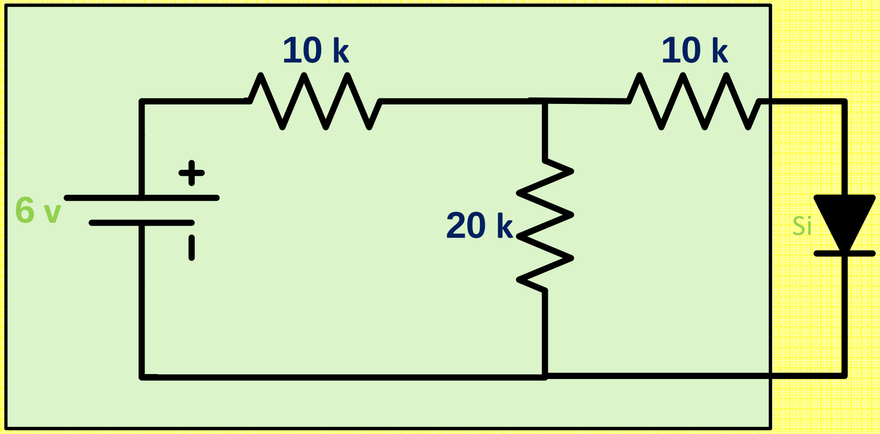
Diode large signal application

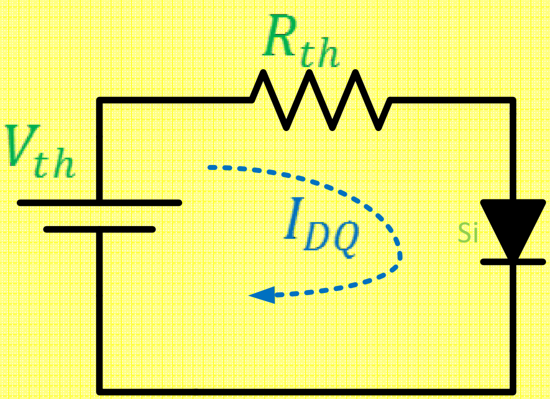
Example

- Find the Q point



Using thevenin's theorem , the circuit is simplified to

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

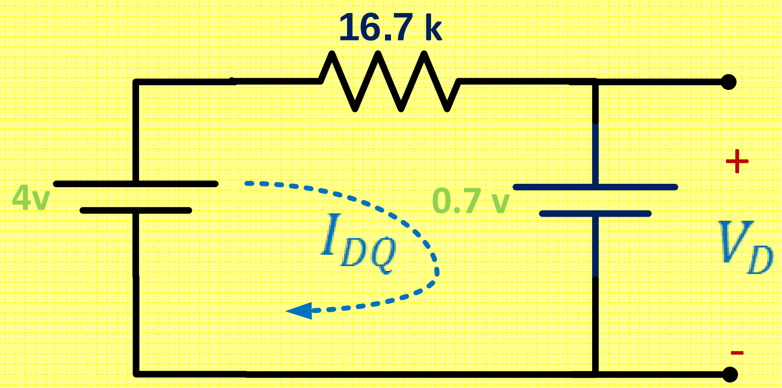


$V_{th} = \frac{20k}{20k+10k} * 6 \; = 4\,V$

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

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

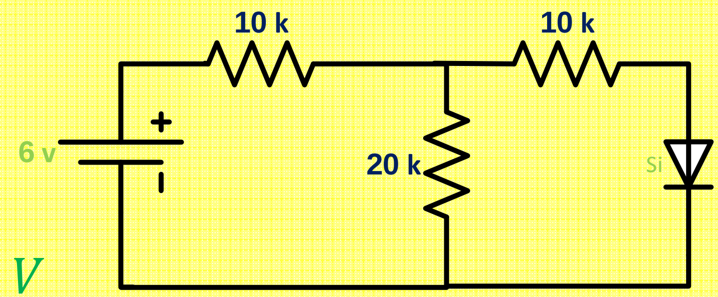
Knee voltage model



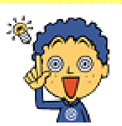
$$I_{DQ} = \frac{4 - 0.7}{16.7K} = 0.198\, mA$$

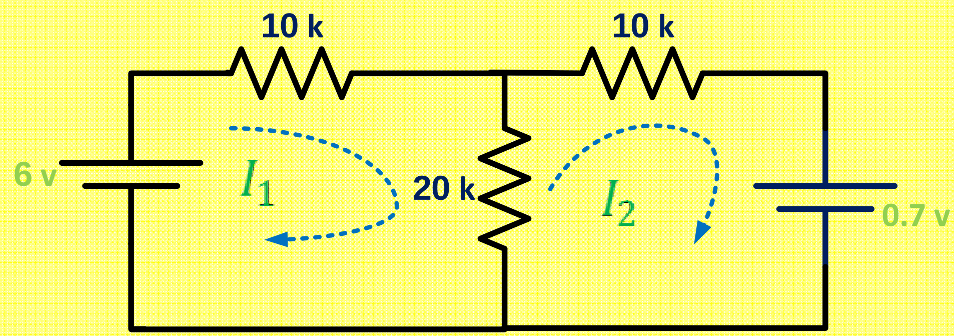
$$V_{DQ} = V_K = 0.7\, V$$

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:

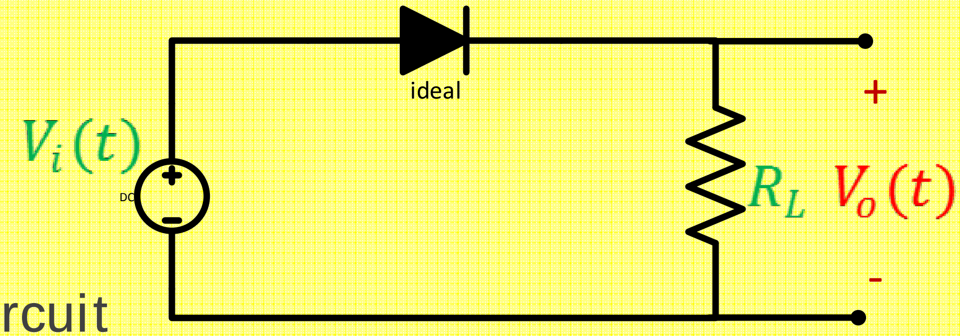
$$I_2 = 0.198\ \ mA$$

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

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

Diode large – signal application

1) Diode clipper circuit



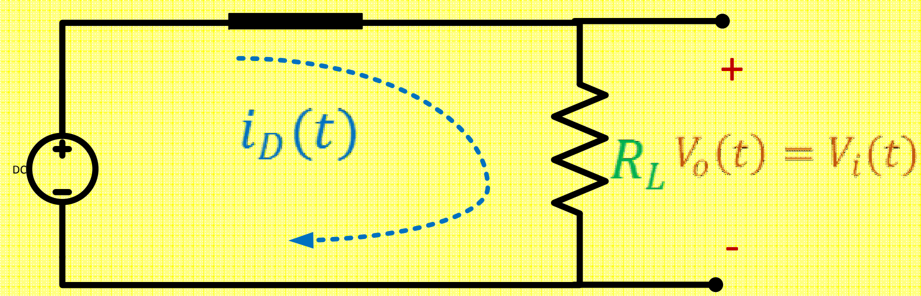
a) assume the diode is on

replace it with short circuit

$$i_D(t) > 0$$

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

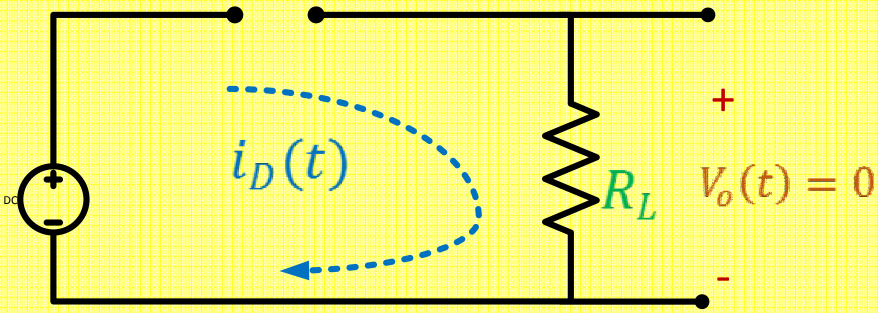
$$\therefore\ V_i(t) > 0$$

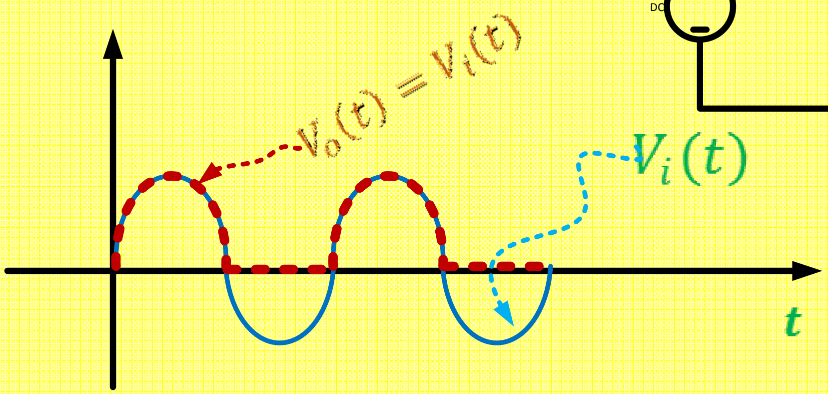


$\therefore$ when $V_i(t) > 0$, the diode is on and $V_O(t) = V_i(t)$

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

$V_O(t) = 0$.





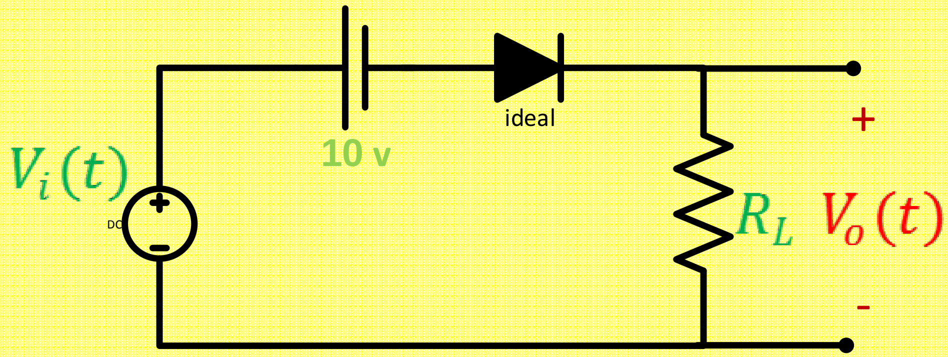
$\therefore$ the clipper circuit used to eliminate portion of the input signal .

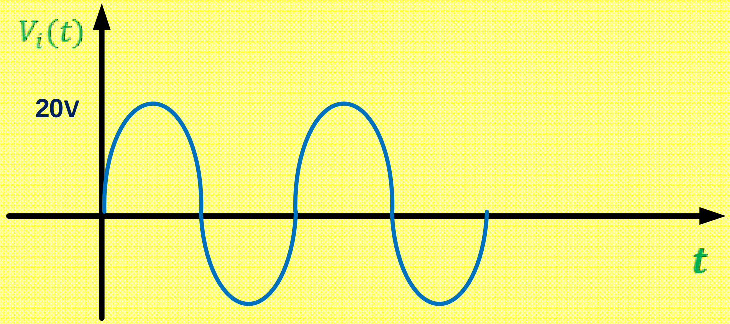
Example

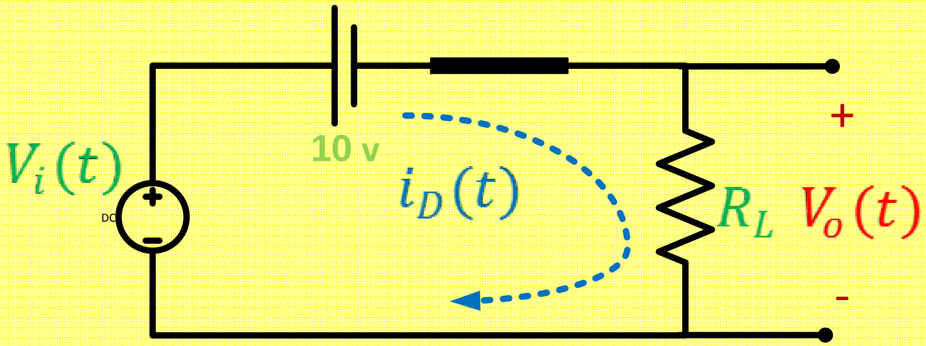
a) assume that the diode is on

b) replace it with short circuit

c) $i_D(t) > 0$







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

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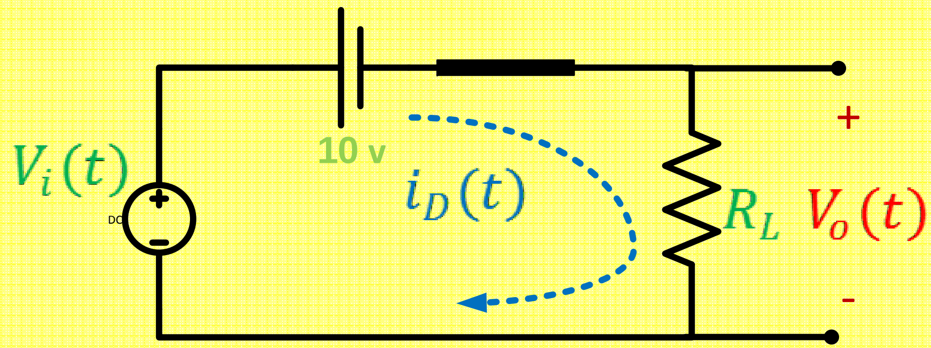


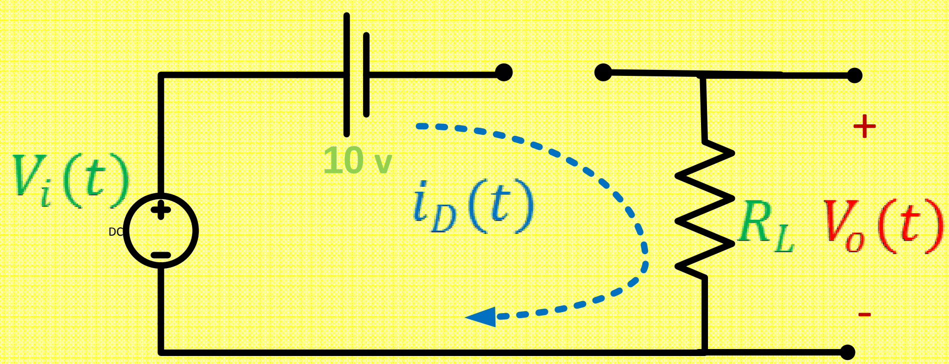
$\therefore\ V_i(t) - 10 > 0$

$\therefore\ V_i(t) > 10$

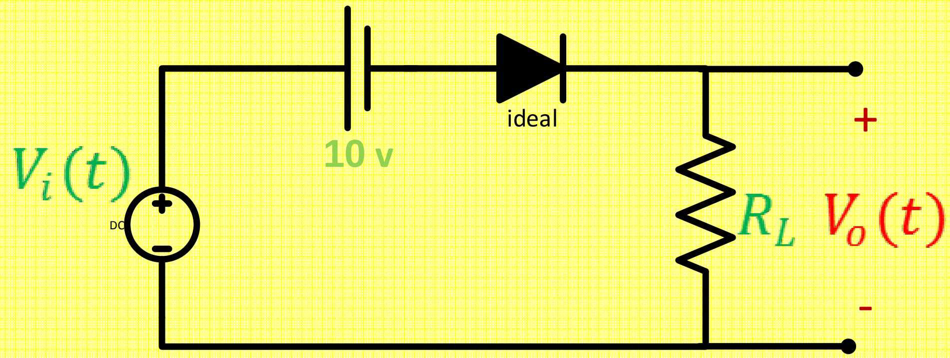
$\therefore$ when $V_i(t) > 10$ V , the diode is on and
$V_O(t) = V_i - 10$

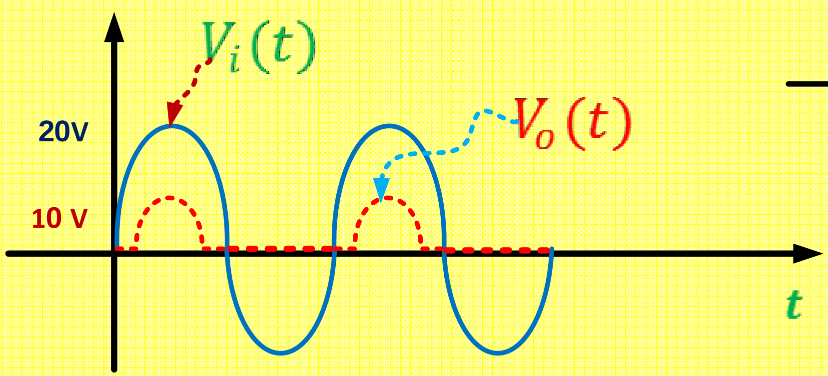
and also we can prove that when $V_i(t) < 10\,V$, the diode is off

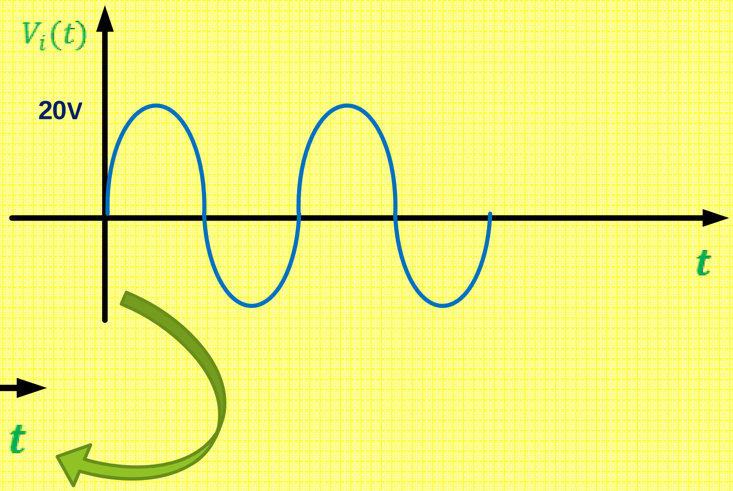
$\therefore\ V_O(t) = 0$



The output







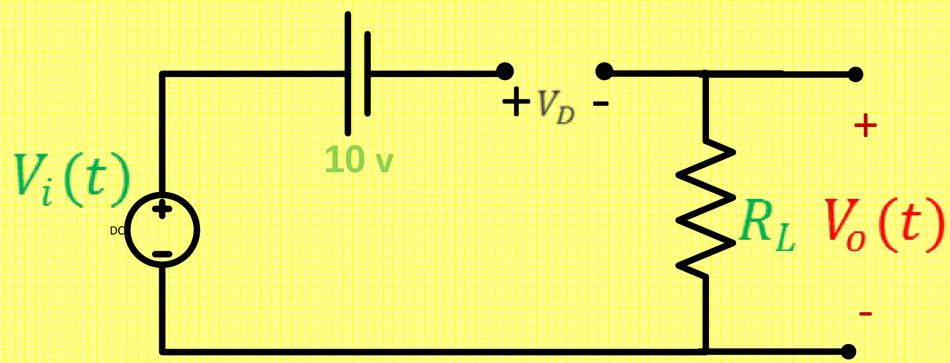
Second method

a) assume that the diode is off , b) replace it with open circuit , c) $V_D(t) < 0$.

$$V_D(t) < 0$$

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

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



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