Diode-Large-Signal-Applications Diode

Clipping at two independent levels

Clamping Circuits

Voltage Multipliers

Clipping at two independent levels

D_1 , D_2 are ideal

1) Assume D_1 on, and D_2 off

$V_o(t) = 5\ V$

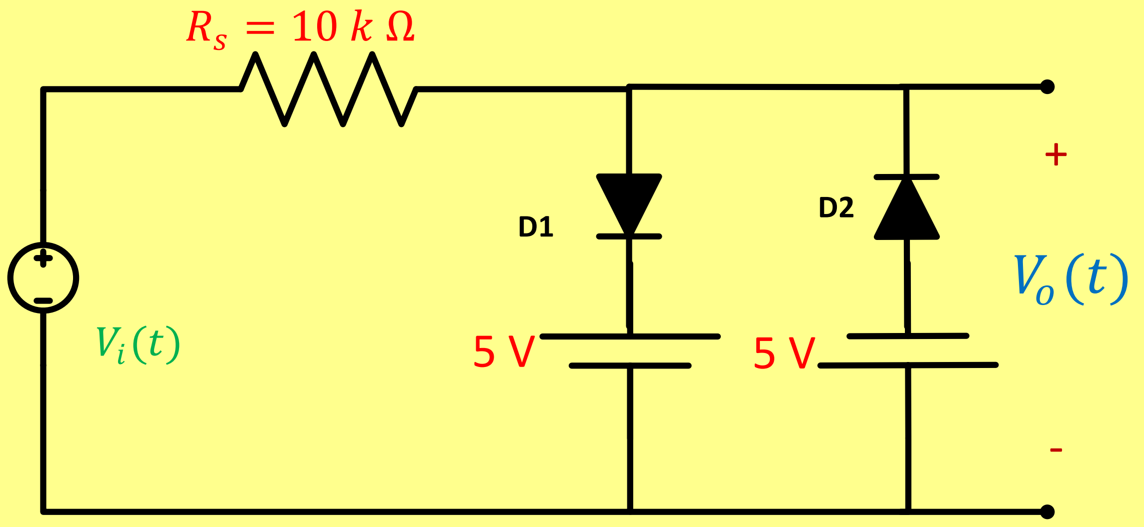
$i_{D1}(t) = \frac{V_i(t) - 5}{10k} > 0$

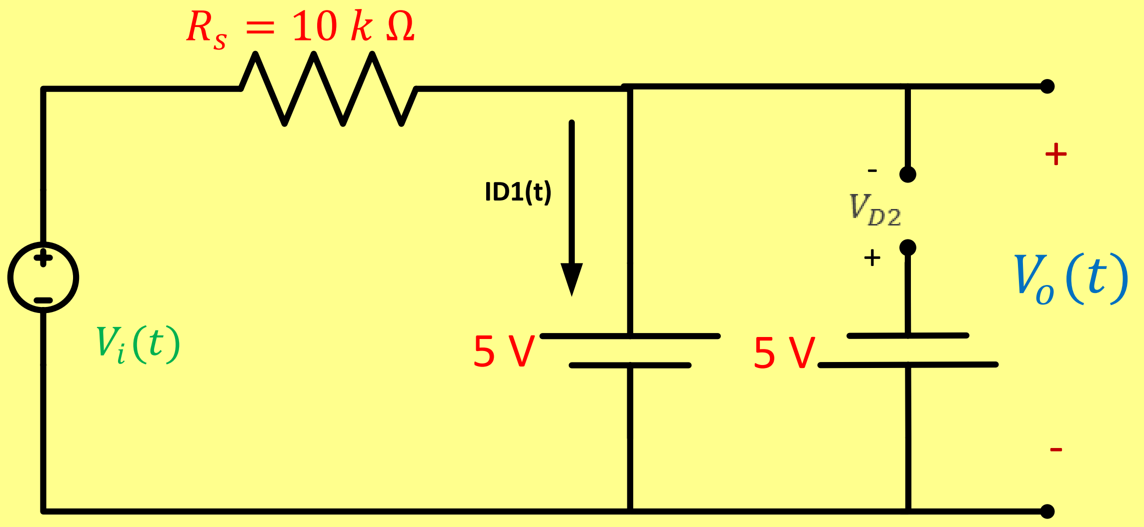
$\therefore\ V_i(t) - 5 > 0$

$\therefore\ V_i(t) > 5\ V$

$V_{D2}\ (t) = \ -5 - 5 = \ -10\ V$

$\therefore$ When $V_i(t) > 5\ V$, $V_o(t) = 5\ V$





- 2) Assume D_2 on, and D_1 off

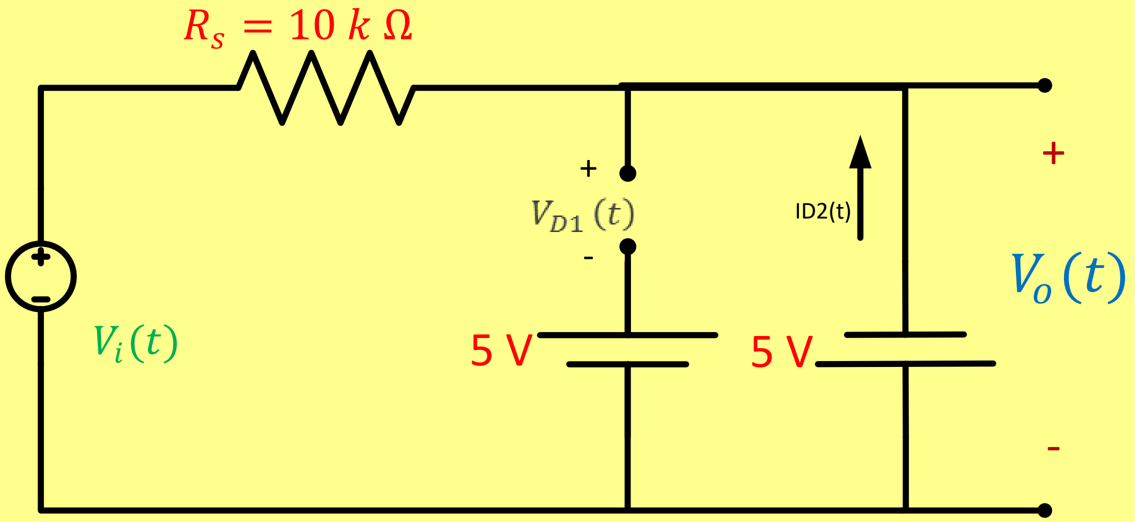
$$V_o(t) = -5\ v$$

$$i_{D2}(t) = \frac{-V_i(t) - 5}{10k} > 0$$

$$-V_i(t) - 5 > 0$$

$$\therefore\ V_i(t) < -5\ V$$

$$V_{D1}(t) = -5 - 5 = -10\ V$$

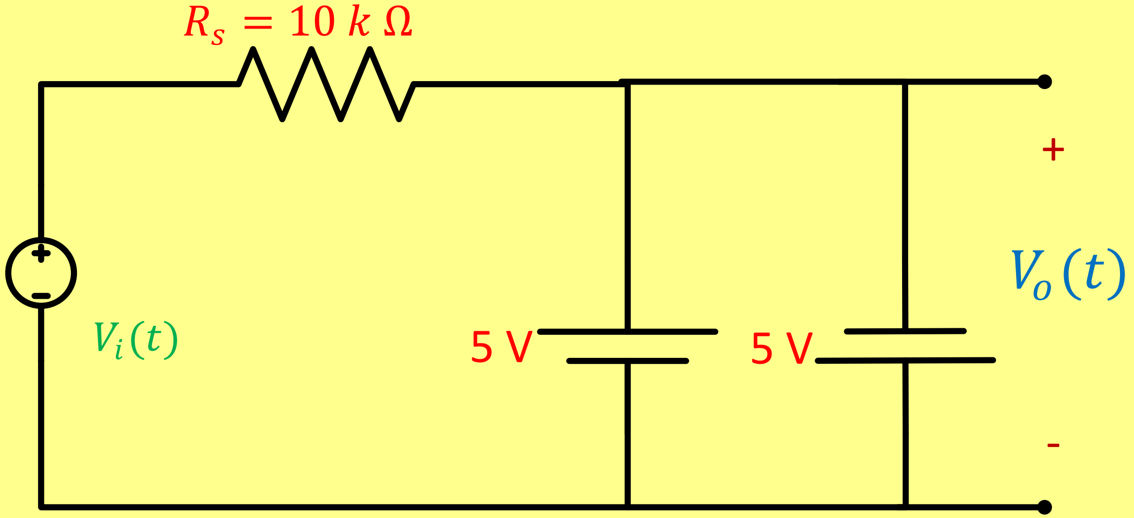


$\therefore$ When $V_i < -5v$, $V_o(\mathrm{t}) = -5V$

- 3) Assume that D_1 and D_2 are on

$V_o = -5\ v$

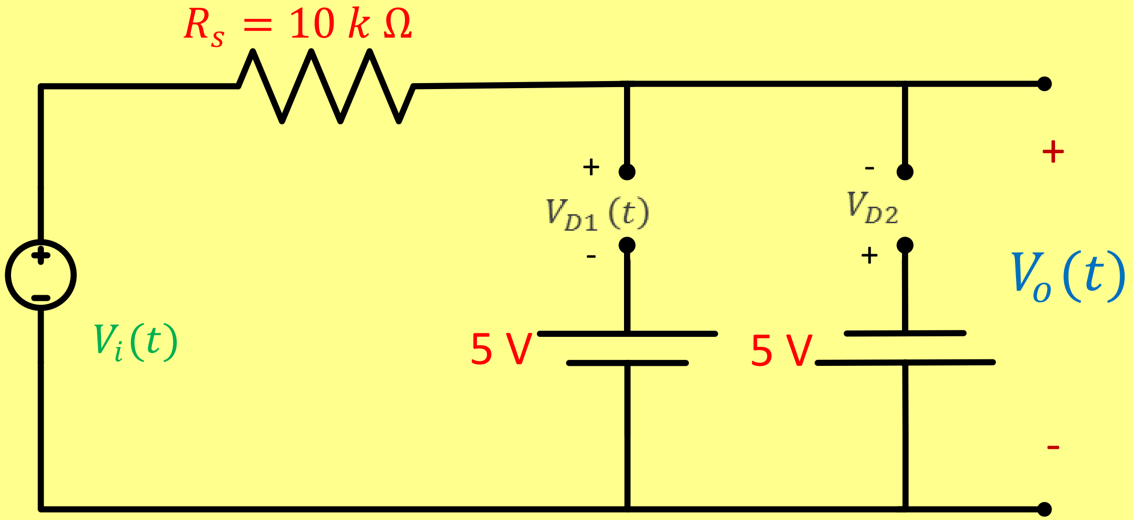
also V_o = +5v ??



This case is not valid

Impossible

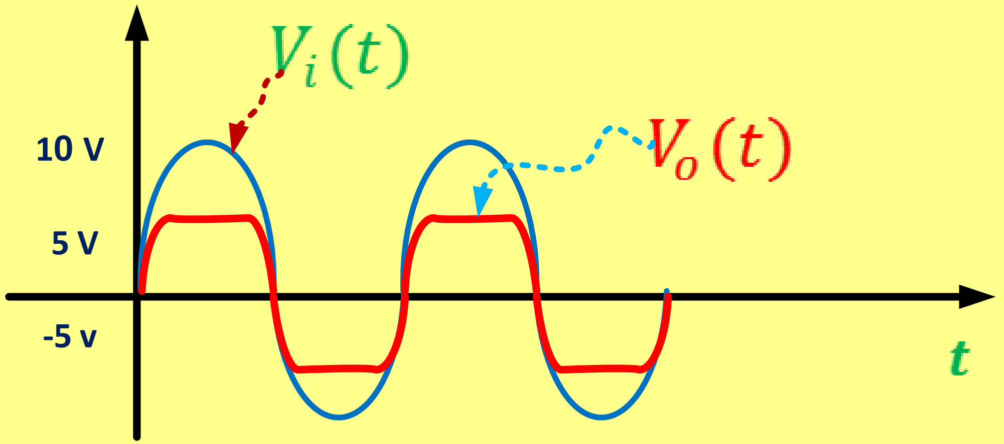
- 4) Assume that D_1 , and D_2 are off



- When +5 > $V_i(t)$ > -5

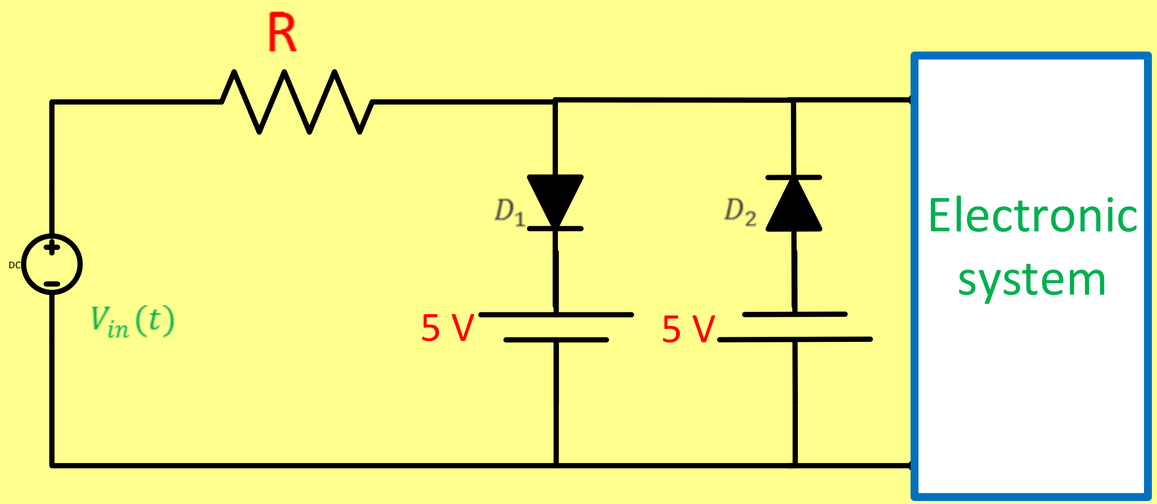
  $V_o(t)$ = $V_i(t)$

Clipping at two independent levels

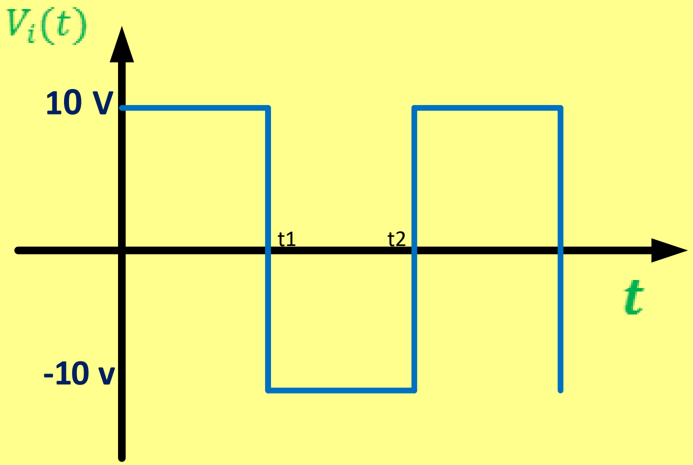


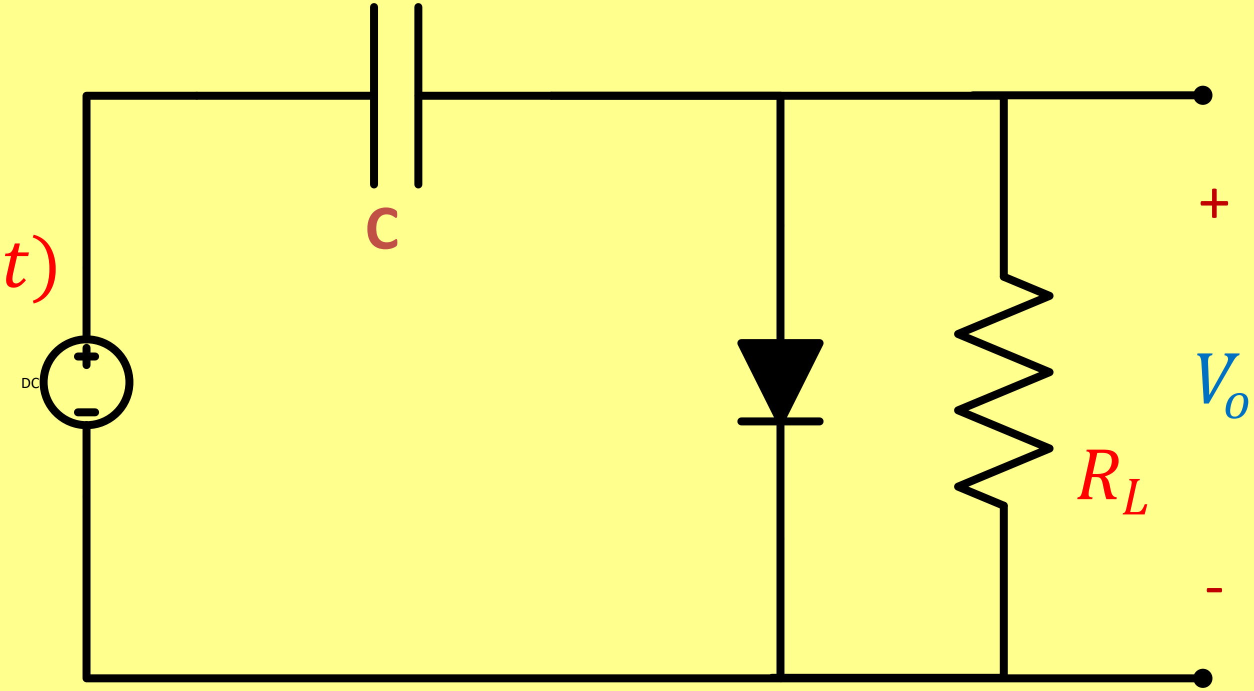
Limiter

For protection



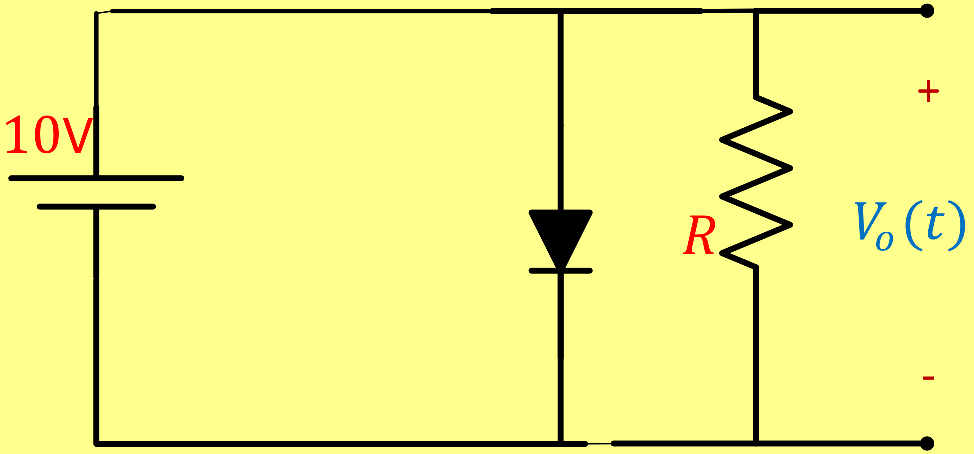
2) Clamping circuit





Diode is ideal , $V_c(0-)=0$

1) at t= 0^+



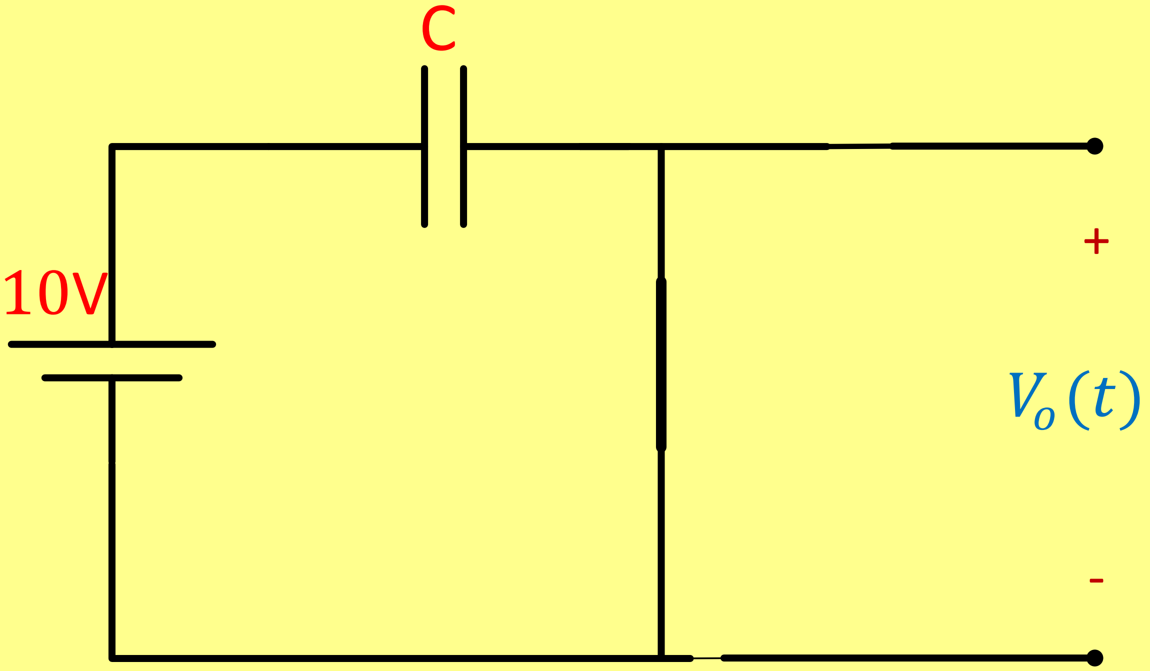
$V_i(0^+) = 10V$; $V_c(0^+) = V_c(0^-) = 0$

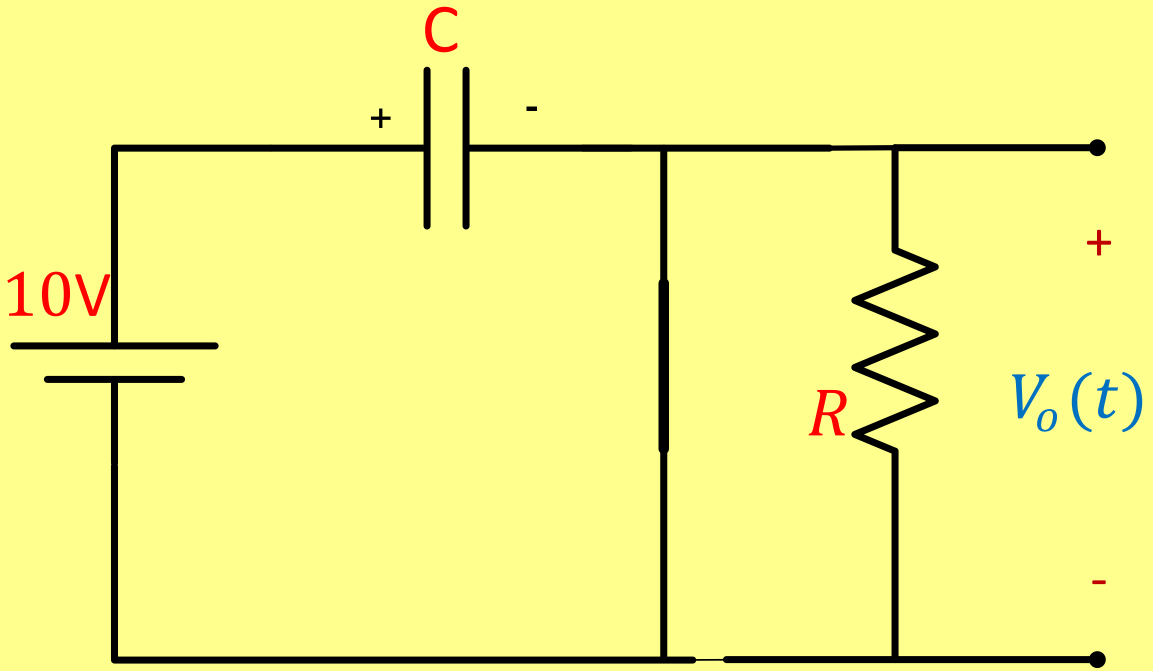
$\therefore\ V_D(0^+) = 10V$,

$\therefore$ **Diode is on and then replaced with short circuit**

In the interval $t_1 > t > 0^+$

- $V_i = 10\ V$, Diode is on (short)





$V_0(t) = 0$

and the capacitor charges toward $+10V$ in $5\tau = 5R_{eq}C = 0$

In the interval $t_2 > t > t_1$

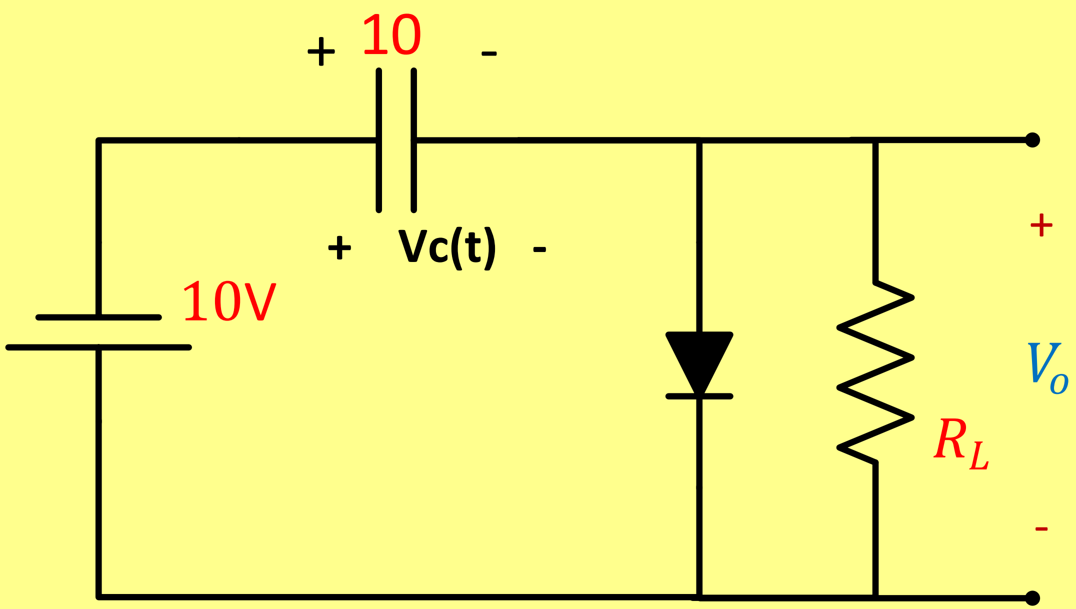
$V_i = -10\ V$

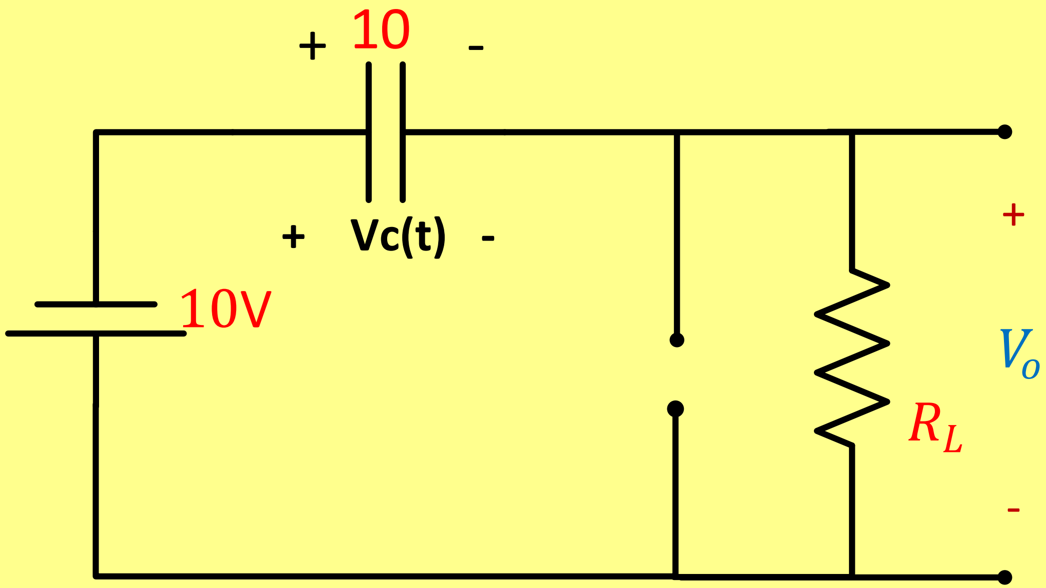
The diode is off and replaced with **open** circuit

- $\therefore V_0(t) = -V_c(t) - 10$
- $V_0(t) = -10 - 10$

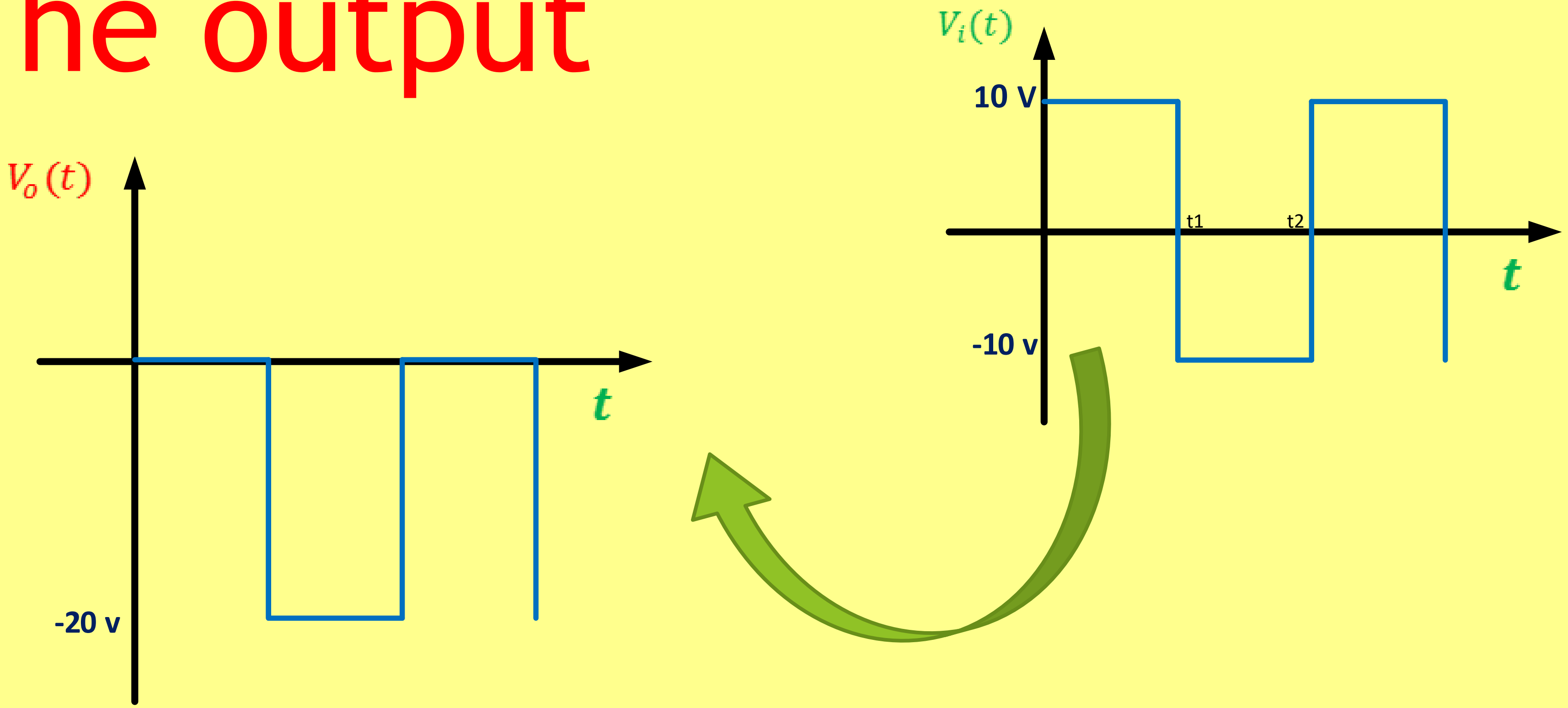
$V_0(t) = -20\ V$

We must choose $RC \gg (t_2 - t_1)$ so that $V_c(t) \equiv 10\ V$ in this interval

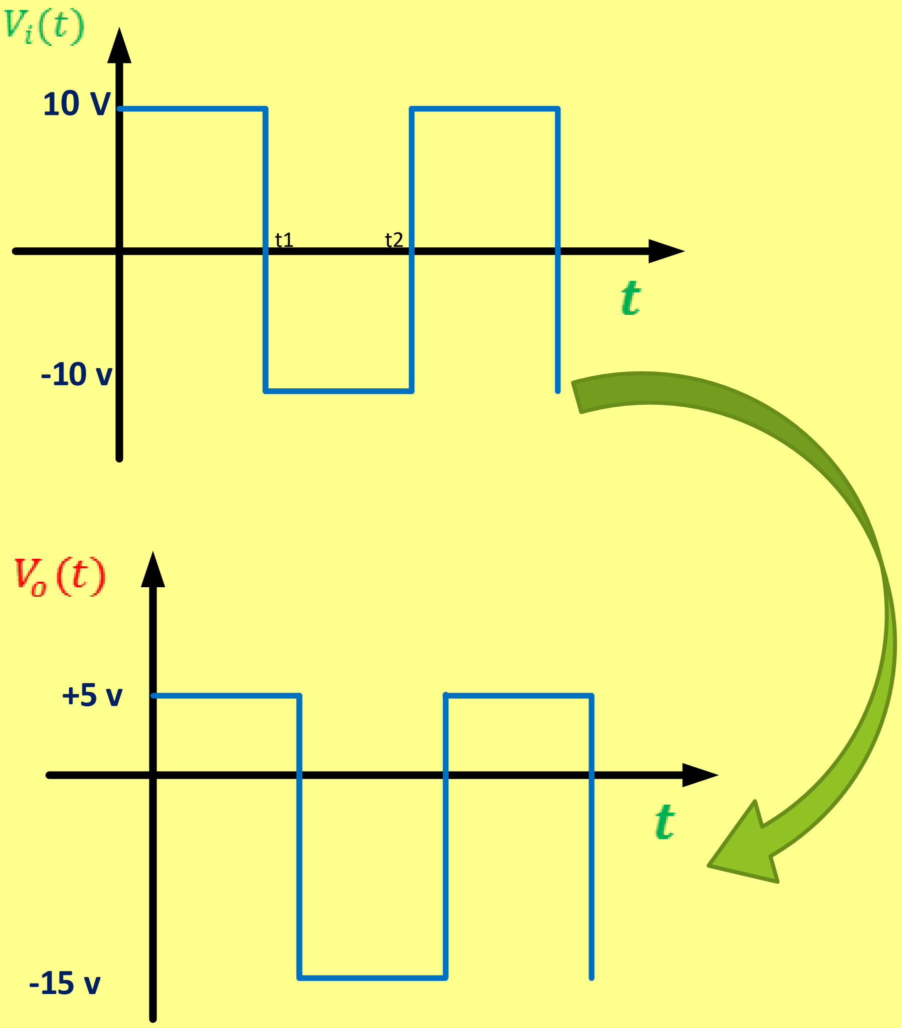


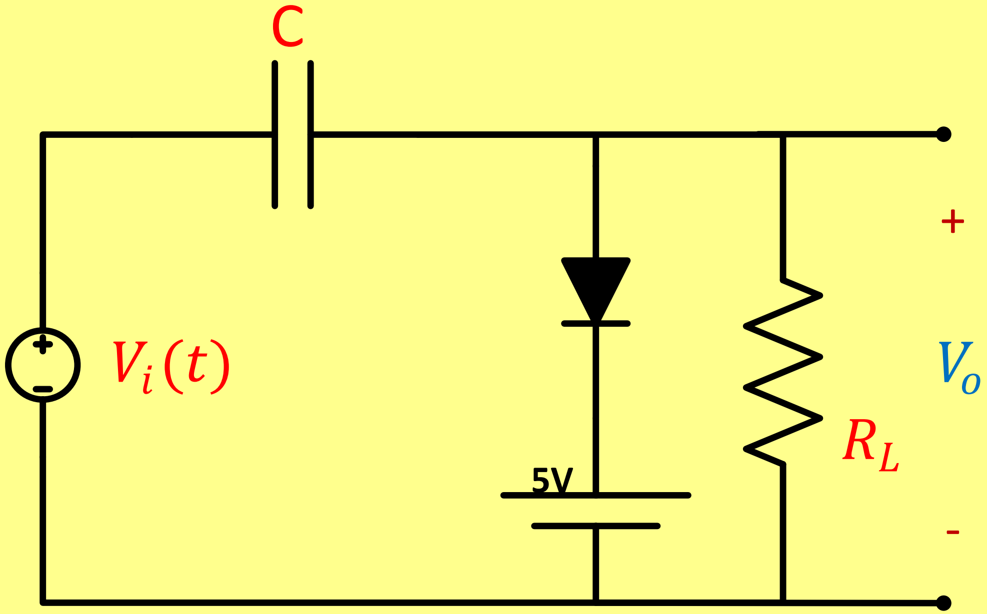


The output



Biased clamping circuit

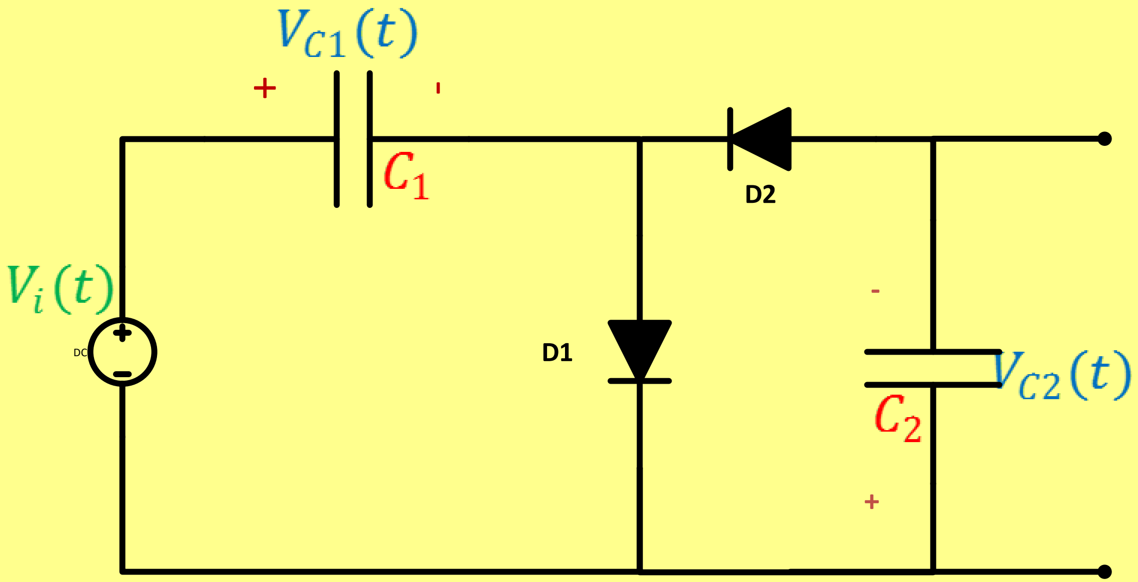




3) Voltage Multiplier

D_1 , and D_2 are ideal

$V_{c1}(0^-) = V_{c2}(0^-) = 0$

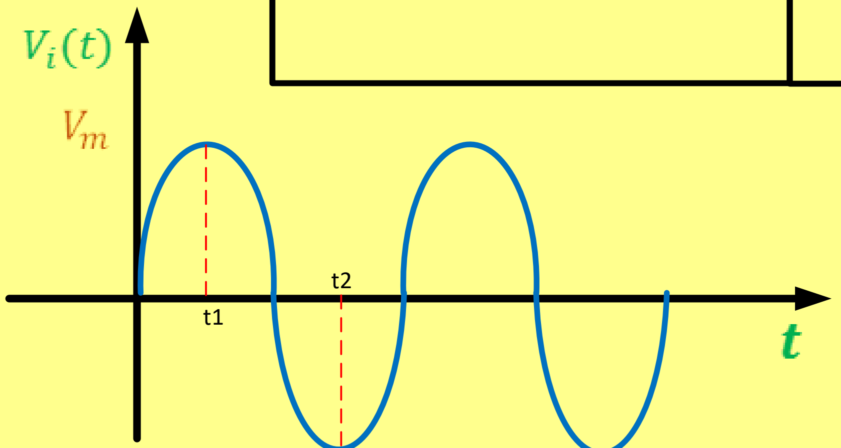


A) **at t = 0^+**

$$V_i(0^+) > 0 \quad V_{c1}(0^+) = V_{c2}(0^+) = 0$$

$$V_{D1}(0^+) > 0\text{V} \quad \therefore D_1 \text{ on}$$

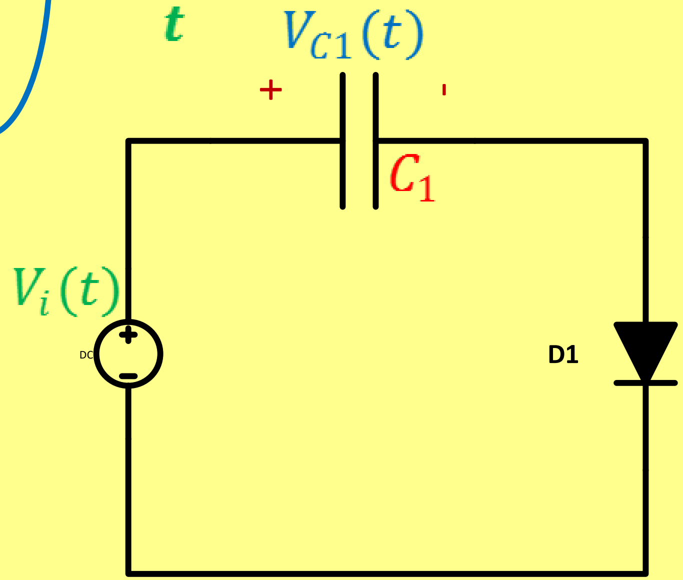
and $V_{D2}(0^+) < 0\text{V} \therefore D_2$ **off**



B) in the interval $t1 > t > 0$

The capacitor C1 charges towards V_m

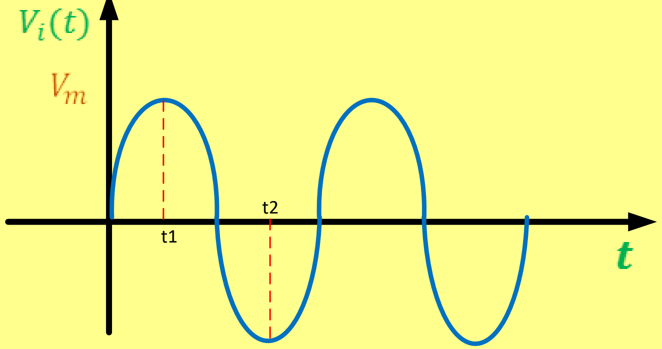
at t_1 ; $V_c(t_1) = V_m$

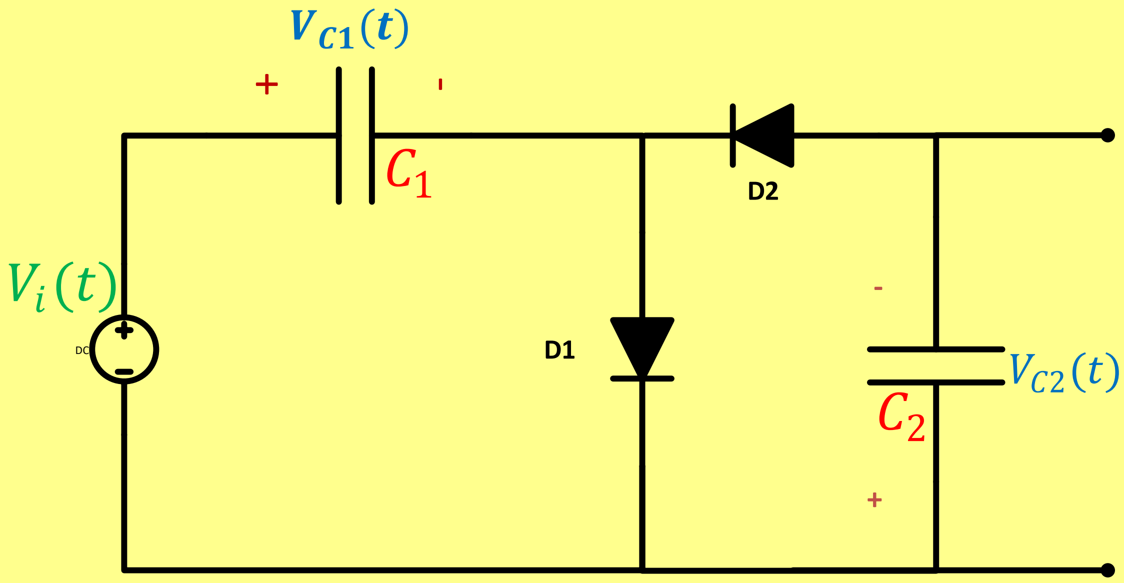


- C) at $t = t_1^+$

  $V_{c1}(t_1^+) = V_m$

  $V_i(t_1^+) < V_m \therefore D_1$ is off , and D_2 is on





- D) in the interval $t_2 > t > t_1$

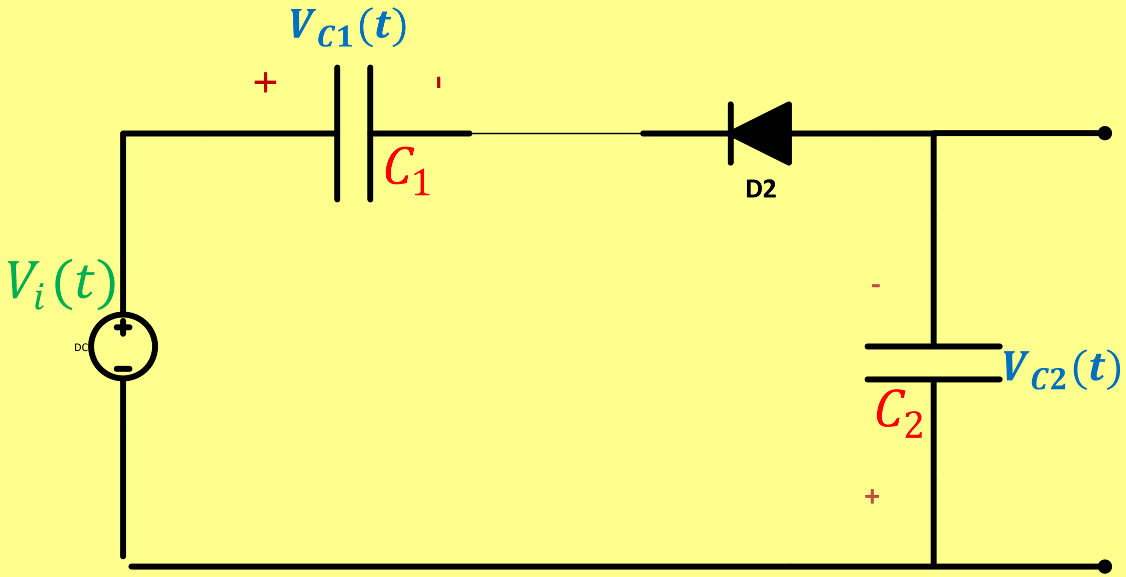
  C_2 charges toward $2V_m$

  at $t = t_2$

  $V_{c2}(t_2) = 2V_m$

  $V_{c2}(t_2) = -V_i(t_2) + V_m$

  $V_{c2}(t_2) = V_m + V_m = 2V_m$



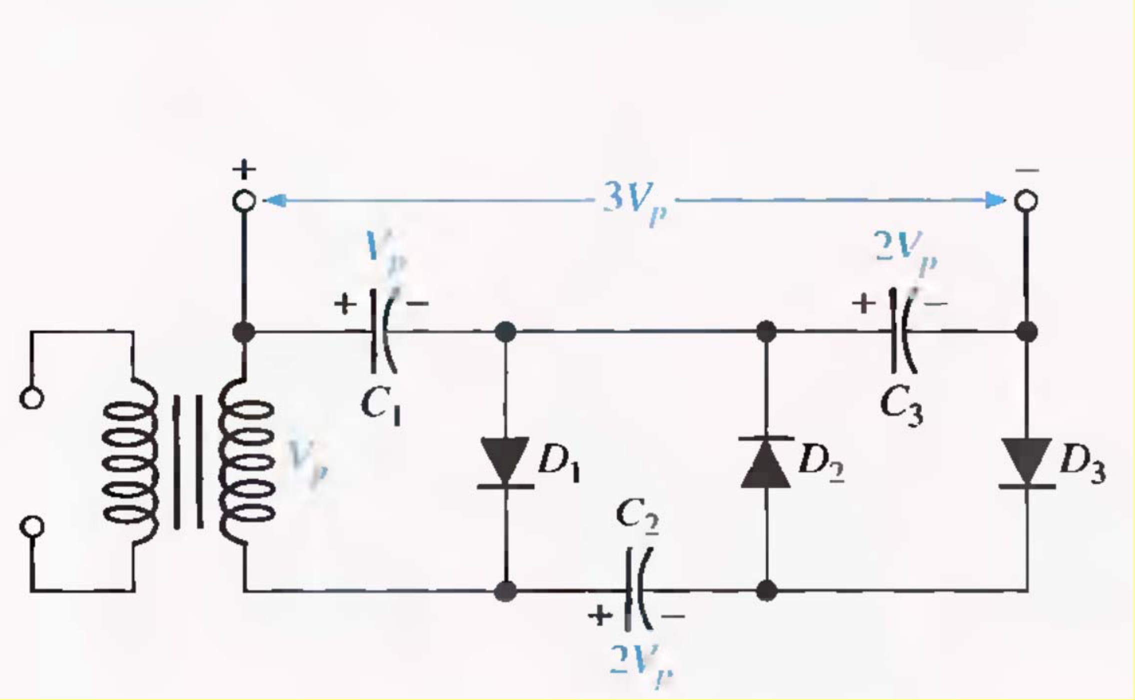
- E) at $t = t_2^+$

  D_2 is off, D_1 is off

  $V_{c1}(t_2^+) = V_m$

  $V_{c2}(t_2^+) = 2V_m$

Voltage Tripler



Voltage Quadrupler