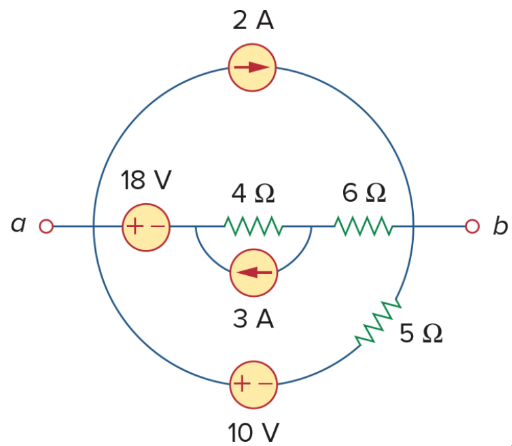
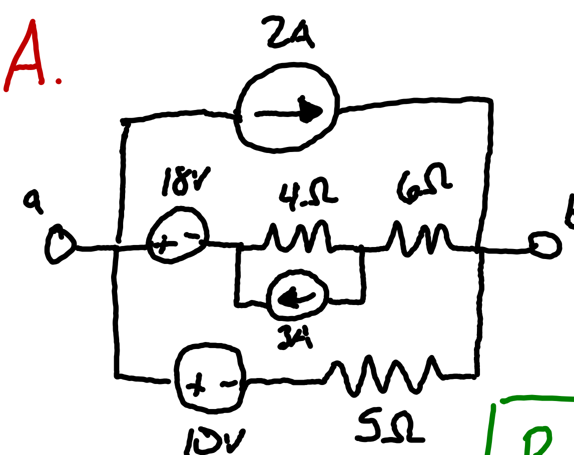
Homework 4
Due: Friday, February 24h, 2023 by 7PM.

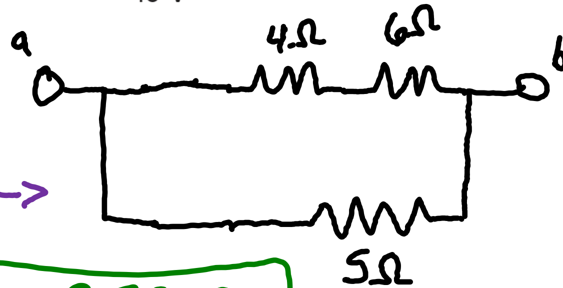
Note: In order to receive full credit, you must show your work and carefully justify your answers. The correct answer without any work will receive little or no credit.

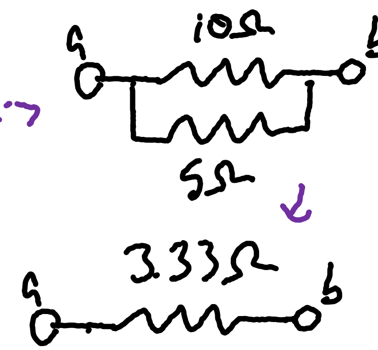
1. For the circuit below:
   A. Find the Thevenin equivalent resistance between nodes a and b.
   B. Find the Thevenin equivalent voltage between nodes a and b.
   C. Draw the Thevenin equivalent circuit.
   D. Use your result on part C to find the Norton equivalent circuit.



A.

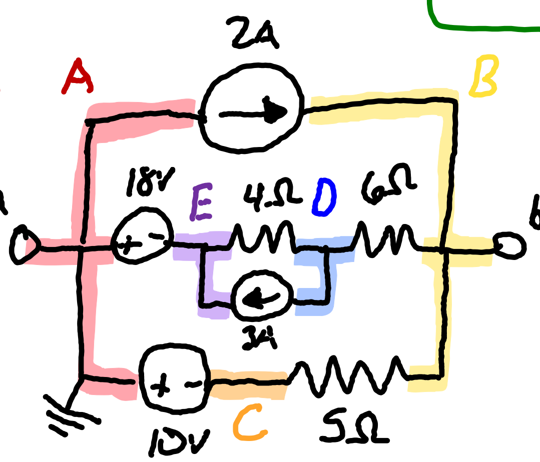






$$\boxed{R_{TH} = 3.33\,\Omega}$$

B



$V_A = 0\text{V}$

$V_E = 18\text{V}$

$V_C = 10\text{V}$

KCL@B

$2 + i_6 = i_5$

$2 + \frac{V_6}{6} = \frac{V_5}{5}$

$60 + 5V_6 = 6V_5$

$60 + 5V_D - 5V_B = 6V_B - 60$

$5V_D - 11V_B = -120$

$-11V_B + 5V_D = -120$

KCL@D

$i_4 = i_6 + 3$

$\frac{V_4}{4} = \frac{V_6}{6} + 3$

$6V_4 = 4V_6 + 72$

$6V_E - 6V_D = 4V_D - 4V_B + 72$

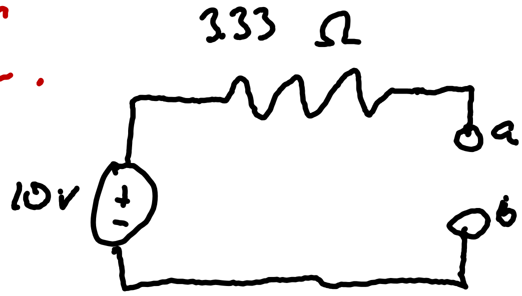
$4V_B - 10V_D = -36$

$V_4 = V_E - V_D$

$V_5 = V_B - 10$

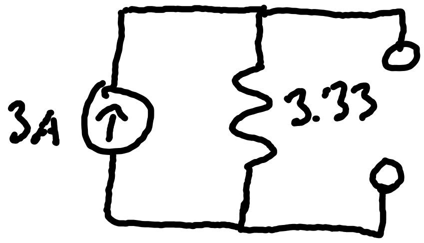
$V_6 = V_D - V_B$

C.

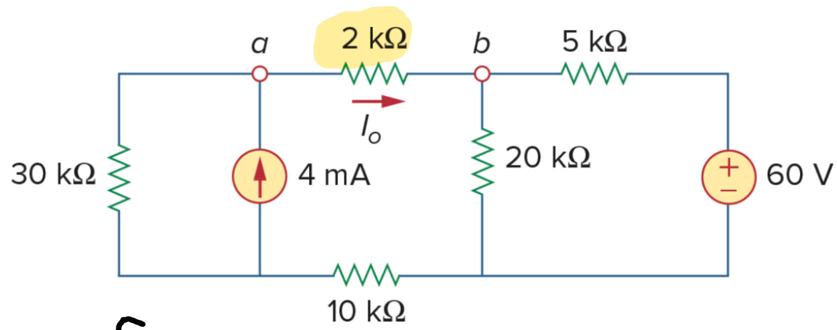


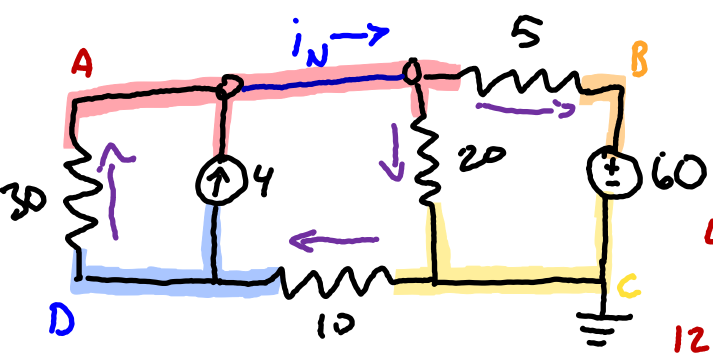
$V_D = 10\,V$ $\boxed{V_{TH} = 10\,V}$

D.



2. For the circuit below:
   A. Find the Norton equivalent circuit between nodes a and b. Assume the 2kΩ resistor is the load.
   B. Use your result from part A to find the voltage across the 2kΩ resistor.





$V_B = 60V$

$V_C = 0V$

$V_{30} = V_A - V_D$

$V_5 = 60 - V_A$

$V_{20} = -V_A$

$V_{10} = V_D$

KCL @ A

$4 + i_{30} = i_5 + i_{20}$

$4 + \frac{V_{30}}{30} = \frac{V_5}{5} + \frac{V_{20}}{20}$

$120 + V_{30} = 6V_5 + \frac{3}{2}V_{20}$

$120 + V_A - V_D = 360 - \frac{15}{2}V_A$

$\frac{17}{2}V_A - V_D = 240$

KCL @ D

$i_{10} = 4 + i_{30}$

$\frac{V_{10}}{10} = 4 + \frac{V_{30}}{30}$

$3V_{10} = 120 + V_{30}$

$3V_D = 120 + V_A - V_D$

$V_A - 4V_D = -120$

$V_A = \frac{360}{11}V$

$V_D = \frac{420}{11}V$

$i_N = 4 + i_{30} = 4 + \frac{V_{30}}{30}$

$= 120 + V_A - V_D$

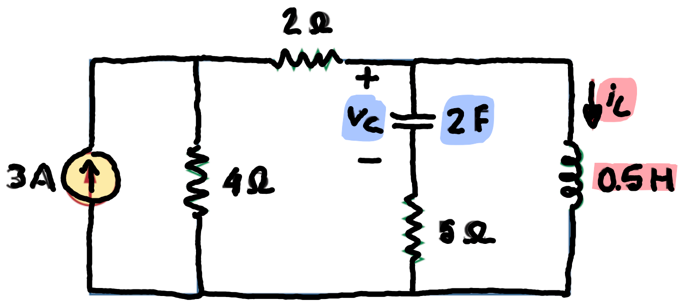
$i_N = \frac{1260}{11} mA = \boxed{1.63 mA}$

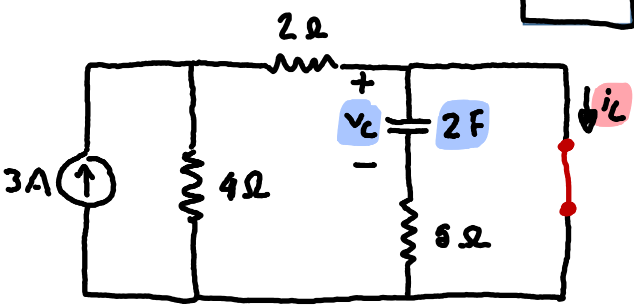
$V_N = i_N R = \frac{1260}{11} \cdot 2 \div 1000$

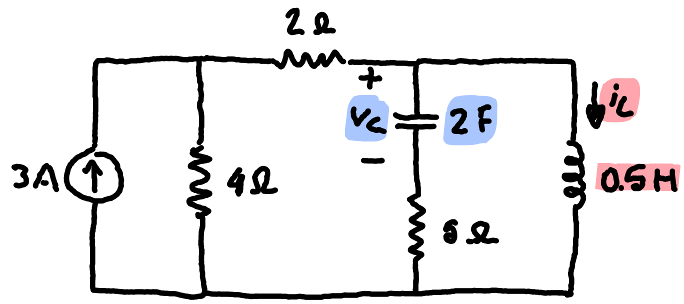
$\boxed{V_N = 3.13V}$

Fuck!!!

3. For the circuit below, determine the voltage across the capacitor Vc and the current through the inductor iL.







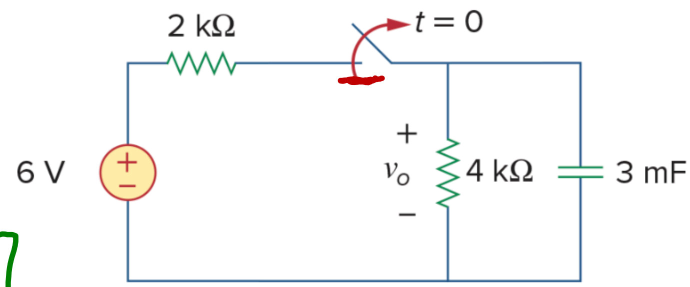
$$\frac{1}{\frac{1}{2}+\frac{1}{4}} \div 2 \cdot 3 = 2A$$

$i_C = 2A$

$V_C = 0V$

Short circuit so no voltage change through the capacitor

4. For the circuit below, determine:
   A. Vo(0)
   B. Vo(∞)
   C. Vo(t) for t ≥ 0
   D. iC(t) for t ≥ 0



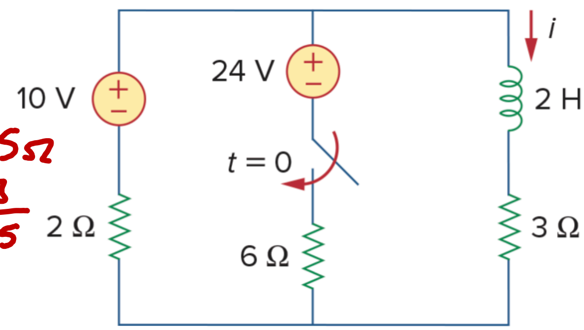
A. $V_o(0) = \frac{4k\Omega}{2k\Omega + 4k\Omega} \cdot 6V = \boxed{4V}$

B. $V_o(\infty) = \boxed{0V}$

C. $V_o(t) = 0 + [4-0]e^{-\frac{t}{12}} = \boxed{4e^{-\frac{t}{12}}}$

D. $i_c(t) = 3 \cdot \frac{d(4e^{-\frac{t}{12}})}{dt} = \boxed{-e^{-\frac{t}{12}}}$

5. For the circuit below, determine:
   A. iL(0)
   B. iL(∞)
   C. iL(t) for t ≥ 0
   D. vL(t) for t ≥ 0



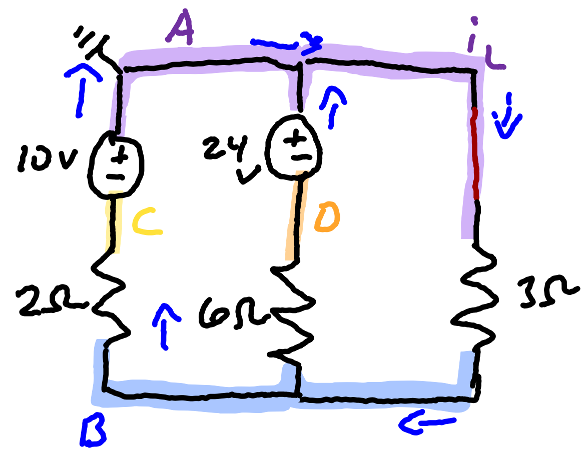
$R_{TH} = \frac{1}{\frac{1}{2}+\frac{1}{6}} = 1.5\Omega$
$+ 3$
4.5

A. $i_L(0) = \boxed{2A}$

B. $i_L(\infty) = \frac{9V}{3\Omega} = \boxed{3A}$

C. $i_L(t) = \boxed{3 - e^{-\frac{9}{4}t}}$

D. $V_L(t) = 2 \cdot \frac{d(3-3e^{-\frac{9}{4}t})}{dt} = \boxed{4.5e^{-\frac{9}{4}t}}$



$V_C = 10V$
$V_D = 24V$
$V_A = 0V$

KCL@B

$i_3 = i_6 + i_2$

$\frac{V_3}{3} = \frac{V_6}{6} + \frac{V_2}{2}$

$V_3 = V_B$
$V_6 = 24 - V_B$
$V_2 = 10 - V_B$

$2V_3 = V_6 + 3V_2$

$2V_B = 24 - V_B + 30 - 3V_B$

$6V_B = 54$

$V_B = 9V$