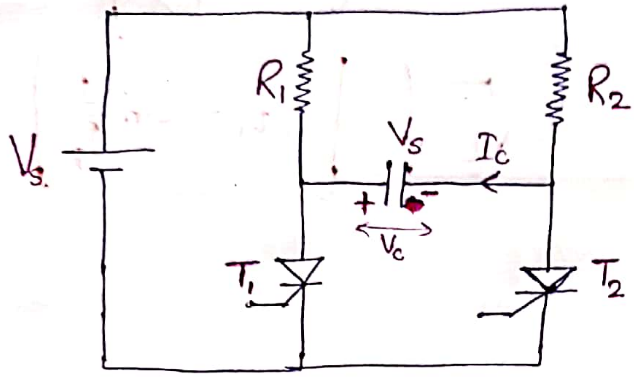
(b) Complementary Commutation or Class C commutation.



Complementary Commutation

- In this technique two thyristors are used for carrying the load current alternately.

- One thyristor is turned-off by turning on the other thyristor. The Load current also transfers from the outgoing thyristor to incoming thyristor.

- In this, one thyristor takes care of the commutation of the other and vice-versa. So, it is also known as complementary commutation.

Assumption :-

1) Capacitor C, is charged initially to voltage V_s, with the polarity marked above in circuit diagram.

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

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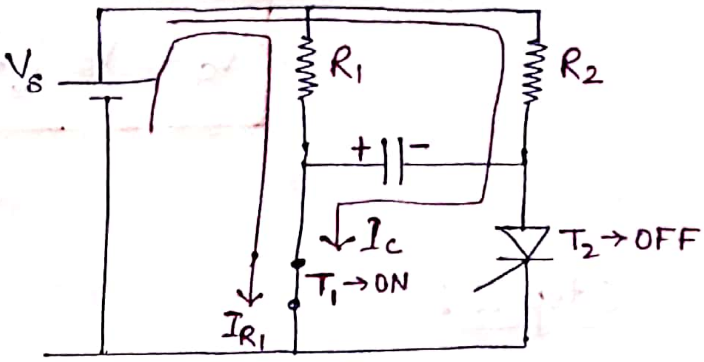
Step 1 :-

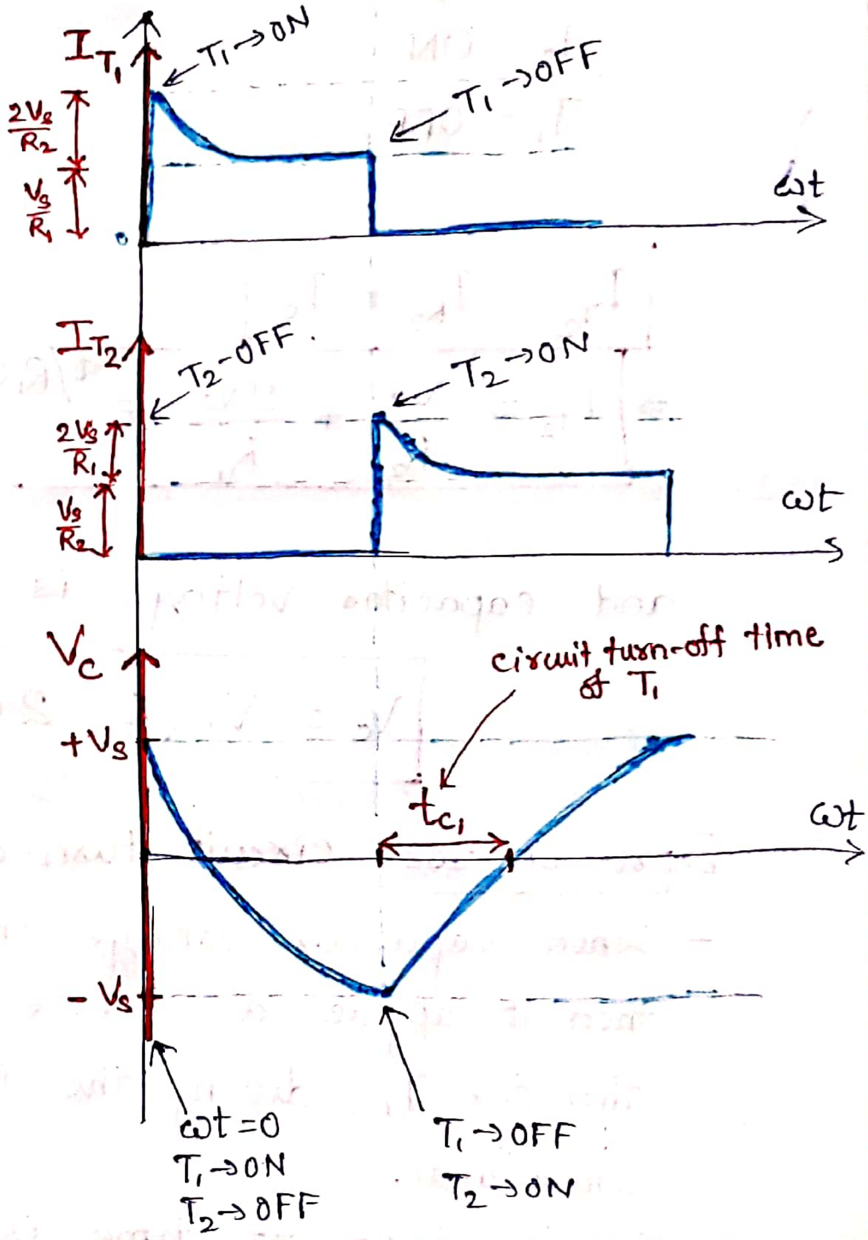
At $t = 0$ sec.

T_1 is turned ON.

T_2 is off.



- The moment T_1 is turned ON, immediately T_2 becomes OFF, due to reverse voltage applied by capacitor C.



- So, when thyristor T_1 is turned ON, current flows ~~in~~ ~~it~~ through it in the manner shown above.

- The thyristor current I_{T_1} has two components.

$$I_{T_1} = I_{R_1} + I_c$$

- We know,

$$I_{R_1} = \frac{V_s}{R_1}$$

and, $$I_c = \frac{(V_s + V_s)}{R_2} e^{-t/R_2C}$$

So, $$I_{T_1} = \frac{V_s}{R_1} + \frac{2V_s}{R_2} e^{-t/R_2C}$$

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- Capacitor voltage is given by,

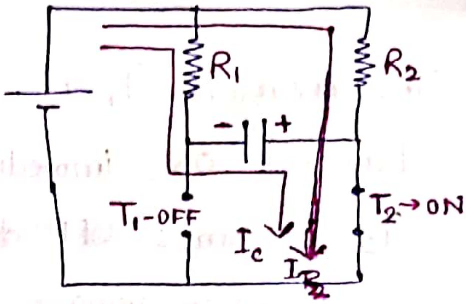
$$V_c = V_s\left(2e^{-t/R_2C} - 1\right)$$

Step 2 :-

At $t = t_1$

$T_2 = ON$

$T_1 = OFF$



$$I_{T_2} = I_{R_2} + I_c$$

$$\Rightarrow I_{T_2} = \frac{V_s}{R_2} + \frac{2V_s}{R_1} \cdot e^{-t/R_1C}$$

and capacitor voltage is given by,

$$V_c = V_s\left(1 - 2e^{-t/R_1C}\right)$$

Expression for circuit turn-off time

- When capacitor voltage changes from $-V_s$ to $+V_s$, then it applies a reverse bias voltage across thyristor T_1, during the interval t_{c1}, shown in waveform.
- Circuit - turn-off time is the duration for which reverse bias voltage is applied across the thyristor, to enable it to regain its blocking capability.

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- So, putting time as t_{c1} in the voltage expression for capacitor in step 2 and equating it to zero, we can find the value of t_{c1}.

- We equate the capacitor voltage to zero, as, at t_{c1}, $V_c = 0$, from the waveform above.

$$\therefore \quad V_c = V_s\left(1 - 2e^{-t_{c1}/R_1C}\right) = 0$$

$$\Rightarrow 1 - 2e^{-t_{c1}/R_1C} = 0$$

$$\Rightarrow e^{-t_{c1}/R_1C} = \frac{1}{2}$$

$$\Rightarrow \frac{-t_{c1}}{R_1C} = \ln\left(\frac{1}{2}\right)$$

$$\Rightarrow \boxed{t_{c1} = R_1C\ln(2)}$$

Imp

- So, circuit-turn-off time for thyristor T_1 is $t_{c1} = R_1C\ln(2)$.

- Similarly, circuit turn off time of $T_2 = t_{c2} = R_2C\ln(2)$

- Peak value of current through $T_1 = I_{T_1} = V_s\left[\frac{1}{R_1} + \frac{2}{R_2}\right]$

- Peak value of current through T_2; $I_{T_2} = V_s\left[\frac{2}{R_1} + \frac{1}{R_2}\right]$

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