Midterm: 11/7 (Mon) 10:10am-12

Lec 1 - Lec 5

Electric Circuits
Quiz 1 Discussion

EE2210, Fall 2022

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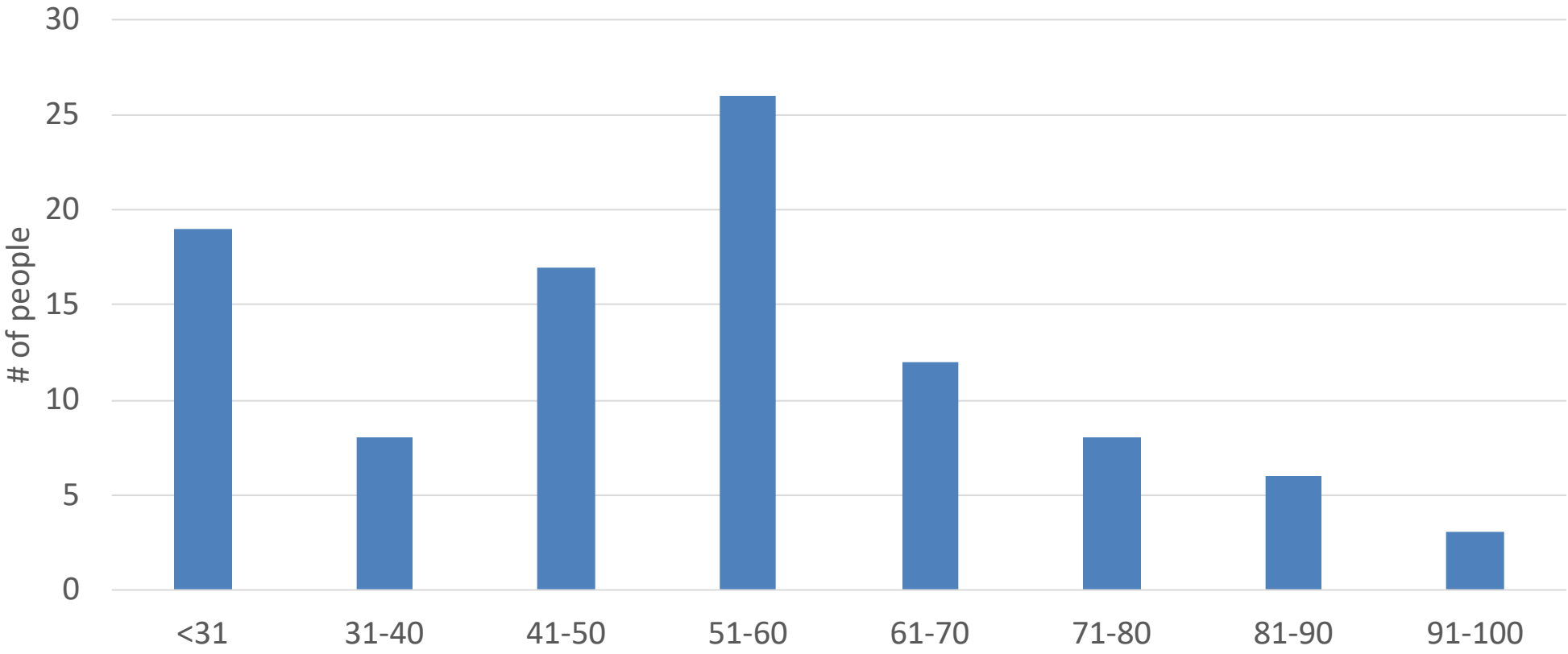
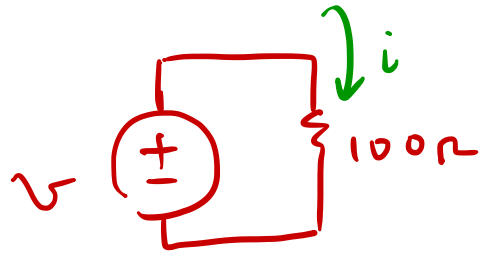
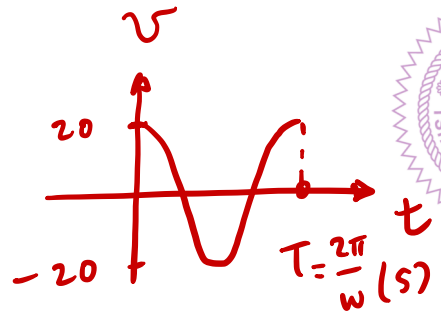
Score Distribution



- Average: 50
- Standard deviation: 23.1

Q1





1. A sinusoidal voltage source, $v = 20 \cdot \cos(\omega t)\ (V)$, is connected across a 100-Ohm resistor.

$f = \frac{\omega}{2\pi}\ (Hz,\ 1/s)$

2. What is the current flowing through the resistor? (4%)
3. What is the instantaneous power supplied by the source to the resistor? (Hint: instantaneous power is a function of time, which indicates the power at any instant of time.) (10%)

★ i-v R C L

1. $i = \frac{v}{R} = \frac{20\cos\omega t}{100} = \frac{1}{5}\cos\omega t \quad A$

2. ★ $p(t) = v \cdot i = 20 \cdot \cos\omega t \cdot \frac{1}{5}\cos\omega t = 4\cos^2\omega t = 4 \cdot \frac{1+\cos 2\omega t}{2} = 2(1+\cos 2\omega t) \quad W$

≥ 0

(*) Energy = ?

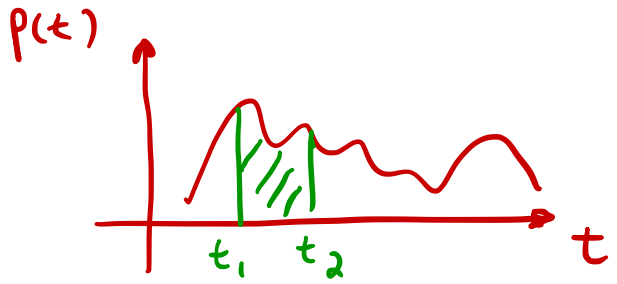
3 ~~4~~. What is the average power supplied by this sinusoidal source? (10%)

4 ~~5~~. An ideal square wave generator is used as the voltage source instead of the sinusoidal source. If the square wave signal has a peak-to-peak value of 20 V and a zero average value, what is the average power supplied by the source? (10%)

3. $P_{avg} = \frac{1}{T}\int_0^T \frac{1}{2}(1+\cos 2\omega t)\,dt = 2 \quad W$

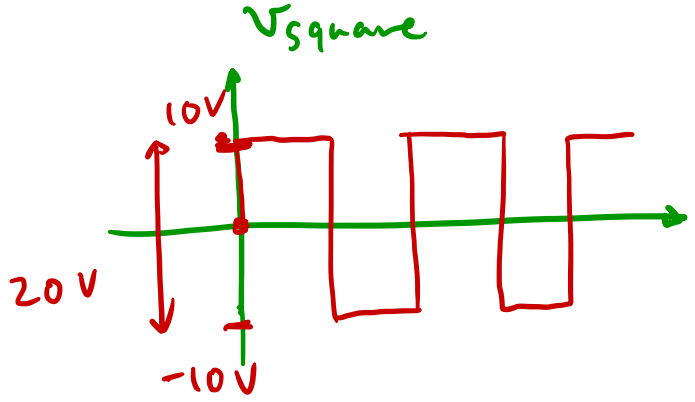
$T = \frac{2\pi}{2\omega}$

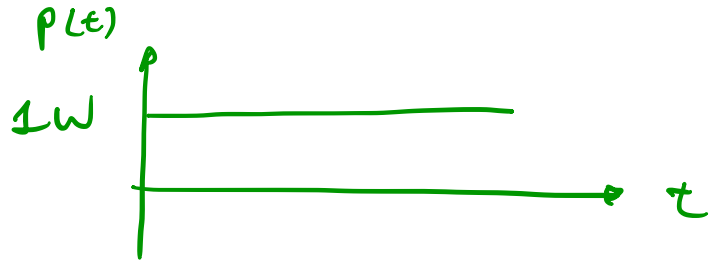
$p(t) = \frac{V^2}{R} = \frac{100}{100} = 1$

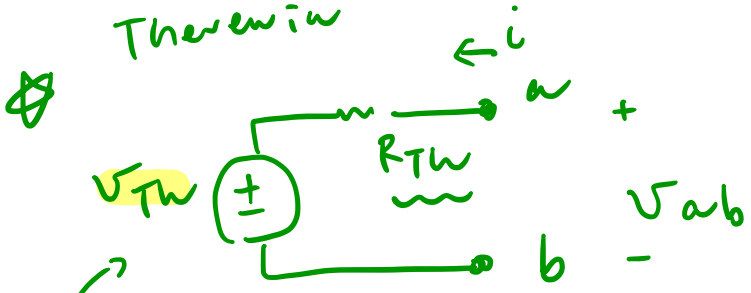


$\frac{1}{t_2-t_1}\int_{t_1}^{t_2} p(t)\,dt$

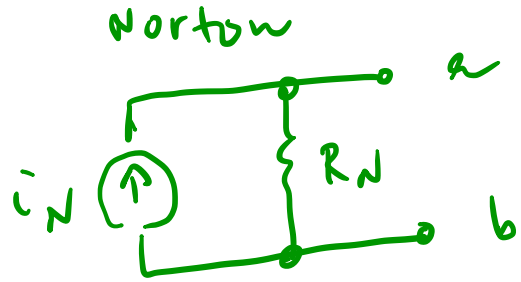
4.



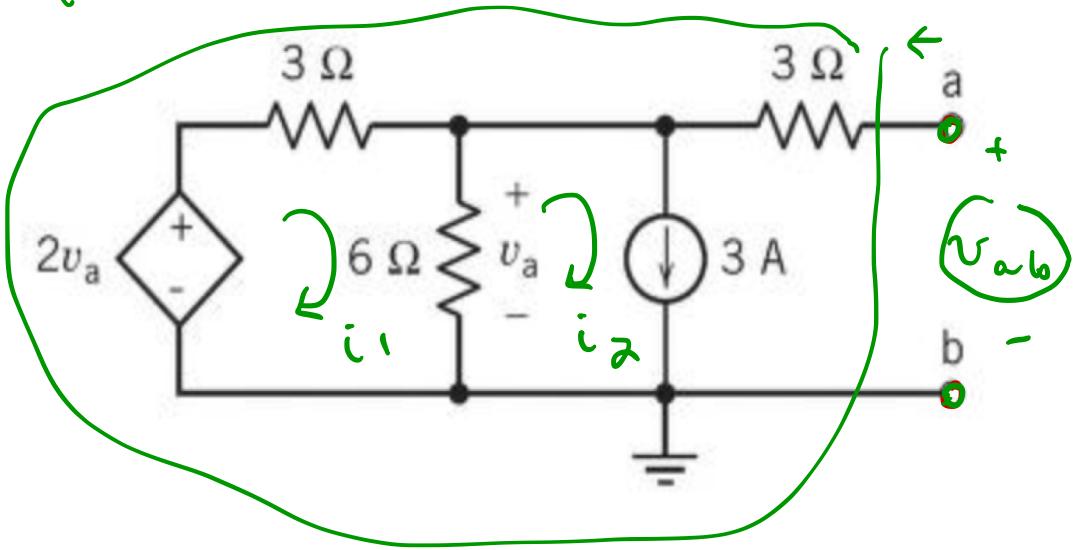




Q2



- Find the Thevenin and Norton equivalent circuits of the following circuit with respect to the terminals a, b in the following figure. (16%)



- Mesh analysis

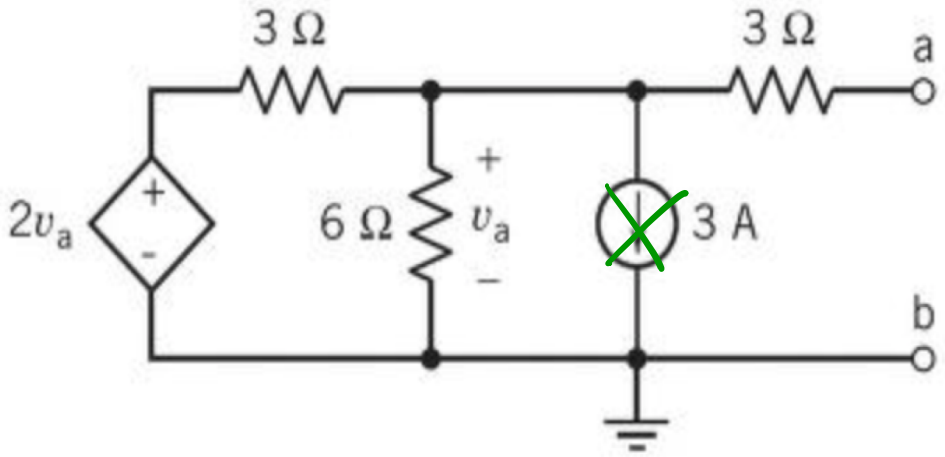
$i_2 = 3\ A$

$$\begin{cases} \text{KVL}: \quad 2v_a - 3i_1 - 6(i_1 - i_2) = 0 \\ v_a = 6(i_1 - i_2) \end{cases}$$

unknowns: i_1, v_a

$$\Rightarrow \quad v_a = 18\ V = v_{TH}$$

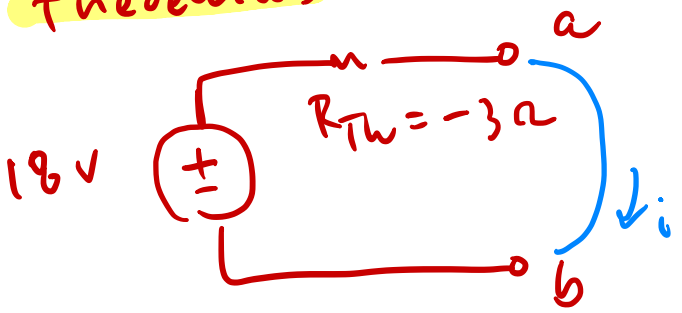
$$i_1 = 6\ A$$



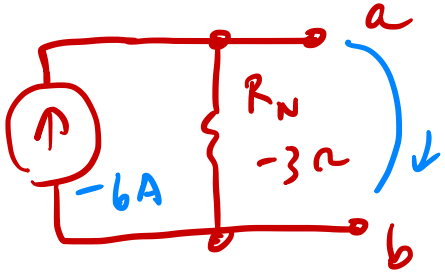
$2v_a = v_a + 2v_a - 2v_{test}$

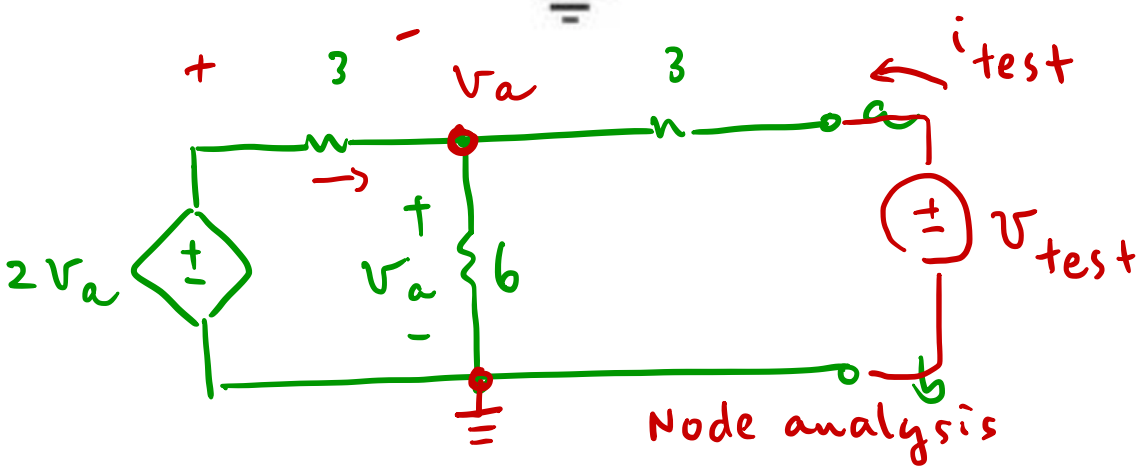
$v_a = 2v_{test}$

thevenin's



Norton





Node analysis

$R_{Th} = \frac{v_{test}}{i_{test}}$

$= -3\Omega$

KCL: $\frac{v_a}{3} = \frac{v_a}{6} + \frac{v_a - v_{test}}{3}$ @ v_a

@ v_{test}

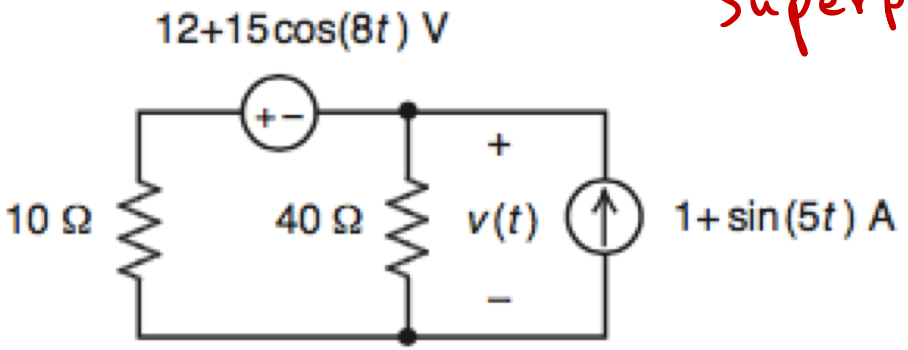
$\frac{v_a - v_{test}}{3} = -i_{test}$

$\frac{2v_{test} - v_{test}}{3} = -i_{test}$

$\Rightarrow \frac{v_{test}}{i_{test}} = -3\Omega$

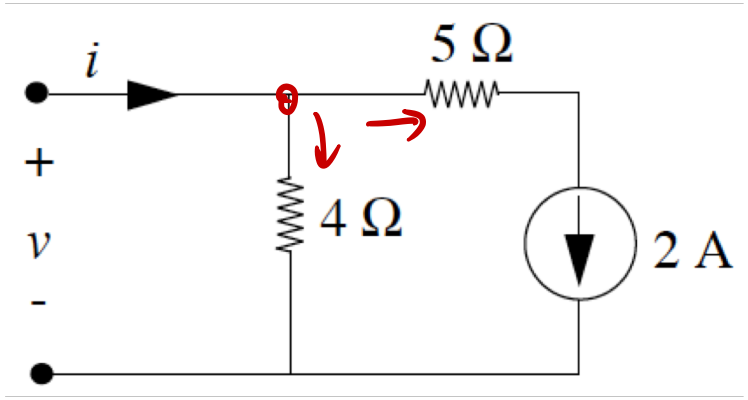
Q3

- Find the node voltage potential *v(t)* in the following figure. (12%)

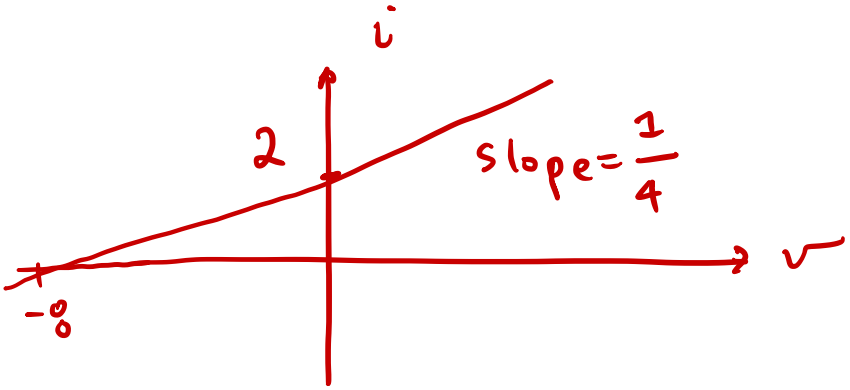


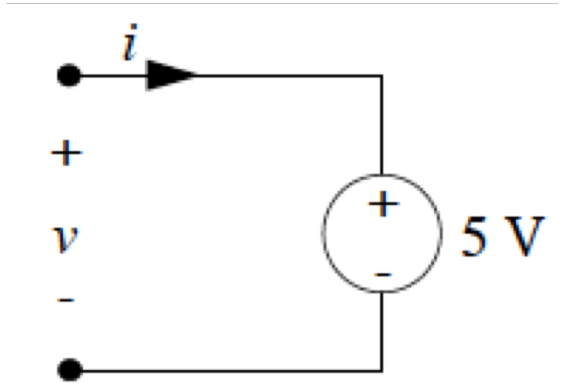
Q4

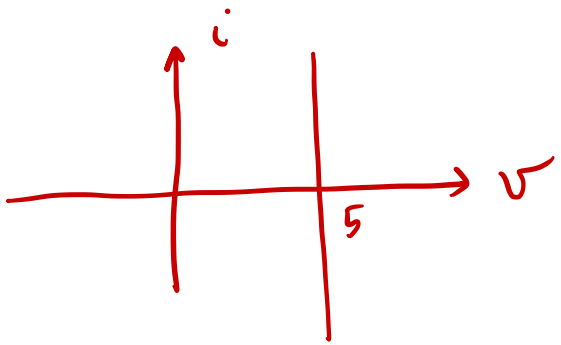
- Sketch the $i - v$ characteristics for the networks in the following figures. (10%)



$i = \frac{v}{4} + 2$



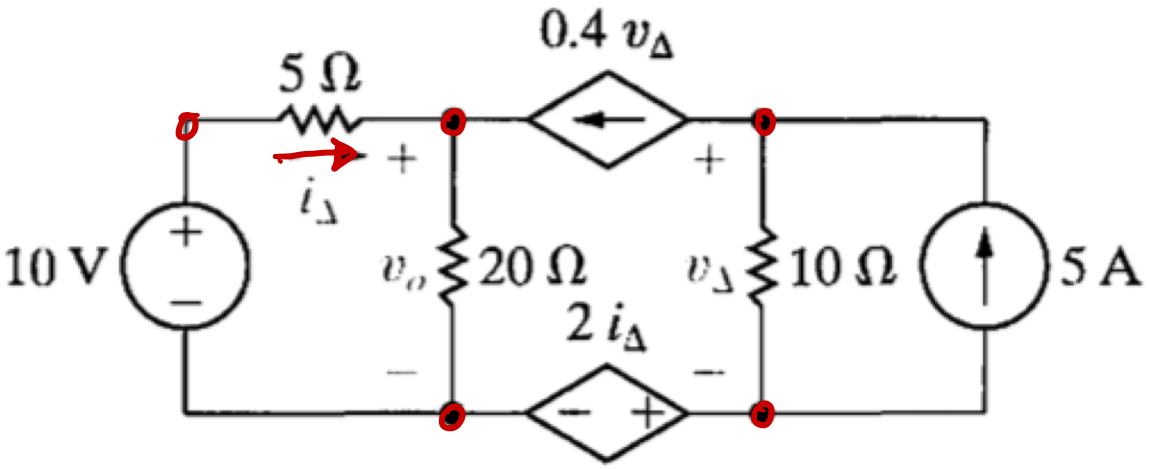


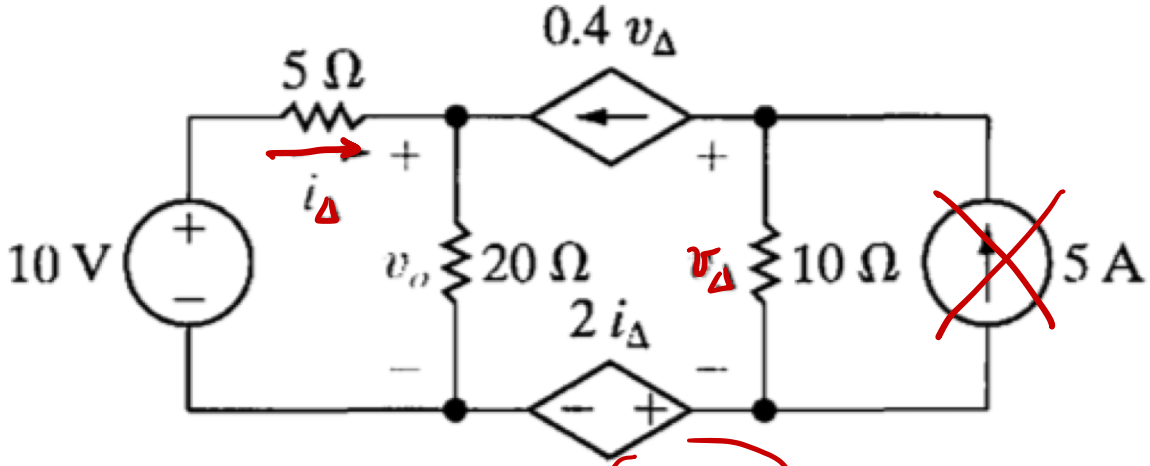


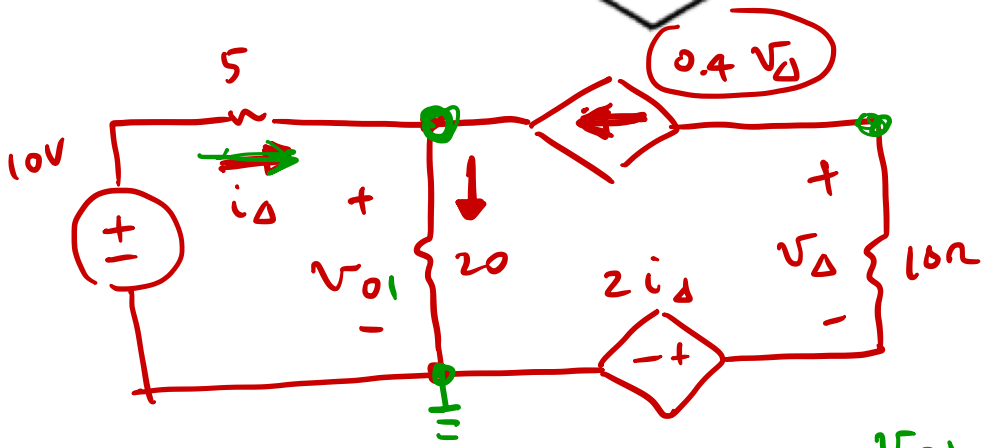
Q5

5 7 3

- How many nodes, how many branches, and how many meshes are in the following figure? (6%)
- Find the voltage v_0 in the network in the following figure using superposition. (12%)







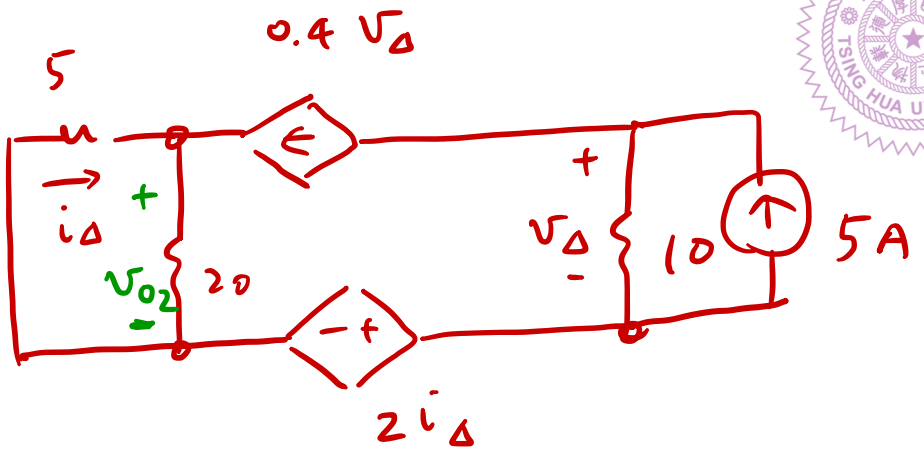
$$i_\Delta + 0.4 v_\Delta = \frac{v_{01}}{20} \Rightarrow i_\Delta = \frac{v_{01}}{20}$$

$$-\frac{v_\Delta}{10} = 0.4 v_\Delta \Rightarrow v_\Delta = 0 \text{ V}$$

$$\text{or } i_\Delta = \frac{10 - v_{01}}{5} = \frac{v_{01}}{80} \Rightarrow$$

$$40 - 4 v_{01} = v_{01}$$

$$40 = 5 v_{01}, \quad v_{01} = 8 \text{V}$$



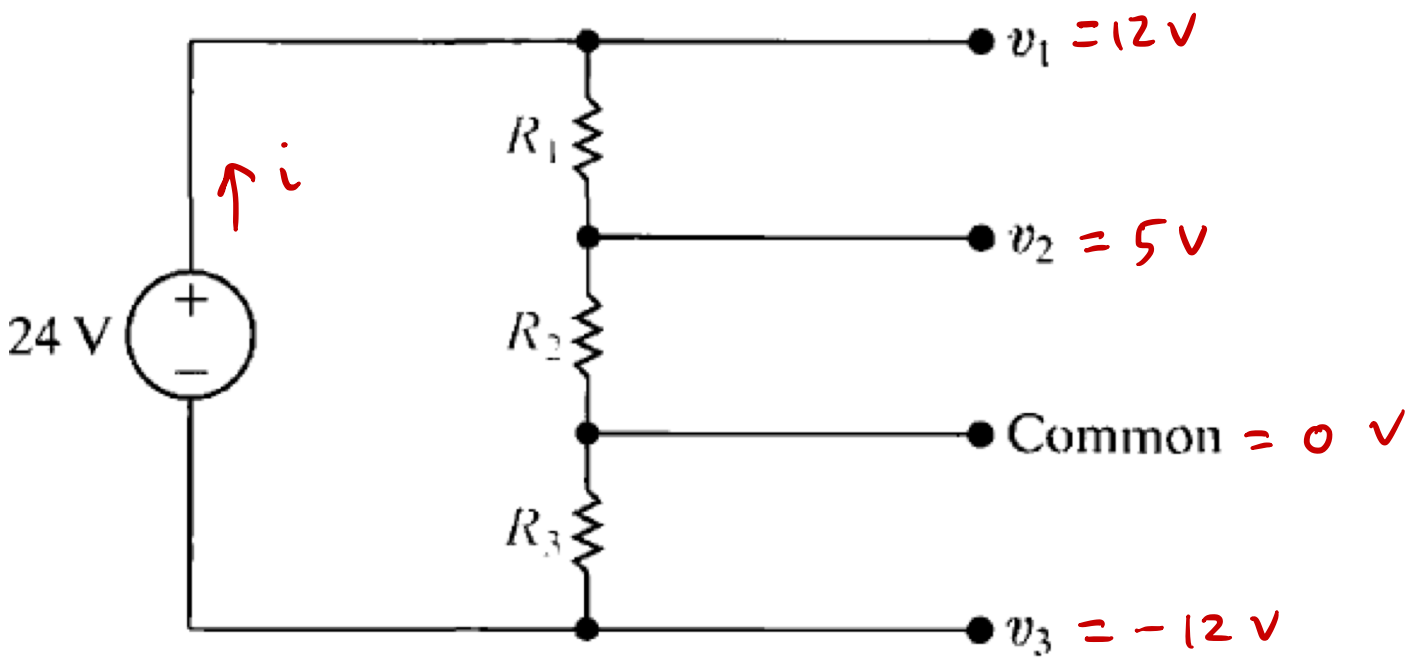
$$\frac{v_\Delta}{10} + 0.4 v_\Delta = 5 \Rightarrow v_\Delta = 10 \text{ V}$$

$$0.4 v_\Delta = \frac{v_{02}}{20} + \frac{v_{02}}{5} \Rightarrow v_{02} = 16 \text{V}$$

$$v_o = v_{01} + v_{02} = 8 + 16 = 24 \text{ V}$$

Q6

- Determine the values of the resistors R_1, R_2, and R_3 such that v_1 = 12 V, v_2 = 5 V, v_3 = -12 V, and the total power dissipated by the circuit by the 24 V source is 80 W in the following figure. Assume the "Common" node is at 0 V of voltage potential. (10%)



$P = 80 = 24 \cdot i \qquad i = \frac{80}{24}$ A

$R_1 = \frac{12-5}{i} = 2.1\ \Omega$

$R_2 = \frac{5-0}{i} = 1.5\ \Omega$

$R_3 = \frac{0-(-12)}{i} = 3.6\ \Omega$