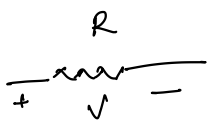
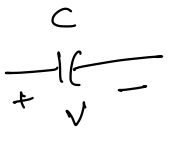
EE16B Discussion

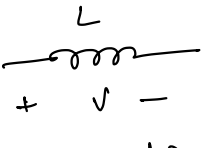
Circuit elements.



$V = IR$

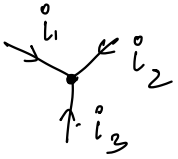


$i = C\frac{dV}{dt}$

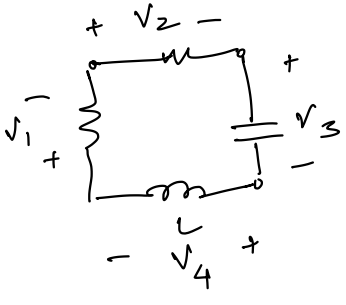


$V = L\frac{di}{dt}$

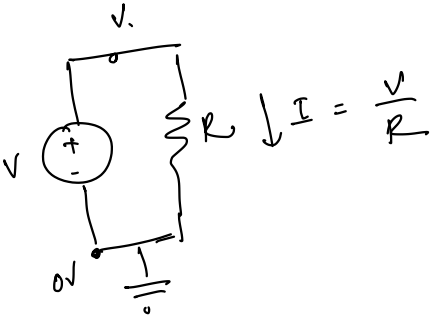
KCL, KVL →



$i_1 + i_2 + i_3 = 0$

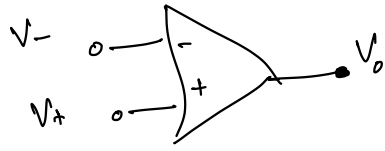


$V_1 + V_2 + V_3 + V_4 = 0$



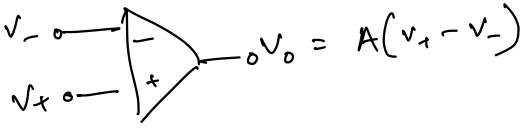
$I = \frac{V}{R}$

op-amps

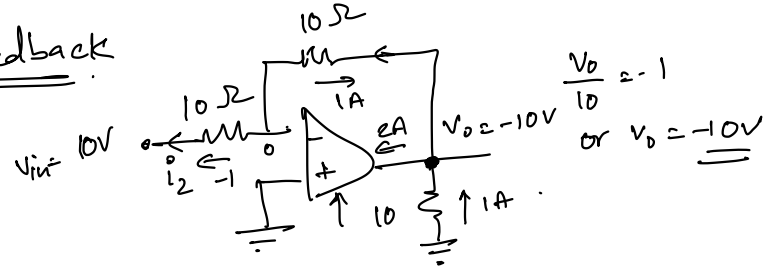


if $V_+ > V_-$ → V_0 is a large + value

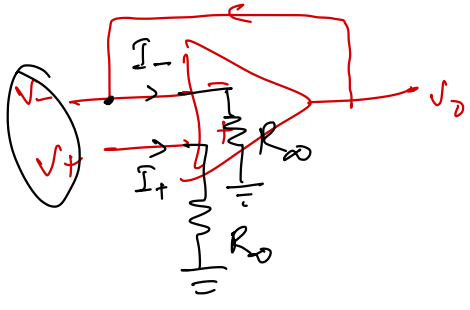
otherwise if $V_+ < V_-$ → V_0 is a large − value.



Negative feedback



Golden Rules



- $I_- = I_+ = 0$
- $V_- = V_+$

1 KCL

Consider the circuit shown below:

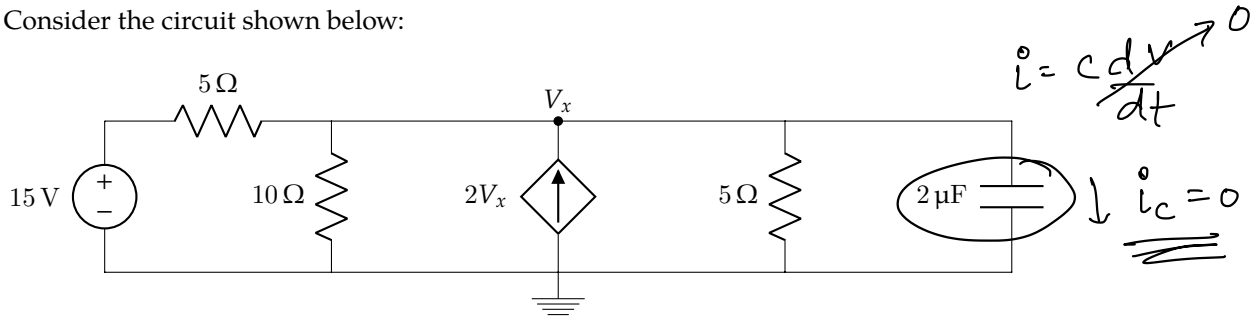
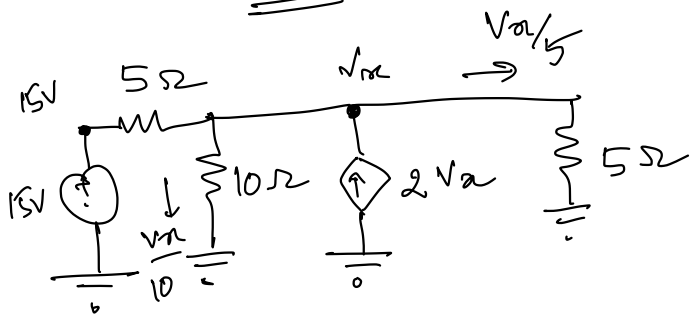


Figure 1: Adapted from Ulaby, Maharbiz, Furse. *Circuits*. Third Edition

Determine the voltage V_x at steady state.



$$-2V_a + \frac{V_a}{5} + \frac{V_a}{10} + \frac{V_a - 15}{5} = 0$$

$$-20V_a + 2V_a + V_a + 2V_a - 30 = 0$$

$$-15V_a - 30 = 0$$

$$V_a = -2V$$

2 KVL

Consider the circuit shown below:

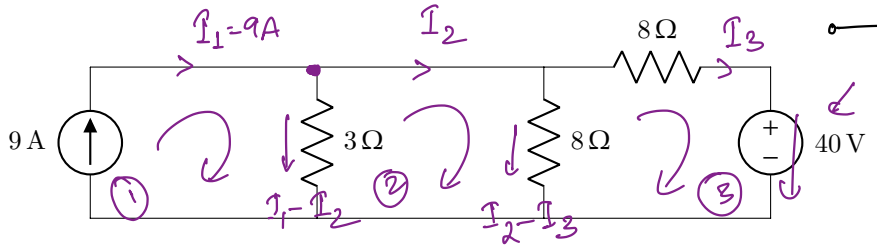
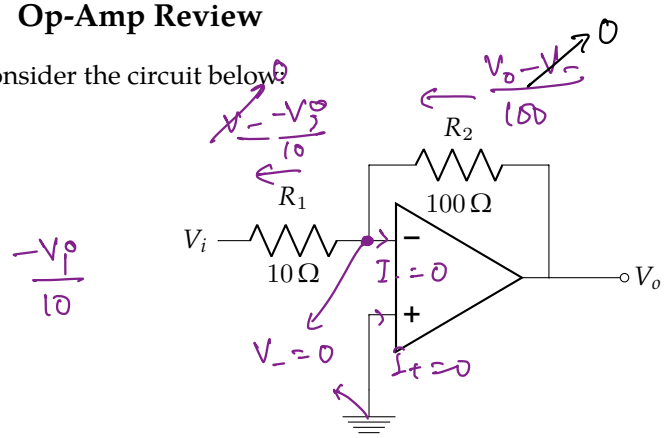


Figure 2: Adapted from Ulaby, Maharbiz, Furse. *Circuits*. Third Edition.

Using KVL, determine the amount of power supplied by the voltage source. Do not use superposition.

3 Op-Amp Review

Consider the circuit below:



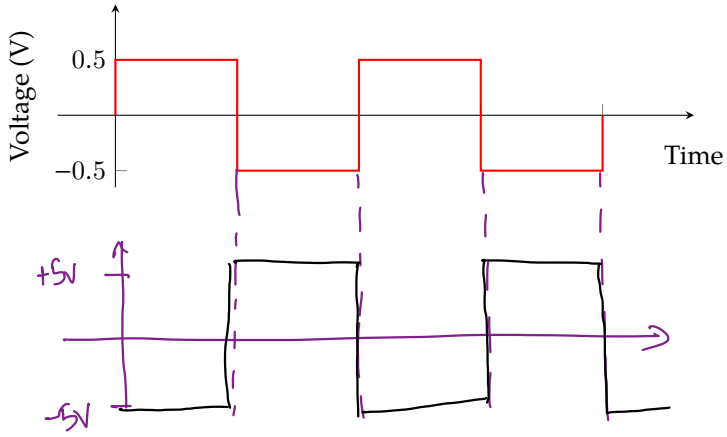
a) Calculate V_o if V_i if $V_i = 0.5\,\text{V}$.

$$\frac{V_o}{100} - \left(\frac{-V_i}{10}\right) = 0$$

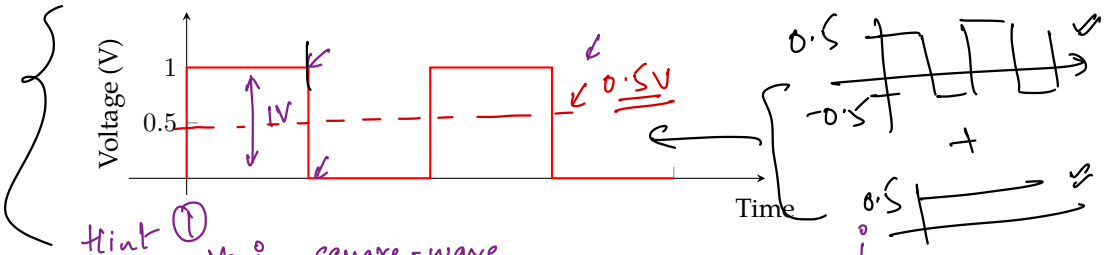
$$\Rightarrow \frac{V_o}{100} = -\frac{V_i}{10} \quad \text{or} \quad V_o = -10V_i$$

$$V_o = -10 \times 0.5 = -5\text{V}$$

b) Sketch V_o if V_i is a square wave with $V_{pp} = 1\,\text{V}$.



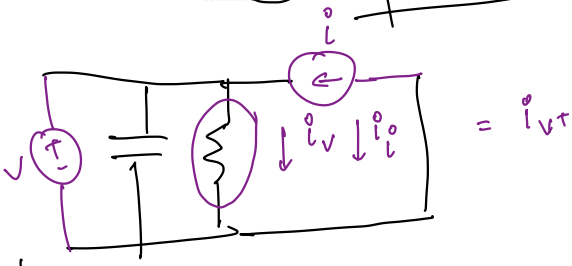
c) Use **superposition** to sketch V_o if V_i is a $1\,V_{pp}$ square wave with a $0.5\,V$ DC offset.

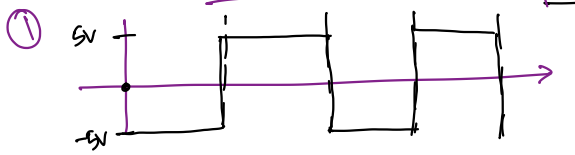


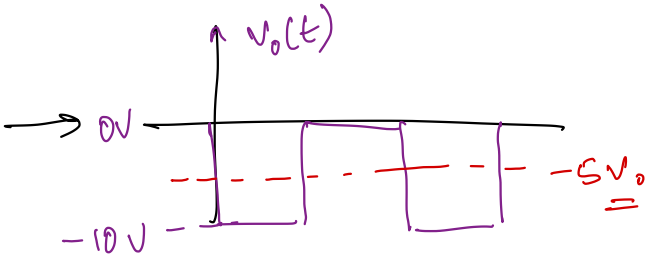
Hint ① V_o is square-wave with no DC offset

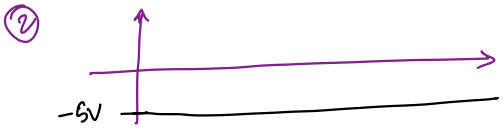
+

② V_o is constant at 0.5 V

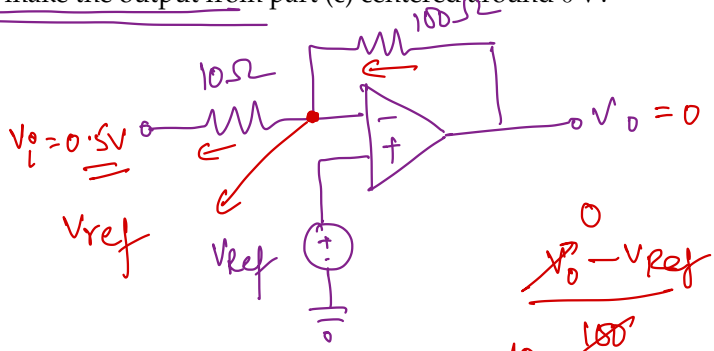








d) Consider the non-inverting input. What value could we replace ground with to make the output from part (c) centered around $0\,V$?



$$\frac{\cancel{V_o}^{0} - V_{ref}}{10} = \frac{V_{ref} - 0.5}{\cancel{100}\ 10}$$

$$-V_{ref} = 10V_{ref} - 5$$

$$V_{ref} = \frac{5}{11}\ V.$$

e) Suppose we only have a $1\,\text{V}$ source, but still wish to center the output from (c) about $0\,\text{V}$. What circuit block should we place at the noninverting input to accomplish this goal?