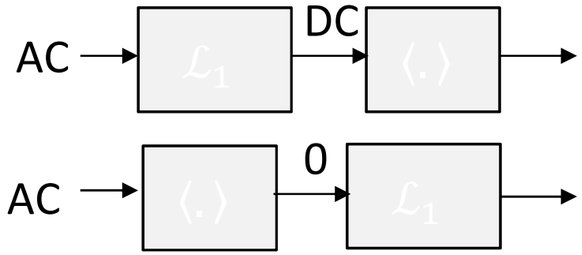
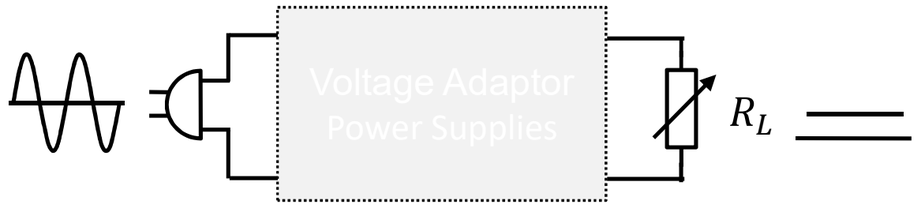
Session6 Electronics1

Diodes

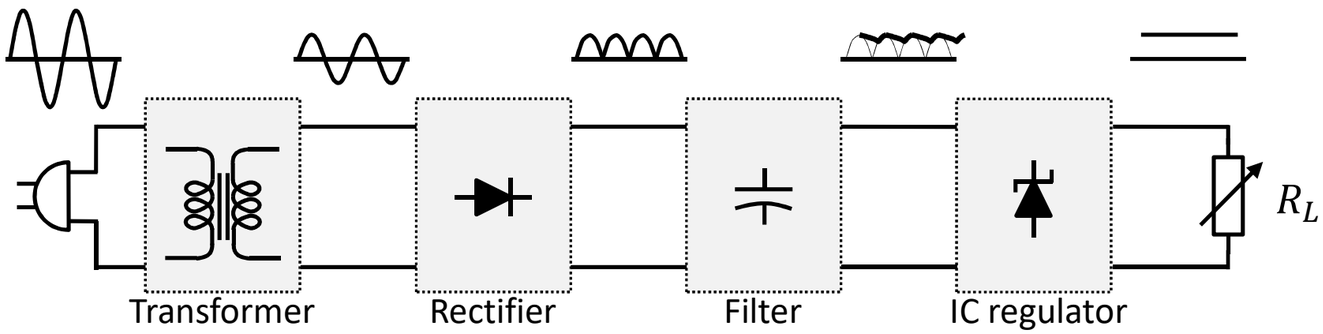
Non-Linear Circuit – Diode!

AC vs. DC



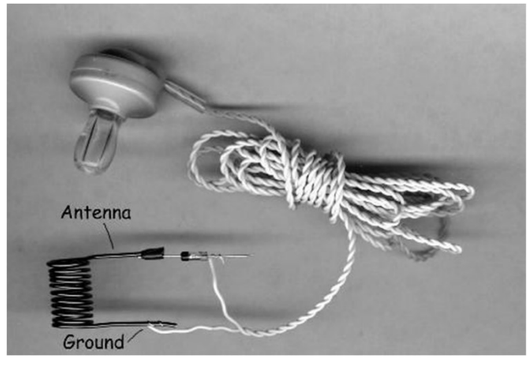


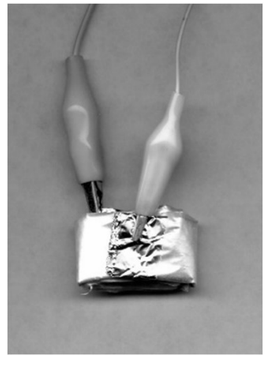
Power Supplies
(Voltage Regulators)

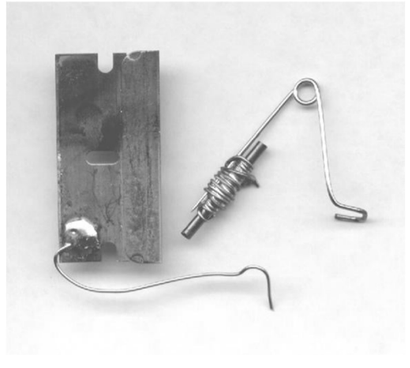


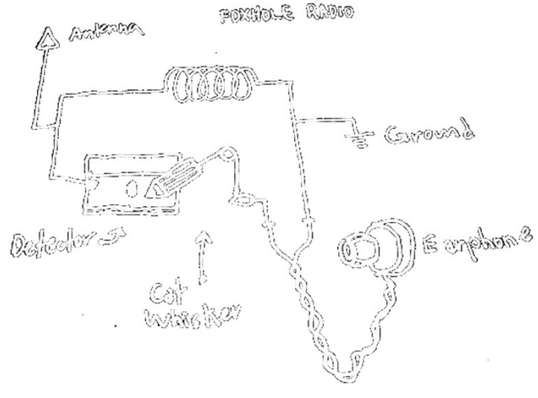
crystal radio

رادیو گوشی

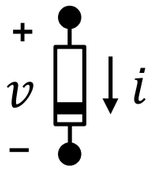




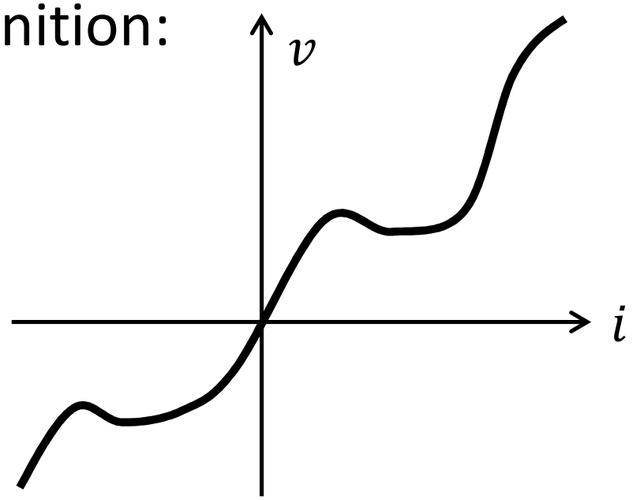




Resistance



Definition:

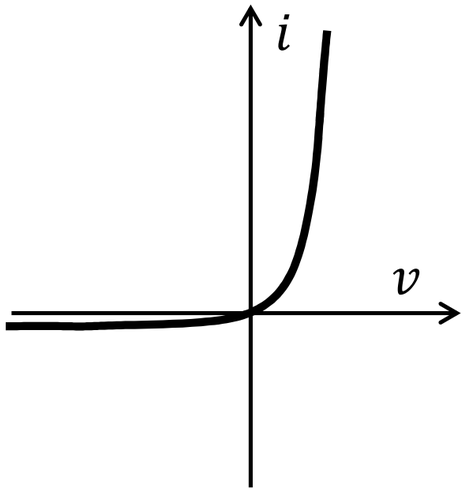


$$i(t) \equiv \hat{G}\,(v(t))$$

conductance

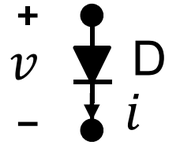
- TI: Time Independent
- TD: Time Dependent

- L: Linear
- NL: Non-linear



NLTI: Diode

$$i(t) = I_s\left(e^{qv(t)/nkT} - 1\right)$$



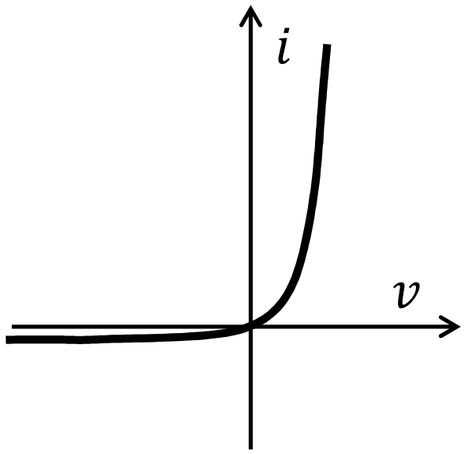
anode

cathode

$$V_T = \left.\frac{kT}{q}\right|_{300°K} = 26mV$$

$$i(t) = I_s\left(e^{v(t)/nV_T} - 1\right) \qquad n = 1 \cdots 2$$

Resistance - NLTI

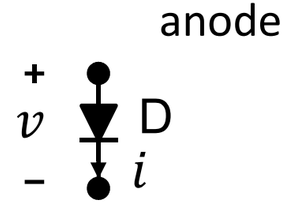


NLTI: Diode

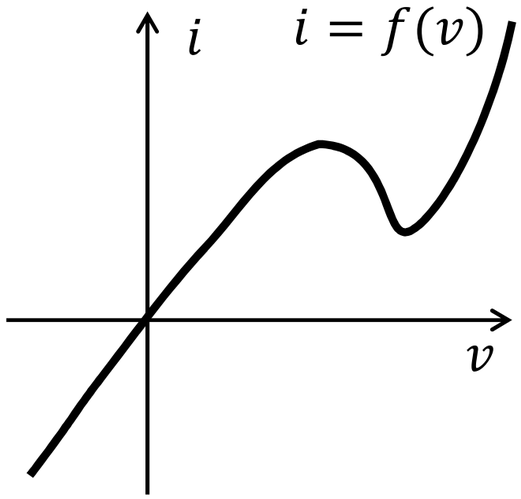
$$i(t) = I_s\left(e^{qv(t)/nkT} - 1\right)$$

$$V_T = \left.\frac{kT}{q}\right|_{300°K} = 26mV$$

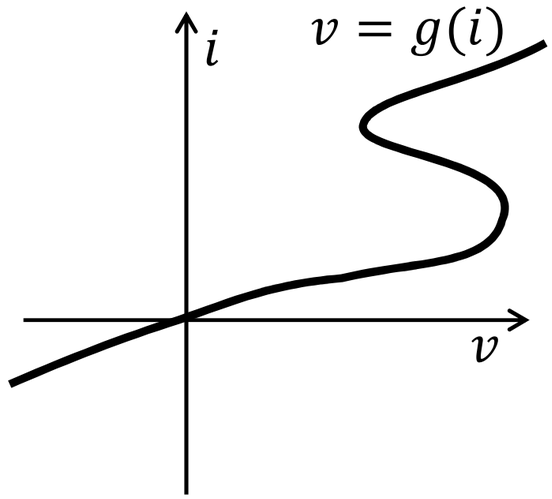
$$i(t) = I_s\left(e^{v(t)/nV_T} - 1\right) \qquad n = 1 \cdots 2$$



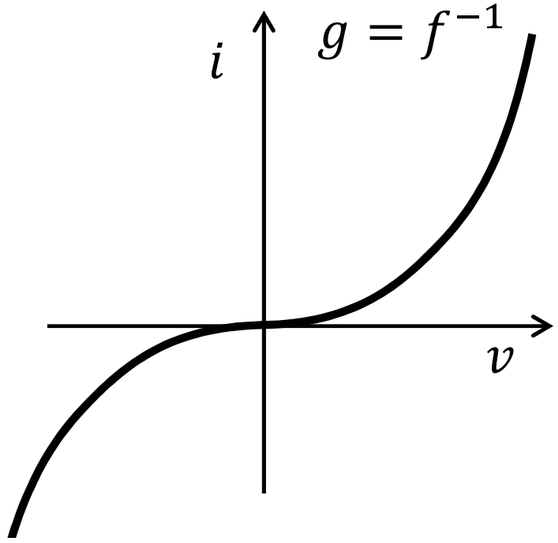
voltage controlled



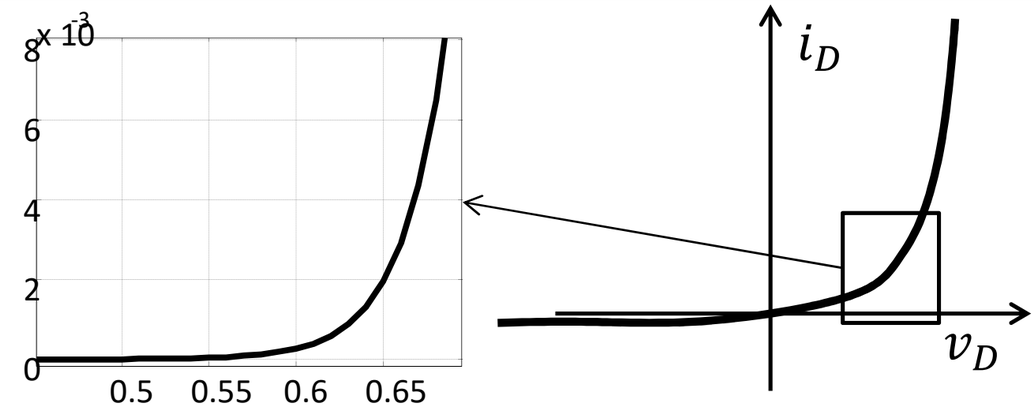
current controlled



both

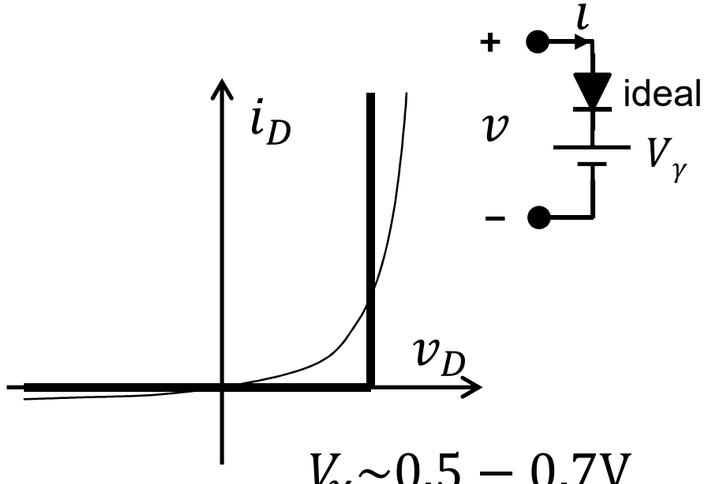


Diode – Large Signal



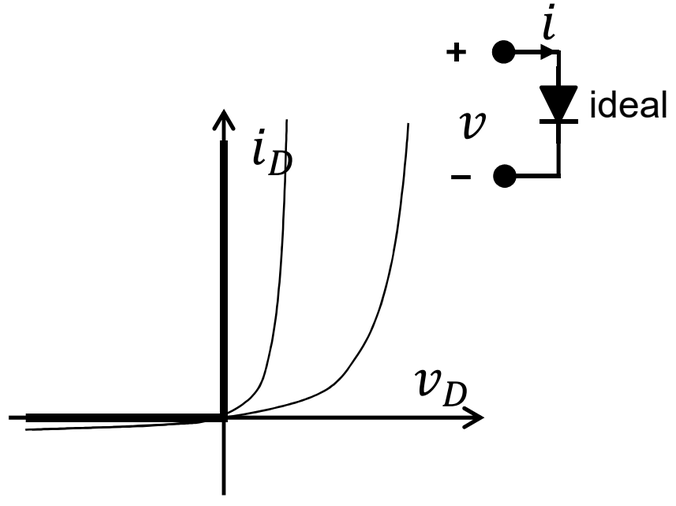
NLTI: Diode $\quad i_D = I_s\left(e^{qv_D/nkT} - 1\right)$

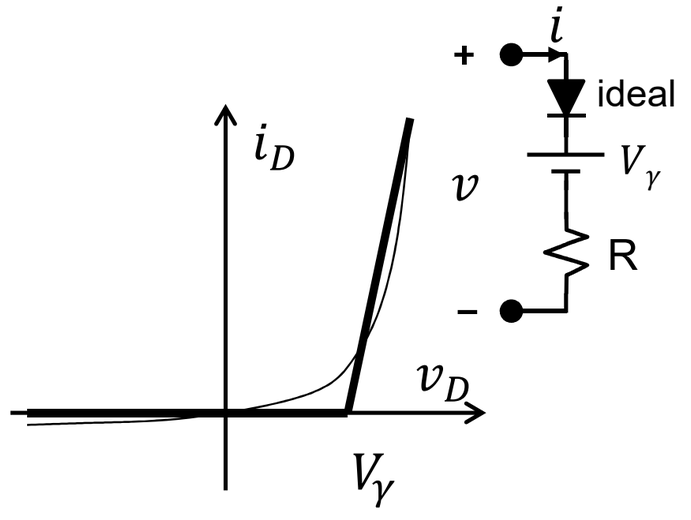
$$V_T = \left.\frac{kT}{q}\right|_{300°K} = 26mV$$

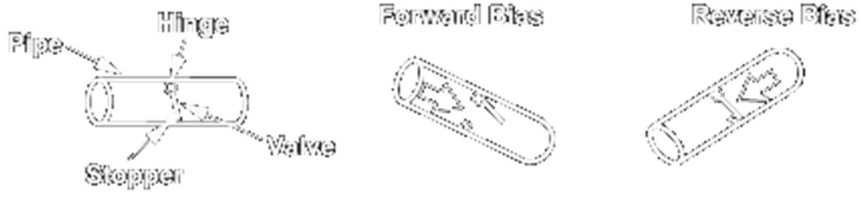


$V_\gamma \sim 0.5 - 0.7\text{V}$

$V_{D,on}$

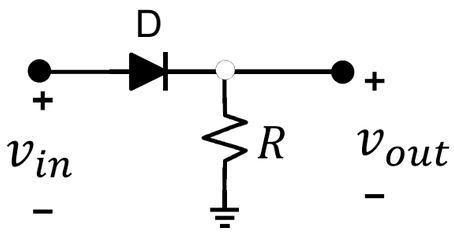


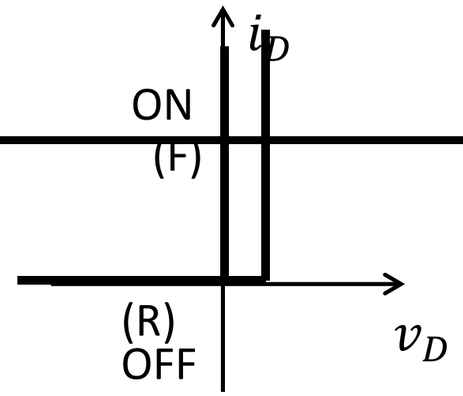




Example 01

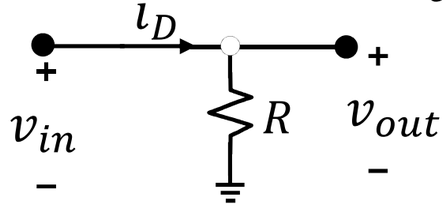
Find $v_{in} - v_{out}$ and $i_{in} - v_{in}$ assume $V_{D.on} = 0\,, 0.7V$





$v_{out} = v_{in}$

1: (F) If $i_D > 0$

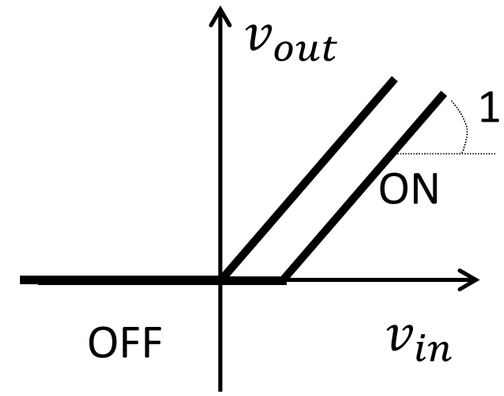


condition $i_D > 0$

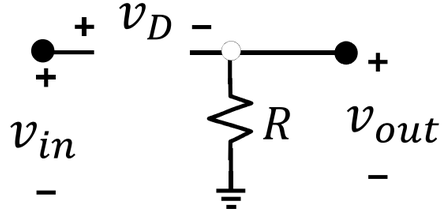
$\rightarrow i_D = v_{out}/R > 0 \rightarrow v_{out} > 0$

$v_{in} > 0$

$i_{in} = i_D = v_{in}/R$



2: (R) If $v_D < 0$

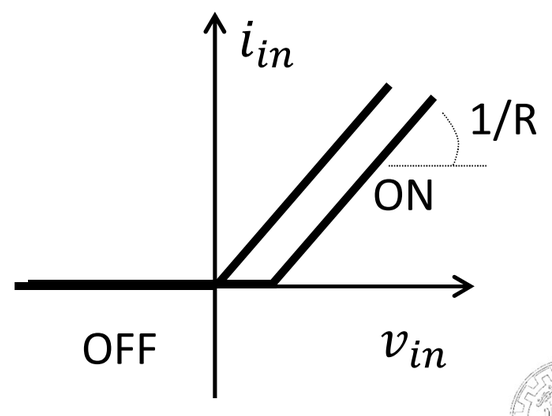


$v_{out} = 0$

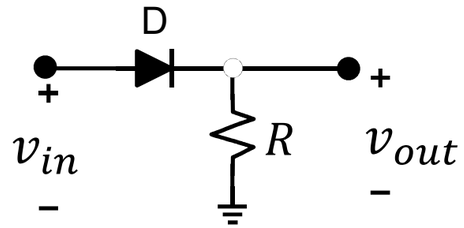
condition $v_D < 0$

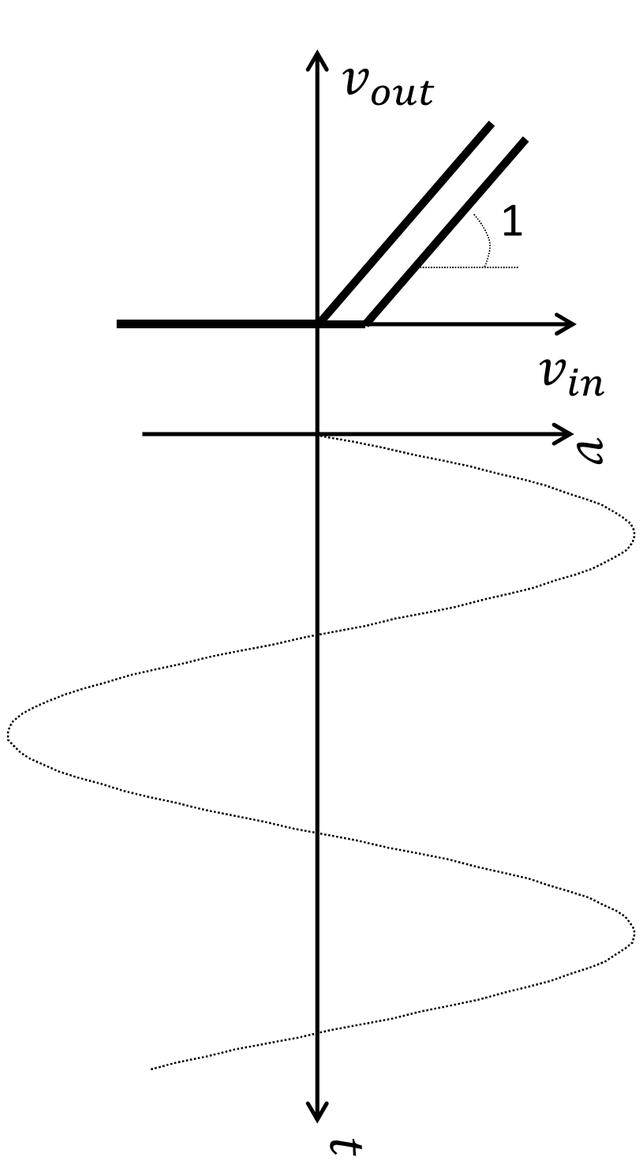
$\rightarrow v_{in} - v_{out} < 0 \rightarrow v_{in} < 0$

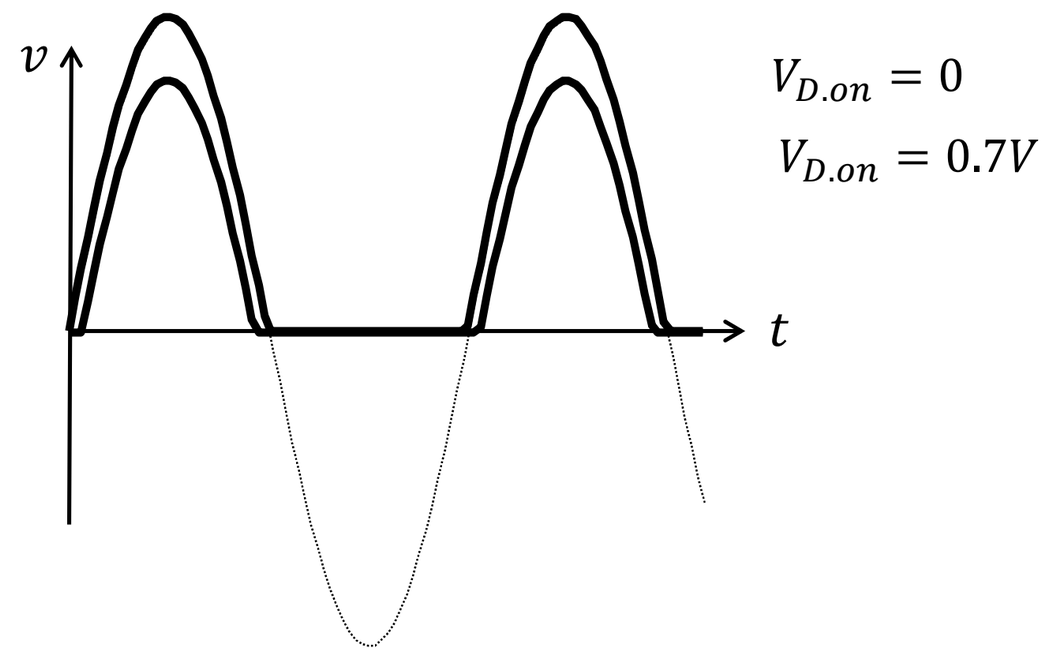
$i_{in} = 0$



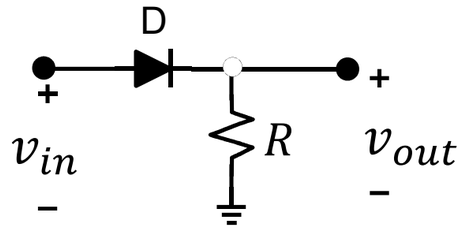
Example 01 - Rectifier

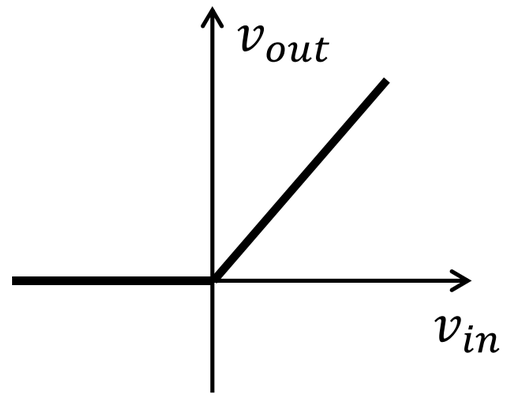


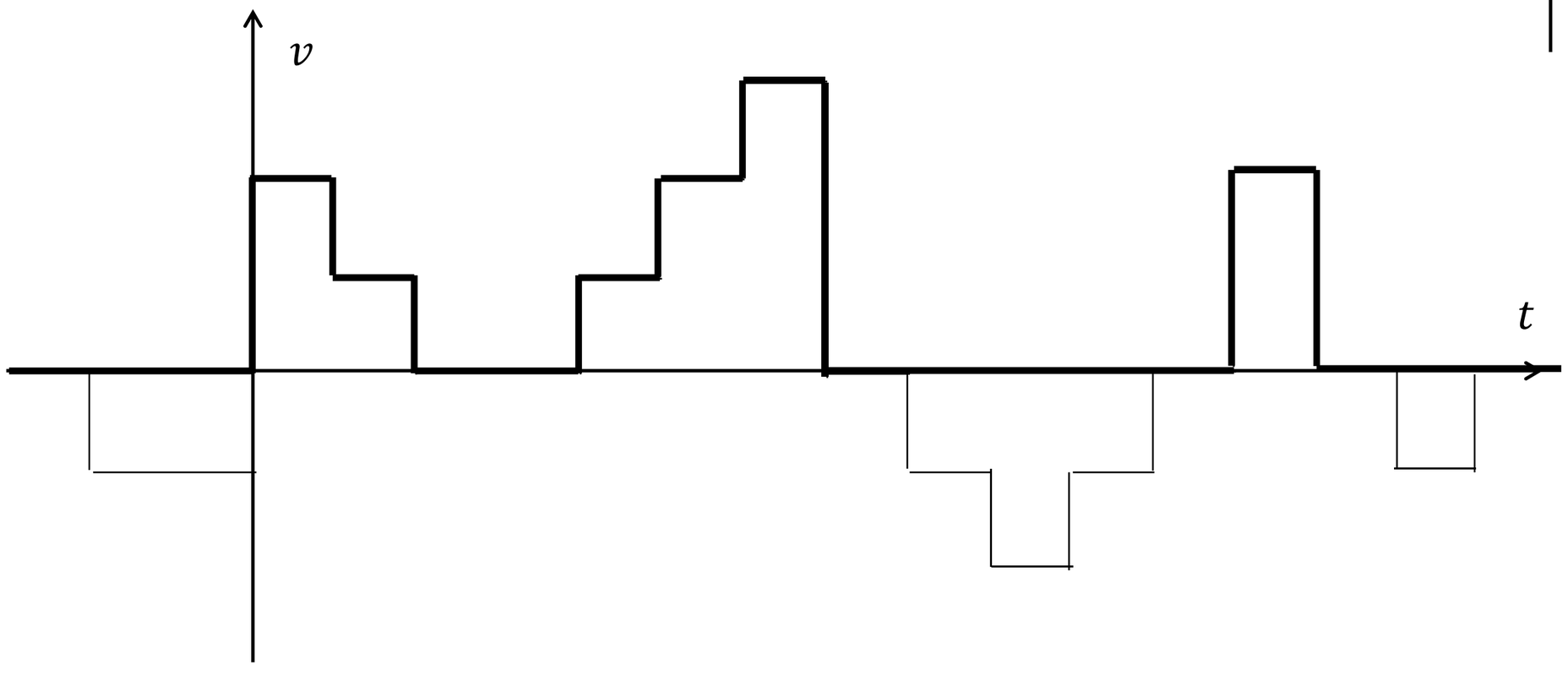




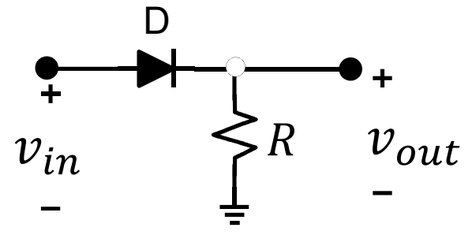
Example 01

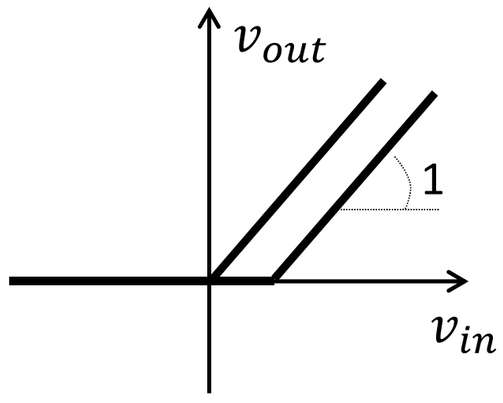


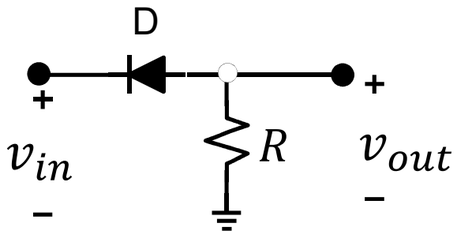


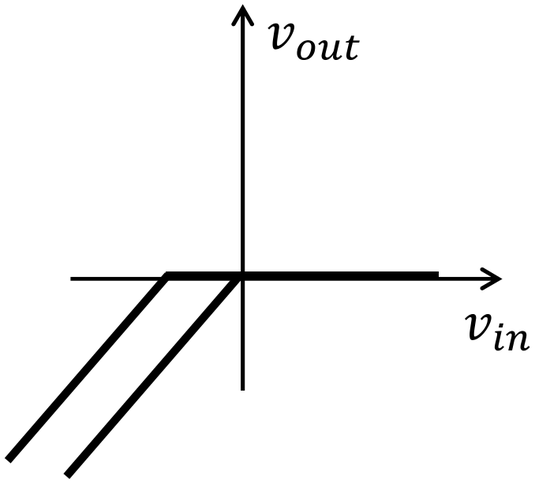


Example 01

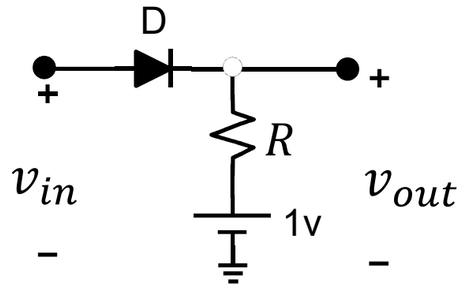


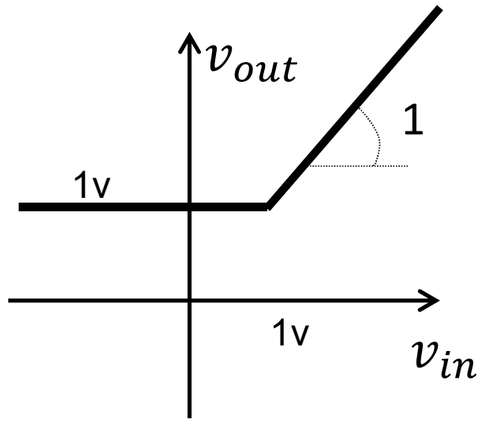


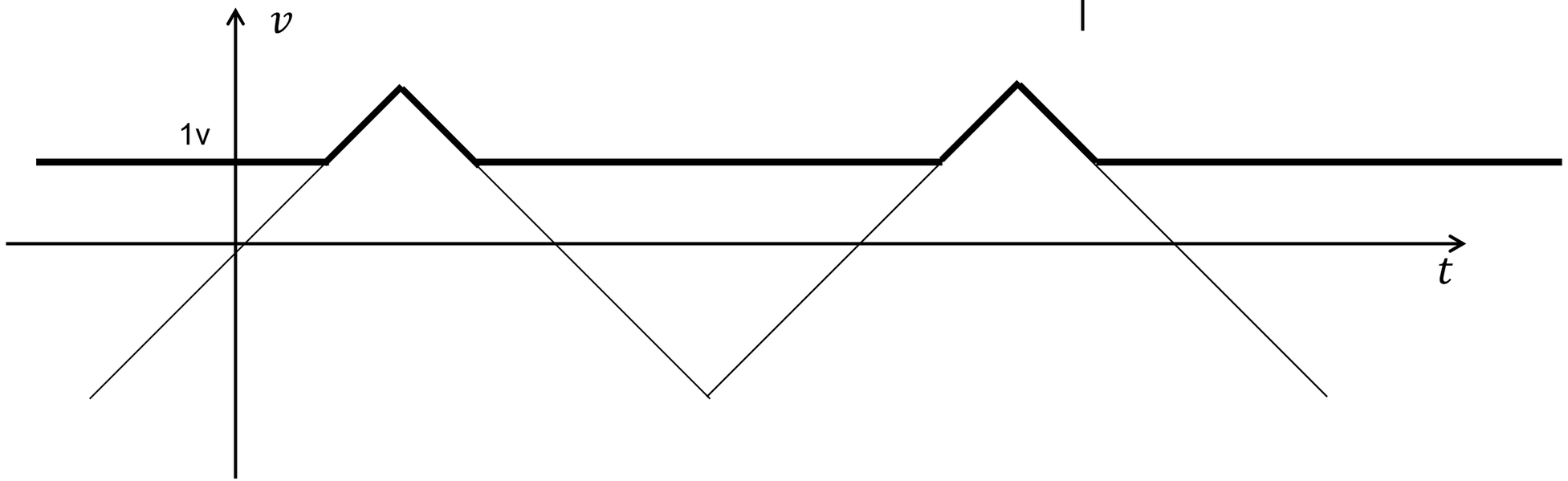




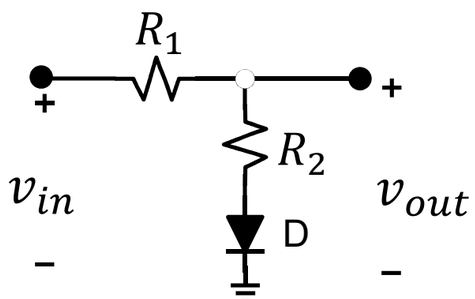
Example 02



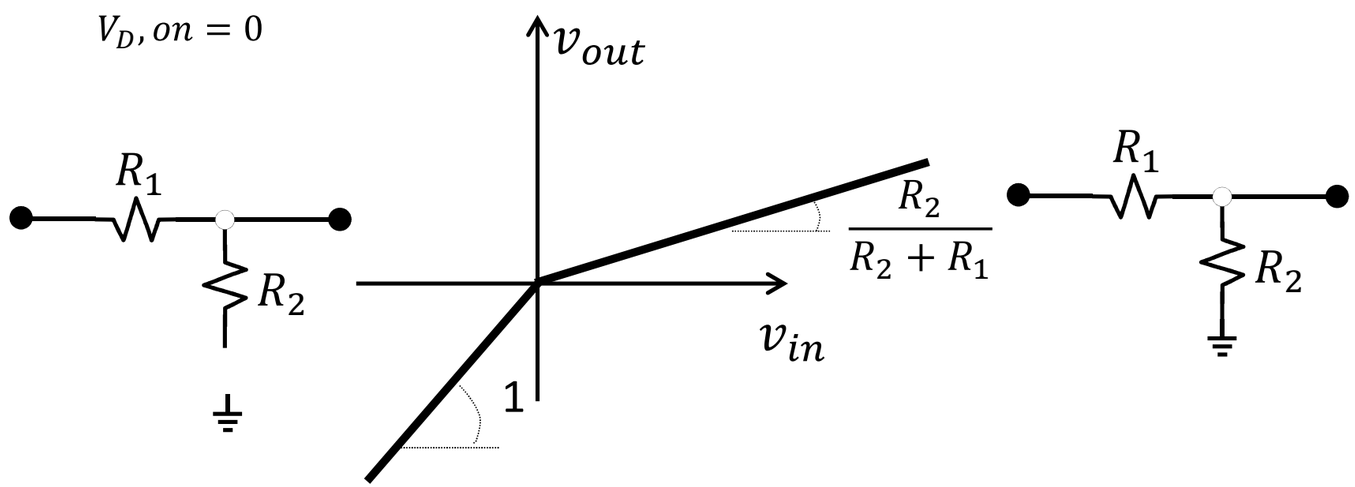




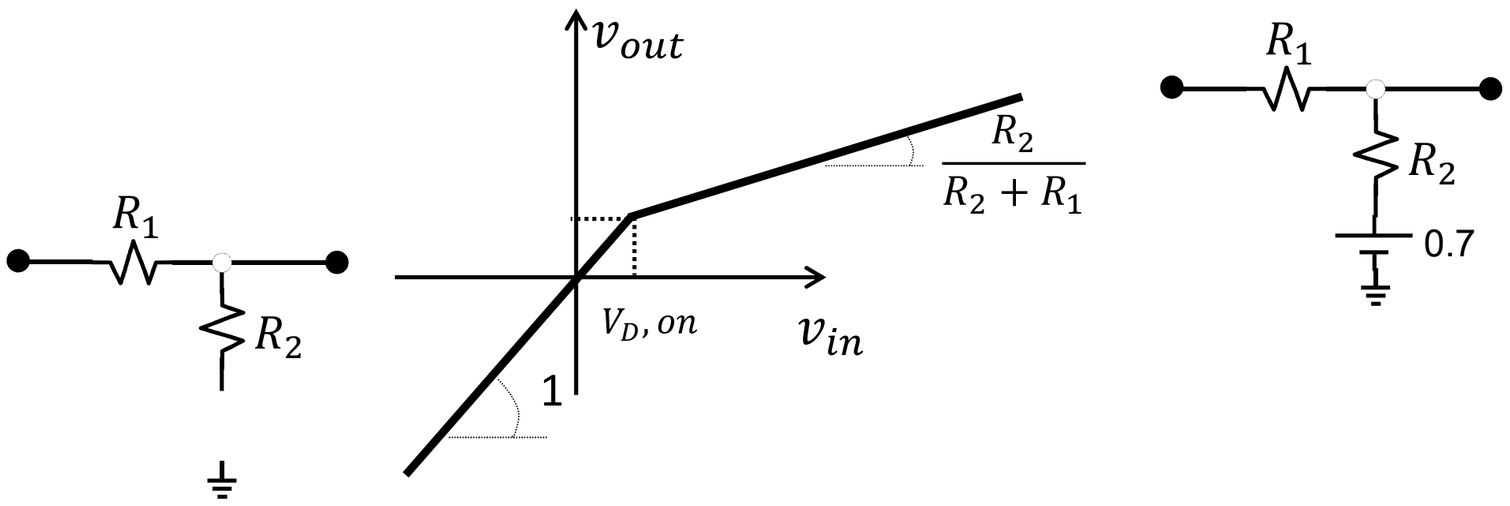
Example 03



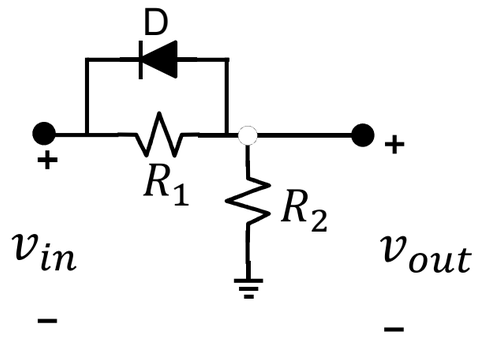
$V_D, on = 0$



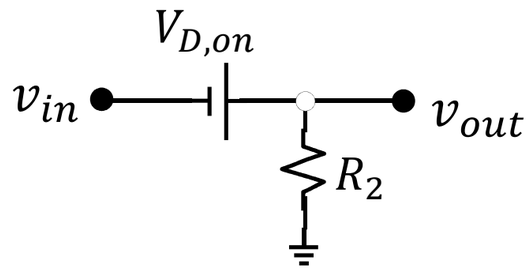
$V_D, on = 0.7V$



Example 04



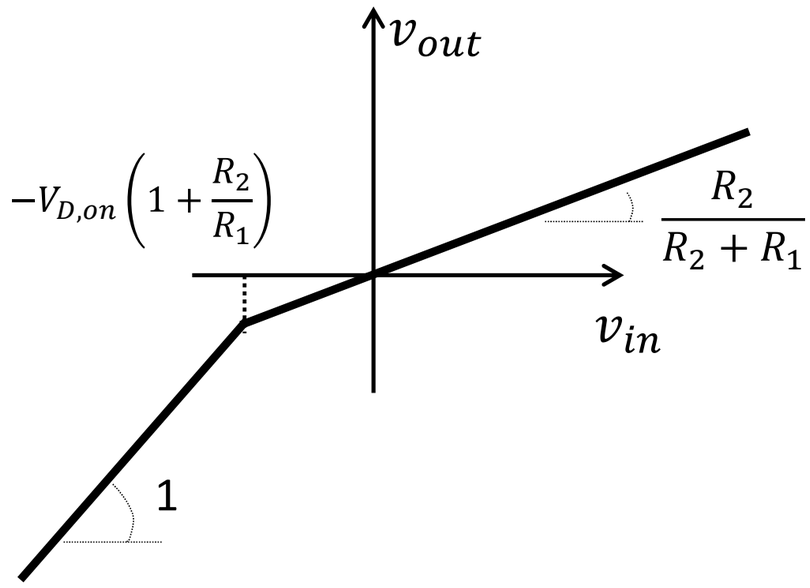
$V_{D,on} = 0.7V$

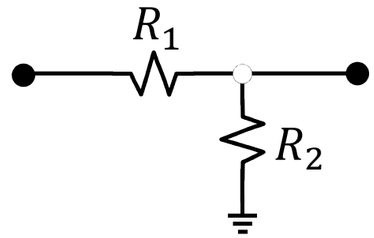


$$v_{out} = v_{in} + V_{D,on}$$

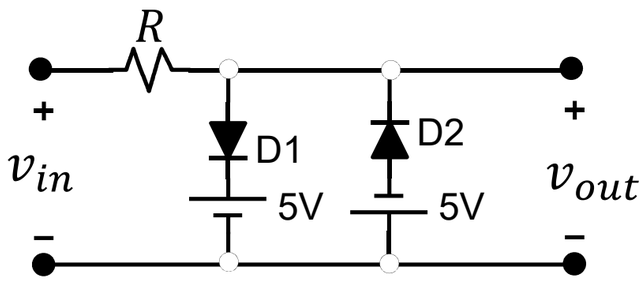
$$I_D = \frac{v_{out}}{R_2} + \frac{V_{D,on}}{R_1} > 0$$

$$v_{in} < -V_{D,on}\left(1 + \frac{R_2}{R_1}\right)$$

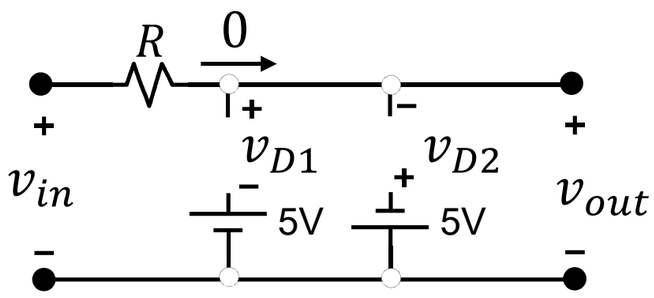




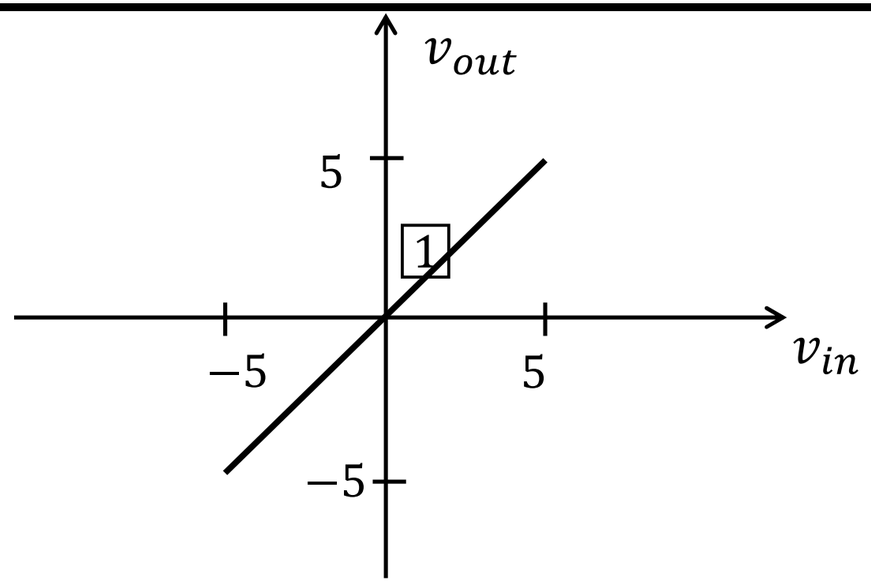
Voltage Limiter



1 : D1:OFF , D2:OFF



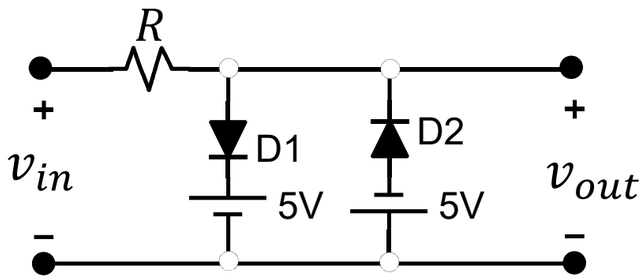
$v_{out} = v_{in}$

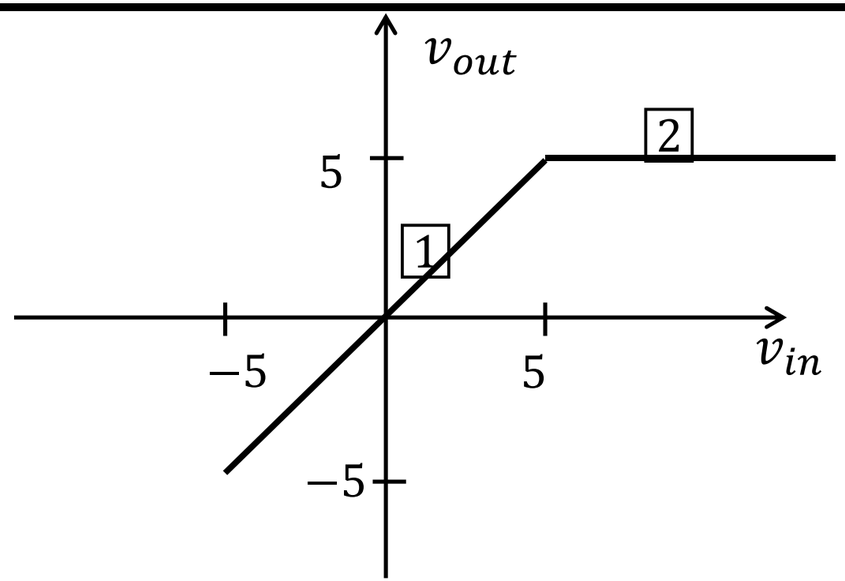


$v_{D1} < 0 \rightarrow v_{out} - 5 < 0 \rightarrow v_{out} < 5$

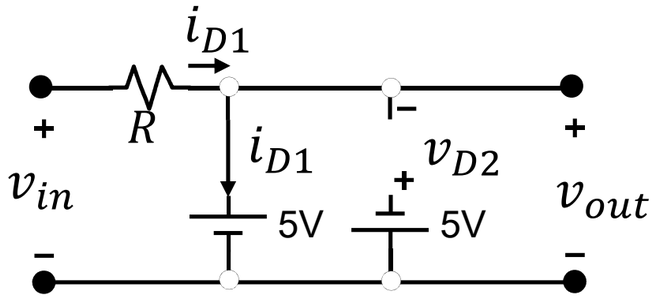
$v_{D2} < 0 \rightarrow -v_{out} - 5 < 0 \rightarrow v_{out} > -5$

Voltage Limiter





2 : D1:ON , D2:OFF

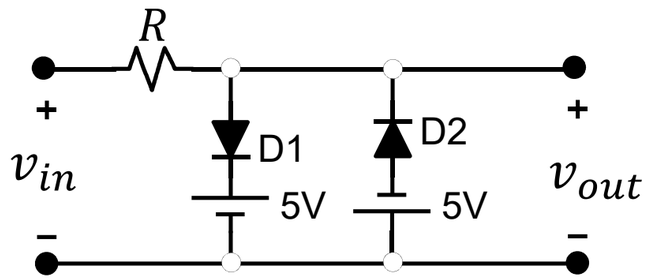


$v_{out} = 5V$

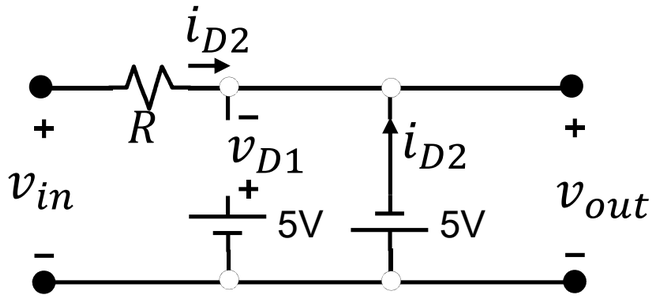
$v_{D2} = -5 - v_{out} = -10 < 0$ $\surd$

$$i_{D1} = \frac{v_{in} - 5}{R} > 0 \rightarrow v_{in} > 5$$

Voltage Limiter



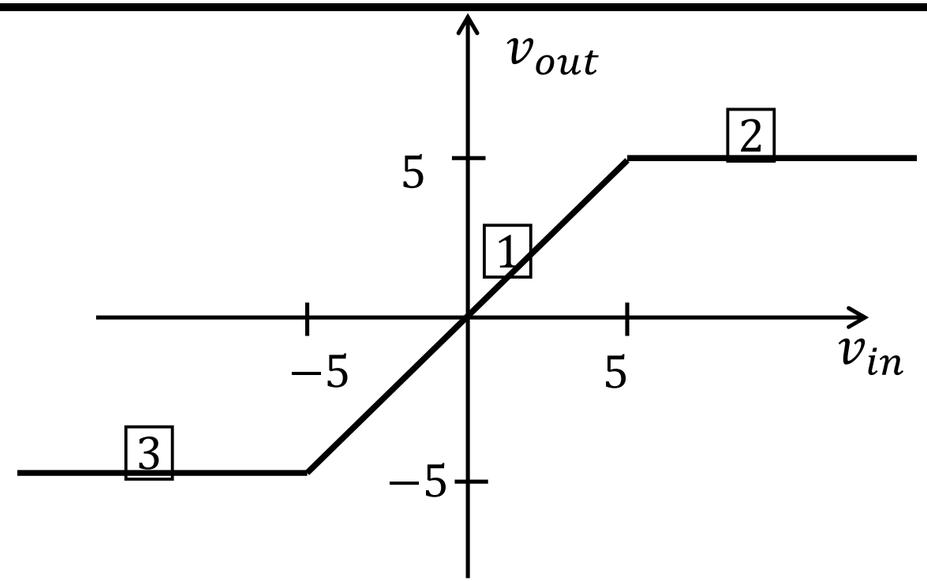
3 : D1:OFF , D2:ON



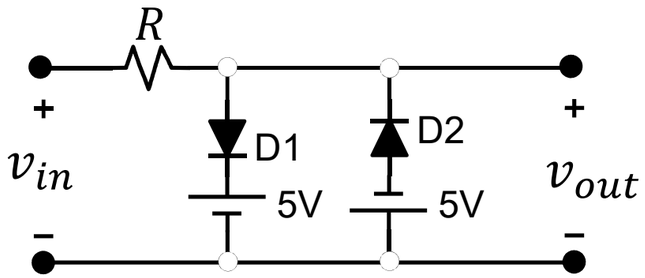
$v_{out} = -5V$

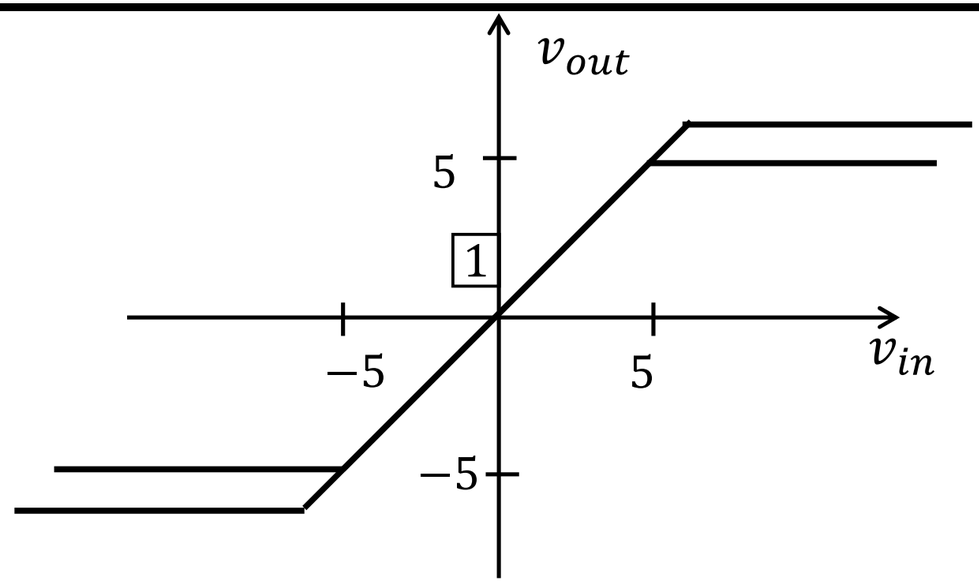
$v_{D1} = v_{out} - 5 = -10 < 0$ $\surd$

$$i_{D2} = \frac{-v_{in} - 5}{R} > 0 \rightarrow v_{in} < -5$$



Voltage Limiter





end