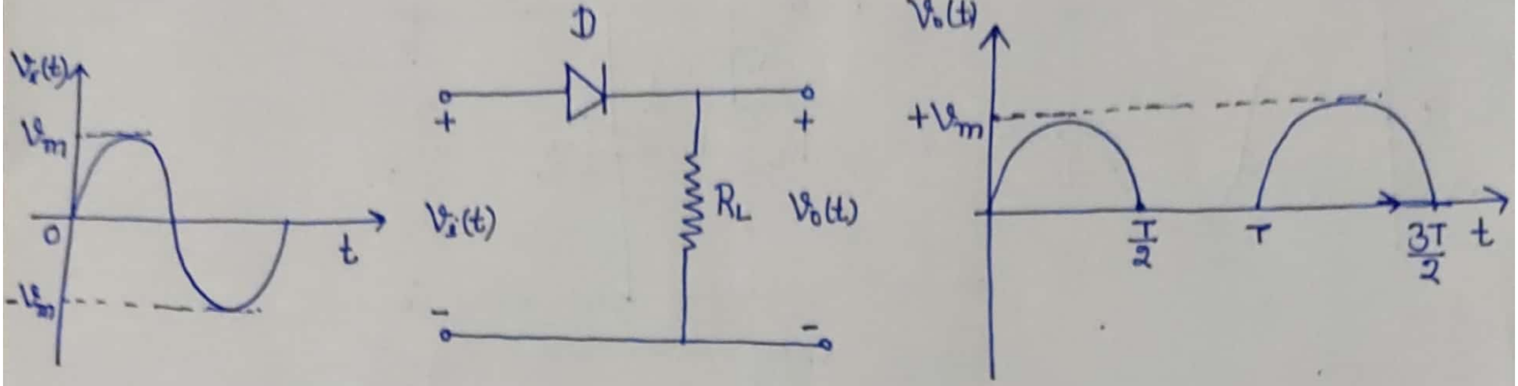
Rectifiers with Capacitive Filters

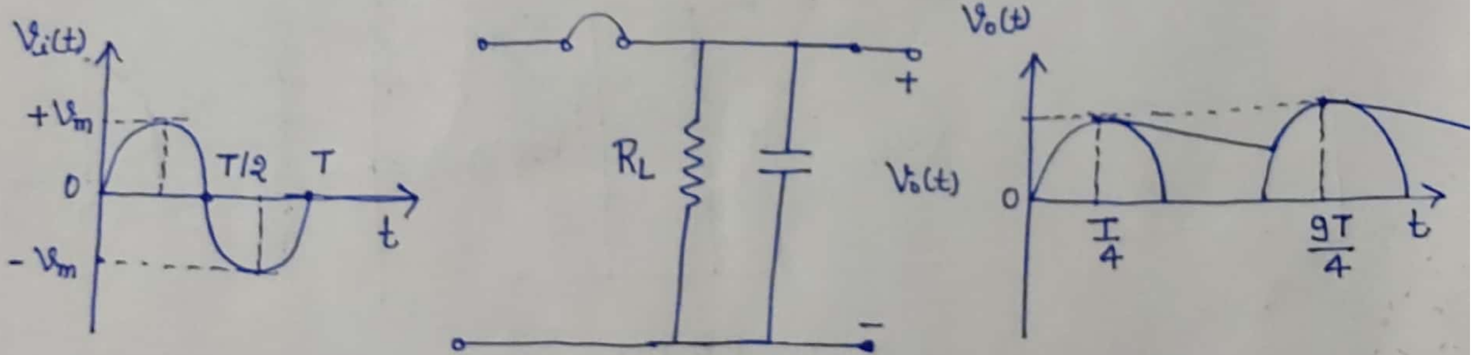


$V_i(t)$: Input Signal

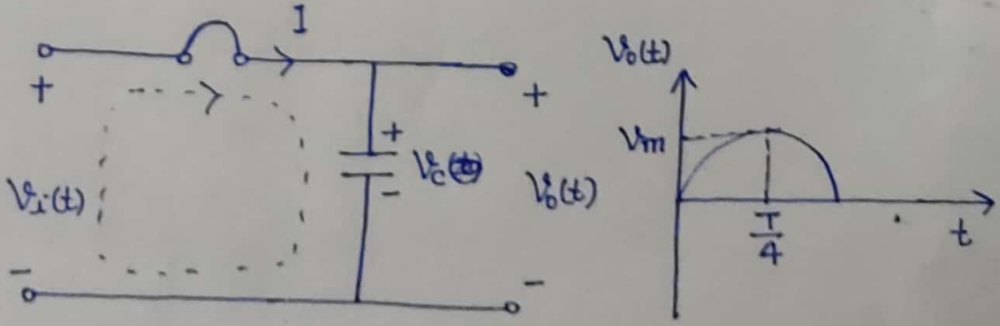
$V_o(t)$: O/P Signal
(Pulsating DC Signal)

Diode is ideal

HWR With Capacitive filter



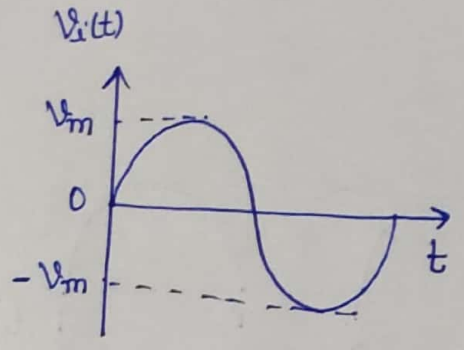
For $0 < t \leq \frac{T}{4}$

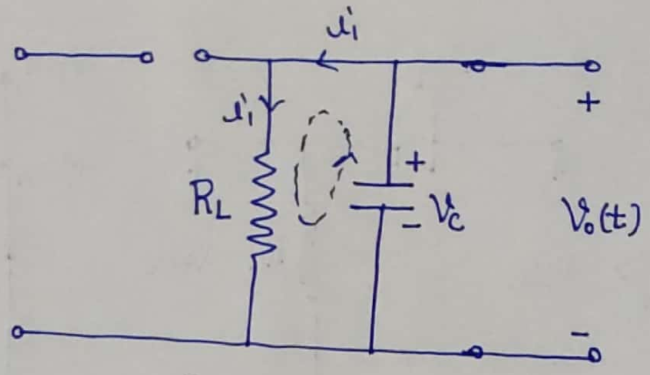


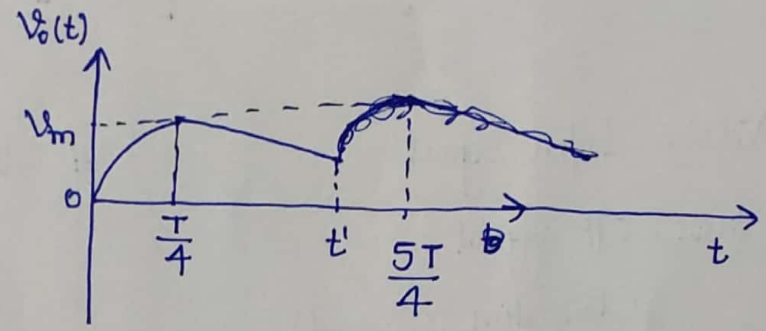
$\cancel{V_C(t) = V_m}$ $V_C = V_m$

Scanned with CamScanner

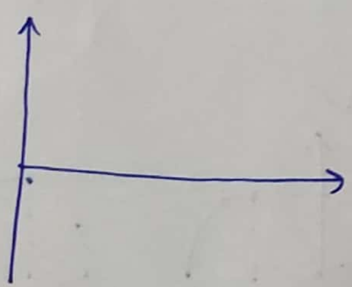
For $\frac{T}{4} \le t \le t'$

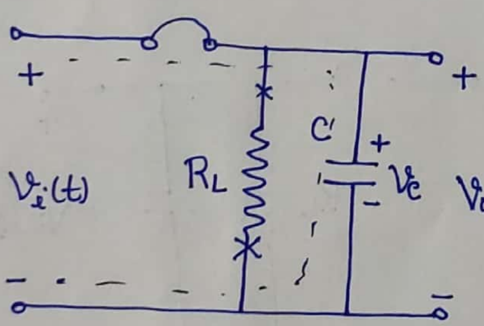


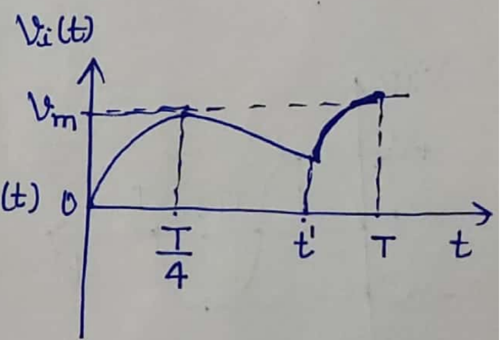




For $t' < t < \frac{5T}{4}$

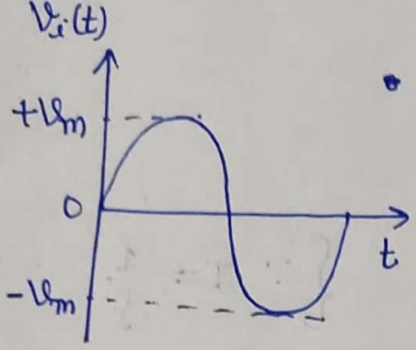


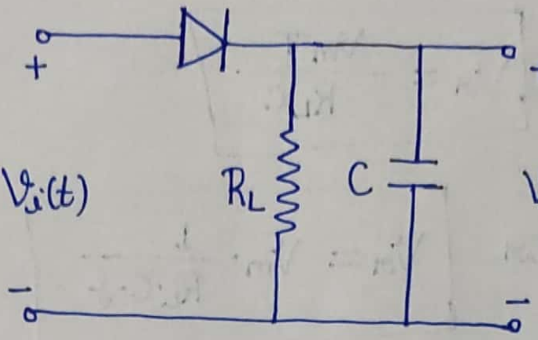


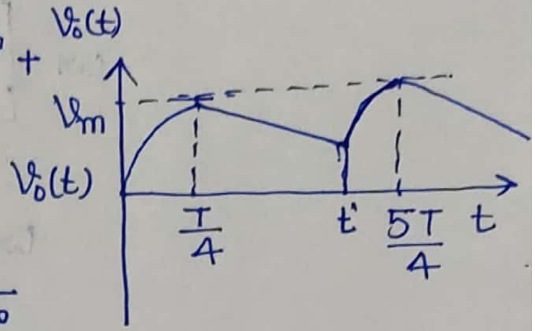


R_L Not effective
(By pass)

Output of HWR with Capacitive filter

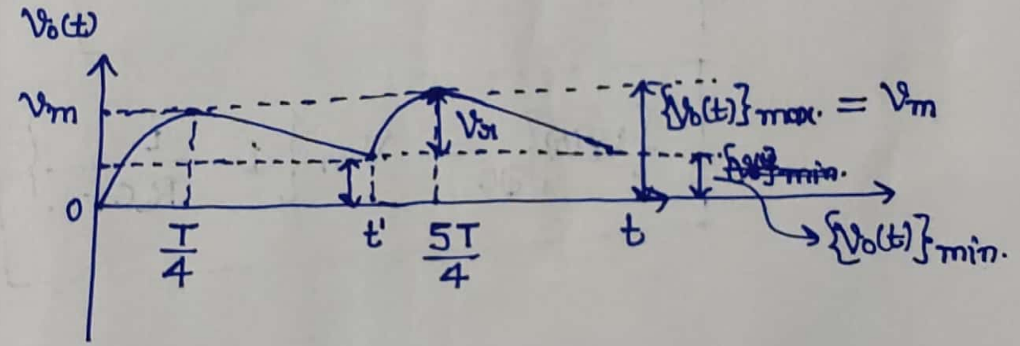






$V_i(t)$: ~~Input~~ AC Signal

$V_o(t)$: Pulsating DC Signal



$$\{V_o(t)\}_{DC} = \frac{\{V_o(t)\}_{max} + \{V_o(t)\}_{min}}{2}$$

$$= \frac{V_m + (V_m - V_r)}{2}$$

Here, V_r = ripple voltage

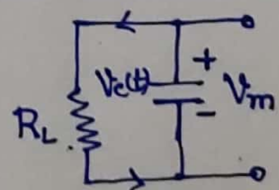
$$= \frac{2V_m - V_r}{2} = V_m - \frac{V_r}{2}$$

$$V_m - V_r = V_m e^{-t'/R_LC}$$

$\because R_LC >> T$, Therefore

$$t' \simeq T$$

$$V_m - V_r = V_m \cdot e^{-\frac{T}{R_LC}}$$



At t=0 $V_c(t) = V_m$ $\quad V_c(t) = V_o e^{-t/R_LC}$

At t=t' $\quad V_c(t') = V_o e^{-\frac{t'}{R_LC}}$

$$V_m - V_r = V_m \cdot \left\{ 1 - \frac{T}{R_L C} \right\}$$

$\left\{ e^{-x} \simeq 1-x \right.$
if $x << 1$

$$V_m - V_r = V_m - \frac{V_m T}{R_L C}$$

or $$\boxed{V_r = \frac{V_m T}{R_L C}}$$

or $$\boxed{V_r = V_m \cdot \frac{1}{R_L \cdot C \cdot f}}$$

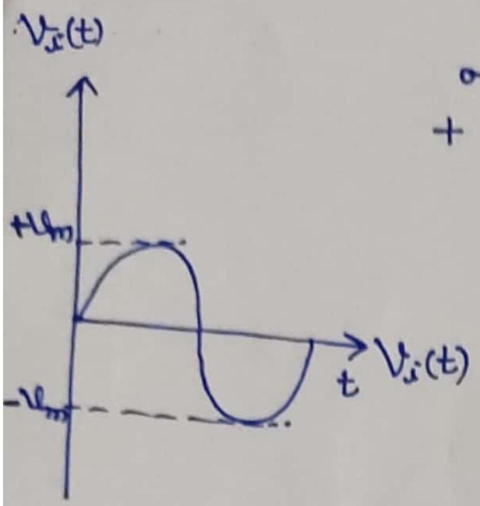
$\left\{ \because T = \frac{1}{f} \right.$

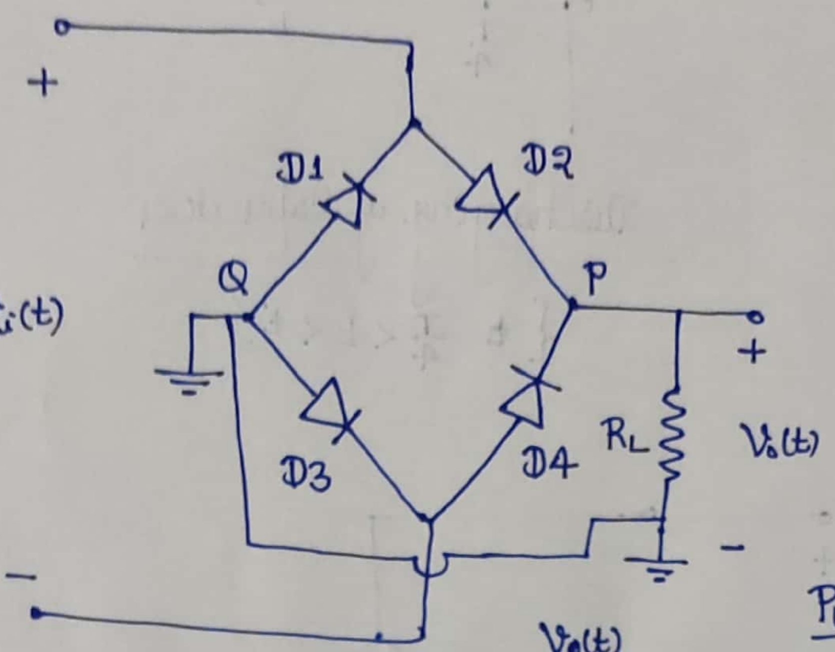
For Small V_r

- R_L should be large
- C " " "
- f " " "

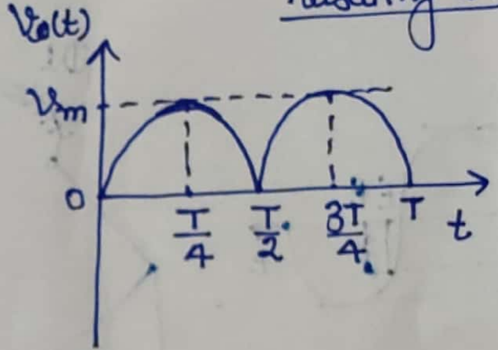
$$\boxed{\left\{ V_o(t) \right\}_{DC} = V_m \left\{ 1 - \frac{1}{R_L C f} \right\}}$$

Bridge Rectifier





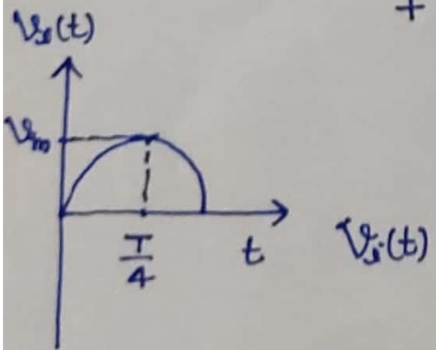
Pulsating DC

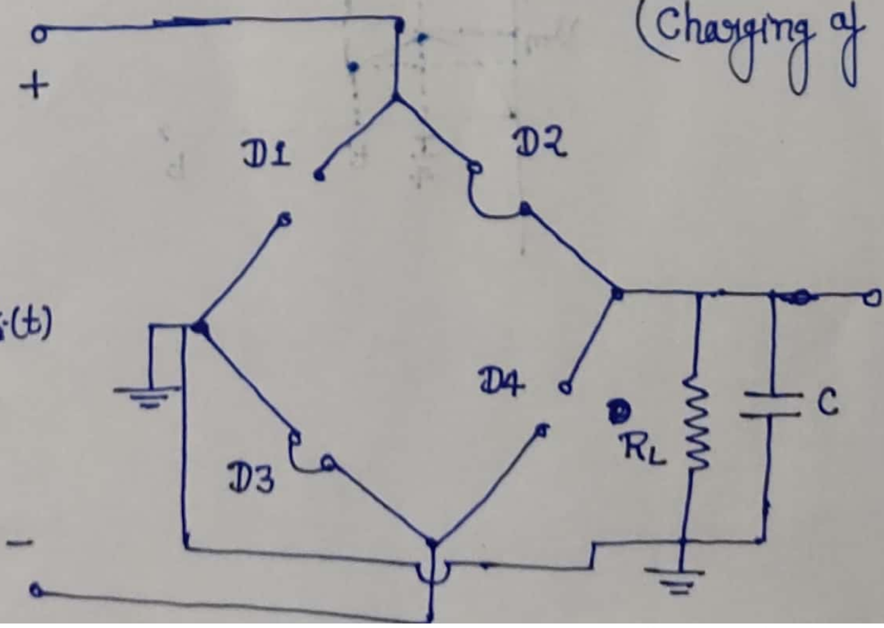


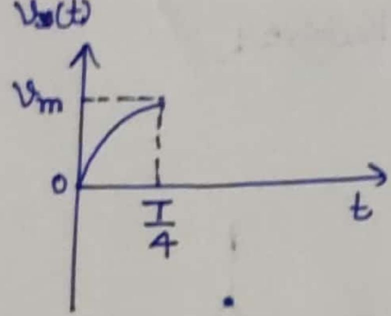
All diodes are ideal

FWR with Capacitive Filter

For $0 < t \leq \frac{T}{4}$
(Charging of Capacitor)

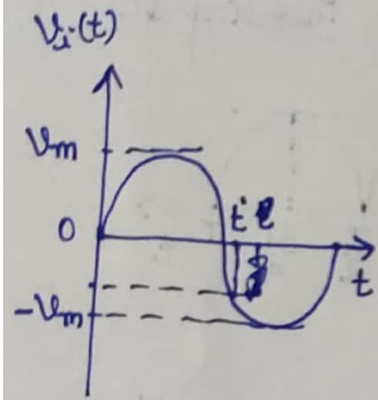


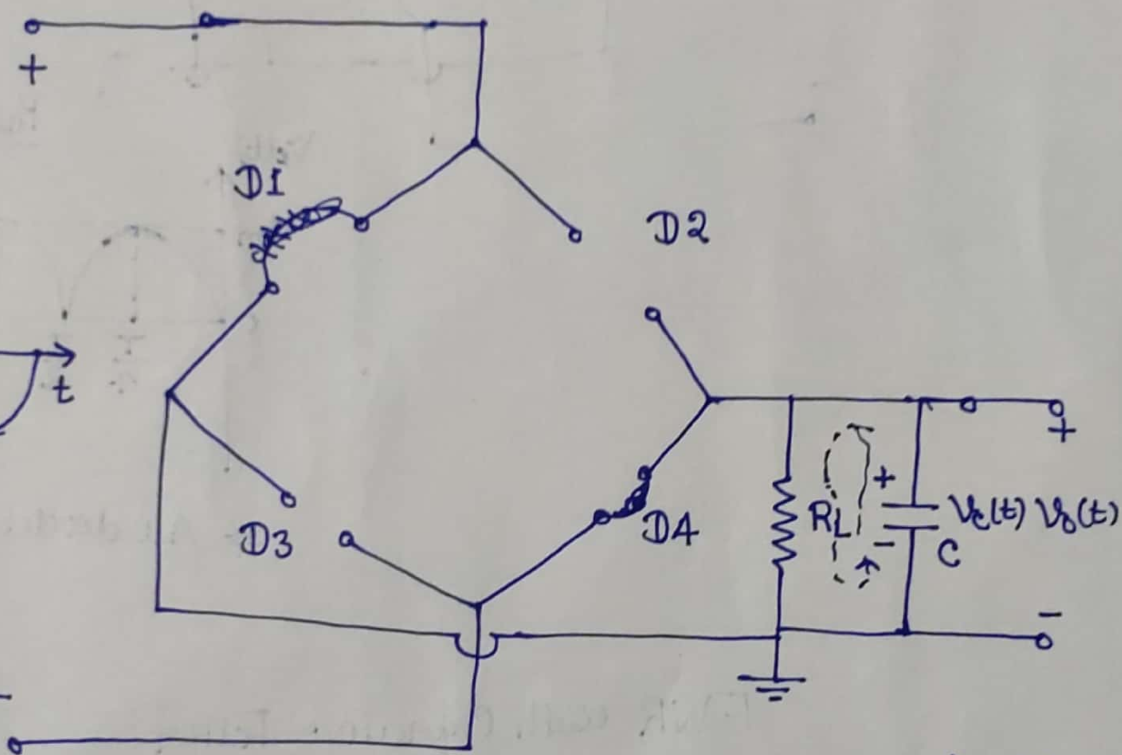




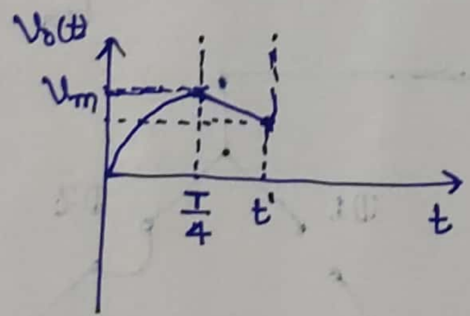
Discharging of Capacitor

$\left\{ \frac{T}{4} < t < t' \right\}$

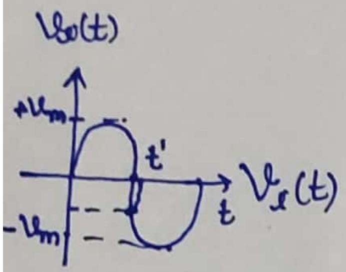


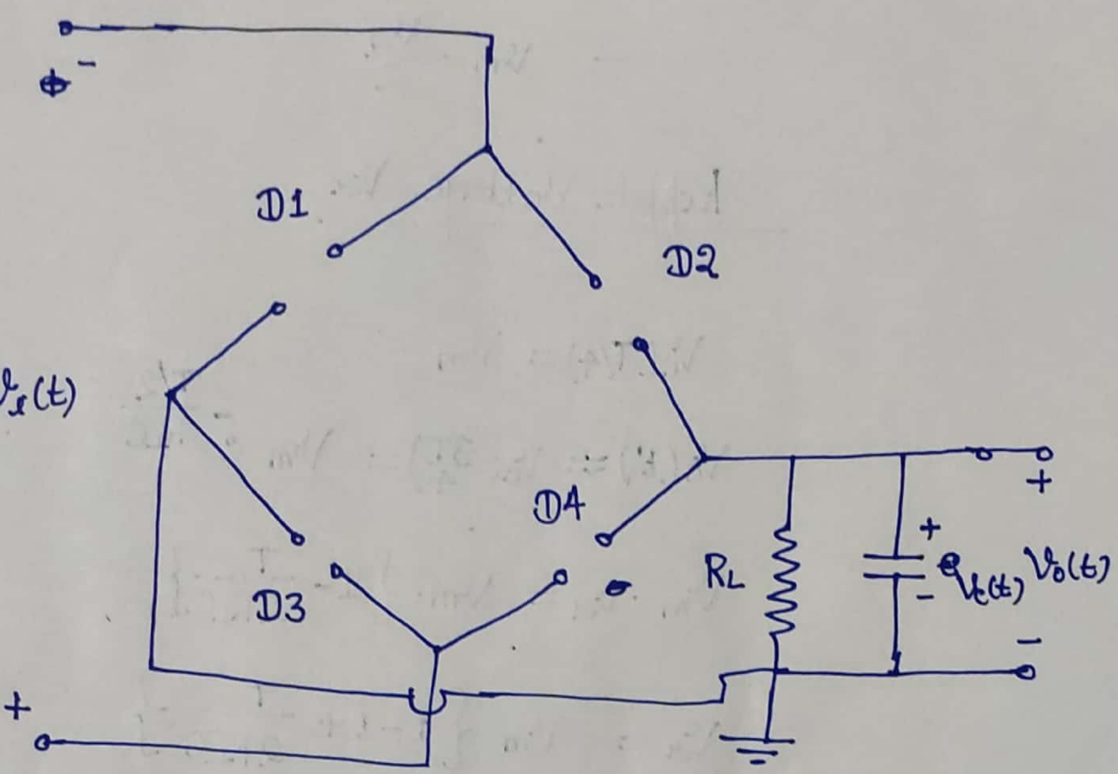


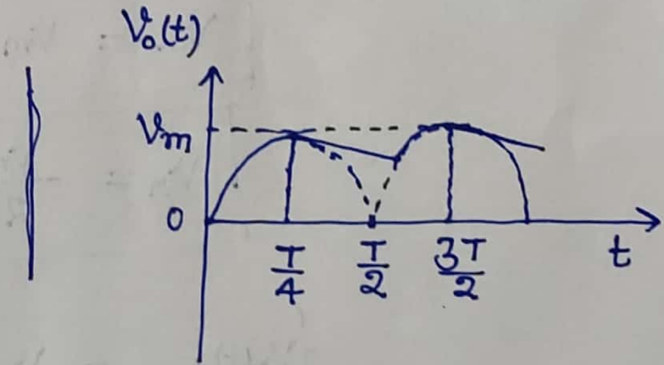
$V_c(\frac{T}{4}) = V_m$



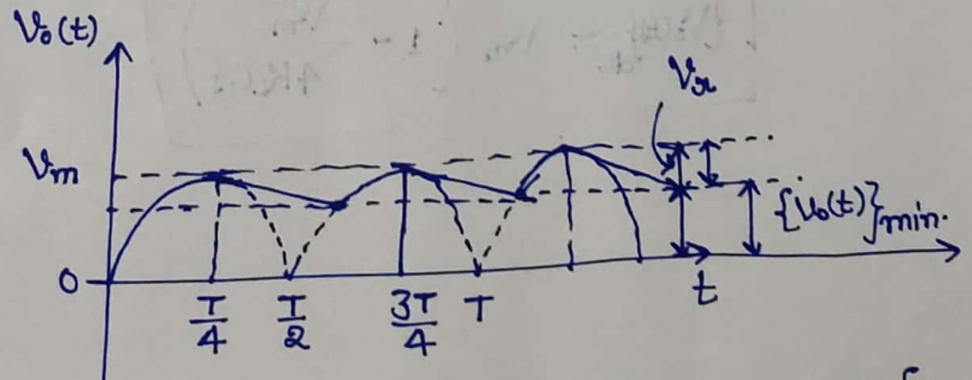
For $t' < t < \frac{3T}{4}$







Output



$$\{V_o(t)\}_{min.} = \{V_o(t)\}_{max.} - V_r$$
$$= V_m - V_r$$

$$\{V_o(t)\}_{Avg} = \{V_o(t)\}_{DC} = \frac{\{V_o(t)\}_{max.} + \{V_o(t)\}_{min.}}{2}$$

$$\{V_o(t)\}_{DC} = \frac{V_m + V_m - V_r}{2}$$

$$= V_m - \frac{V_r}{2}$$

Ripple Voltage V_r

$$V_C(T/4) = V_m$$

$$V_C(t') \approx V_C\left(\frac{3T}{4}\right) = V_m\, e^{-\frac{T/2}{R_L C}}$$

$$V_m - V_r = V_m \cdot \left\{1 - \frac{T}{2R_L C}\right\}$$

$$V_r = V_m \left\{1 - 1 + \frac{T}{2R_L C}\right\}$$

$$\boxed{V_r = V_m \frac{T}{2R_L C}}$$

$$\boxed{V_r = \frac{V_m}{2fR_L C}}$$

$$\{V_o(t)\}_{dc} = V_m - \frac{1}{4}\frac{V_m}{R_L C f}$$

$$\boxed{\{V_o(t)\}_{dc} = V_m\left(1 - \frac{V_m}{4R_L C f}\right)}$$