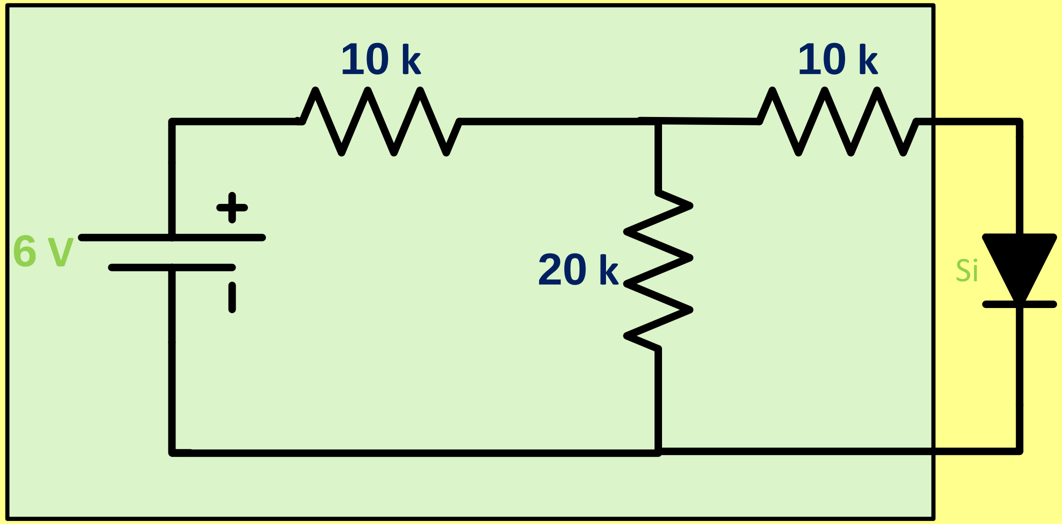
Diode large signal application

Example

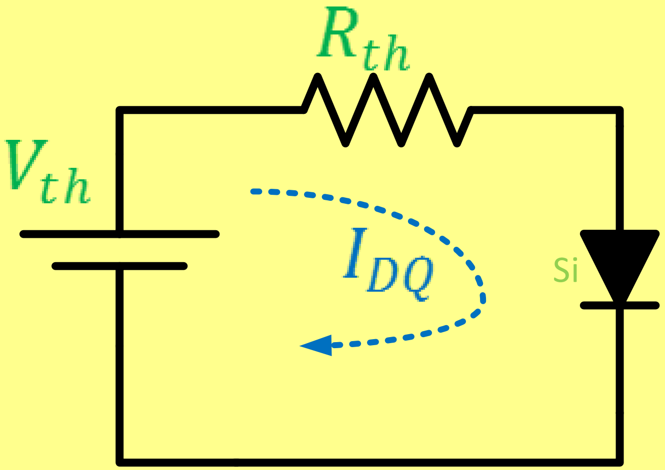
- Find the Q point



Using thevenin's theorem , the circuit is simplified to

$$R_{th} = 10k + 10k \,||\, 20k = 16.7k$$

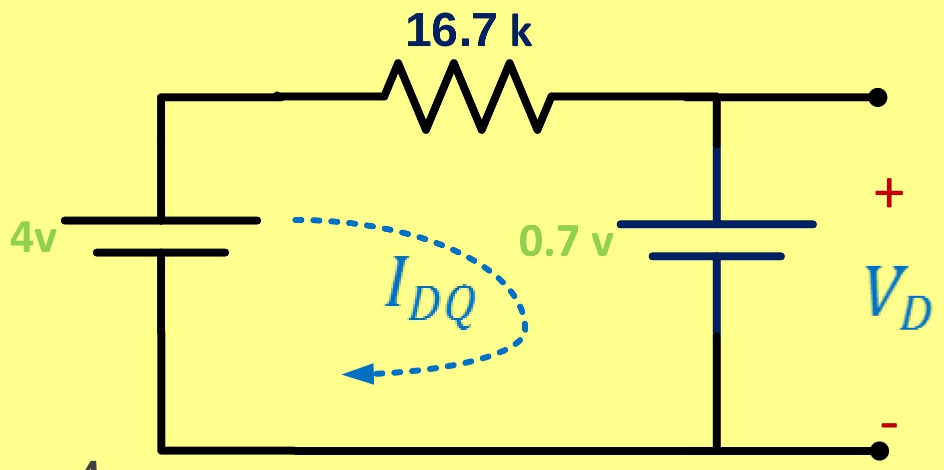
$$V_{th} = \frac{20k}{20k+10k} * 6 \; = 4\,V$$



since $V_{th} \geq \; V_k$, the diode is on

since $V_{th} < 10\,V_k$, we must use the knee voltage model

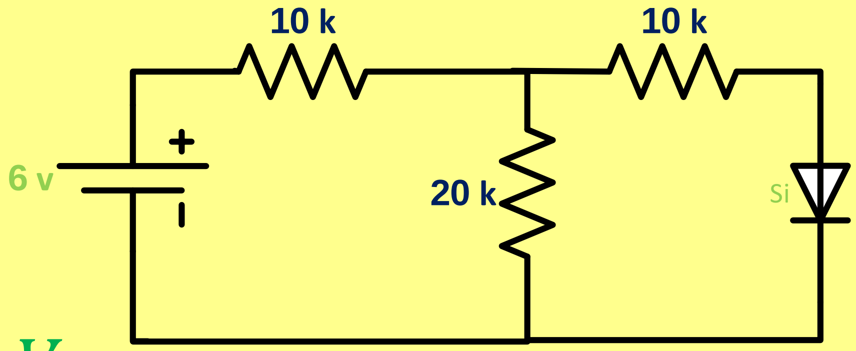
Knee voltage model



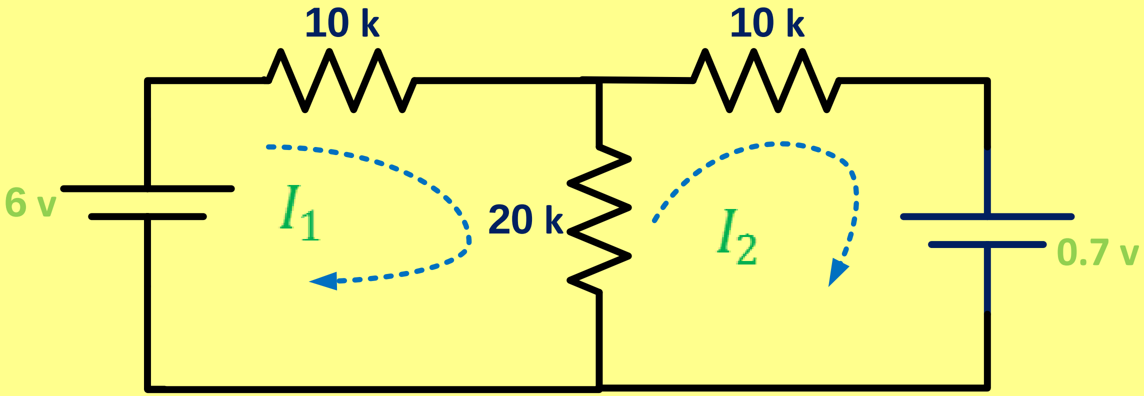
$$I_{DQ} = \frac{4 - 0.7}{16.7K} = 0.198\ mA$$

$$V_{DQ} = V_K = 0.7\ V$$

Second method



assume the diode is on , replace it with $V_K = 0.7\ V$



KVL:

$$6 \;=\; 30\, I_1 \;-20\, I_2$$
$$-0.7 = -20\, I_1 + 30\, I_2$$

Solve for:

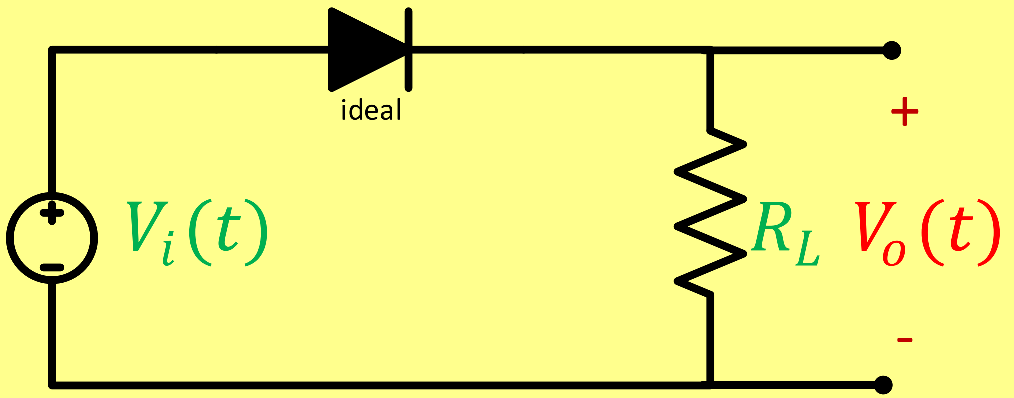
$$I_2 = 0.198\ mA$$

$$\therefore\ I_D = \ I_2 = 0.198\ mA$$

Since $I_D > 0$, $\therefore$ our assumption is ok

Diode large - signal application

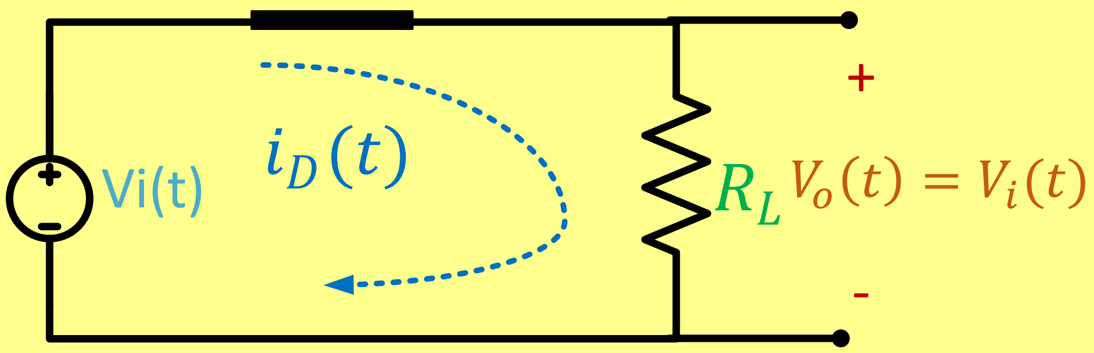
1) Diode clipper circuit



a) assume the diode is on

replace it with short circuit

$$i_D(t) > 0$$
$$i_D(t) = \frac{V_i(t)}{R_L} > 0$$
$$\therefore\ V_i(t) > 0$$

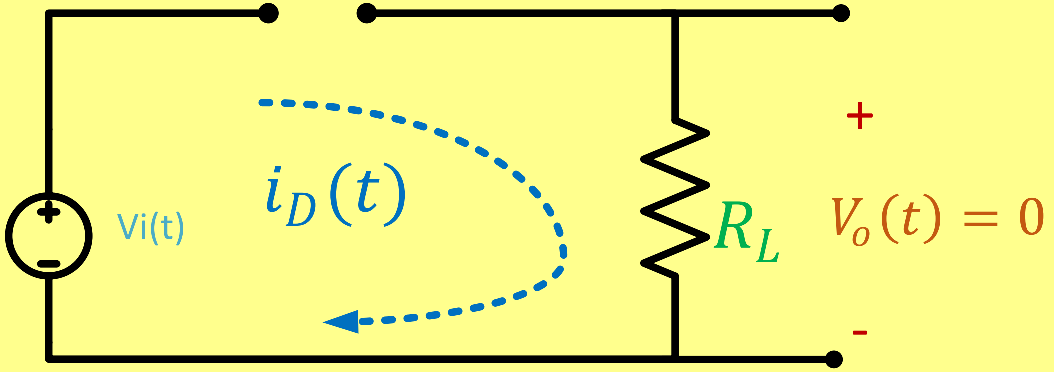


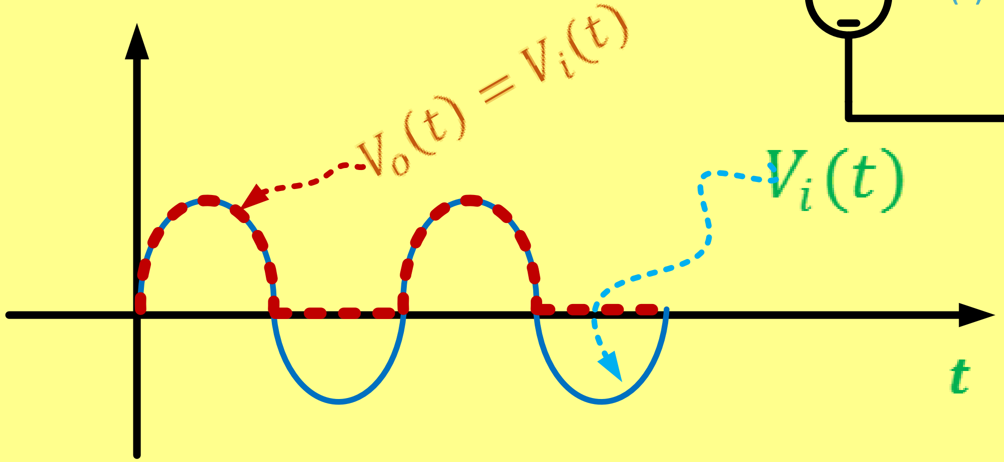
$\therefore$ when $V_i(t) > 0$, the diode is on and $V_O(t) = V_i(t)$

$\therefore$ when $V_i(t) < 0$, the diode is off and $V_O(t) = ?$.

∴ when $V_i(t) < 0$, the diode is off

$V_O(t) = 0$.





∴ the clipper circuit used to eliminate portion of the input signal .

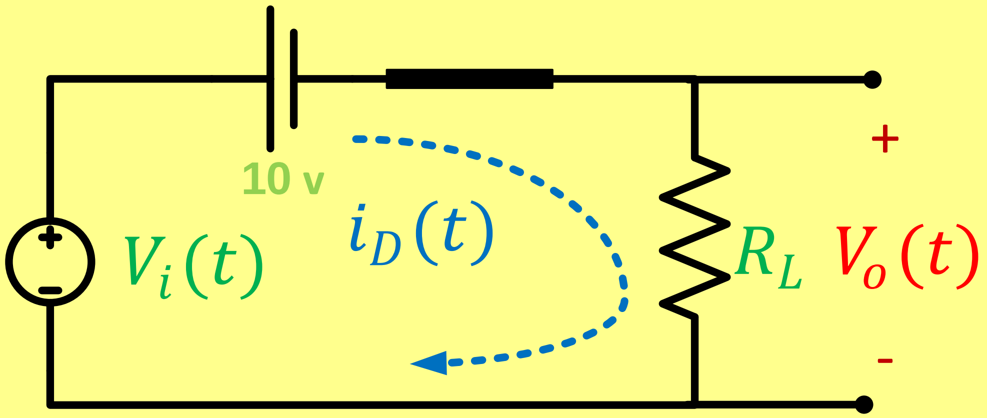
Example

a) assume that the diode is on

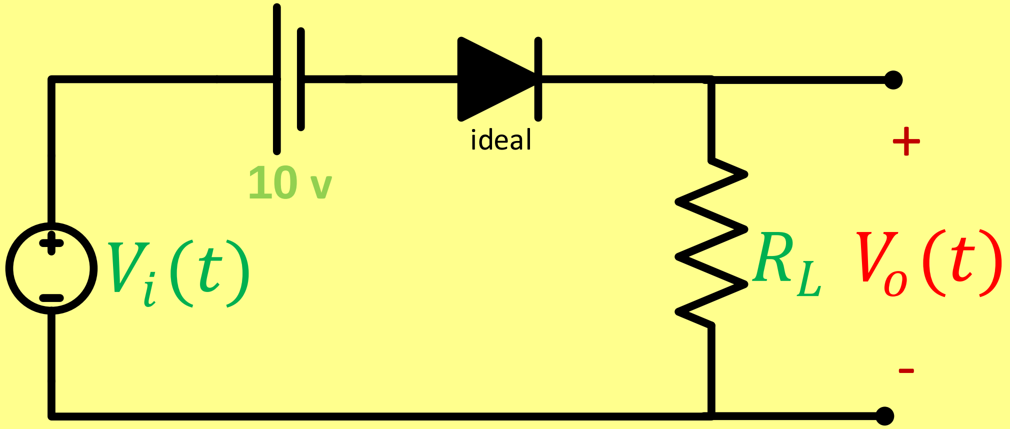
b) replace it with short circuit

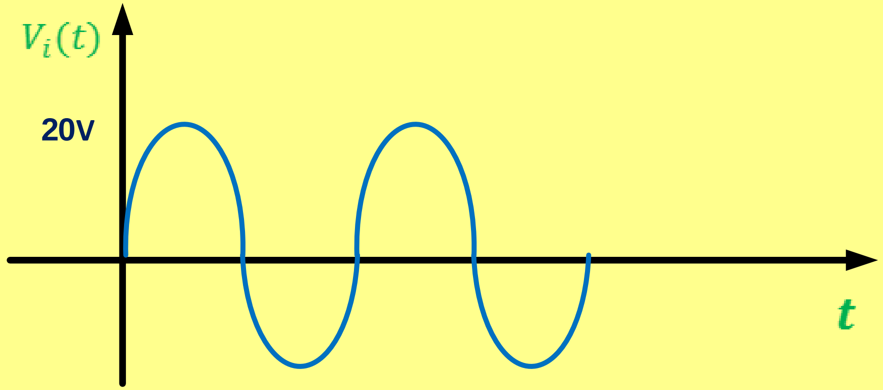
$$V_O(t) = V_i - 10$$

c) $i_D(t) > 0$

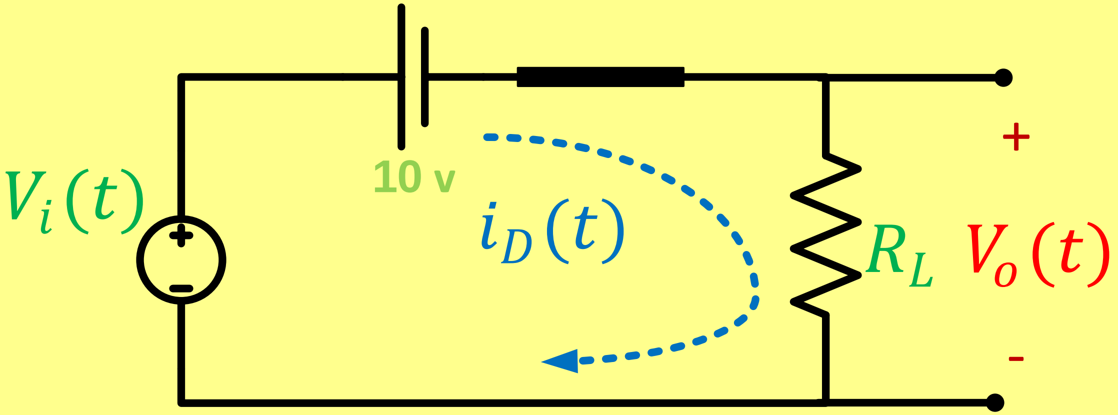


$$i_D(t) = \frac{V_i(t) - 10}{R_L} > 0$$





$$i_D(t) = \frac{V_i(t) - 10}{R_L} > 0$$



$$\therefore\ V_i(t) - 10 > 0$$

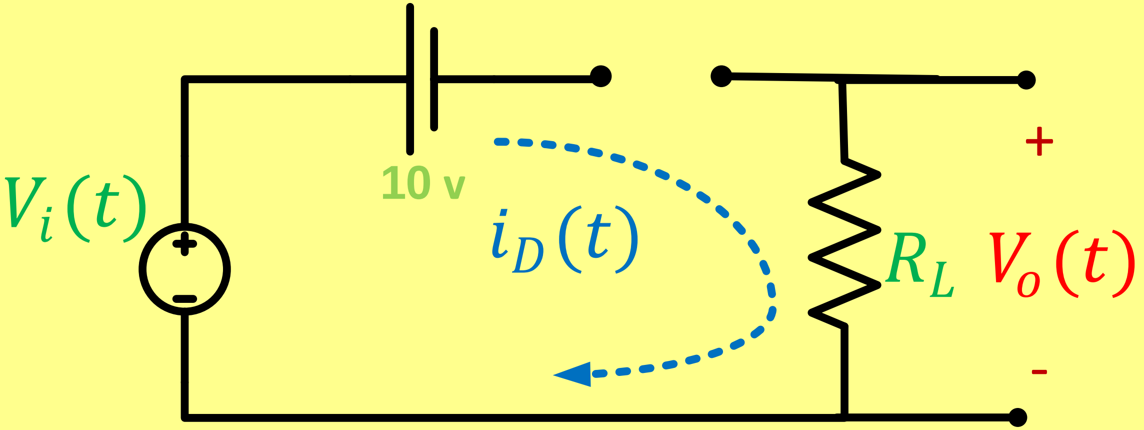
$$\therefore\ V_i(t) > 10$$

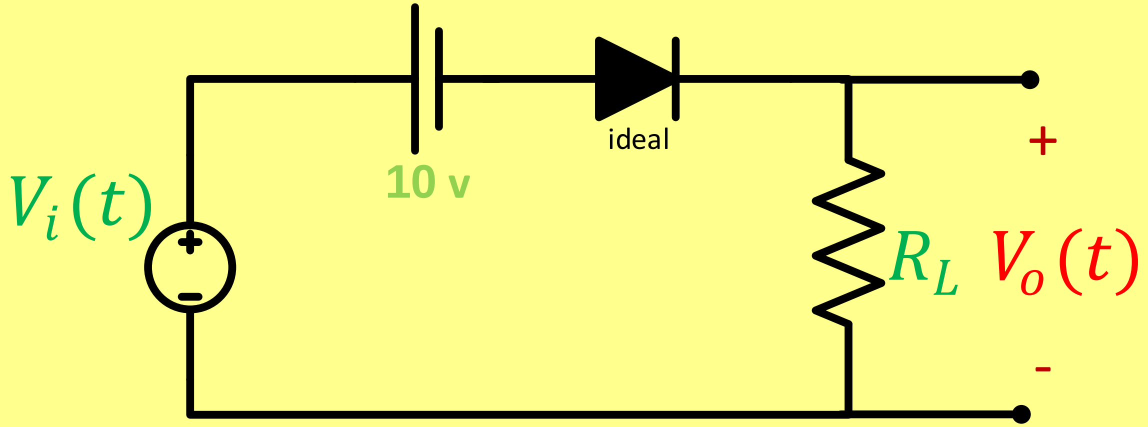
$$V_O(t) = V_i - 10$$

$\therefore$ when $V_i(t) > 10$ V , the diode is on and $V_O(t) = V_i - 10$

and also we can prove that when $V_i(t) < 10\,V$, the diode is off

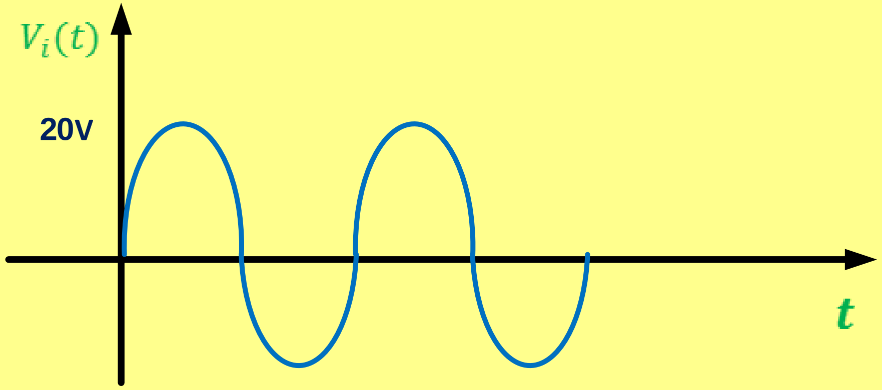
$$\therefore\ V_O(t) = 0$$

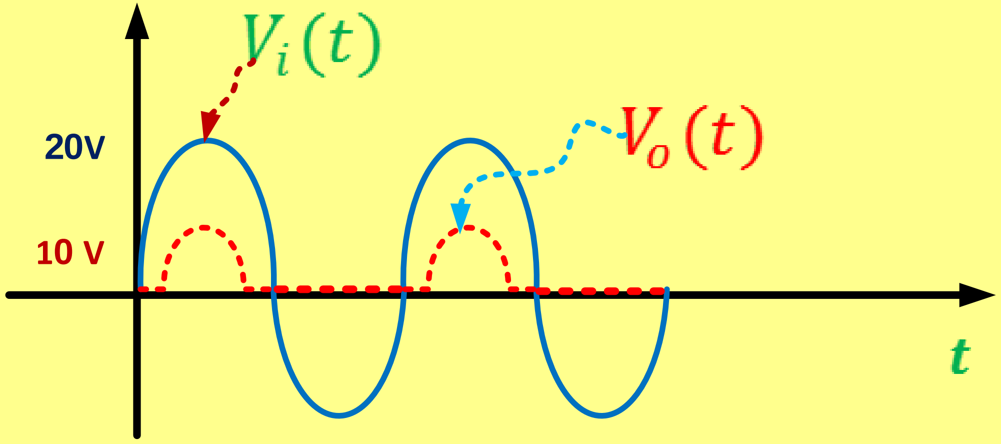




∴ when $V_i(t) > 10$ V , the diode is on and $V_O(t) = V_i - 10$

∴ when $V_i(t) < 10$ V , the diode is off and $V_O(t) = \ 0$



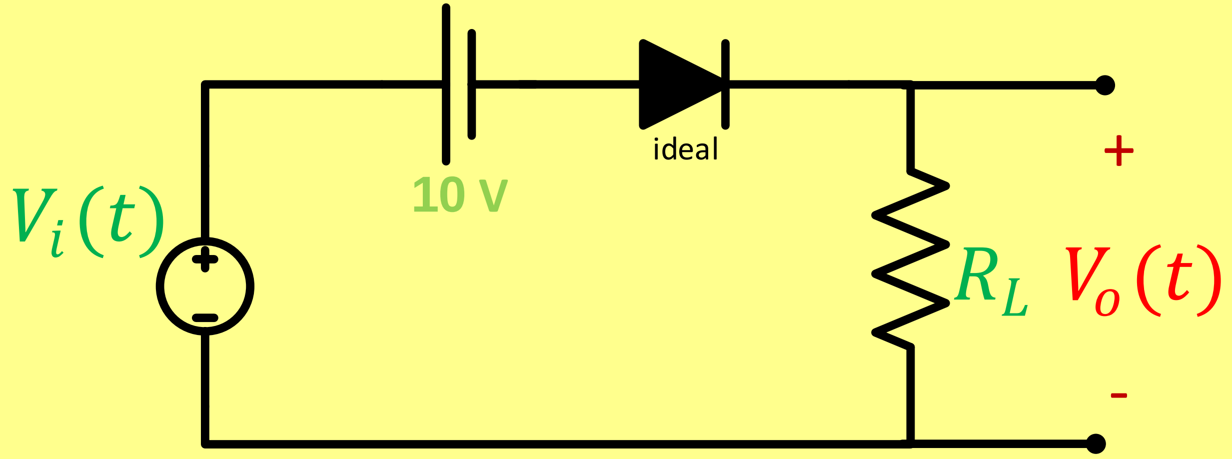


Second method

a) assume that the diode is off

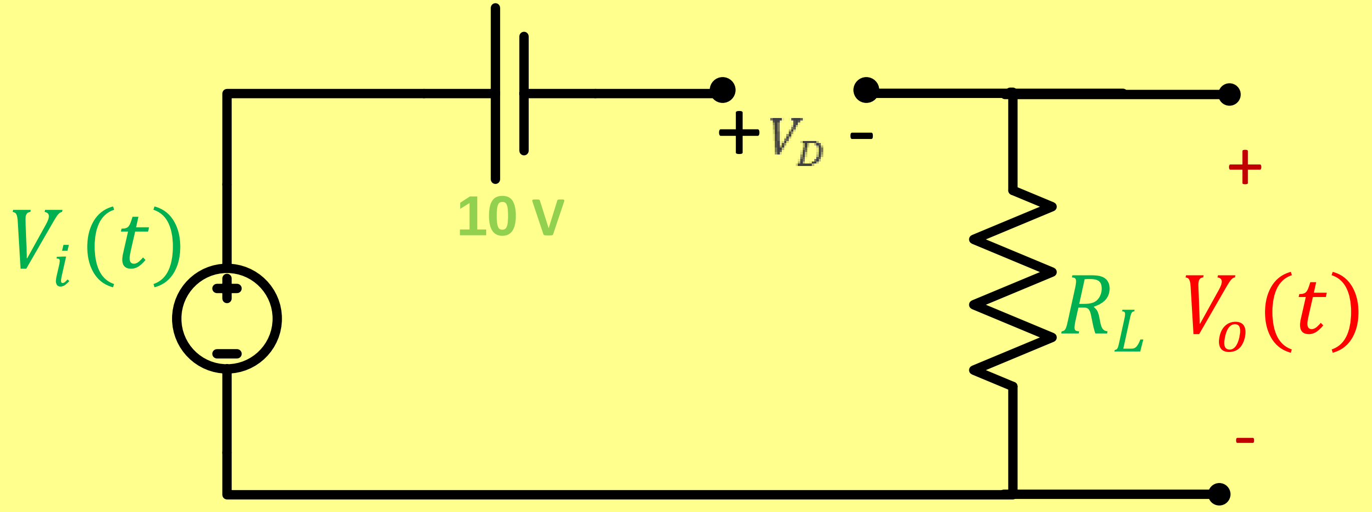
b) replace it with open circuit

c) $V_D(t) < 0$.



$$V_D(t) = -10 + V_i$$

$$V_i(t) < 10 \text{ V}$$



∴ when $V_i(t) < 10$ V , the diode is off and $V_O(t) = 0$