Basic Electrical Engineering

ECS 303

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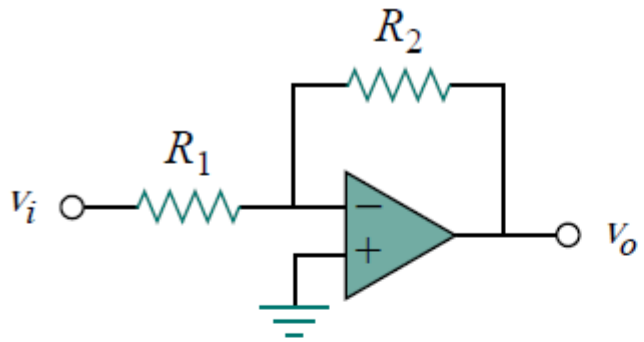
Lecture 8 (Review)

Office Hours:
BKD 3601-7
Tuesday 14:00-16:00
RS ETU (1st floor)
Friday 15:00-16:00

Announcement

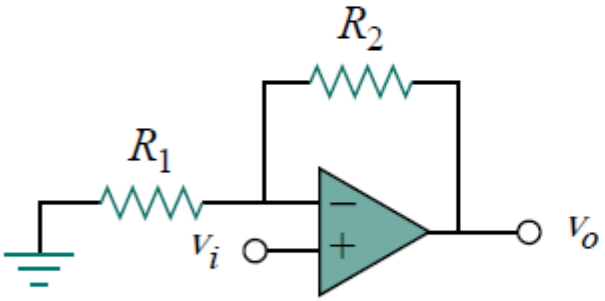
- Reading assignment
  - Chapter 3: 3.1-3.5, 3.7
  - Chapter 4
  - Chapter 5

Op Amp



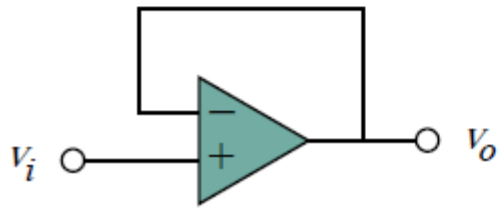
Inverting amplifier

$$v_o = -\frac{R_2}{R_1} v_i$$



Noninverting amplifier

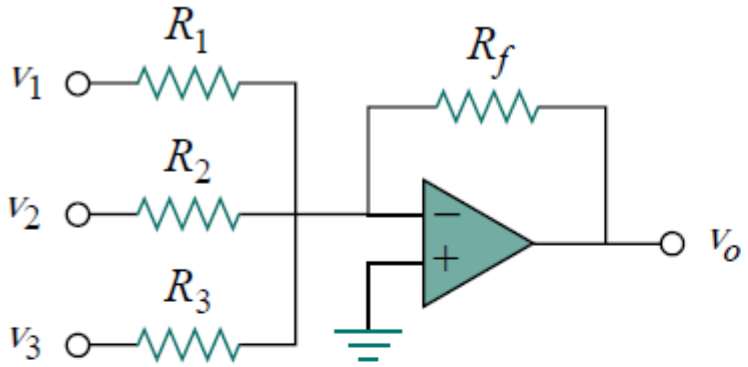
$$v_o = \left(1 + \frac{R_2}{R_1}\right) v_i$$



Voltage follower

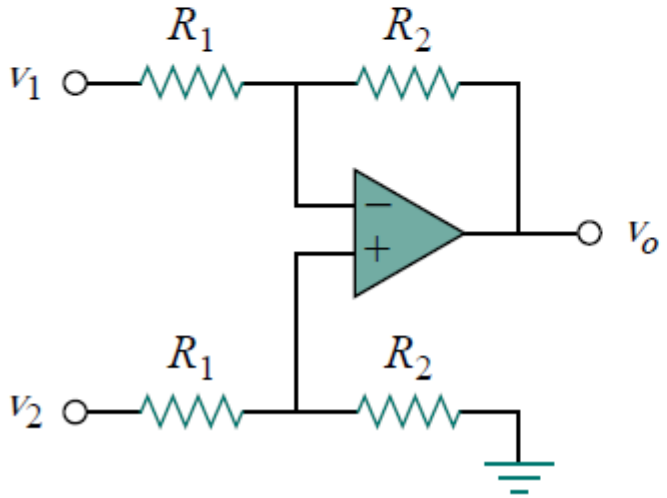
$$v_o = v_i$$

Op Amp



Summer

$$v_o = -\left(\frac{R_f}{R_1}v_1 + \frac{R_f}{R_2}v_2 + \frac{R_f}{R_3}v_3\right)$$



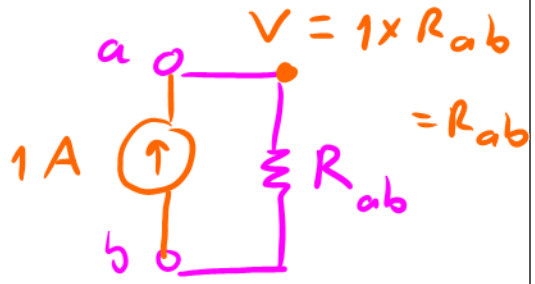
Difference amplifier

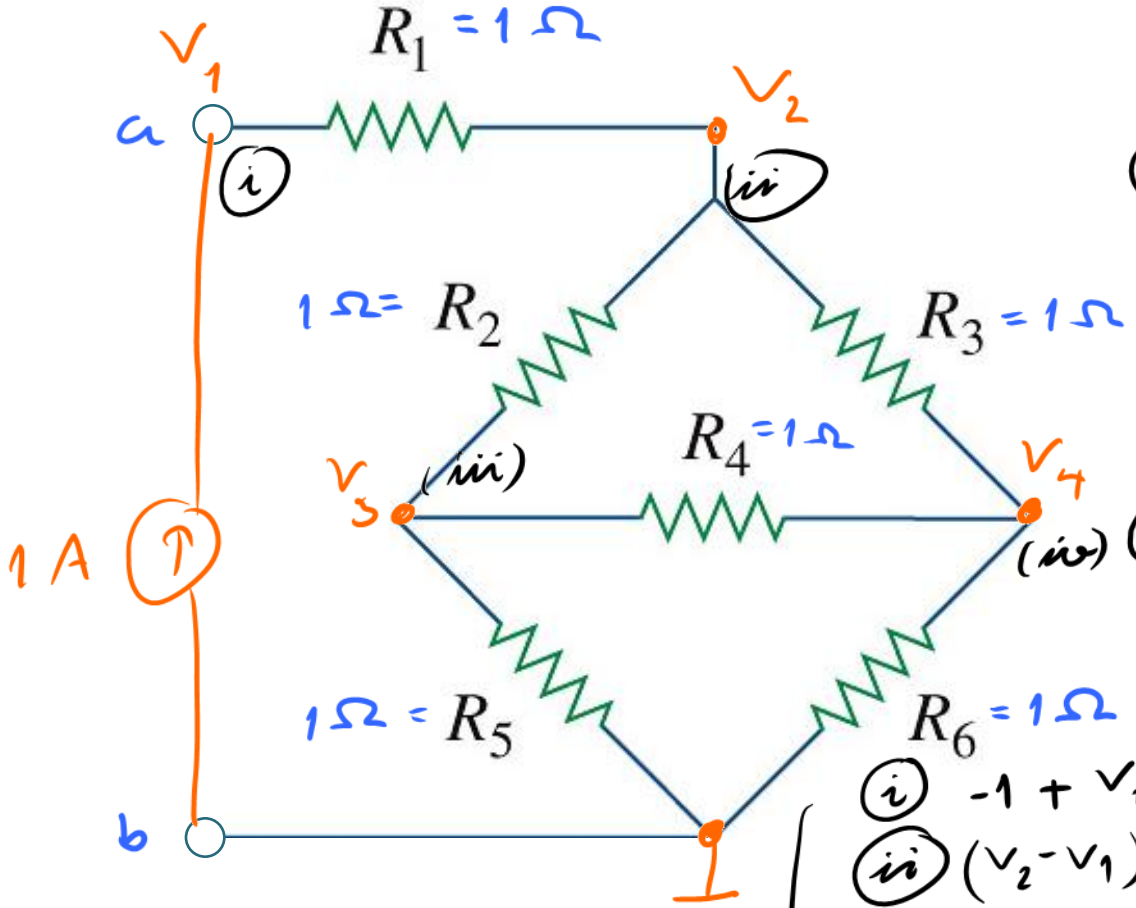
$$v_o = \frac{R_2}{R_1}(v_2 - v_1)$$

Midterm Exam

- Not to torture you!
- Most questions are straightforward
- A few difficult ones
  - Worth 1 to 2 points each
- Study
  - HW questions
    - Only small parts of HWs are graded.
    - Please take a careful look at the solution.
  - Lecture notes
  - Textbook chapters
- Check the course web site!
  - There might be useful information for you.

Equivalent Resistance





(1) these two circuits are equivalent; so $V_1 = R_{ab}$.

(2) Use nodal analysis to find V_1.

(i) $-1 + V_1 - V_2 = 0$

(ii) $(V_2 - V_1) + (V_2 - V_3) + (V_2 - V_4) = 0$

(iii) $(V_3 - V_2) + (V_3 - V_4) + V_3 = 0$

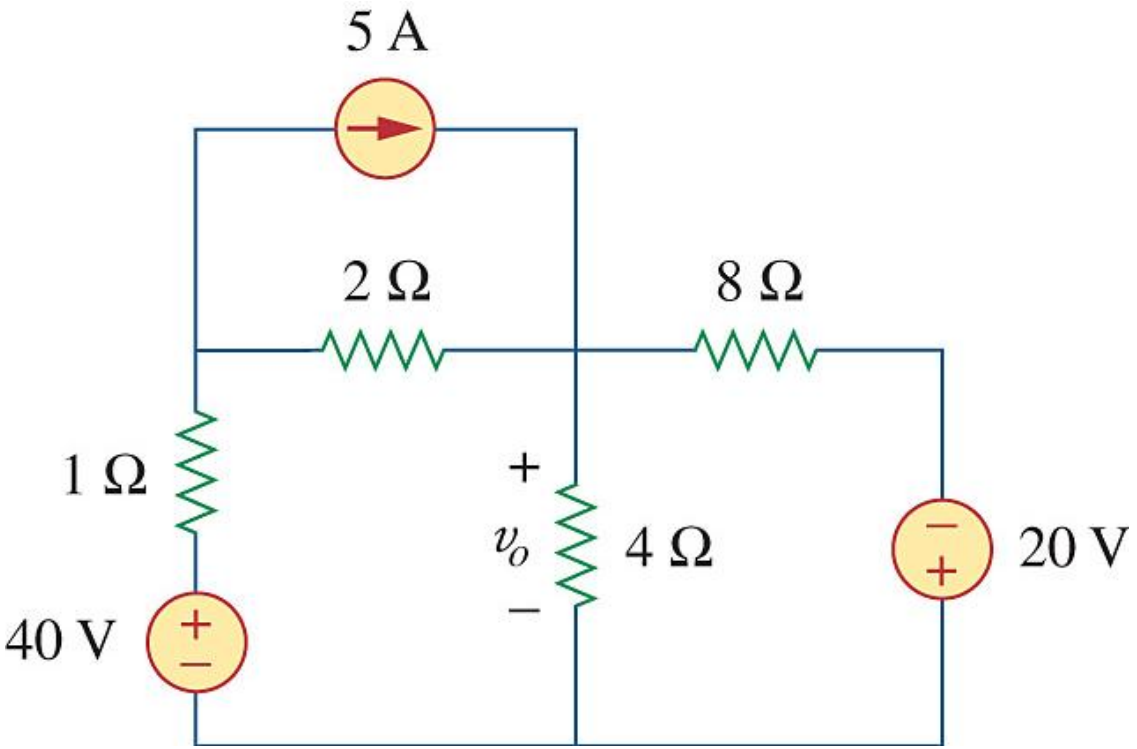
(iv) $(V_4 - V_2) + (V_4 - V_3) + V_4 = 0$

$R_{ab} = 2 \Leftarrow V_1 = 2 \Leftarrow$ (Maple)

Big Question

Find v_0 using

1. Nodal Analysis
2. Mesh Analysis
3. Superposition
4. Source Transformation
5. Thevenin equivalent
6. Norton equivalent



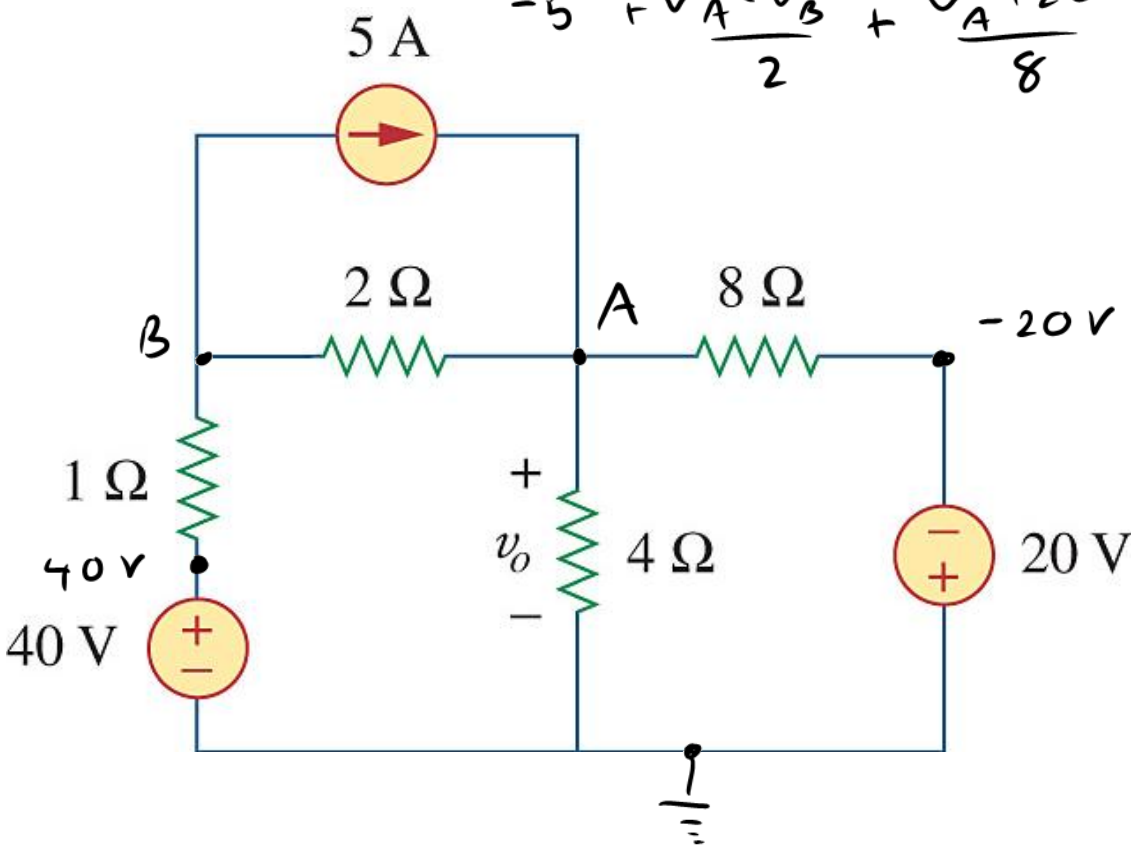
Nodal Analysis

$$\text{At B}: \quad 5 + \frac{V_B - V_A}{2} + \frac{V_B - 40}{1} = 0$$

$$\text{At A}: \quad -5 + \frac{V_A - V_B}{2} + \frac{V_A + 20}{8} + \frac{V_A - 0}{4} = 0$$

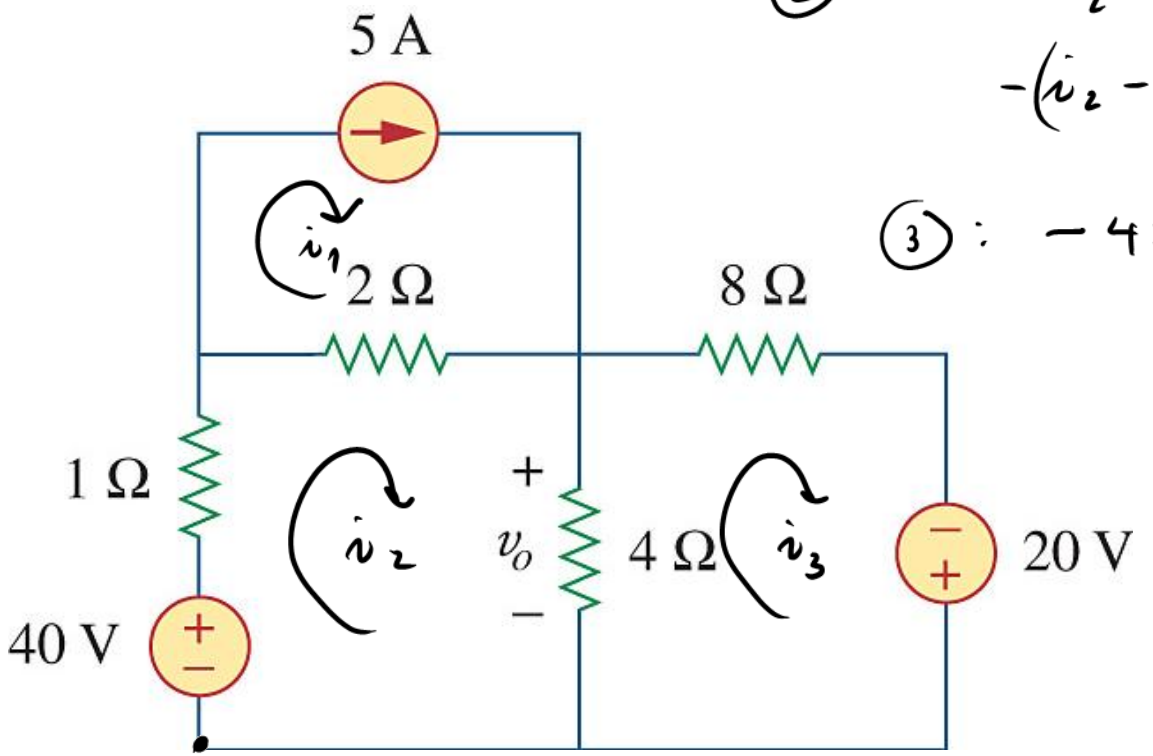
maple $\Rightarrow$ $V_A = 20$, $V_B = 30$

$v_o = 20\ V$



Mesh Analysis

① $i_1 = 5\,A$



② : $40 - i_2 \times 1 - (i_2 - i_1) \times 2 - (i_2 - i_3) \times 4 = 0$

③ : $-4 \times (i_3 - i_2) - 8 \times i_3 + 20 = 0$

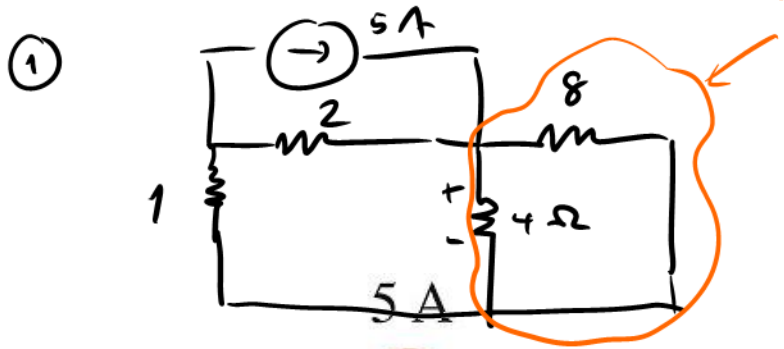
⇓ maple

$i_2 = 10$

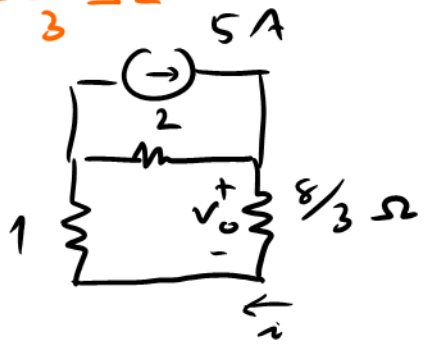
$i_3 = 5$

$v_o = (i_2 - i_3) \times 4 = 20\ V.$

Superposition

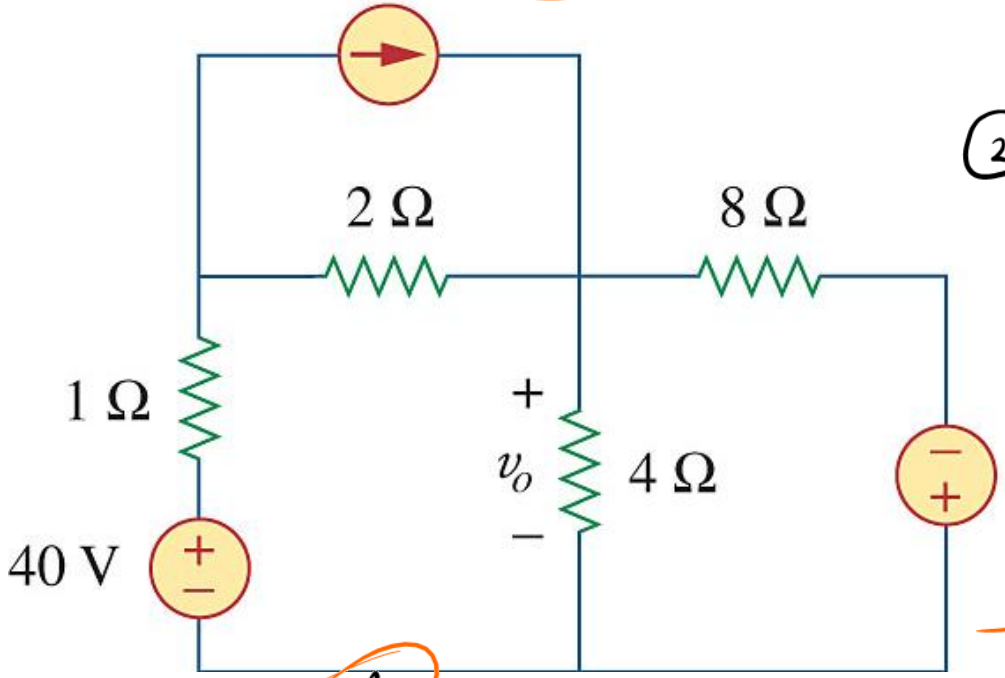


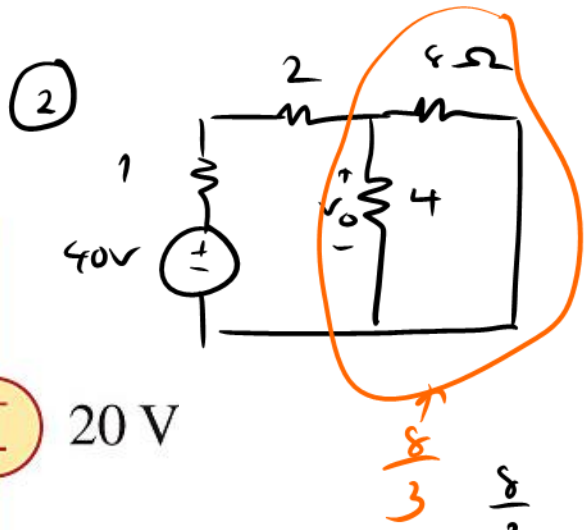
$8 // 4 = \frac{8}{3}\ \Omega$



$$i = 5 \times \frac{2}{2 + (1 + \frac{8}{3})} = \frac{30}{17}$$

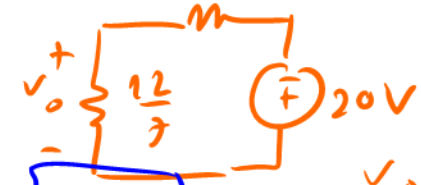
$$v_o = i \times \frac{8}{3} = \frac{80}{17}$$





$\frac{8}{3}$

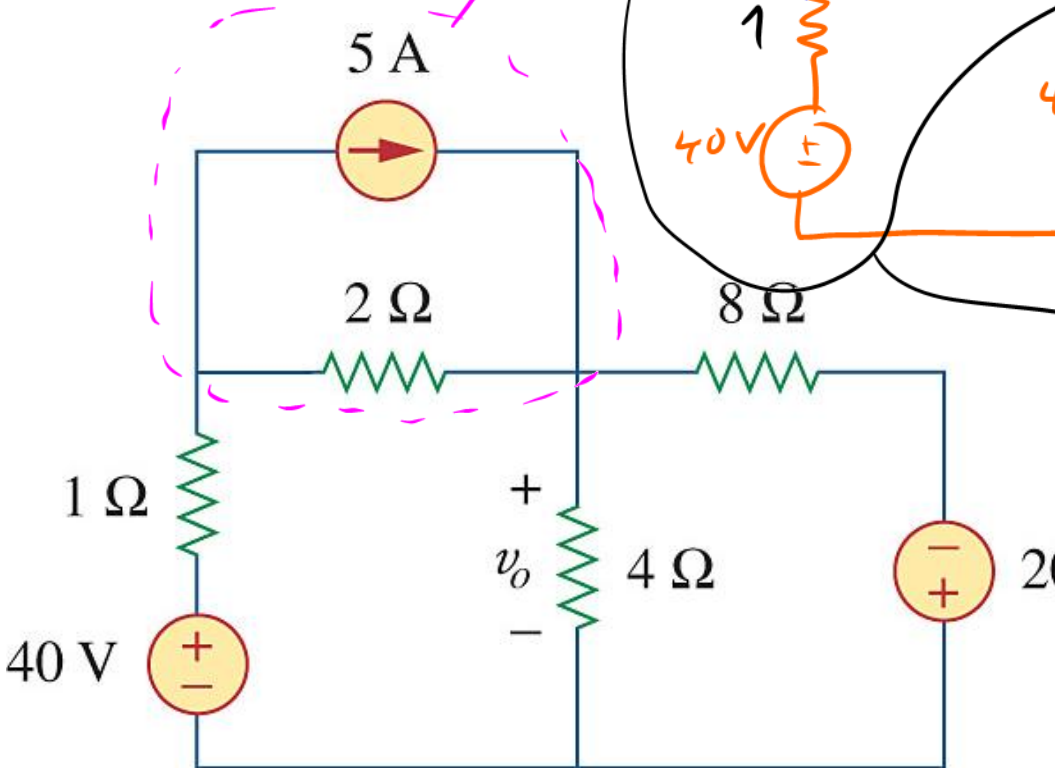
$$v_o = 40 \times \frac{\frac{8}{3}}{1 + 2 + \frac{8}{3}} = \frac{40 \times 8}{9 + 8} = \frac{320}{17}$$

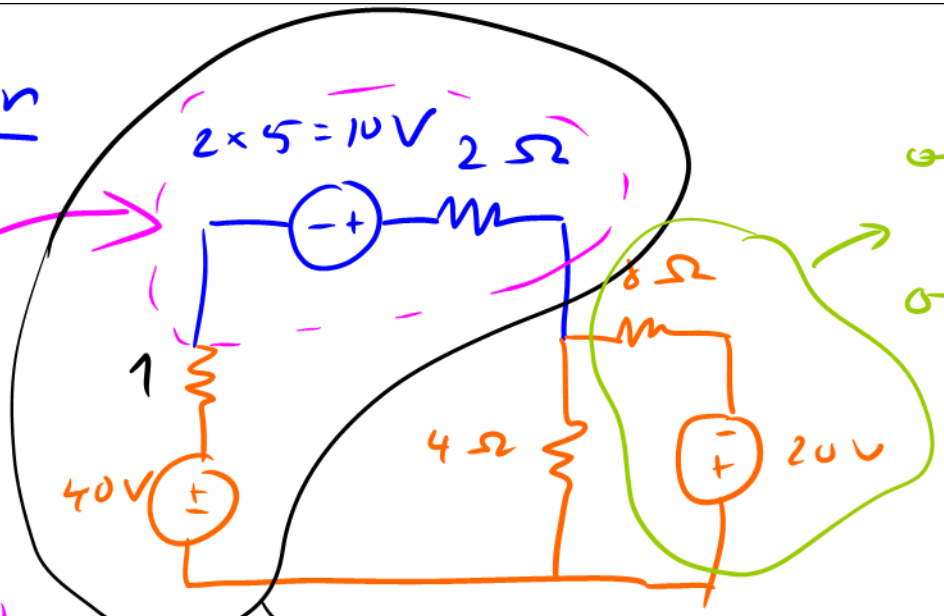


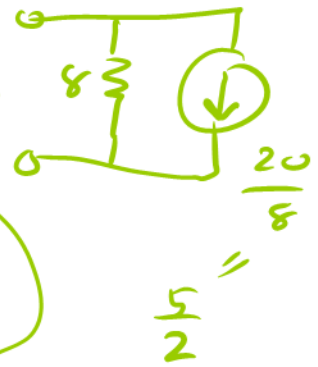
$$v_o = -\frac{60}{17}$$

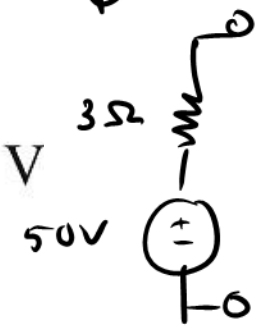
$$v_o = \frac{80}{17} + \frac{320}{17} - \frac{60}{17} = \boxed{20\text{V}}$$

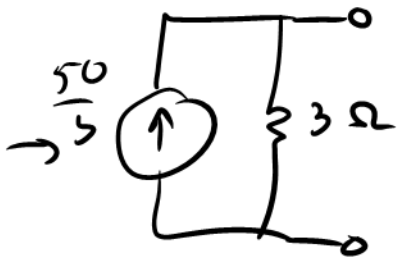
Source Transformation



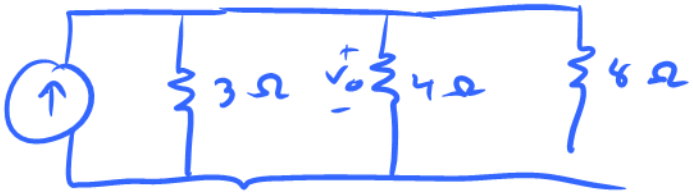








$\frac{85}{6} = \frac{50}{5} - \frac{5}{2}$



$v_o = \frac{85}{6} \times \frac{24}{17}$

$= \boxed{20\text{ V}}$