Jan 21, 2019 Name or ID: Possible Solutions

NOTE: for all quizzes, only one solution method is shown. There are other valid ways to find the answers.

ENEL 343 Quiz 1 – Review of Electric Circuits

50 minutes, non-programmable calculator, closed book

True / False section (10% of the quiz mark) Marking: +2 if correct, – 1 if incorrect, zero if blank.

1. F____ GFCI is an acronym for Ground Fault Current Interrupter.

Actually: Ground Fault Circuit Interrupter

2. T____ An exception to the principle of current flow in a circuit is the Van de Graaff generator.

3. F____ The most fundamental electric charge is that of an electron or a proton.

Quarks have fractions of proton charge (+ or – 1/3 or 2/3)

4. F____ For a device or circuit element, the power equation, P =vi, is not valid at an instant of time, but can only be evaluated as an average over a given period of time.

Usually P= vi is true even at an instant since energy flows in electric circuits between roughly 1/3 and 90% of the speed of light. Even so, P= vi is often calculated as an average, for example integrate vi for one cycle of 60Hz, or even one year, and divide by the time interval to obtain the average power.

5. T____ An incandescent light bulb with a light output of 500 lumen has an electrical to visible-light energy efficiency on the order of 2%, while a modern 500 lumen LED light has an efficiency of about 13%.

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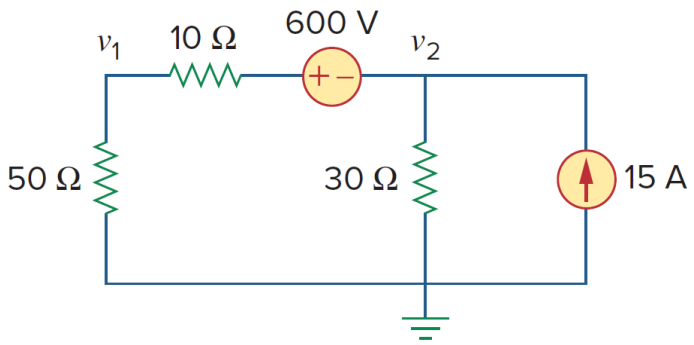
1. For the following circuit, use Nodal analysis to find v_2. Also determine v_1. Find the power in each of the five circuit elements, indicating if the power is being supplied by the element or absorbed, and the reason why.



From assignment Problem 3.13:

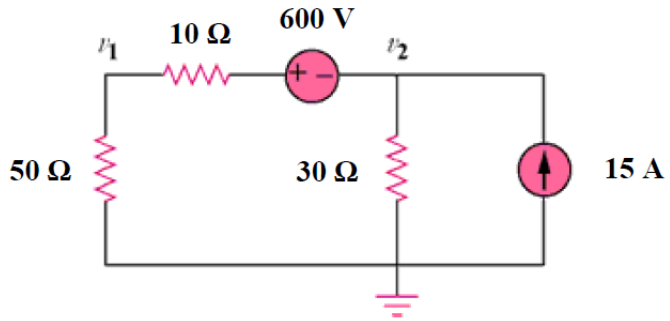


Figure 3.62
For Prob. 3.13.

Solution

Step 1. We note that the 10 ohm resistor is in series with the 50 ohm resistor which can be replaced by a 60 ohm resistor. The then gives us a circuit with one unknown node and we can write one nodal equation to let us solve for v_2.

Once we have v_2 we can use voltage division to solve for v_1.

$$\frac{(v_2+600)-0}{60}+\frac{v_2-0}{30}-15=0 \text{ and } v_2=[(v_1+600)-0](50/60).$$

Step 2. $[(1/60)+(1/30)]v_2 = -(600/60)+15 = 5 = 0.05v_2$ or $v_2 =$ **100 V**.

Now $v_1 = 700(50/60) =$ **583.3 V**.

To find power, first get the currents:
I_{30} = 100V/30Ω = 3.3A
So by KCL I_{10} to the left is 15A - 3.3A = 11.7A

Then use I^2R for power in resistors (all resistors dissipate power since a resistor converts electricity to heat).

For sources, use P = V I. For both sources in this particular circuit, current leaves the positive terminal so each source supplies power in this circuit.
Note: In other circuits, if current enters the positive terminal of a source, then the source is receiving power (for example: when charging a car battery, the battery absorbs power, storing electrochemical energy).

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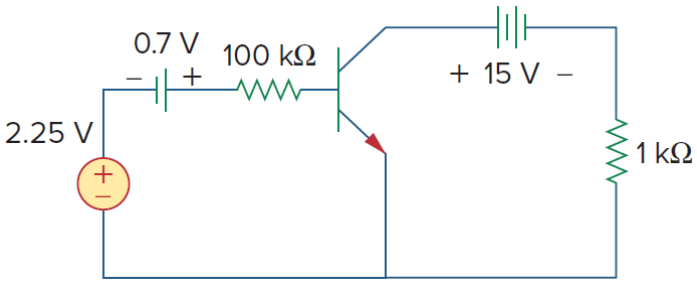
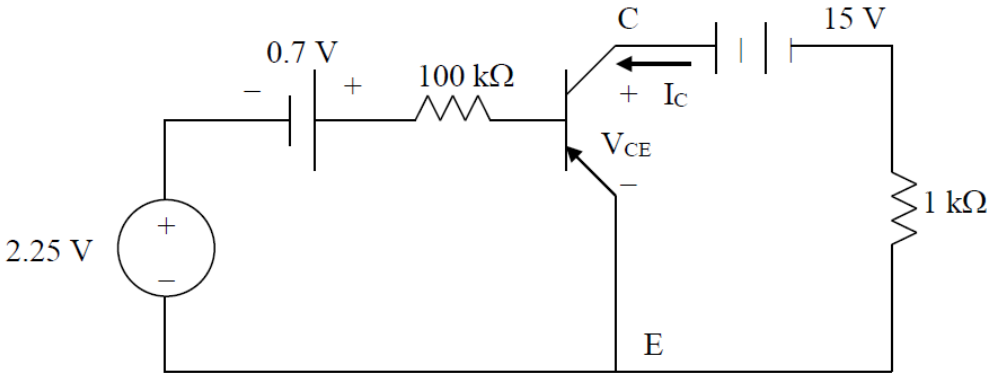
2. For the transistor circuit shown here, find I_B and V_{CE}. Let $\beta = 100$, and $V_{BE} = 0.7$ V.



From assignment Problem 3.89:



For the left loop, applying KVL gives

$$-2.25 - 0.7 + 10^5 I_B + V_{BE} = 0 \text{ but } V_{BE} = 0.7 \text{ V means } 10^5 I_B = 2.25 \text{ or}$$

$$I_B = \mathbf{22.5\ \mu A}.$$

For the right loop, $-V_{CE} + 15 - I_C x 10^3 = 0$. Addition ally, $I_C = \beta I_B = 100x22.5x10^{-6} =$ 2.25 mA. Therefore,

$$V_{CE} = 15 - 2.25x10^{-3}x10^3 = \mathbf{12.75\ V}.$$

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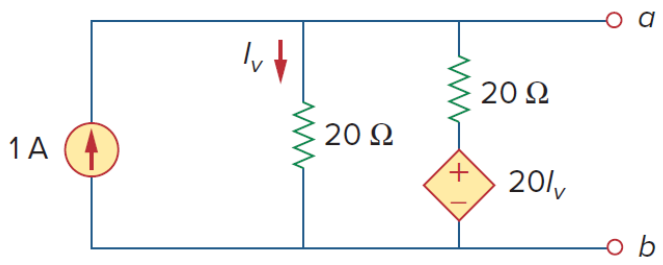
3. In the circuit below, determine the Thevenin and Norton equivalent circuits. Show your work and draw the circuits. If a resistance of 30Ω is connected across the ab terminals in the original circuit, what is voltage V_{ab}?



From assignment Problem 4.47:

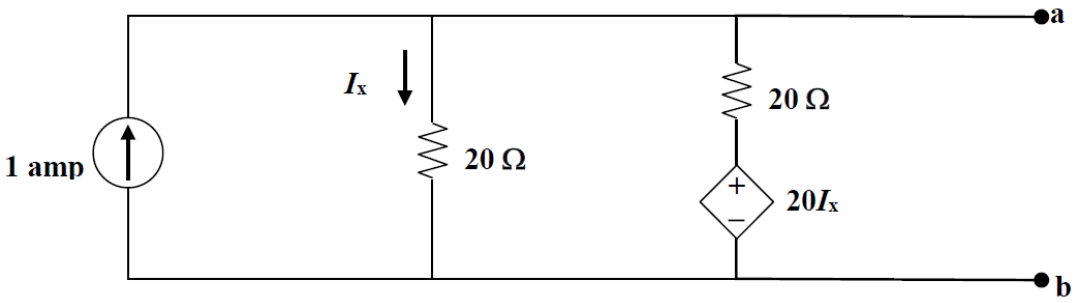


Figure 4.114
For Prob. 4.47.

Solution

Step 1. We note that there is a dependent source which means to best way to identify the equivalent circuits is to find $V_{oc} = V_{Thev}$ and $I_{sc} = I_N$ and $R_{eq} = V_{oc}/I_{sc}$.

$-1 + [(V_{oc}-0)/20] + [(V_{oc}-20I_x)/20] = 0$ and $I_x = V_{oc}/20$.

Solving these equations, gives $V_{OC} = 20V$. Thus $V_{Th} = 20V$.

Step 2: Find I_N, by shorting terminal a to terminal b and find I_{SC}. It can be reasoned that all of the 1Amp will flow through the short, so $I_{SC} = 1$ A. Alternatively: with the short, the voltage across the first 20 Ohm resistor is zero, so Ix = 0, so 20Ix = 0, so the voltage across the second 20 Ohm is zero which thus has zero current. Again all of the 1 Amp flows through the short, so $I_{SC} = 1$ A. Thus, $I_N = 1$ A

Step 3: $R_{Th} = R_N = V_{Th} / I_N = 20V / 1A = 20\Omega$.

For the question of Vab when a 30Ω load is across terminals a and b: use the Thevenin equivalent circuit, so we have a voltage divider of 20Ω and 30Ω series resistors, so Vab = 20V x 30 Ω / [20Ω + 30Ω] = 12V.