac{4-V_3}{1} = \frac{V_3-V_1}{0.1} + \frac{V_3-V_2}{0.2}$

$\Rightarrow 4 - V_3 = 10V_3 - 10V_1 + 5V_3 - 5V_2$

$4 = -10V_1 - 5V_2 + 16V_3$ (1)

node 1 : $\frac{V_3-V_1}{0.1} = \frac{V_1-V_2}{1} + \frac{V_1}{0.2}$

$10V_3 - 10V_1 = V_1 - V_2 + 5V_1$

$\Rightarrow 16V_1 - V_2 - 10V_3 = 0$ (2)

node 3 : $\frac{V_1-V_2}{1} + \frac{V_3-V_2}{0.2} = \frac{V_2}{0.1}$

$V_1 - V_2 + 5V_3 - 5V_2 - 10V_2 = 0$

$V_1 - 16V_2 + 5V_3 = 0$ (3)

(continued)

Part B (6 points) Solve for V_1, V_2 and then I_x.

We want to remove V_3 first

From (2) & (3),

$(2) + 2\times(3) \Rightarrow$

$$\begin{array}{r} 16V_1 - V_2 - 10V_3 = 0 \\ 2V_1 - 32V_2 + 10V_3 = 0 \\ \hline 18V_1 - 33V_2 = 0 \end{array} \quad (4)$$

From (1) & (3),

$(1)\times 5 - (3)\times 16 \Rightarrow$

$$\begin{array}{r} 20 = -50V_1 - 25V_2 + 80V_3 \\ -)\ 0 = 16V_1 - 256V_2 + 80V_3 \\ \hline 20 = -66V_1 + 231V_2 \end{array} \quad (5)$$

From (4) & (5)

$(4)\times 11 + (5)\times 3$

$$\begin{array}{r} 18\times 11 V_1 - 33\times 11 V_2 = 0 \\ -66\times 3 V_1 + 231\times 3 V_2 = 60 \\ \hline (693 - 363)V_2 = 60 \end{array}$$

$$V_2 = \frac{60}{330} = \frac{2}{11}\,[V]$$

$V_2 \rightarrow (4)$

$$18V_1 - 33\frac{6}{33} = 0$$

$$18V_1 = 6 \qquad V_1 = \frac{6}{18} = \frac{1}{3}\,[V]$$

$$V_1 - V_2 = \frac{1}{3} - \frac{2}{11} = \frac{11-6}{33} = \frac{5}{33}\,[V]$$

$$I_x = \frac{V_1 - V_2}{1\,\Omega} = \frac{5}{33}\,[A]$$

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