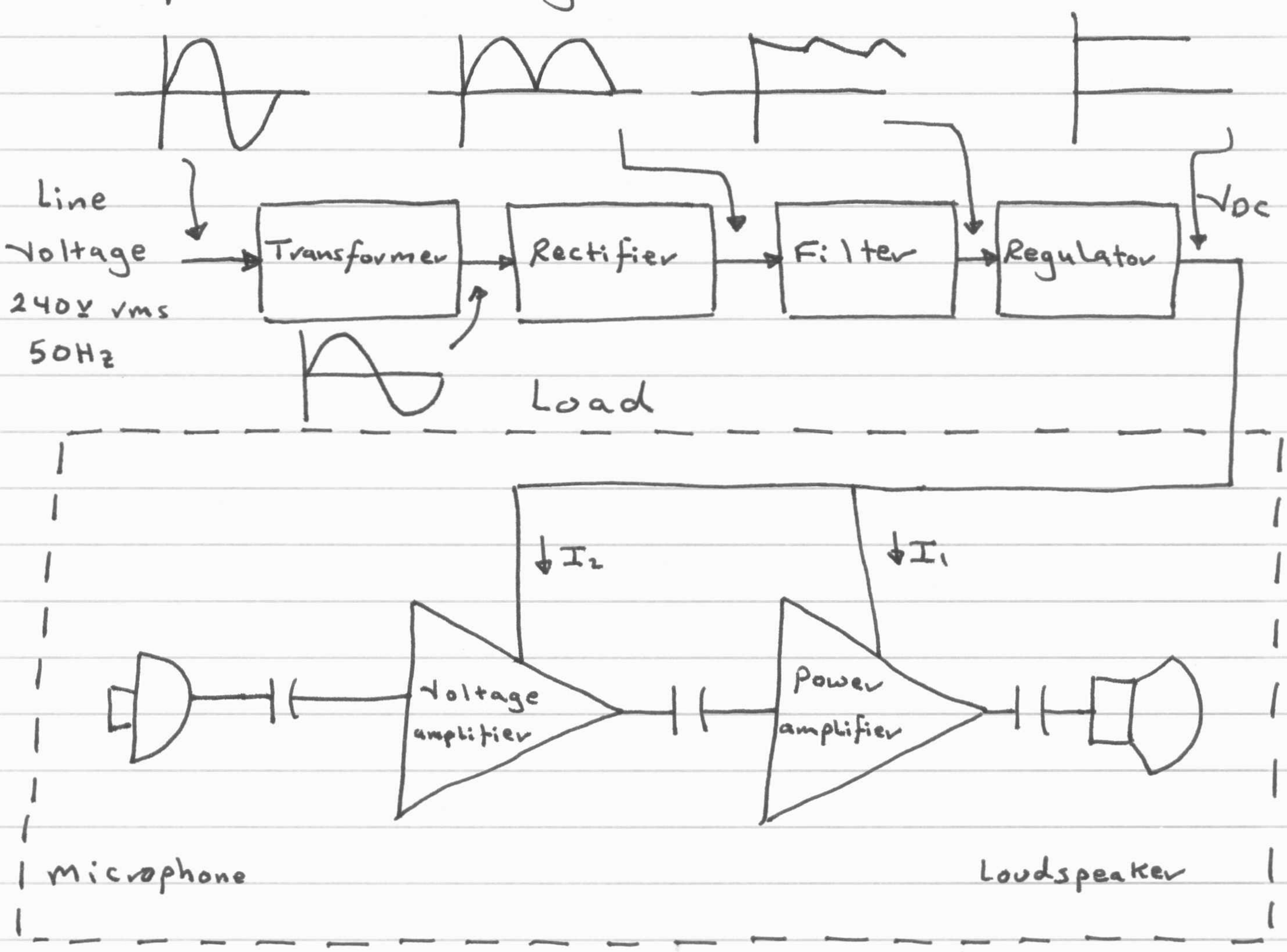
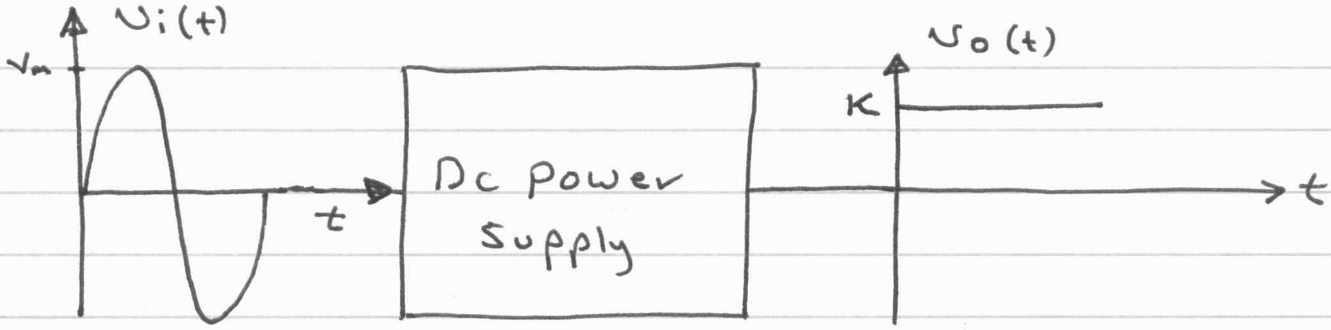
Dc Power Supply

All electronic Circuits and systems require a stable source of dc Voltage and Current (or dc power) to operate Correctly.



Load model

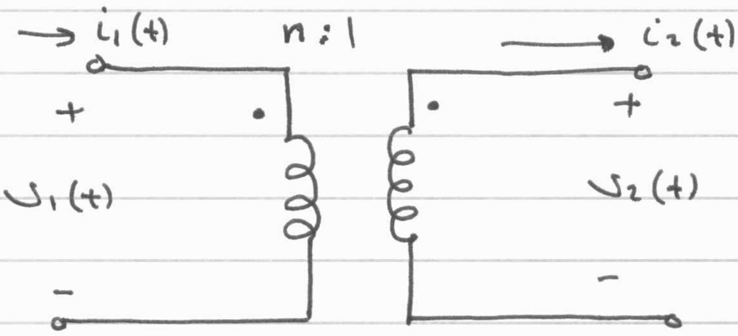
$$R_L = \frac{V_{DC}}{I_1 + I_2}$$



ac Line Voltage

The basic power Supply Consists of a transformer, rectifier, filter, and a regulator

Transformer : used to increase or decrease the amplitude of the ac line voltage

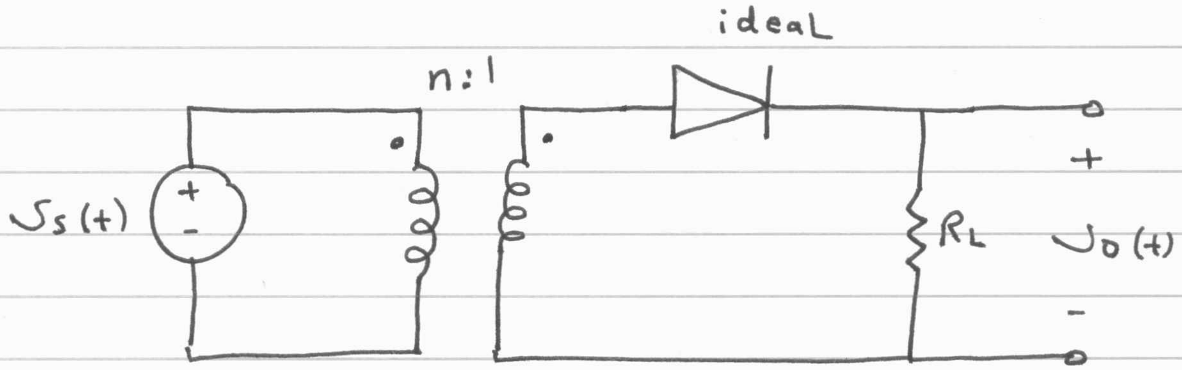


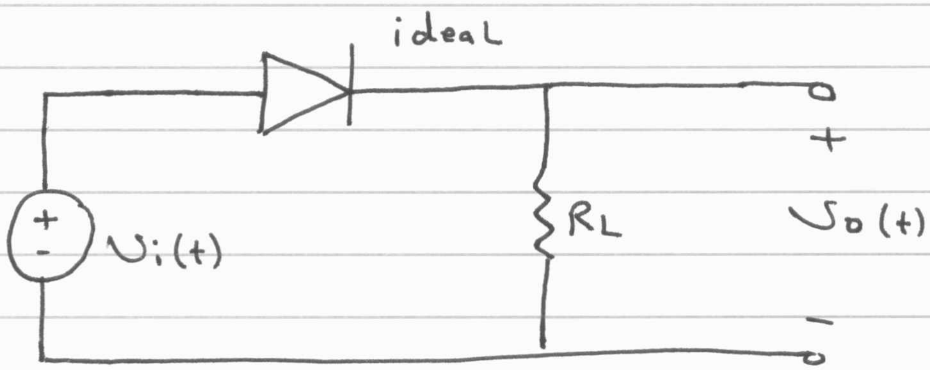
$$v_2(t) = \frac{1}{n} v_1(t)$$

$$i_2(t) = n\, i_1(t)$$

Rectifier : used to Conver the ac voltage (Zero-average value) into either positive or negative pulsating dc

1. Have-Wave Rectifier





$$v_i(t) = \frac{v_s(t)}{n}$$

a) when $v_i(t) > 0$, Diode is on (short circuit)

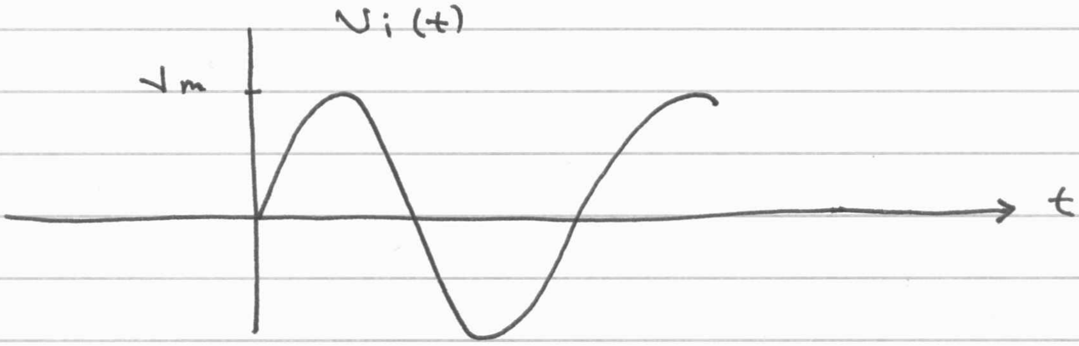
$\therefore v_o(t) = v_i(t)$

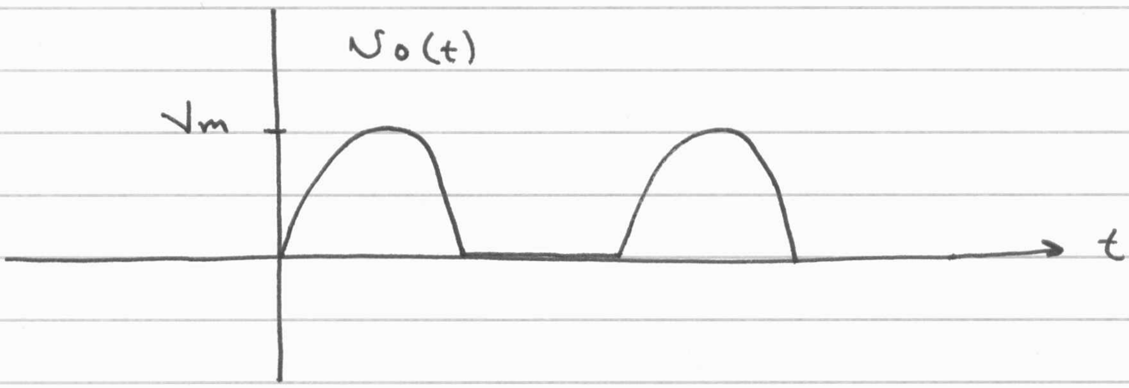
$\therefore v_D(t) = 0$

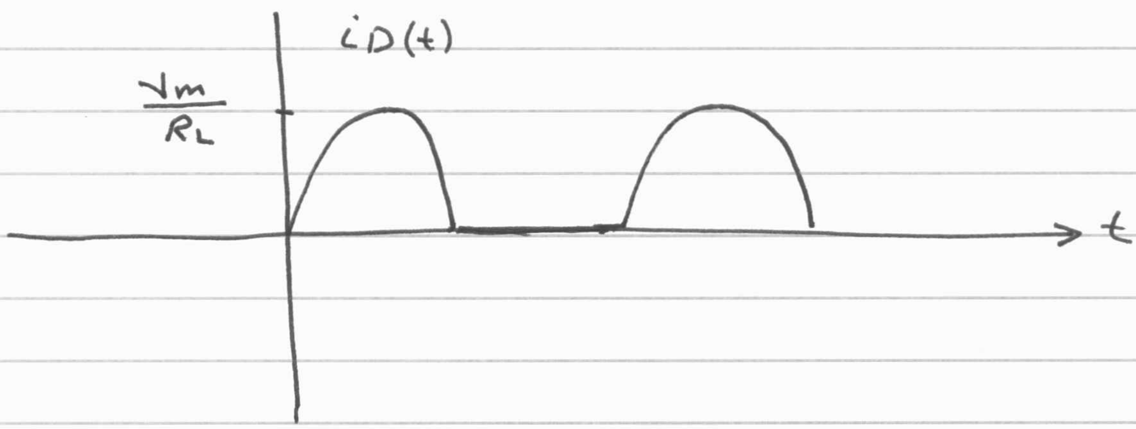
b) when $v_i(t) < 0$, Diode is OFF (open circuit)

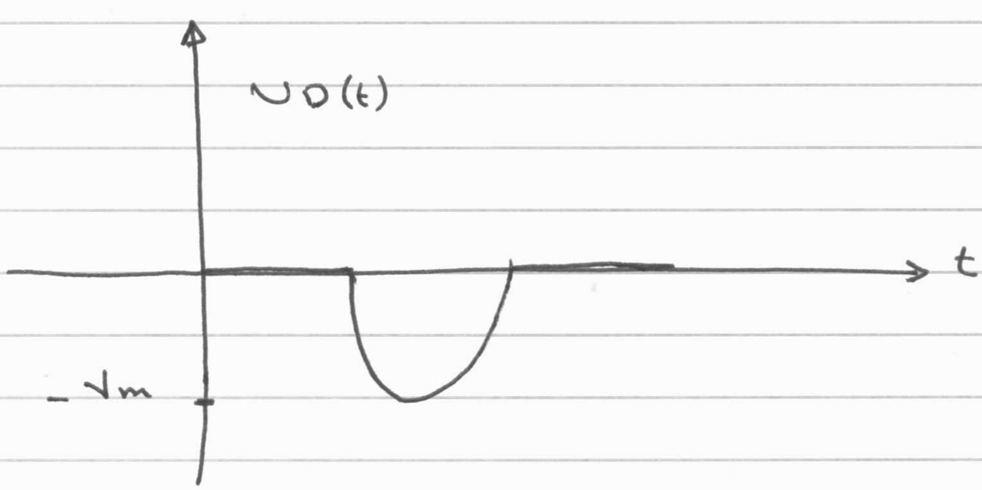
$\therefore v_o(t) = 0$

$\therefore v_D(t) = v_i(t)$


vi (t)
Vm
t


vo (t)
Vm
t


iD (t)
Vm / RL
t


vD (t)
- Vm
t

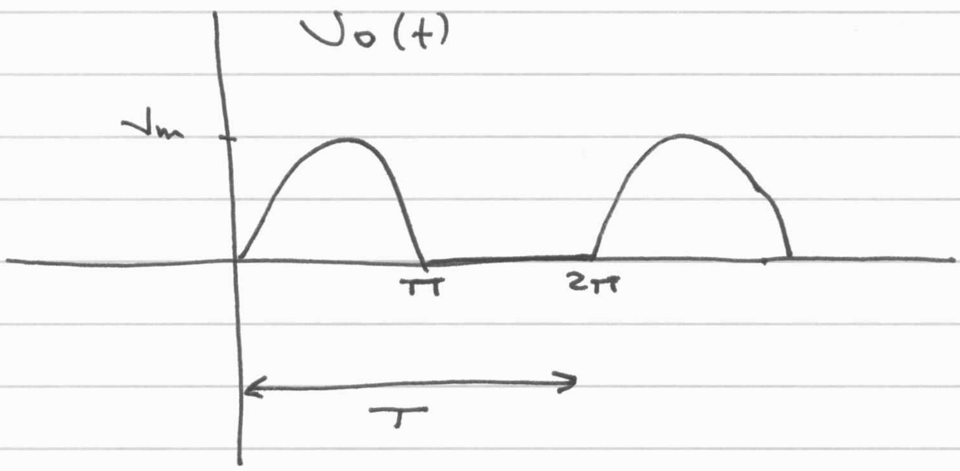
$$v_{o,av} = \frac{1}{T}\int_0^T v_o(t)\,dt$$

$$= \frac{1}{2\pi}\int_0^{\pi} \sin\theta \, d\theta$$

$$v_{o,av} = \frac{V_m}{\pi}$$

$$T = T_o$$

$$f = f_o$$



$$i_D(t)_{,av} = \frac{V_m}{\pi R_L}$$

Important Electrical Ratings

I_{FM} ≡ maximum forward current

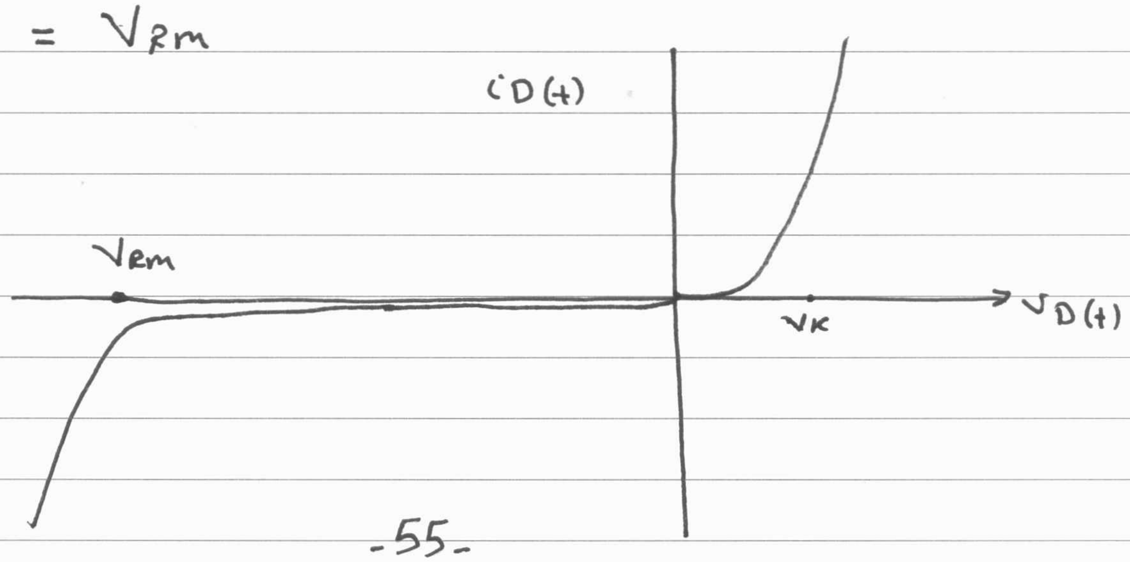
I_{FM} = Maximum average current that can safely be sustained by the diode when it is forward biased

V_{RM} ≡ maximum reverse voltage

V_{RM} = maximum voltage that can be applied to the diode in the reverse bias polarity before voltage break down occure

PIV ≡ Peak inverse voltage

$PIV = V_{Rm}$



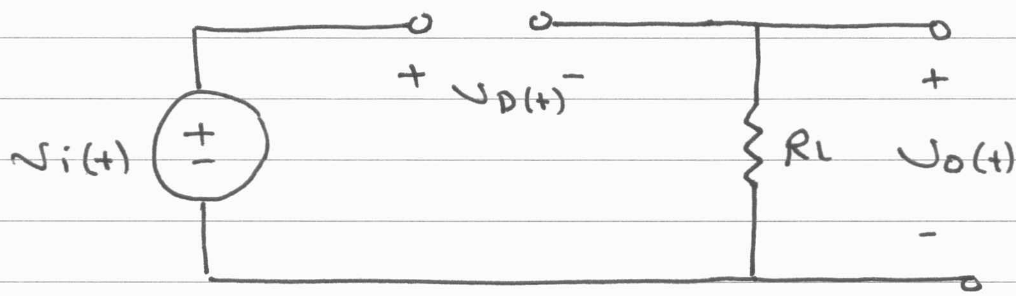
∴ For the have-wave rectifier

$$V_{o,av} = \frac{V_m}{\pi}$$

$$I_{FM} = \frac{V_m}{\pi R_L}$$

$$PIV = -V_m$$

When $v_i(t) < 0$, Diode is OFF

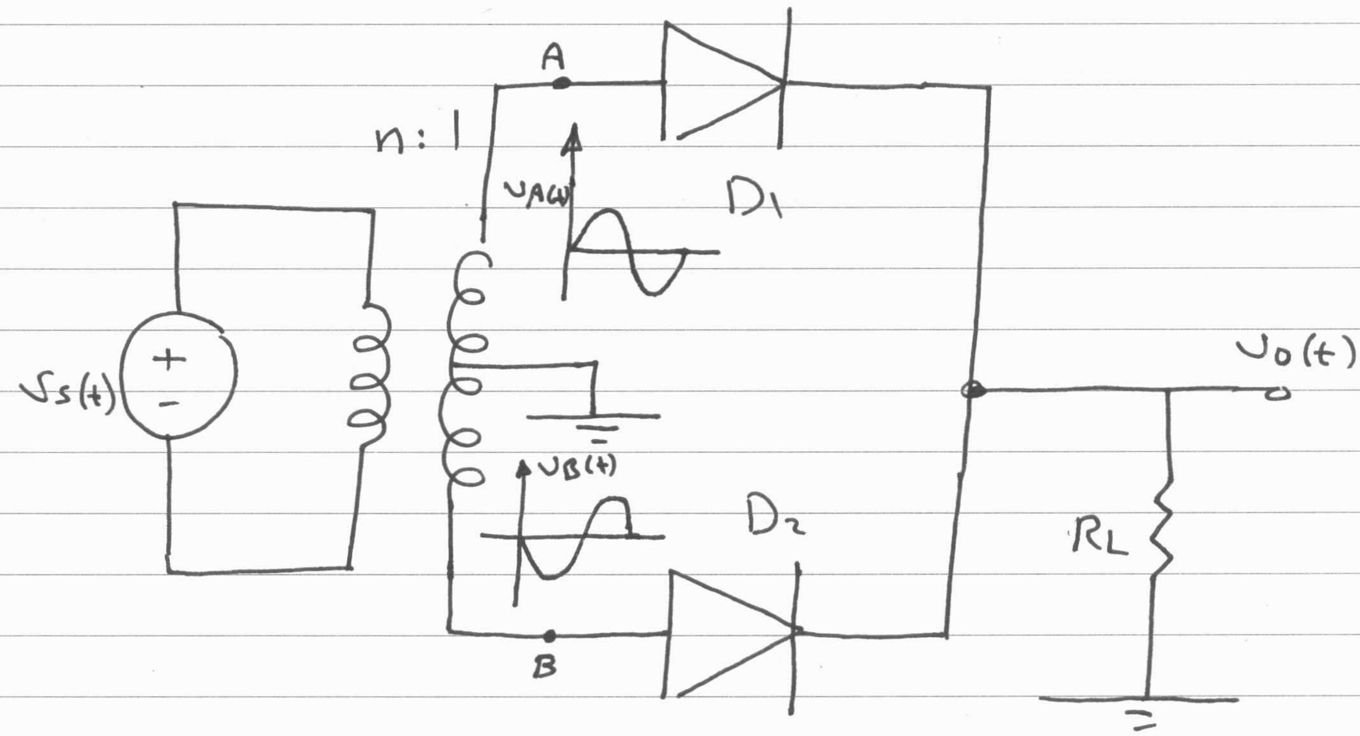


$$v_D(t) = v_i(t) < 0$$

$$\therefore v_{D(t),max} = -V_m$$

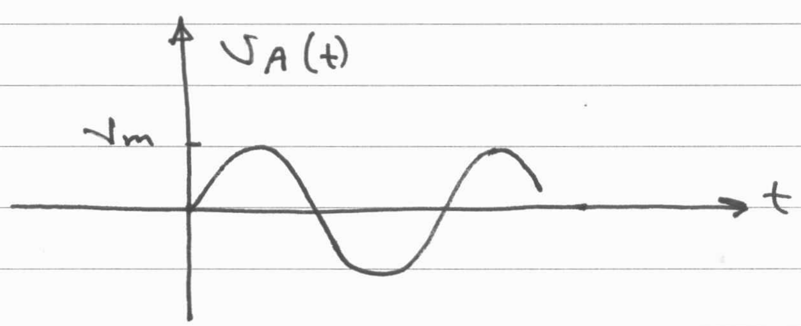
2) Full-wave Rectifier

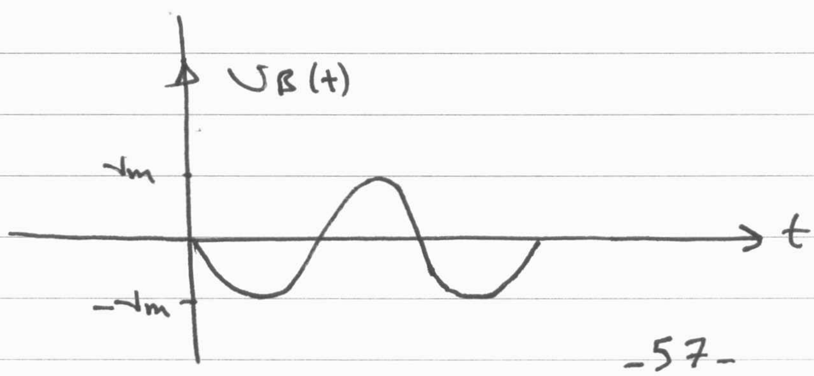
a) Center-tapped transformer full-wave Rectifier



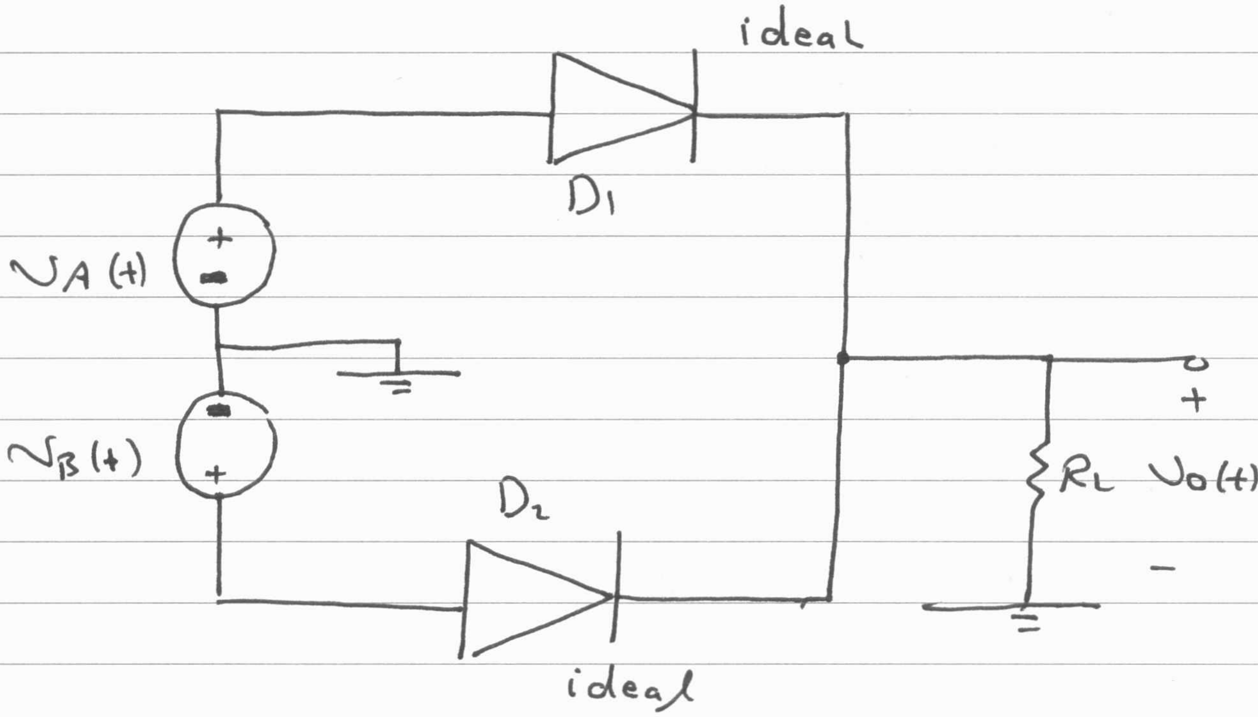
$v_A(t)$, $v_B(t)$ have the same amplitude

But 180° out of phase





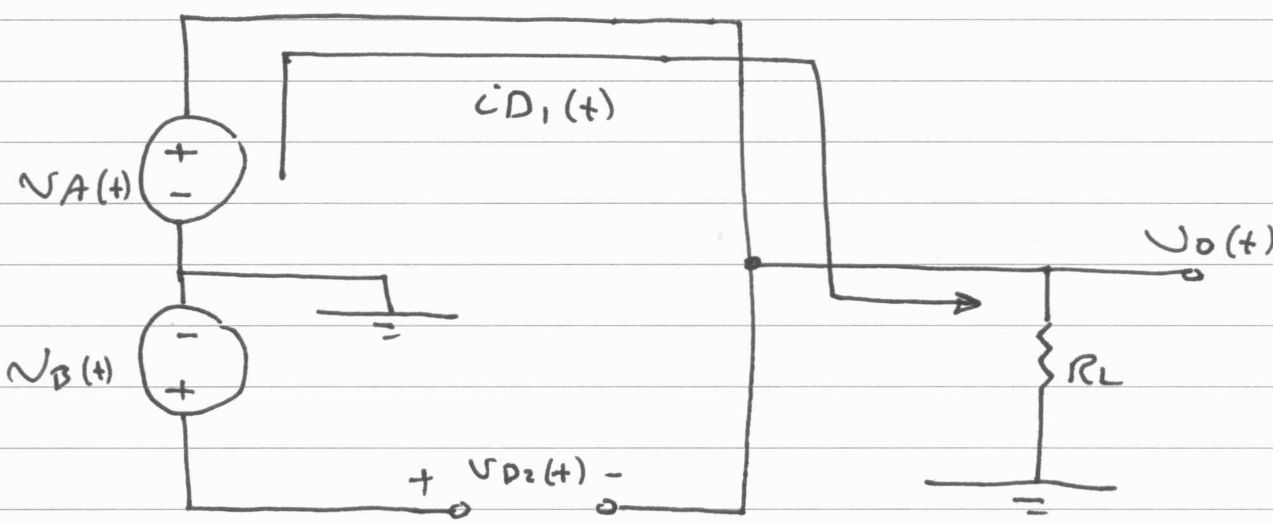
Simplified Circuit



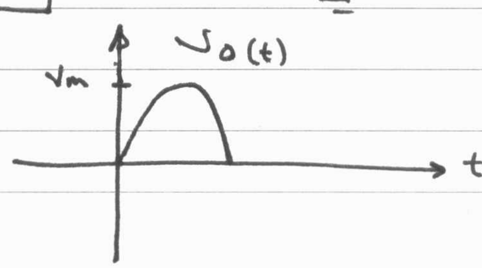
1) When $v_S(t) > 0$

$v_A(t) > 0$, D_1 is on

$v_B(t) < 0$, D_2 is OFF



$v_o(t) = v_A(t)$



$v_{D_2}(t) = v_B(t) - v_A(t)$

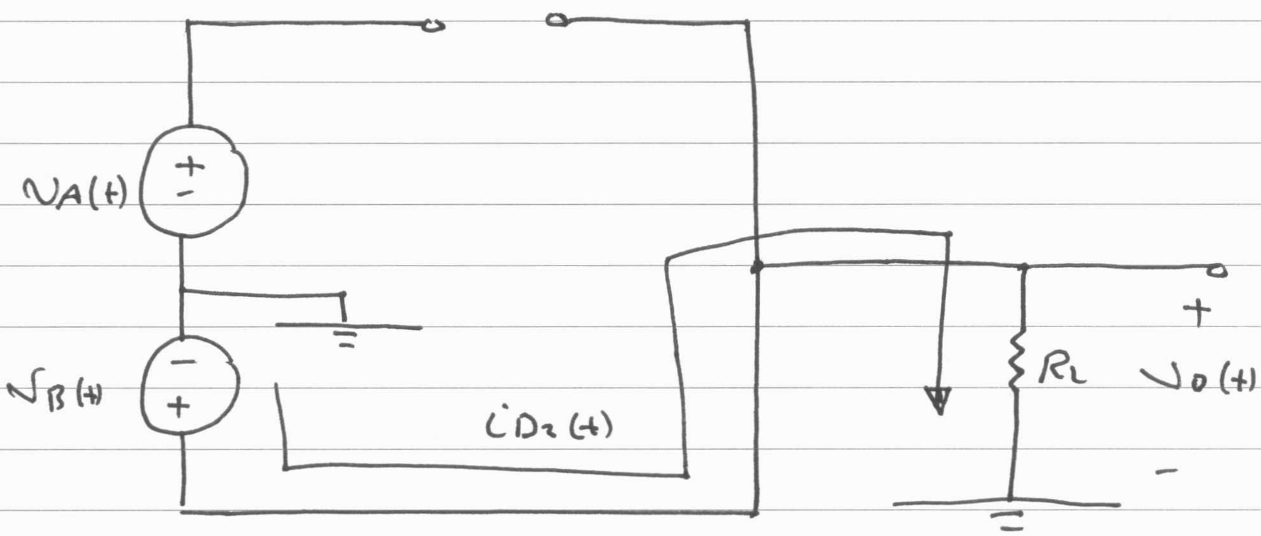
$v_{D_2}(t)_{,max} = -V_m - V_m$

$v_{D_2}(t)_{,max} = -2V_m$

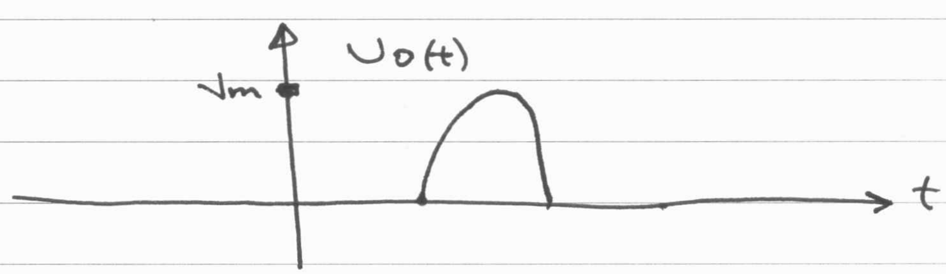
$\therefore$ PIV $= -2V_m$

2) When $v_s(t) < 0$

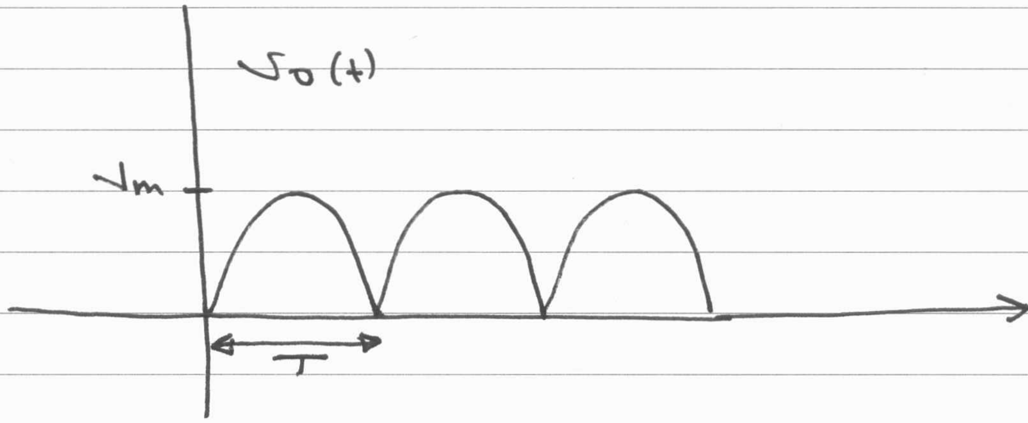
$v_A < 0$; D_1 is OFF
$v_B > 0$; D_2 is on

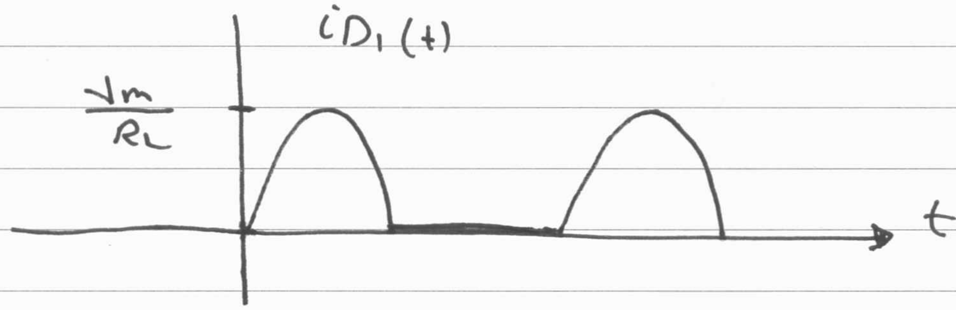


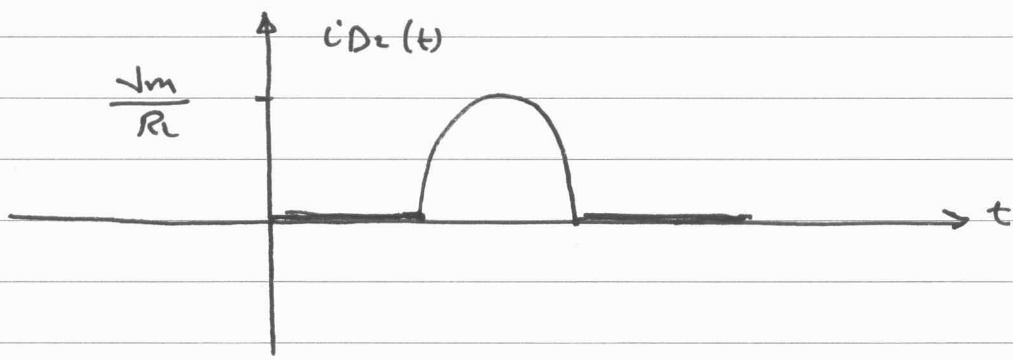
$\therefore v_o(t) = v_B(t) > 0$



∴ For a Complete Cycle of $V_s(t)$







$$V_{o,av} = \frac{2V_m}{\pi}$$

$$PIV = -2V_m$$

$$T = \frac{1}{2} T_o$$

$$f = 2 f_o$$