PART 1: True/ False Questions (1point for each)

(1) Ideal basic circuit elements can have three terminals. F

(2) 10 fF (femto F) is equal to 10^{-15} F F

(3) When measuring voltage, a Voltmeter must be placed in series with the voltage being measured. F

(4) The internal (output) resistance of an ideal current source is zero. F

(5) The node-voltage method can be used for planar circuits. T

(6) The mesh-current method can be used for nonplanar circuits. F

(7) In general, an essential node having a single branch is preferred as the reference node. F

(8) When a current source is between two essential nodes, we can combine those nodes to form a supernode. F

(9) To find Thevenin equivalent resistance, voltage sources must be deactivated as short. T/F Both

(10) Thevenin voltage and resistance are independent of the value of the load resistance. T

(11) In a Thevenin equivalent circuit, the maximum voltage transfer occurs when $R_L = R_{TH}$, where R_L and R_{TH} are the load resistance and the Thevenin resistance, respectively. F

(12) The capacitance decreases as the permittivity of the insulator between the metal plates of the capacitor increases. F

(13) The larger capacitance, the smaller change in the voltage across the capacitor. T

(14) Inductor tries to prevent current from being changed instantly. T

(15) If the current flow in the inductor is in the direction of the voltage rise, it follows the passive sign convention. F

(16) When there is no change in the current through a inductor, the inductor can be regarded as an open circuit. F

PART 2: Fill Blanks

(1) Following “Passive Sign Convention”, if $P > 0$, power is being (received) by the circuit component. (2)

(2) The level of Voltage or Current of (dependent) sources is determined by some other current or voltage in the circuit. (2)

(3) **Ammeter** measures current and must be placed in (series) with the current being measured, and its ideal internal resistance is (zero). (2)

(4) A (linear) system obeys the principle of (superposition), which states that whenever the system is excited or driven by more than one independent source, the total response is the sum of the individual responses. (2)

(5) The equivalent capacitance is decreased when capacitors are connected in (Series). The equivalent inductance is decreased when inductors are connected in (Parallel). (2)

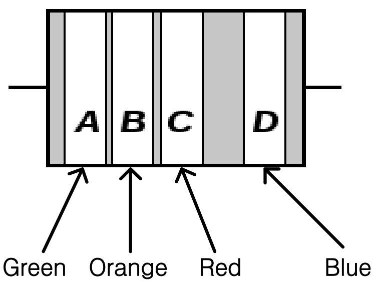
(6) This symbol represents a (Current) controlled (Voltage) source. (2)

$v_s = \rho i_x$ 

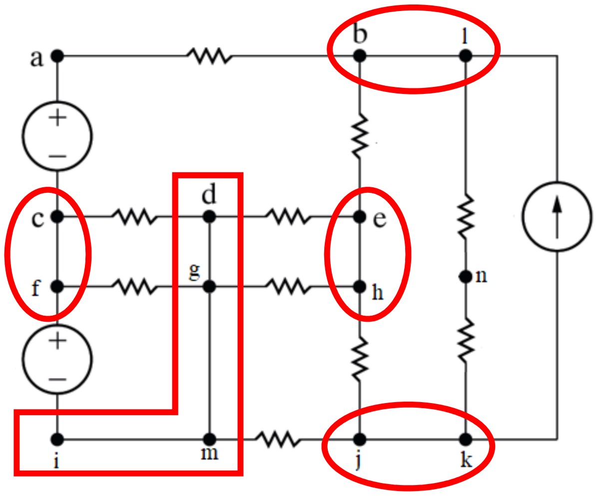
(7) The resistance of the resistor below is (532M) Ω. (2)

(No tolerance and range need to be considered.)

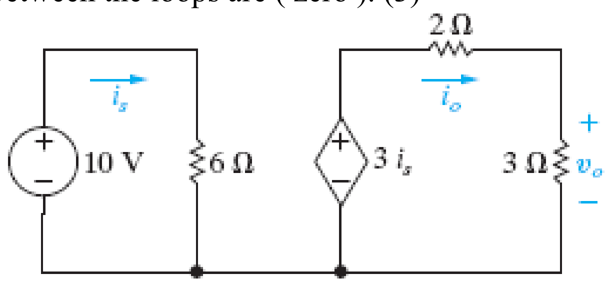
Color	Number	Color	Number
Black	**0**	**Green**	**5**
Brown	**1**	**Blue**	**6**
Red	**2**	**Violet**	**7**
Orange	**3**	**Gray**	**8**
Yellow	**4**	**White**	**9**



(8) The circuit below has (5) essential nodes. (3)



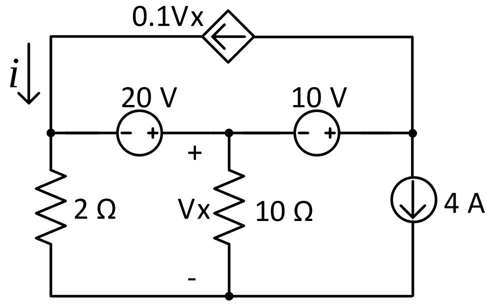
(9) The two loops of the circuit below can be considered to be (disconnected) because the (net current) between the loops are (zero). (3)

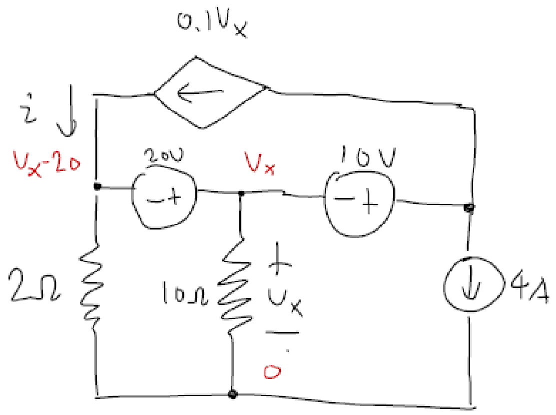


(10) To study Circuit Theory is really (Fun)! (4)

PART 3: Solve Circuits (8+4 point for each)

Find ‘*i*’





KCL

$$4 + \frac{V_x}{10} + \frac{V_x - 20}{2} = 0$$

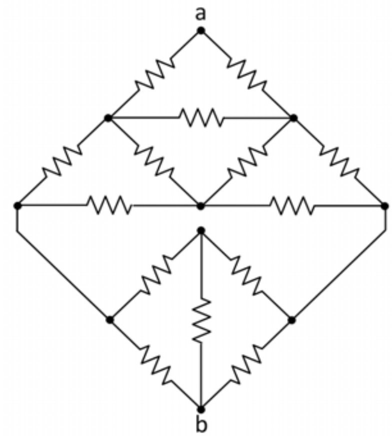
$$40 + V_x + 5V_x - 100 = 0$$

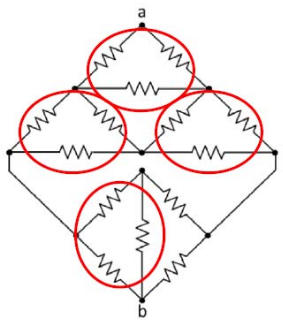
$$6V_x = 60$$

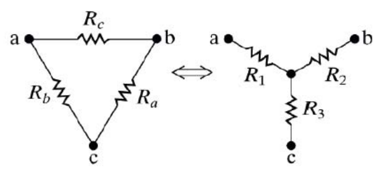
$$V_x = 10$$

$$i = 0.1V_x = 1A$$

All resistors equally have the resistance of 24 kΩ. Find the equivalent resistance Rab between the terminal a-b. Hint: transformation





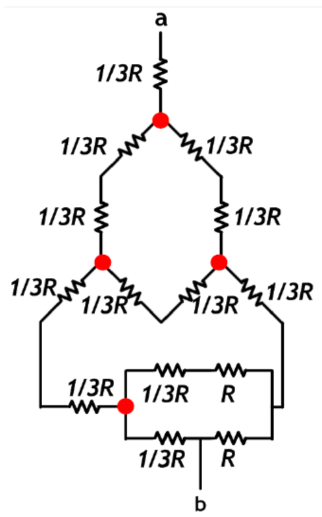


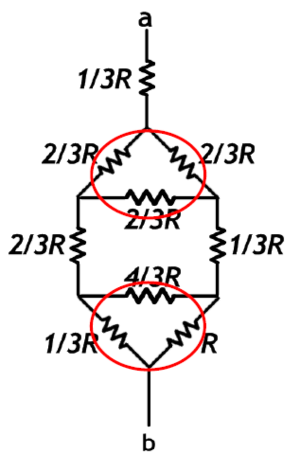
Δ-to-Y transformation

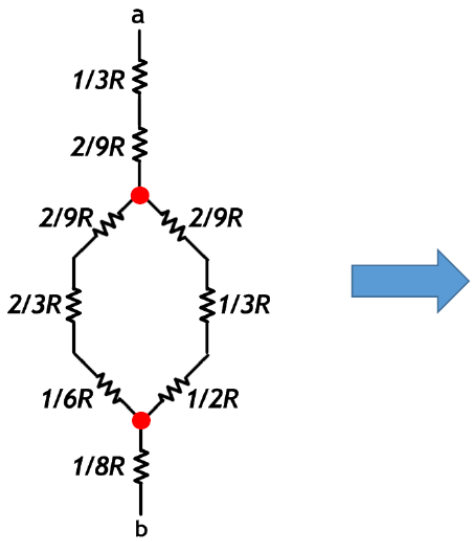
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c},$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c},$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}.$$



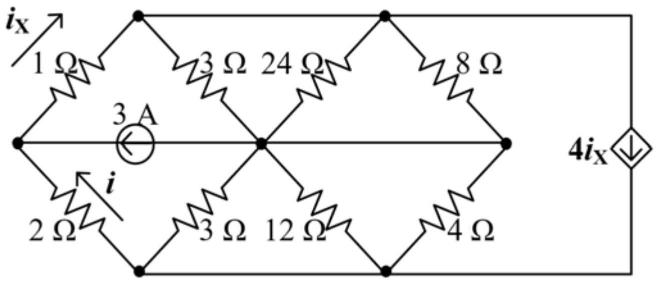


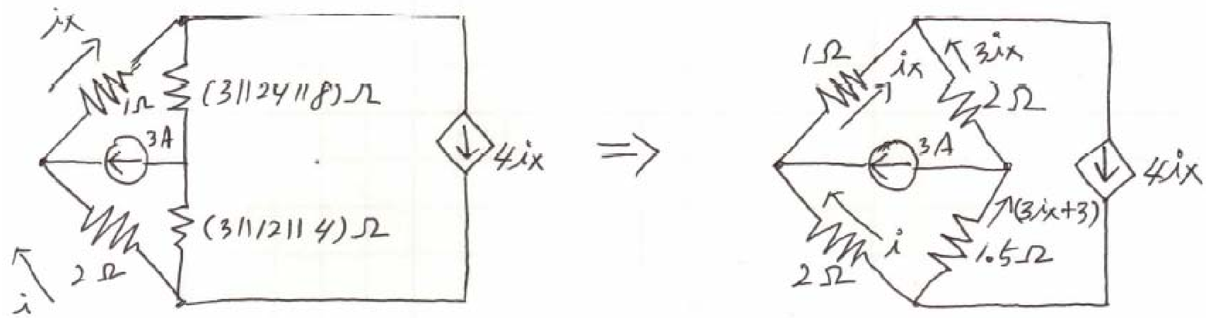


$$R_{ab} = \frac{1}{3}R + \frac{2}{9}R + \left(\frac{2}{9}R + \frac{2}{3}R + \frac{1}{6}R\right) || \left(\frac{2}{9}R + \frac{1}{3}R + \frac{1}{2}R\right) + \frac{1}{8}R$$
$$= \frac{29}{24}R$$

Rab = 29 kOhm

Find '*i*'





$\Rightarrow \; i_x = i + 3$

$\Rightarrow \; 2i + i_x = \frac{3}{2}(3i_x + 3) + 6i_x$

$4i + 2i_x = 9i_x + 9 + 12i_x$

$4i + 2i_x = 21i_x + 9$

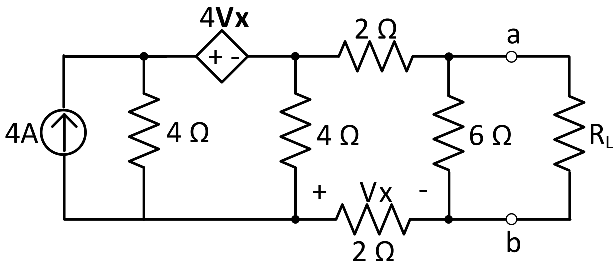
$4i = 19i_x + 9 = 19(i+3) + 9$

$19i + 66 = 4i$

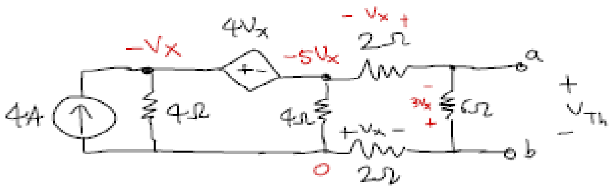
$15i = -66$

$i = -4.4A$

Find the maximum power received by R_L.
(Hint: using Thevenin/Norton equivalent circuit)



1. To find V_{Th},



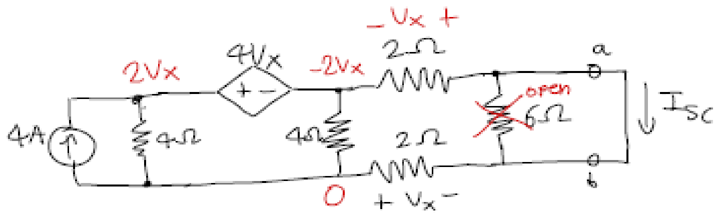
KCL

$$\frac{V_x}{2} + \frac{5V_x}{4} + \frac{V_x}{4} + 4 = 0$$

$$2V_x = -4 \qquad V_x = -2$$

$$V_{Th} = -3V_x = 6V$$

2. To find R_{Th},

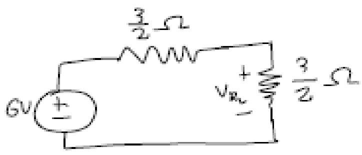


KCL

$$\frac{V_x}{2} + \frac{2V_x}{4} - \frac{2V_x}{4} + 4 = 0 \qquad V_x = -8V$$

$$I_{sc} = -\frac{V_x}{2} = 4A \qquad R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{3}{2}\Omega$$

When $R_L = R_{Th}$, R_L receives the maximum power.



$$P_{max,R_L} = \frac{V_{R_L}^2}{R_L} = \frac{3^2}{\frac{3}{2}}$$

$$= 6W$$

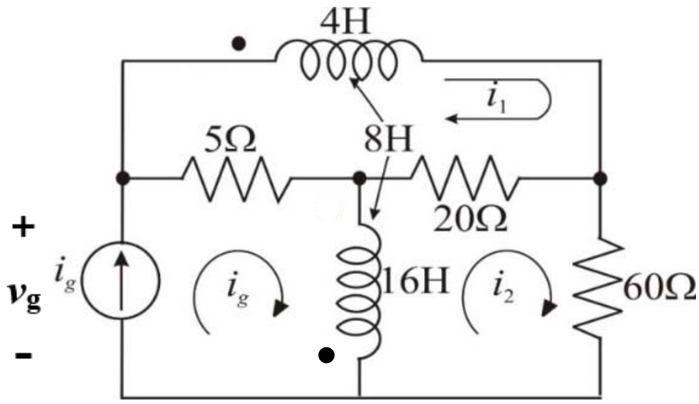
Let v_g represent the voltage across the current source in the circuit. The reference for v_g is positive at the upper terminal of the current source.

$$i_g = 16 - 16e^{-5t}\text{A}$$

$$i_1 = 4 + 64e^{-5t} - 68e^{-4t}\text{A}$$

$$i_2 = 1 - 52e^{-5t} + 51e^{-4t}\text{A}$$

The value of $v_g(t)$ is A + Be^{-5t}+ Ce^{-4t}. Find the value of C. (A, B, C are constant.)



There was error in this problem. Therefore, all students are considered to answer this problem correctly.