EECE 210 Quiz 1, Fall 2010/2011

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1. An electric field ξ is applied in a region containing both positive and negative charges. A current I_N flows due to the negative charges, and a current I_P flows due to the positive charges. Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 1 is considered incorrect).

   A. I_N and I_P are in the same direction as ξ.

   B. I_N and I_P are in the opposite direction to ξ.

   C. I_P is in the direction of ξ and I_N is in the opposite direction.

   D. I_N is in the direction of ξ and I_P is in the opposite direction.

   E. The total current is zero.

   Solution: The positive charges will flow in the direction of ξ and the negative charges will flow in the opposite direction. The currents of both types of charge will be in the direction of ξ.

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2. Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 2 is considered incorrect).

   A. An ideal capacitor **always** absorbs power.

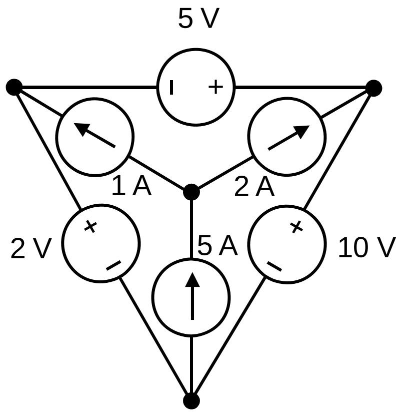
   B. An ideal inductor **always** delivers power.

   C. An ideal passive resistor **always** absorbs power.

   D. An ideal, dependent voltage source **always** delivers power.

   E. An ideal, dependent current source **always** absorbs power.

Solution: Ideal capacitors, inductors and sources can absorb or deliver power. An ideal passive resistor always absorbs and dissipates power.



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3. Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 3 is considered incorrect).

   A. The connection of current sources is valid, but the connection of voltage sources is invalid.

   B. The connection of current sources is invalid, but the connection of voltage sources is valid.

   C. The connections of current sources and of voltage sources are valid.

   D. The connections of current sources and of voltage sources are invalid.

E. the circuit cannot be made valid by changing the values of the sources.

Solution: The connection of current sources is invalid because it violates conservation of charge at the node in the middle. The connection of voltage of sources is invalid because it violates conservation of energy around the outer loop.

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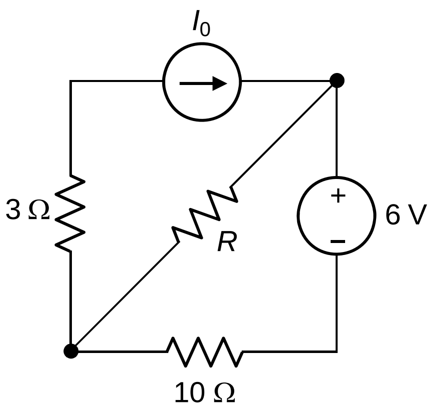
4. In the circuit shown, I_0 = 1 A and the 6 V source does not absorb or deliver any power. Determine the power absorbed or delivered by the source I_0. Note that the value of *R* need not be known.



   A. 9 W absorbed
   B. 9 W delivered
   C. 24 W absorbed
   D. 24 W delivered
   E. No power absorbed or delivered.

Solution: Since the 6 V source does not absorb or deliver any power, it follows that the current through the 6 V source and the 10 Ω resistor is zero, which means that the voltage across *R* is 6 V, and the current through *R* and the 3 Ω resistor is I_0. It follows that the power dissipated in the resistors is $6I_0 + 3I_0^2$, which is also the power delivered by the source.

Version 1: I_0 = 1 A, *P* = 6 + 3 = 9 W.

Version 2: I_0 = 2 A, *P* = 12 + 12 = 24 W.

Version 3: I_0 = 3 A, *P* = 18 + 27 = 45 W.

Version 4: I_0 = 4 A, *P* = 24 + 48 = 72 W.

Version 5: I_0 = 5 A, *P* = 30 + 75 = 105 W.

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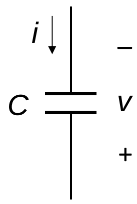
5. For the assigned positive directions shown, the voltage-current relationship for an ideal capacitor is:



   A. $i = Cdv/dt$
   B. $i = -Cdv/dt$
   C. $v = Cdi/dt$
   D. $v = -Cdi/dt$
   E. $v = -(1/C)di/dt$.

Solution: The assigned positive direction of current is that of a voltage rise across the capacitor. According to the passive sign convention, the *i-v* relation is written with a negative sign.

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6. An ideal, parallel-plate capacitor of 10 μF is charged to V_C = 1 V. if the distance between the parallel plates is doubled, what will be the voltage across the capacitor?
   A. 3 V
   B. 6 V
   C. 2 V
   D. 4 V
   E. 5 V.

Solution: The charge on the capacitor is $10 \times V_C = 10V_C$ C. If the distance between the plates is doubled, the charge remains the same, but the capacitance is halved to 5 μF. The new voltage is $10V_C/5 = 2V_C$ V.

Version 1: V_C = 1 V, voltage = 2 V.

Version 2: V_C = 1.5 V, voltage = 3 V.

Version 3: V_C = 2 V, voltage = 4 V.

Version 4: V_C = 2.5 V, voltage = 5 V.

Version 5: V_C = 3 V, voltage = 6 V.

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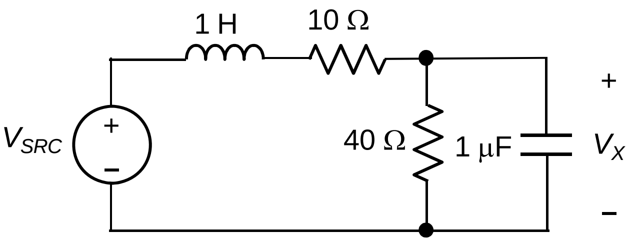
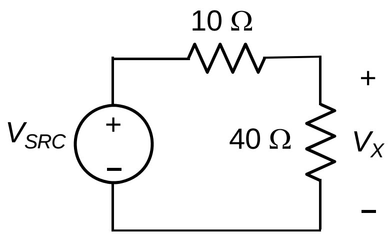
7. If all voltages and currents are dc, determine V_X assuming V_{SRC} = 2 V.
   A. 1.6 V
   B. 2.4 V
   C. 3.2 V
   D. -1.6 V
   E. -2.4 V.





Solution: Under dc conditions, the inductor behaves as a short circuit and the capacitor as an open circuit. The circuit reduces to that shown. From voltage division, $V_X = \frac{40}{10+40} V_{SRC} = 0.8 V_{SRC}$ V.

Version 1: V_{SRC} = 2 V, V_X = 1.6 V.

Version 2: V_{SRC} = 2.5 V, V_X = 2 V.

Version 3: V_{SRC} = 3 V, V_X = 2.4 V.

Version 4: V_{SRC} = 3.5 V, V_X = 2.8 V.

Version 5: V_{SRC} = 4 V, V_X = 3.2 V.

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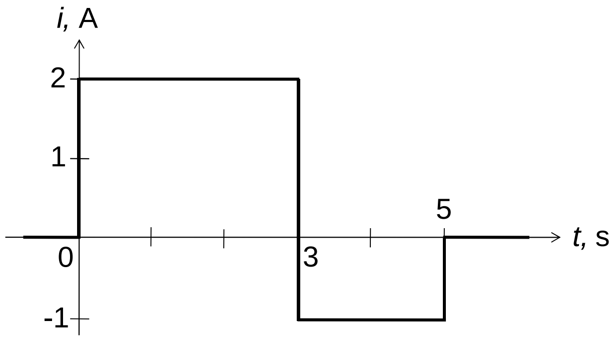
8. The current through a 2 μF capacitor is shown as a function of time. Determine the charge on the capacitor at t = 3.4 s.



A. 5.6 C
B. 5.2 C
C. 4.8 C
D. 4.4 C
E. 4 C.

Solution: The charge at $t > 3$ s is the net area under the curve, which gives $q = 2\times3 - 1\times(t - 3) = (9 - t)$ C.

Version 1: t = 3.4 s, q = 5.6 C.

Version 2: t = 3.8 s, q = 5.2 C.

Version 3: t = 4.2 s, q = 4.8 C.

Version 4: t = 4.6 s, q = 4.4 C.

Version 5: t = 5 s, q = 4 C.

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9. If the current in Problem 8 is applied to a resistor R = 5 Ω, determine the average power dissipated in the resistor over the interval from t = 0 to t = 5 s.

A. 50 W
B. 14 W
C. 70 W
D. 24 W
E. 12.5 W.

Solution: The power dissipated from t = 0 to t = 3 s is $(2)^2\times R = 4R$; the power dissipated from t = 3 s to t = 5 s is $(-1)^2\times R = R$; the average power dissipated is $P = (4R\times3 + R\times2)/5 = 2.8R$ W

Version 1: R = 5 Ω, P = 14 W.

Version 2: R = 10 Ω, P = 28 W.

Version 3: R = 15 Ω, P = 42 W.

Version 4: R = 20 Ω, P = 56 W.

Version 5: R = 25 Ω, P = 70 W.

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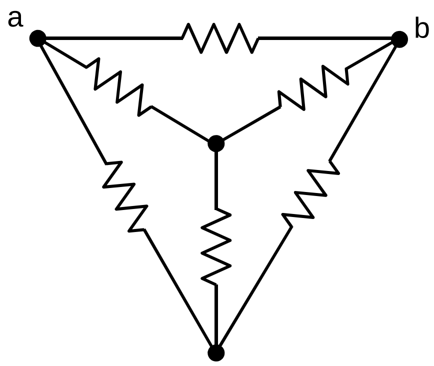
10. Determine the resistance between nodes a and b if each of the resistances connected in Y is R and each of the resistances connected in the outer Δ is $3R$, with $R = 1\ \Omega$.



A. 15 Ω

B. 20 Ω

C. 15 Ω

D. 1 Ω

E. 10 Ω.

Solution: If the Δ is transformed to Y, each of the resistances in Y is R Ω, and the two Y connections are in parallel. For each Y, the resistance between nodes a and b is $2R$ Ω, and these in parallel give R Ω.

Alternatively, if the Y is transformed to Δ, the resistances connected in Δ are $3R$ Ω. The two Δ connections in parallel will give a Δ connection of $1.5R$ Ω resistors. The resistance between nodes a and b will be $1.5R$ Ω in parallel with $3R$ Ω, which again gives R Ω.

Version 1: $R = 1\ \Omega$, $R_{ab} = 1\ \Omega$.

Version 2: $R = 5\ \Omega$, $R_{ab} = 5\ \Omega$.

Version 3: $R = 10\ \Omega$, $R_{ab} = 10\ \Omega$.

Version 4: $R = 15\ \Omega$, $R_{ab} = 15\ \Omega$.

Version 5: $R = 20\ \Omega$, $R_{ab} = 20\ \Omega$.

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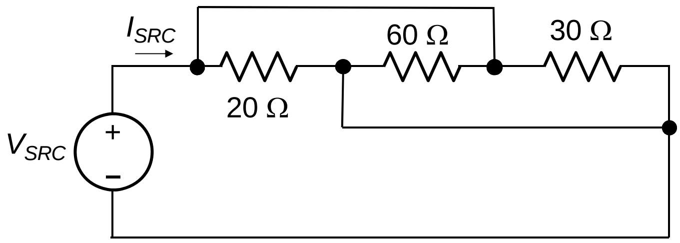
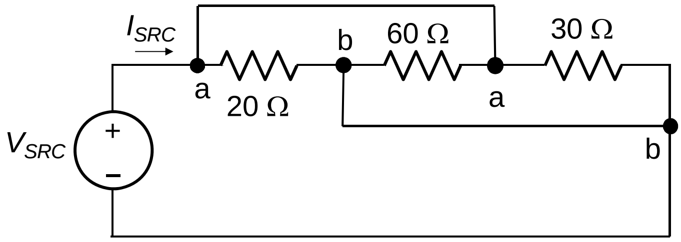
11. Determine I_{SRC} if V_{SRC} = 10 V.



Solution: If the nodes are labeled, it is seen that the three resistances are effectively connected between two nodes, which means that they are in parallel; 30 Ω in parallel with 60 Ω is (30)(60)/90 = 20 Ω, and 20 Ω in parallel with 20 Ω is 10 Ω. Hence, $I_{SRC} = V_{SRC}/10 = 0.1V_{SRC}$ V.



Version 1: V_{SRC} = 10 V, I_{SRC} = 1 A.

Version 2: V_{SRC} = 15 V, I_{SRC} = 1.5 A.

Version 3: V_{SRC} = 20 V, I_{SRC} = 2 A.

Version 4: V_{SRC} = 25 V, I_{SRC} = 2.5 A.

Version 5: V_{SRC} = 30 V, I_{SRC} = 3 A.

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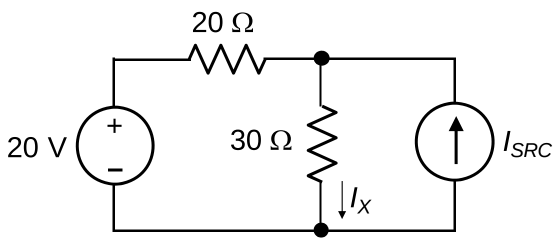
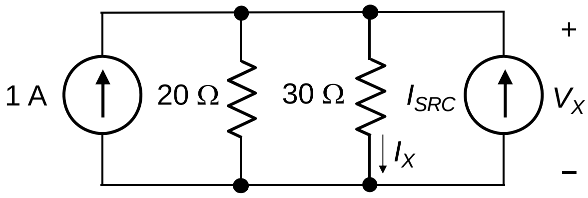
12. Determine I_X <u>**using source transformation**</u>, and assuming I_{SRC} = 1 A.



Solution: The 20 V source in series with 20 Ω is transformed to a current source of (20 V)/(20 Ω) = 1A in parallel with 20 Ω. Applying KCL:

$I_{SRC} + 1 = \dfrac{V_X}{20} + \dfrac{V_X}{30} = \dfrac{V_X}{12}$. It follows that $V_X = 12(I_{SRC} + 1)$, and $I_X = \dfrac{V_X}{30} = 0.4(I_{SRC} + 1)$.



Alternatively, the two current sources can be combined into a single current source (I_{SRC} + 1) A. From current division, $I_X = \dfrac{20}{20+30}(I_{SRC}+1) = 0.4(I_{SRC}+1)$.

Version 1: I_{SRC} = 1 A, I_X = 0.8 A.

Version 2: I_{SRC} = 1.5 A, I_X = 1 A.

Version 3: I_{SRC} = 2 A, I_X = 1.2 A.

Version 4: I_{SRC} = 2.5 A, I_X = 1.4 A.

Version 5: I_{SRC} = 3 A, I_X = 1.6 A.

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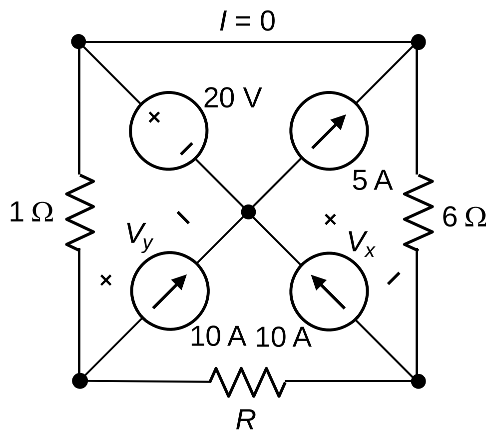
13. In the circuit shown, the current in the top connection is zero. Determine:

10% (a) R

10% (b) V_x

10% (c) V_y.



Solution:

(a) From KCL at node b, I_{be} = 5 A.

From KCL at node e, I_{de} = 5 A.

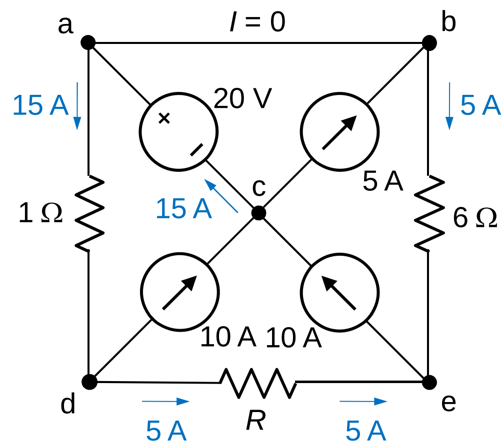
From KCL at node c, I_{ca} = 15 A.

From KCL at node a, I_{ad} = 15 A.

As a check, KCL at node d is satisfied.

From ohm's law, V_{be} = 30 V, V_{ad} = 15 V, and the voltage across R is 5R.

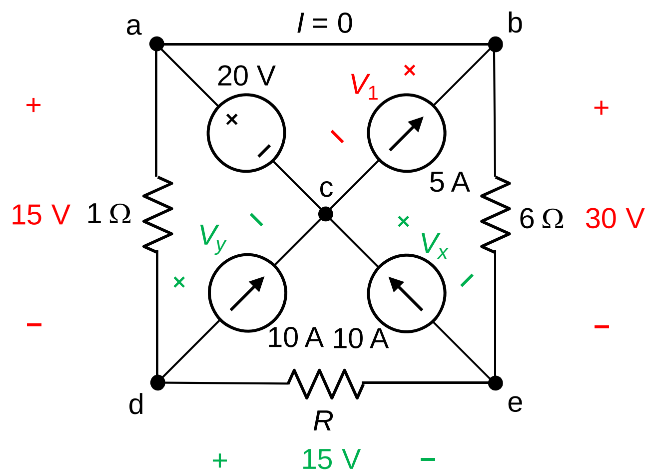
Applying KVL to the outer loop starting from node e and going CW: 5R + 15 – 30 = 0, which gives 5R = 15, and R = 15/5 = 3 Ω.



(b) From KVL around the mesh abc, starting from node a and going CW:

$-V_1 + 20 = 0$, or $V_1 = 20$ V.

From KVL around mesh cbe, starting from node c and going CW: $V_1 - 30 + V_x = 0$, or $V_x = 10$ V.



(c) From KVL around the mesh acd, starting from node a and going CW:

$-20 + V_y + 15 = 0$, or $V_y = 5$ V.

As a check, KVL around the mesh ced, starting from node c and doing CW: $-V_x + 15 - V_y = 0$, or -10 + 15 -5 = 0.