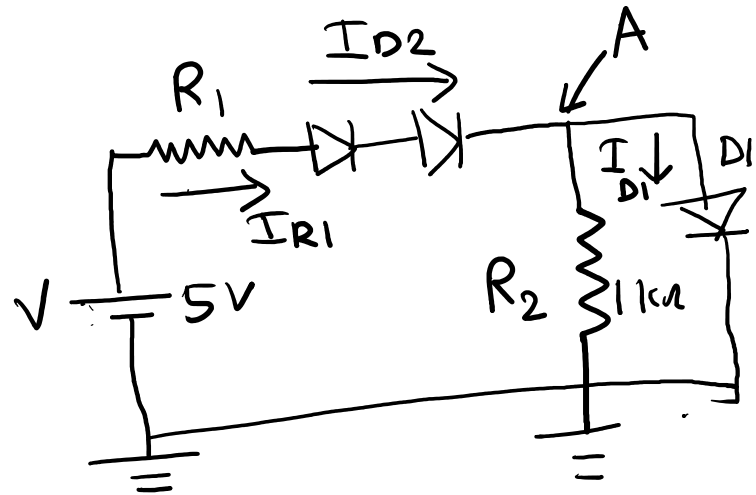
Class-10 and 11



$$\begin{cases} V = 5V, \; R_2 = 1K\Omega, \; V_\gamma = 0.65V \\ I_{D1} = \dfrac{I_{D2}}{2} = \dfrac{I_{R1}}{2} \end{cases}$$

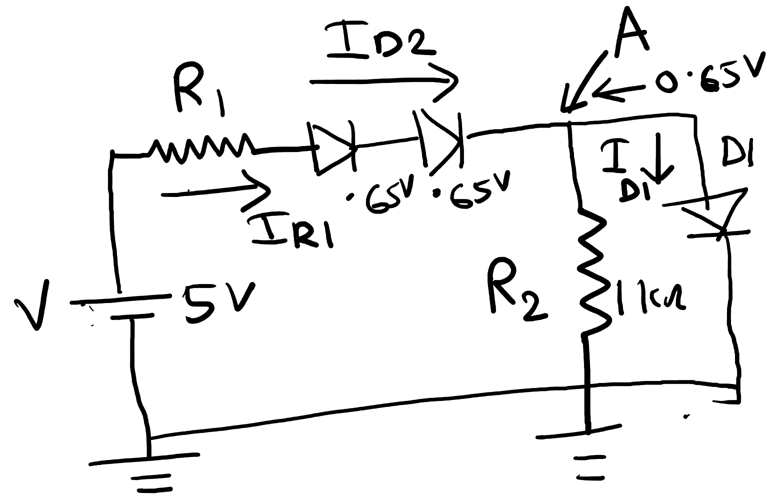
$R_1 = ?$ I_{D1}, I_{D2} ?

$$V_A = V_{D1} = V_{R2} = V_\gamma$$

$$I_{R2} = \frac{V_\gamma}{R_2} = \frac{0.65V}{1K\Omega} = 0.65mA$$

$$I_{R1} = I_{D1} + I_{R2} \Rightarrow I_{R1} = \frac{I_{R1}}{2} + I_{R2}$$

$$\Rightarrow I_{R1} = 2I_{R2} = 2 \times 0.65\,mA = 1.3mA$$



$$I_{R1} = \frac{V - 3V_\gamma}{R_1}$$

$$\Rightarrow 1.3\,mA = \frac{5V - 3 \times 0.65V}{R_1}$$

$$= \frac{5V - 1.95V}{R_1}$$

$$\Rightarrow R_1 = \frac{3.05V}{1.3\,mA} = 2.346\,k\Omega$$

$$I_{D2} = I_{R1} = 1.3\,mA$$

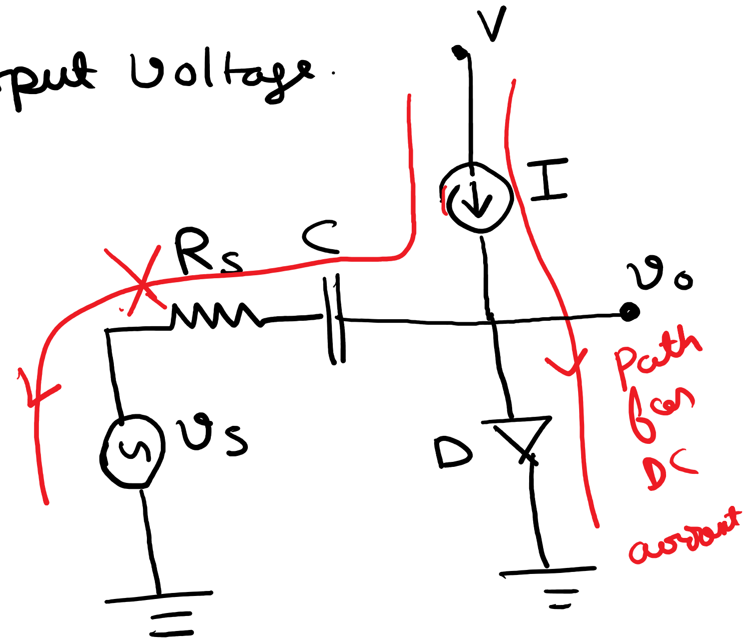
$$I_{D1} = \frac{I_{R1}}{2} = \frac{1.3\,mA}{2} = 0.65\,mA$$

Ans.

v_s = applied AC signal.

v_o = ac component of the output voltage.

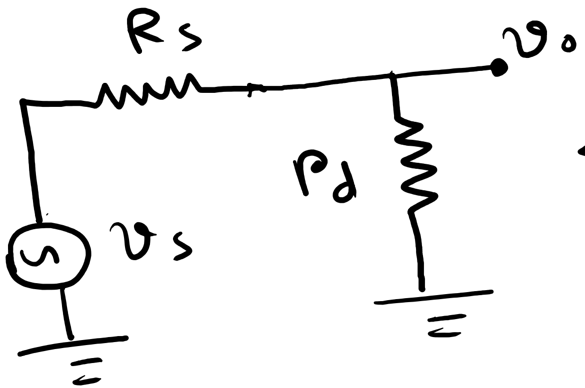
Find an expression for v_o in terms of v_s. Assume that the capacitor acts as a short circuit to the AC signal.

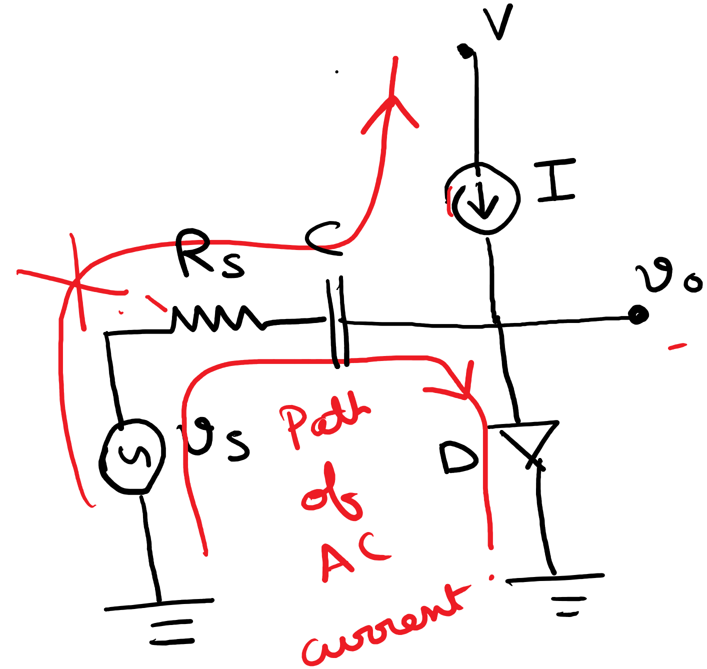


$$I_D^{DC} = I$$

$$g_d = \frac{I}{V_T} \qquad r_d = g_d^{-1} = \frac{V_T}{I}$$

Equivalent AC circuit





$$r_d = \frac{V_T}{I}$$

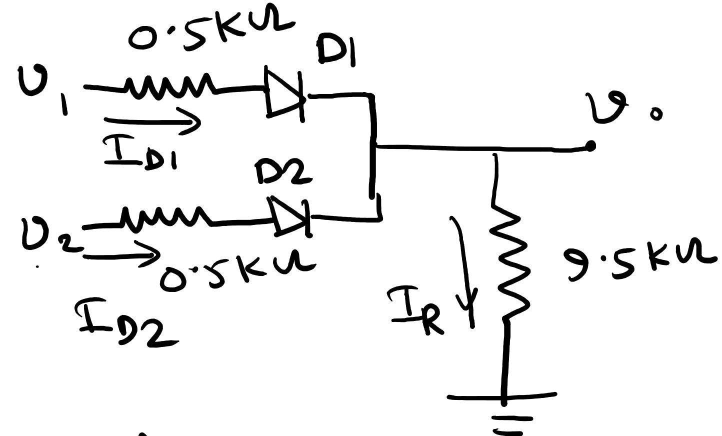
$$v_o = \frac{r_d}{R_s + r_d} v_s$$

$$= \frac{V_T/I}{R_s + V_T/I} v_s = \frac{V_T}{R_s I + V_T} v_s$$

$$v_o = \frac{V_T}{R_s I + V_T} v_s$$

Q3

v_o, I_{D1}, I_{D2} $\left\{ \begin{array}{l} (a)\ v_1 = 10V,\ v_2 = 0V \\ (b)\ v_1 = 5V,\ v_2 = 0V \\ (c)\ v_1 = 10V,\ v_2 = 5V \\ (d)\ v_1 = v_2 = 10V \end{array} \right\}$ $V_\gamma = 0.6V$



(a) $I_{D1} = I_R = \dfrac{v_1 - V_\gamma}{0.5 + 9.5K\Omega}$

$= \dfrac{10V - 0.6V}{10K\Omega} = 0.94mA$

$v_o = I_R \times 9.5K\Omega = 0.94mA \times 9.5K\Omega = 8.93V$

$I_{D2} = 0$

(c) D1 is always forward biased. Let us assume that D2 is reverse biased.

In this case $I_{D1} = 0.94mA$, $v_o = 8.93V$

Since we haven't got any fallacy, our initial assumption of reverse biased D2 is actually correct. So, $I_{D1} = 0.94\,mA$, $v_o = 8.93V$, $I_{D2} = 0$

(d) $$I_{D1} = \frac{10V - v_o - V_\gamma}{0.5\,k\Omega} = I_{D2}$$

$$I_R = I_{D1} + I_{D2} = \frac{20V - 2v_o - 2V_\gamma}{0.5\,k\Omega}$$

$$10V = I_{D1} \times .5\,k\Omega + I_R \times 9.5\,k\Omega + V_\gamma$$

$$\Rightarrow 9.4V = 10V - v_o - 0.6V + 19 \times (20V - 2v_o - 1.2V)$$

$$\Rightarrow v_o = 9.15V, \quad I_{D1} = I_{D2} = 0.482\,mA$$

Q4

$I_{D2} = I_{D3} = I_D = 0.5mA$. $V_\gamma = 0.6V$

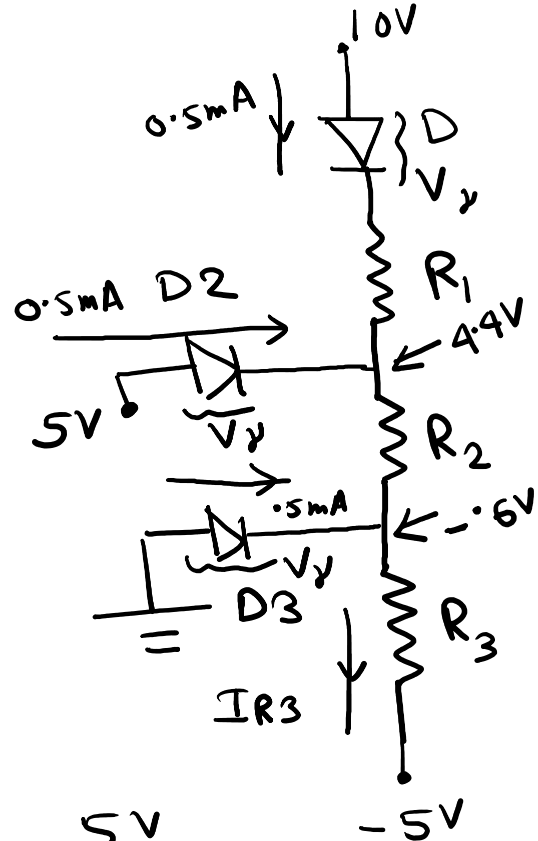
$R_1, R_2, R_3 = ?$

$I_{R3} = I_D + I_{D2} + I_{D3}$

$= 1.5mA$

$I_{R3} = \dfrac{-0.6V - (-5V)}{R_3}$

$\Rightarrow R_3 = \dfrac{4.4V}{1.5mA} = 2.93K\Omega$



$I_{R2} = I_D + I_{D2} = 1mA$

$I_{R2} = \dfrac{4.4V - (-0.6V)}{R_2} \Rightarrow R_2 = \dfrac{5V}{I_{R2}} = \dfrac{5V}{1mA}$

$= 5K\Omega$.

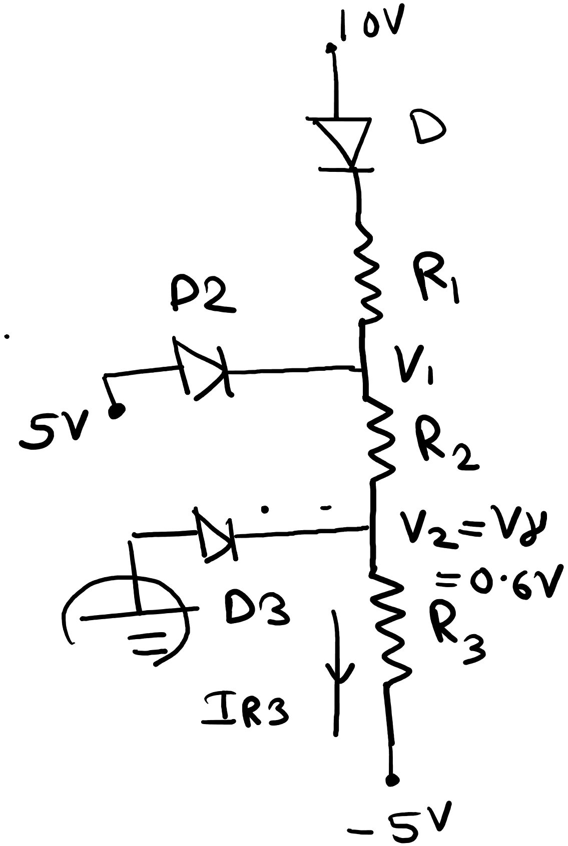
$$0.5\,mA = I_{R1} = \frac{10V - 4.4V - 0.6V}{R_1}$$

$$\Rightarrow R_1 = \frac{5V}{0.5\,mA} = 10\,k\Omega$$

$V_\gamma = 0.6V$

(a) $R_1 = R_3 = 2K\Omega$, $R_2 = 6K\Omega$ | V_1 and $V_2 = ?$

(b) $R_1 = 6K\Omega$, $R_2 = R_3 = 5K\Omega$ | V_1 and $V_2 = ?$



(a) Assume D_1 and D_2 are reverse biased.

$$I_D = I_{R1} = I_{R2} = I_{R3}$$

$$= \frac{10V - (-5V) - V_\gamma}{R_1 + R_2 + R_3} = 1.43mA$$

$$V_1 = 10V - I_{R1}R_1 - V_\gamma = \underline{\underline{6.56V}}$$

$$V_2 = 10V - V_\gamma - I_{R1}(R_1 + R_2) = -2.02V$$

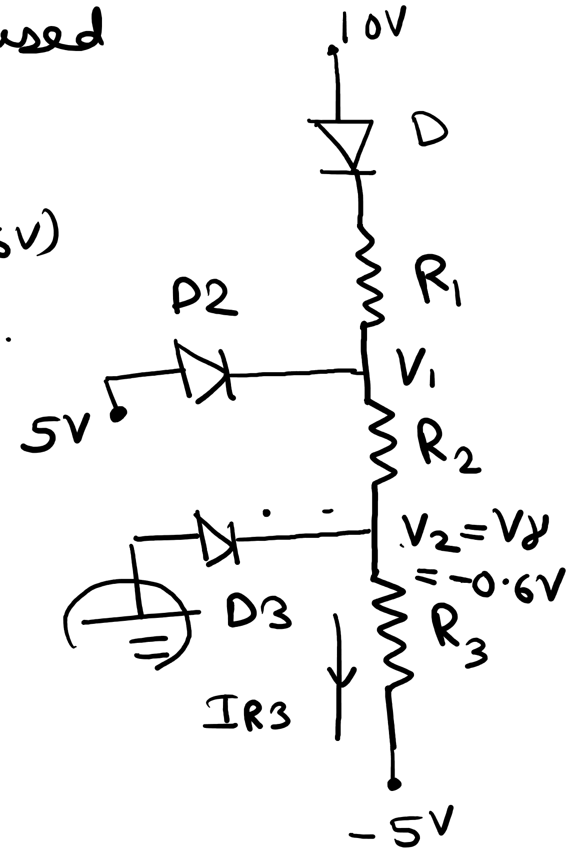
So, the assumption that D2 and D3 are reverse biased is incorrect.

So, we know that D3 is forward biased

And so, $V_2 = -V_\gamma = -0.6V$

$$I_{R1} = \frac{10V - V_\gamma - V_2}{R_1 + R_2} = \frac{10V - 0.6V - (-0.6V)}{R_1 + R_2}$$

$$= 1.25mA$$



$$V_1 = 10V - V_\gamma - I_{R1} R_1$$

$$= 10V - 0.6V - 1.25 \times 2V$$

$$= 6.9V$$

$V_1 = -0.6V$ and $V_2 = 6.9V$

(b) = $R_1 = 6K\Omega$, $R_2 = R_3 = 5K\Omega$

Assume that D_2 and D_3 are reverse biased.

$$I_D = I_{R1} = I_{R2} = I_{R3}$$

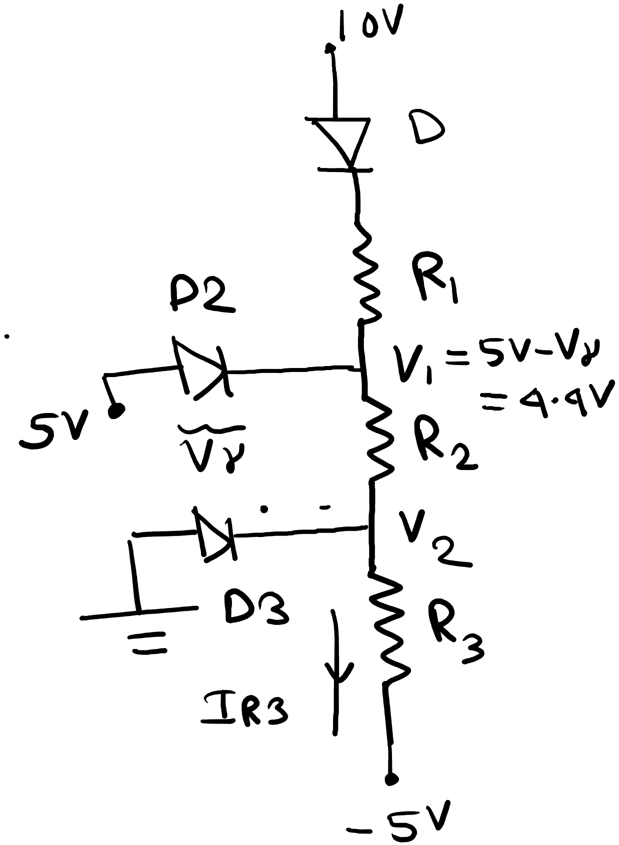
$$= \frac{10V - V_\gamma - (-5V)}{(R_1 + R_2 + R_3)}$$

$$= \frac{14.4}{16} mA = 0.9 mA$$

$$V_1 = 10V - V_\gamma - I_{R1} \times R_1$$

$$= 10V - 0.6V - 5.4V = 4V$$

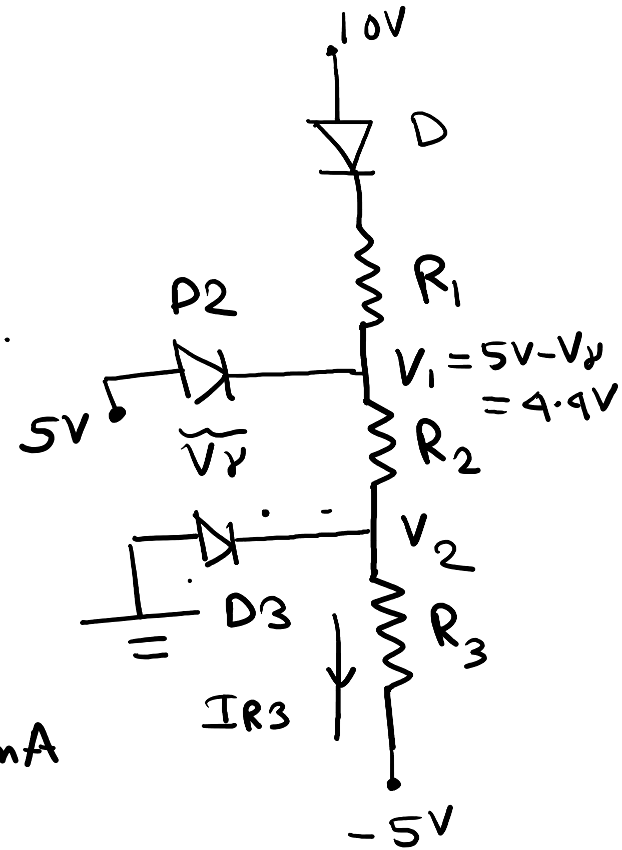
So, D2 must be forward biased.



So, V_1 must be $4.4V$.

$$I_{R1} = \frac{10V - V_\gamma - 4.4V}{R_1}$$

$$= \frac{5V}{6K\Omega} = 0.83mA$$



Assuming that D3 is reverse biased,

$$I_{R2} = I_{R3} = \frac{V_1 - (-5V)}{R_3 + R_2}$$

$$= \frac{4.4V + 5V}{10K\Omega} = 0.94mA$$

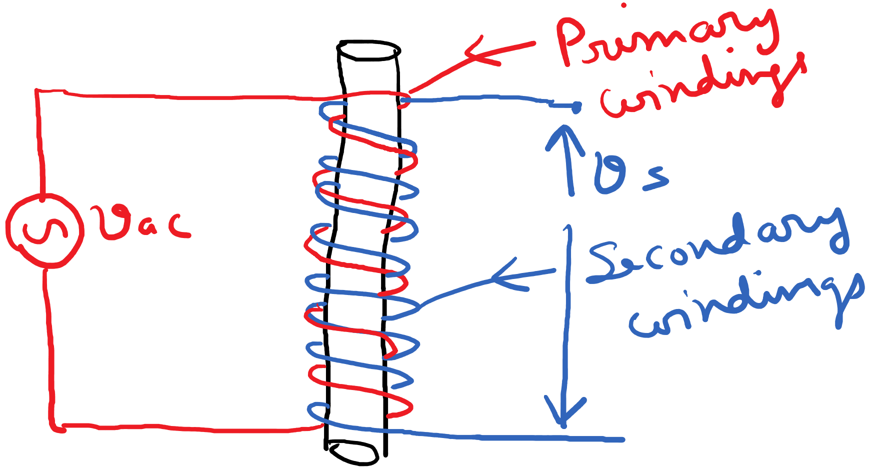
$$V_2 = V_1 - I_{R2}R_2 = 4.4V - 0.94mA \times 5K\Omega$$
$$= -0.3V$$

So, our assumption that D3 is reverse biased is actually.

So, $V_1 = 4.9V$, $V_2 = -0.3V$

Class - 11

Diode circuits



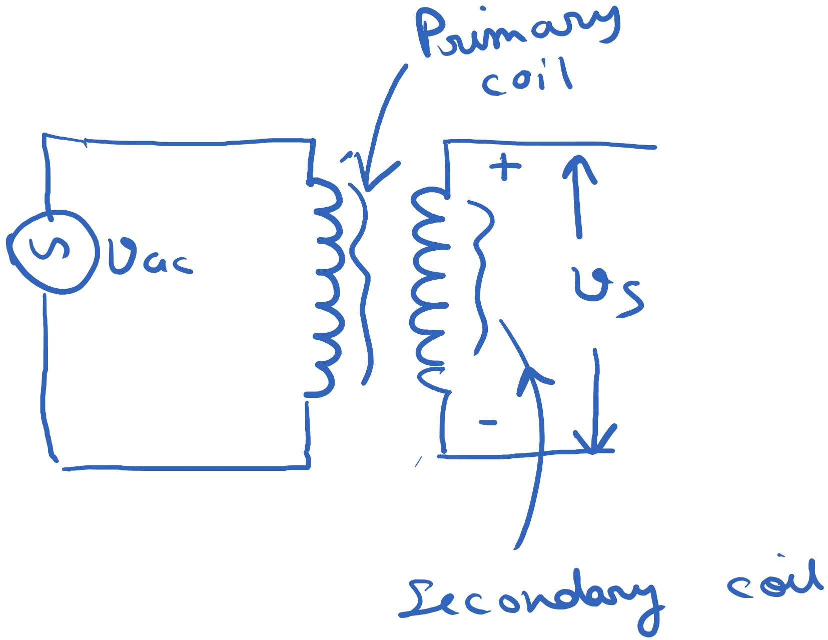
$N_1 \rightarrow$ number of turns of the primary coil.

$N_2 \rightarrow$ number of turns of the secondary coil.

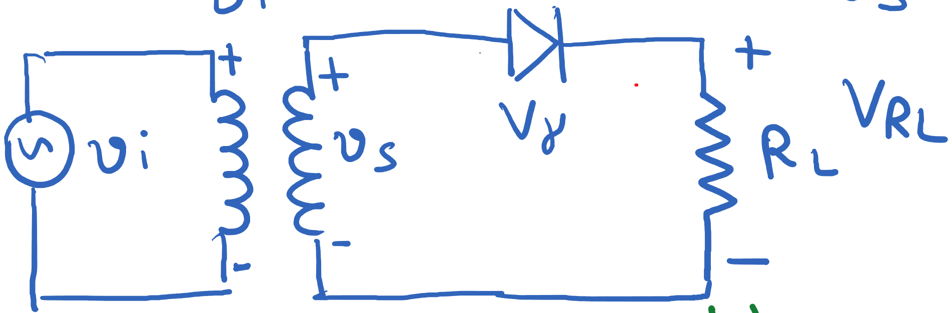
Voltage drop or voltage developed per unit turn of both the primary coil and the secondary coil is the same.

$$\frac{v_{ac}}{N_1} = \frac{v_s}{N_2}$$

$$\Rightarrow v_s = v_{ac} \times \frac{N_2}{N_1}$$



Half-wave rectifier:-

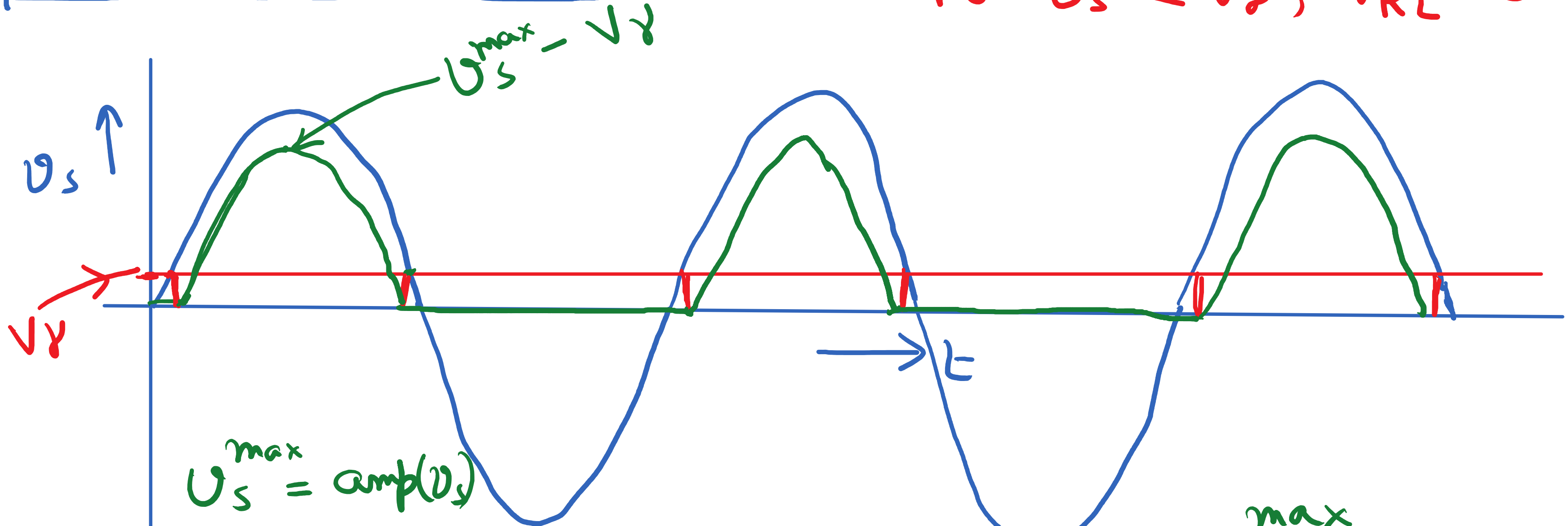


$$v_s = v_i \times \frac{N_2}{N_1}$$

For $v_s > V_\gamma$,

$$V_{RL} = v_s - V_\gamma$$

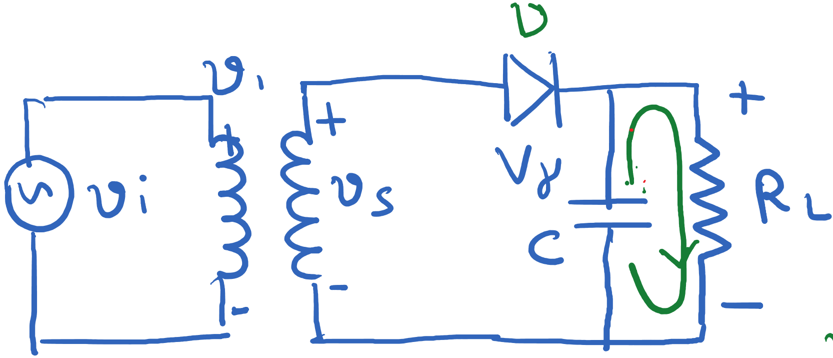
For $v_s < V_\gamma$, $V_{RL} = 0$



$v_s^{max} = \text{amp}(v_s)$

PIV = peak inverse voltage = v_s^{max}

Half wave rectifier with capacitor filter



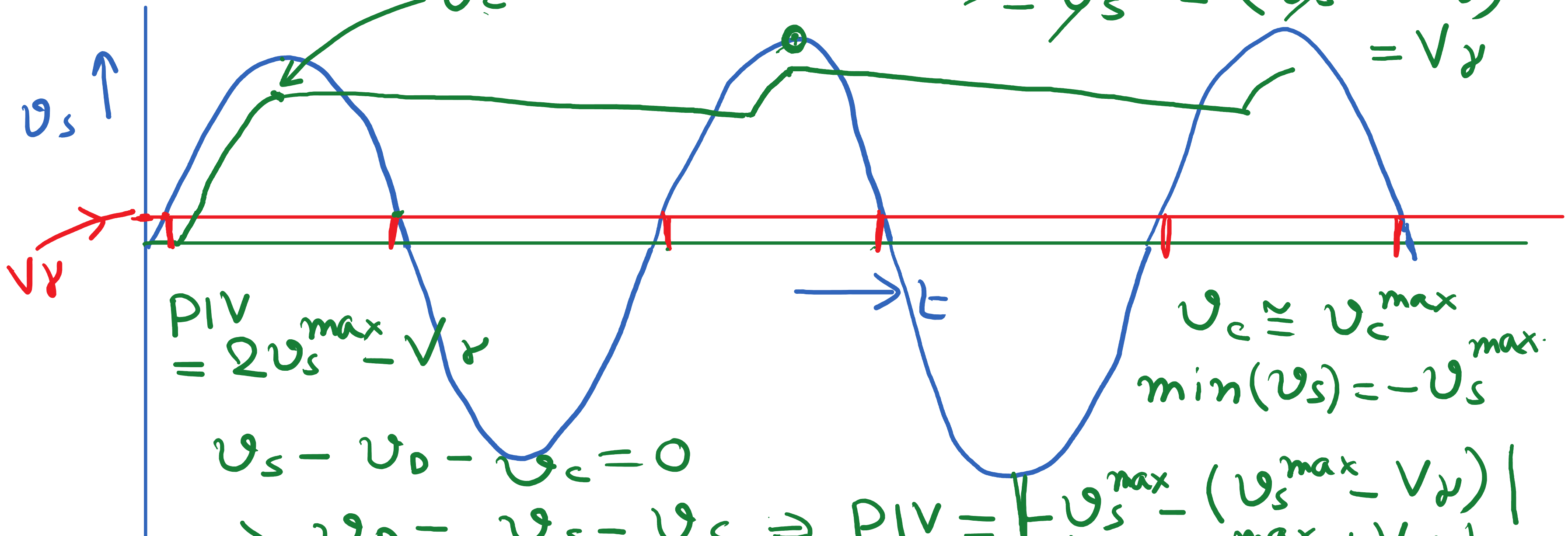
$$V_D = v_s - v_c^{max}$$

$$V_D^{max} = v_s^{max} - v_c^{max}$$

$$= \cancel{v_s^{max}} - (\cancel{v_s^{max}} - V_\gamma)$$

$$= V_\gamma$$

$$v_c^{max} = v_s^{max} - V_\gamma$$



PIV $= 2v_s^{max} - V_\gamma$

$$v_c \cong v_c^{max}$$

$$\min(v_s) = -v_s^{max}$$

$$v_s - v_D - v_c = 0$$

$$\Rightarrow v_D = v_s - v_c \Rightarrow PIV = \left| -v_s^{max} - (v_s^{max} - V_\gamma) \right|$$

$$= \left| -2v_s^{max} + V_\gamma \right|$$

$\Rightarrow$

$= \left| -2v_s^{max} + V_\gamma \right|$

$$v_D = v_S - v_C^{max}$$

$$\leq v_S^{max} - v_C^{max}$$

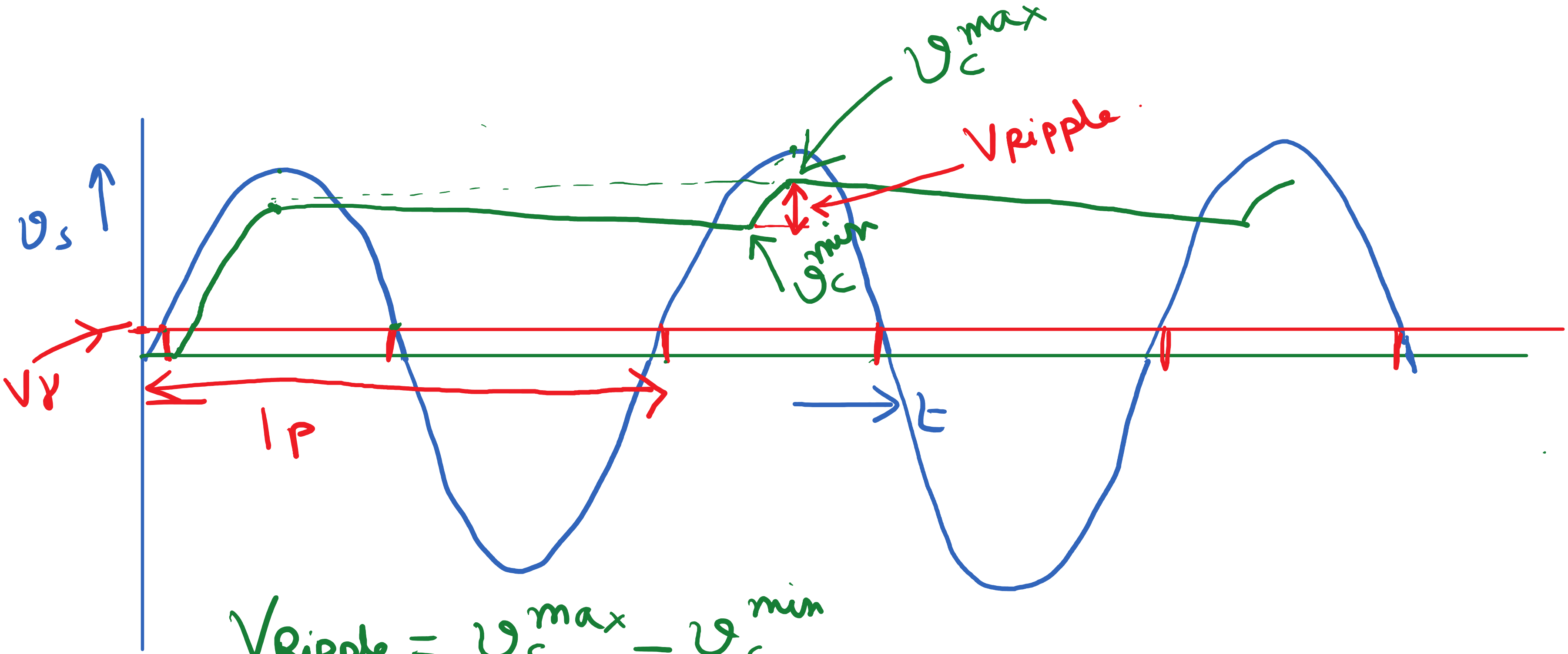
$$= v_S^{max} - \left(v_S^{max} - V_\gamma\right)$$

$$= V_\gamma$$

$$v_D \leq V_\gamma$$

For half wave rectifier with capacitor filter, the PIV of the diode is $2v_s^{max} - V_\gamma$.

For half wave rectifier without capacitor filter the PIV of the diode is v_s^{max}



$$V_{Ripple} = v_c^{max} - v_c^{min}$$

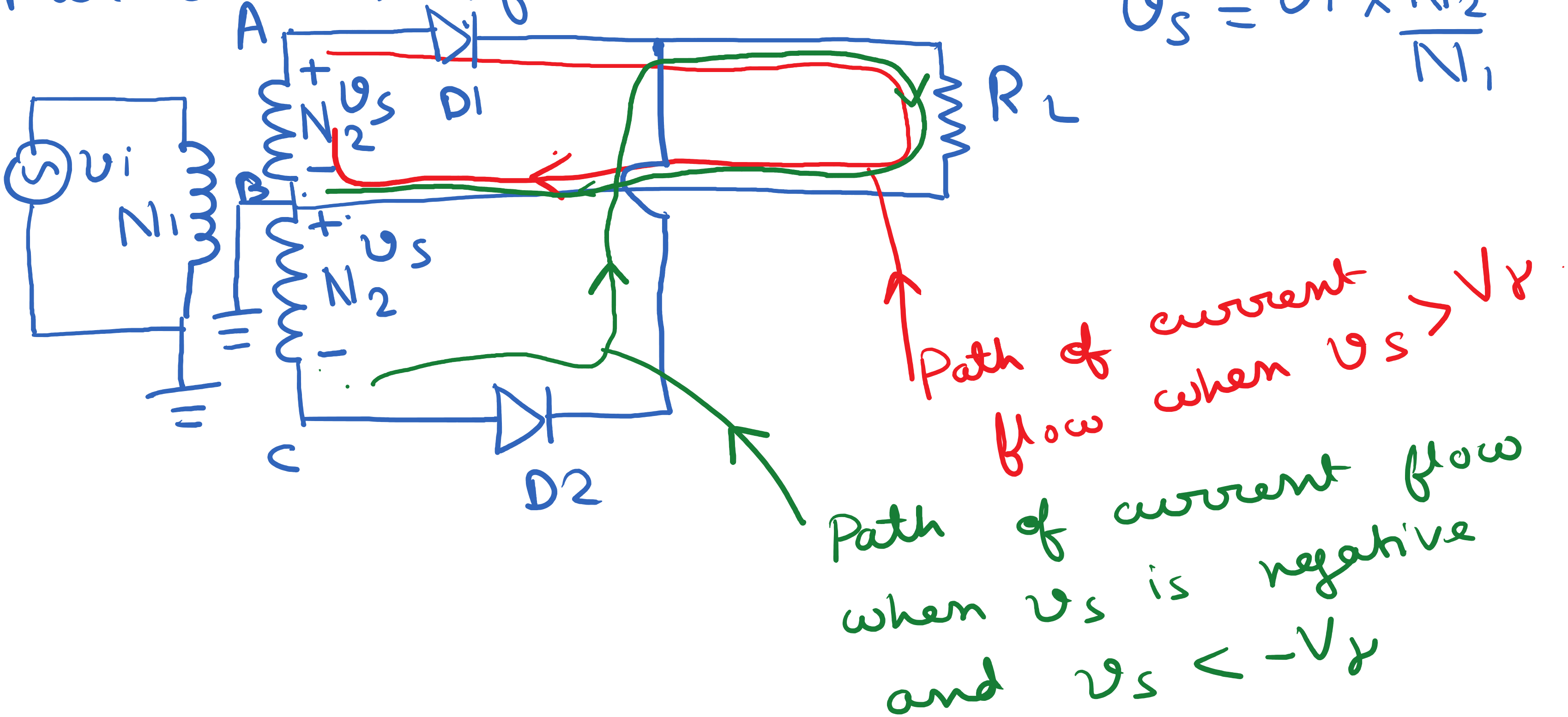
$$\frac{V_{Ripple}}{v_c^{max}} = \frac{T_p}{C R_L} \Rightarrow V_{Ripple} = \frac{T_p \, v_c^{max}}{C R_L}$$

Ripple voltage is the difference between the maximum and minimum output voltage.

Ideally, the ripple voltage should be zero. So, we try to make the ripple voltage as low as possible.

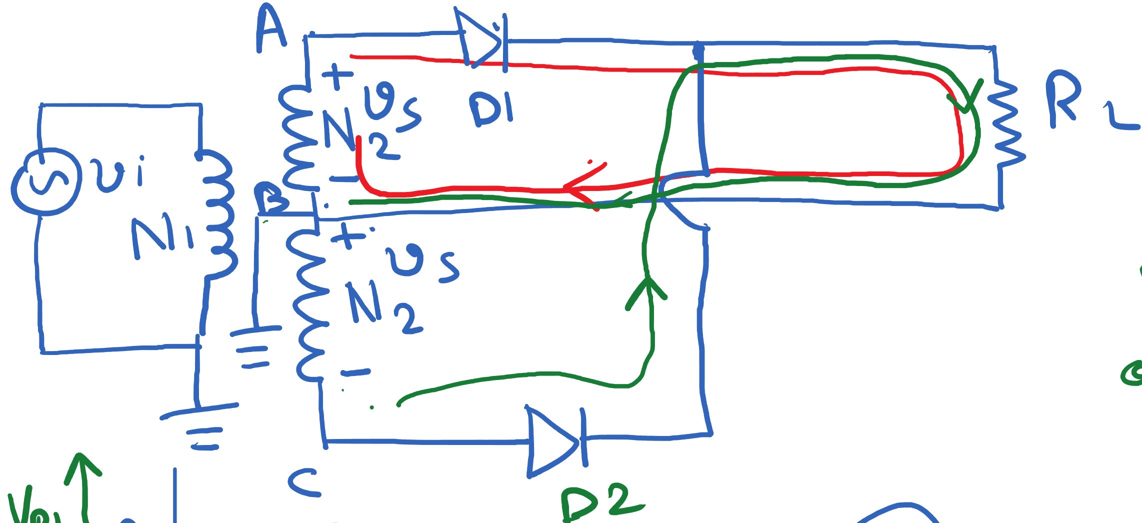
Full-wave rectifier :-

$$v_s = v_i \times \frac{N_2}{N_1}$$



During the positive part of the cycle the diode D1 conducts, while during the negative part of the cycle, the diode D2 conducts.

Both during the positive and negative parts of the cycle, voltage drop across the load resistor R_L is actually positive.



During the positive part of the cycle $V_A > V_B > V_C$

During the -ve part of the cycle $V_C > V_B > V_A$