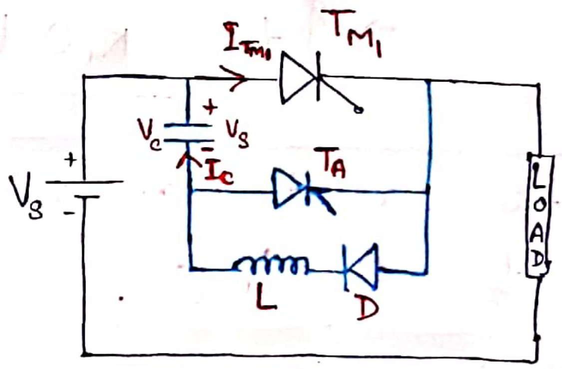
(C) Voltage Commutation or Impulse Commutation or Class D commutation.



- In this method of commutation, a reverse voltage is suddenly applied across the thyristor, to turn it off. So, it is also known as Voltage commutation.

- This type of commutation is also known as auxiliary commutation, as an auxiliary thyristor T_A is used to turn-off the main thyristor T_M.

Assumptions :-

1). Capacitor is initially charged with V_s volts and polarity is as marked in the circuit diagram.

2) Load current is assumed to be constant.

3) Before t=0 sec., both T_M and T_A are off.

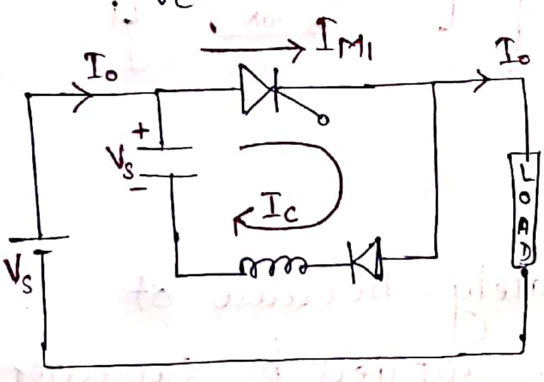
- Operation of the commutation circuit can be understood in two steps.

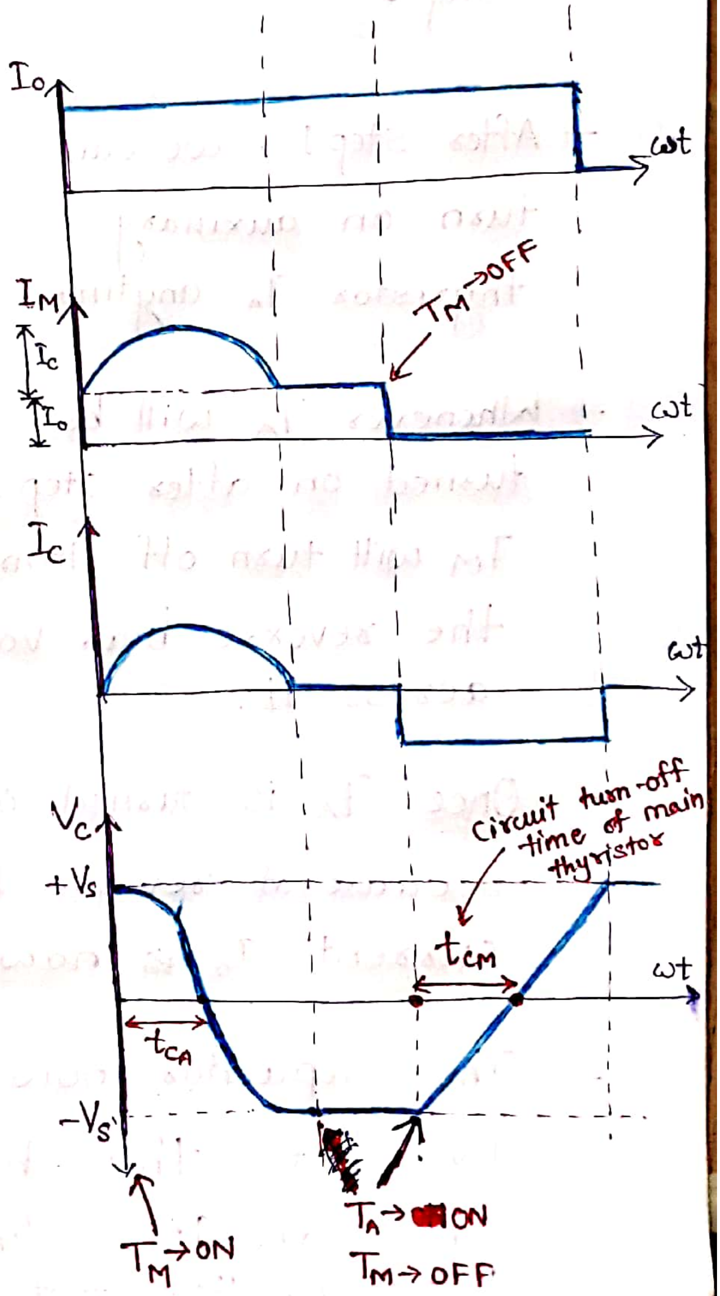
Step 1 :-

at t=0 sec.

T_M → turned ON.

$\therefore V_c = +V_s$





$$I_{M_1} = I_o + I_c$$

and

$I_c = I_p \sin \omega_o t$,

$$\Rightarrow I_c = V_s \sqrt{\frac{C}{L}} \sin \omega_o t$$

At end of step 1

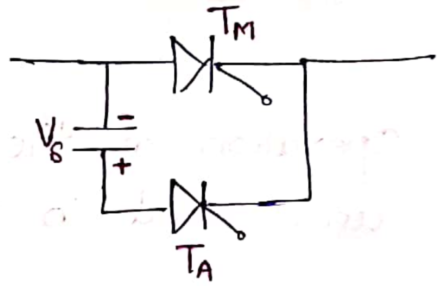
↳ $V_c = -V_s$

↳ $I_c = 0$

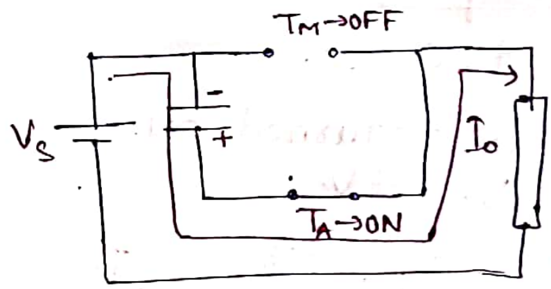
↳ $I_M = I_o$

Step 2 :-

- The capacitor voltages changes or reverses its polarity at the end of step 1.



- After step 1, we can turn on auxiliary thyristor T_A anytime.



- Whenever T_A will be turned-on after step 1, T_M will turn-off immediately, because of the reverse bias voltage applied by capacitor across it.

- Once T_A is turned ON, T_M is turned-off because of reverse bias voltage and load current, I_o now flows through T_A.

- The capacitor now charges from $-V_s$ to $+V_s$, but this charging is linear and not sinusoidal. It is linear because load current I_o, passing through it is maintained constant by load.

Finding circuit-turn-off time

→ For main thyristor, circuit-turn-off time, t_{CM} can be obtained from the capacitor voltage expression. We know.

$$V_c = \frac{1}{C}\int I_c\,dt.$$

Now, we know $I_c = I_0$ and time is t_{CM}. and $V_c = V_s$.

$$\Rightarrow V_s = \frac{I_0}{C} \cdot t_{CM}$$

$$\Rightarrow \boxed{t_{CM} = \frac{V_s \cdot C}{I_0}}$$

→ For Auxiliary thyristor, when T_M is ON, reverse voltage is applied for half cycle of discharging period. i.e. for $\omega t = \frac{\pi}{2}$.

$$\omega_0 t_{CA} = \frac{\pi}{2}$$

$$\Rightarrow t_{CA} = \frac{\pi}{2} \times \frac{1}{\omega_0}$$

$$\Rightarrow \boxed{t_{CA} = \frac{\pi}{2}\sqrt{LC}} \qquad \left(\because \omega = \frac{1}{\sqrt{LC}}\right)$$

→ Circuit turn-off time of $T_M = t_{CM} = C\dfrac{V_s}{I_0}$

→ Circuit turn-off time of $T_A = t_{CA} = \dfrac{\pi}{2}\sqrt{LC}$

– Peak value of current through $T_M = I_0 + V_s\sqrt{\frac{C}{L}}$ and through $T_A = I_0$

– Minimum time required to turn off T_M after getting turned on at $t=0$ is $\pi\sqrt{LC}$