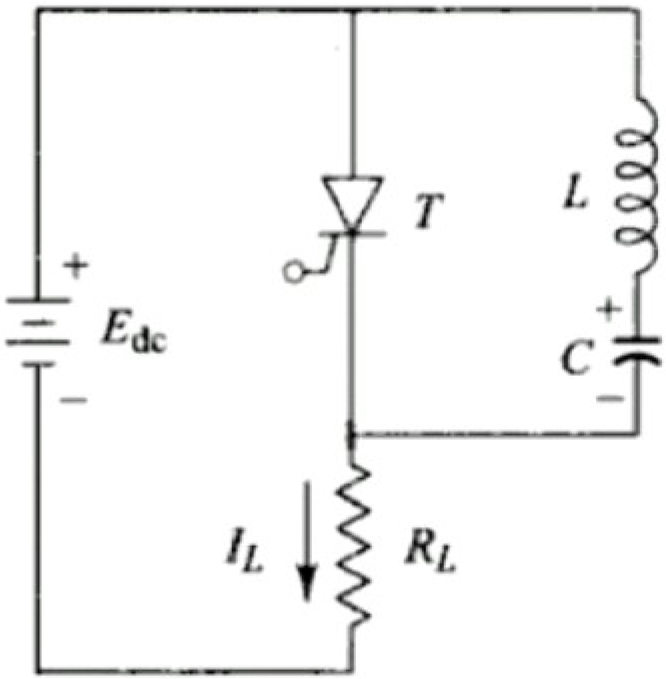


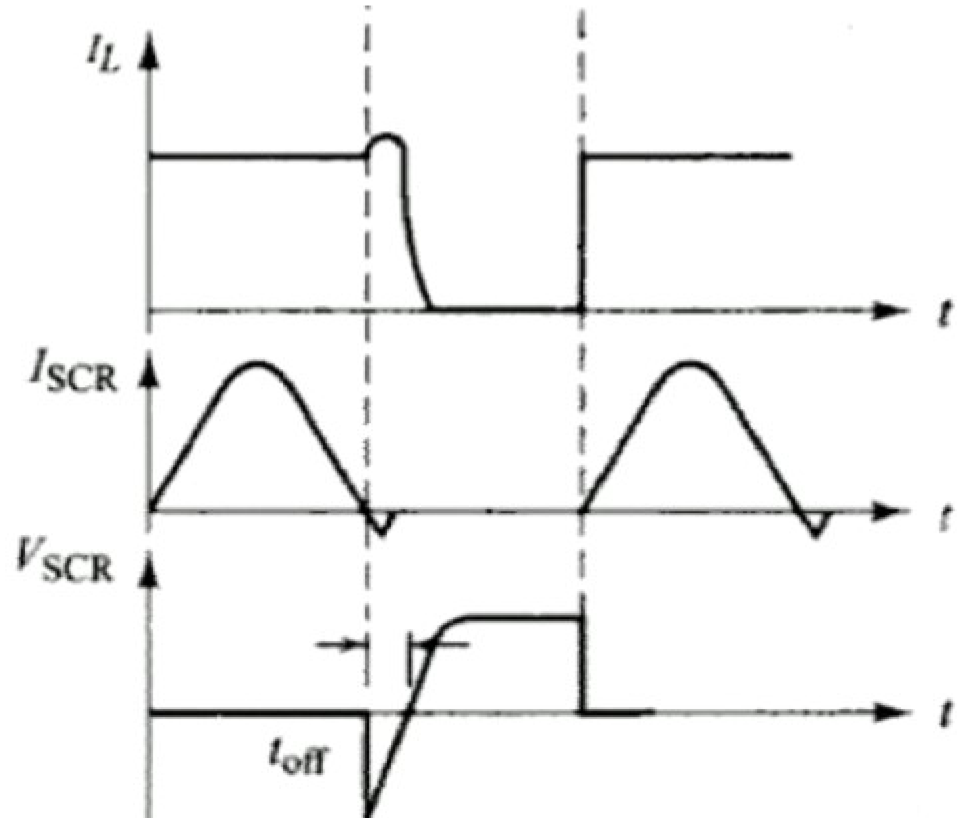


Fig. 2.15 *Class B commutation circuit* **Fig. 2.16** *Associated waveforms*

Initially, as soon as the supply voltage E_{dc} is applied, the capacitor C starts

Design Considerations

The circuit equations for the LC circuit are:

$$L \frac{\mathrm{d}i}{\mathrm{d}t} + \frac{1}{C}\int i\,\mathrm{d}t = 0$$

$$\therefore \qquad L \frac{\mathrm{d}^2 i}{\mathrm{d}t^2} + \frac{1}{C}\, i(t) = 0$$

Taking laplace transform of the above equation, $\left(S^2 L + \frac{1}{C}\right) I(s) = 0$

$$\therefore \qquad i(t) = E_{\mathrm{dc}} \sqrt{\frac{C}{L}} \sin \omega_0 t$$

Where $\omega_0 = \sqrt{\frac{1}{LC}}$

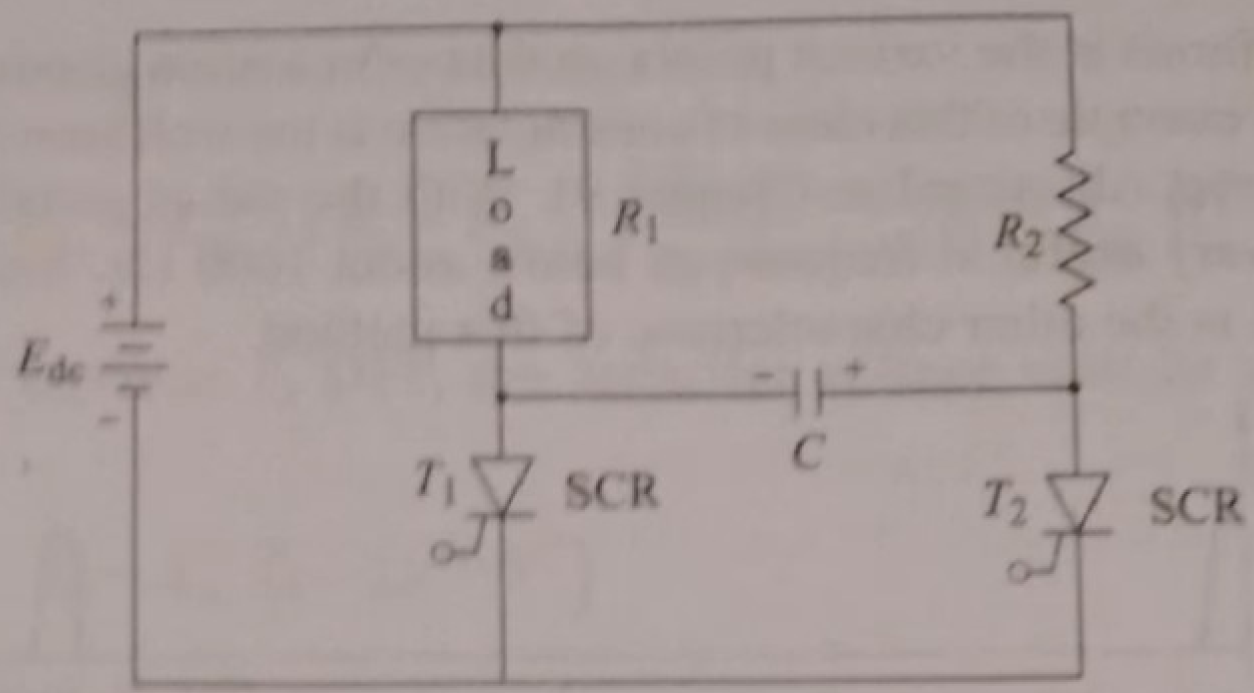


Fig. 2.17 *Class C–commutation circuit*

Circuit Operation

(a) Mode 0: [Initial-state of circuit] Initially, both the thyristors are OFF.

 Therefore, the state of the devices are –

(c) Mode 2: When a triggering pulse is applied to the gate of T_2, T_2 will be turned on. As soon as T_2 is ON, the negative polarity of the capacitor C is applied to the anode of T_1 and simultaneously, the positive polarity of capacitor C is applied to the cathode. This causes the reverse voltage across the main thyristor T_1 and immediately turns it off.

Charging of capacitor C now takes place through the load and its polarity becomes reverse. Therefore, charging path of capacitor C becomes

$$E_{dc+} - R_1 - C_{+} - C - T_{2(a-k)} - E_{dc-}$$

Hence, at the end of Mode 2, the states of the devices are

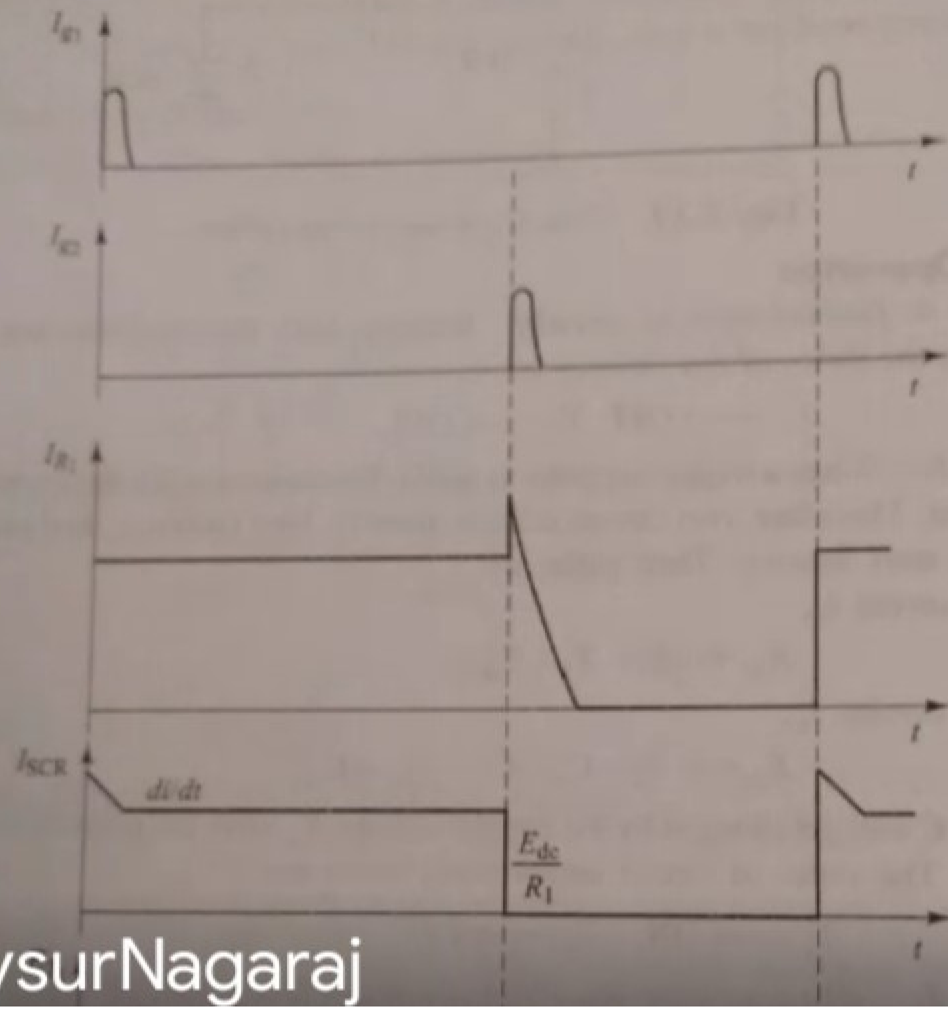
$$T_1 \longrightarrow \text{OFF}, \quad T_2 \longrightarrow \text{ON}, \quad E_{c_1} = -E_{dc}$$

(d) Mode 3: Now, when thyristor T_1 is triggered, the discharging current of capacitor turns the complementary thyristor T_2 OFF. The state of the circuit at the end of this Mode 3 becomes

$$T_1 \longrightarrow \text{ON}, \quad T_2 \longrightarrow \text{OFF}, \quad E_{c_1} = E_{dc}$$

 operation is equivalent to Mode 1 operation.

commutation is the other characteristic of this method.



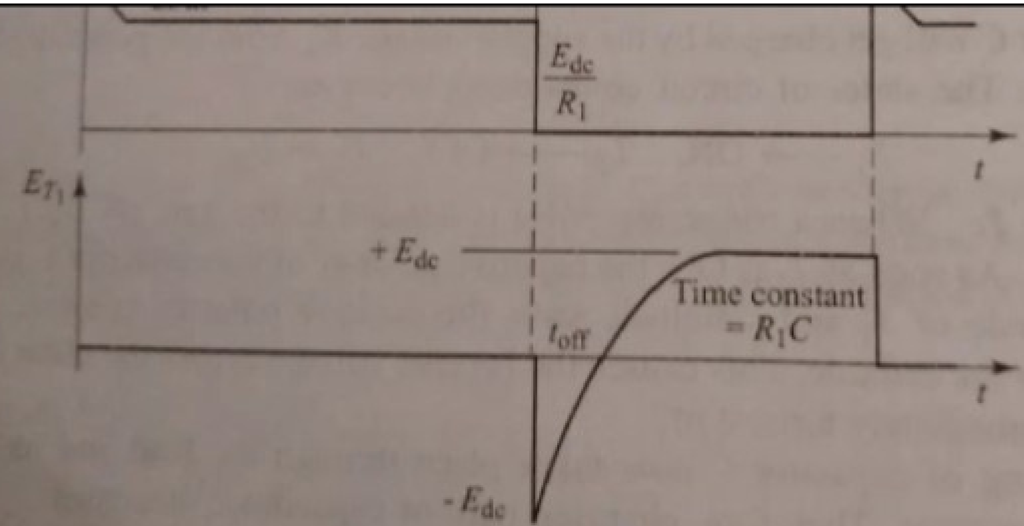


Fig. 2.18 *Circuit waveforms*

Design Considerations

As explained previously, when thyristor T_1 is conducting, capacitor C is charged to d.c. supply voltage E_{dc} through the resistor R_2. Now, when T_2 is triggered, a voltage twice the d.c. supply voltage E_{dc} is applied to the R_1C series circuit so that current through the circuit is,

$$i = \frac{2E_{dc}}{R_1} e^{-t/R_1C} \tag{2.42}$$

Therefore, the voltage across the thyristor T_1 is

$$E_{T_1} = E_{dc} - i\,R_1 = E_{dc} - \frac{2E_{dc}}{R_1} e^{-t/R_1C} \cdot R_1 = E_{dc}\left(1 - 2\,e^{-t/R_1C}\right)$$

For making thyristor T_1 OFF, the capacitor voltage must be equal to the voltage E_{t_1}.

$$\therefore \quad E_c = E_{dc}\left(1 - 2\,e^{-t/R_1C}\right) \tag{2.43}$$

Let $t = t_{off}$ when $E_c = 0$.

$\therefore$ Equation (2.43) becomes

$$0 = E_{dc}\left(1 - 2\,e^{-t_{off}/R_1C}\right) \quad \text{or} \quad 0 = 1 - 2\,e^{-t_{off}/R_1C} \tag{2.44}$$

$$\therefore \qquad t_{off} = 0.6931\, R_1 C \tag{2.45}$$

or

$$C = 1.44\, \frac{t_{off}}{R} \tag{2.46}$$

So from Eq. (2.45), R_1 and C must be such that the turn-off time of SCR T_1, t_{off} is satisfied.

The maximum allowable $\frac{dV}{dt}$ rating for SCR T_1 may be obtained from the SCR T_1 data sheet.

The maximum $\frac{dV}{dt}$ across T_1 using the commutating components is given by

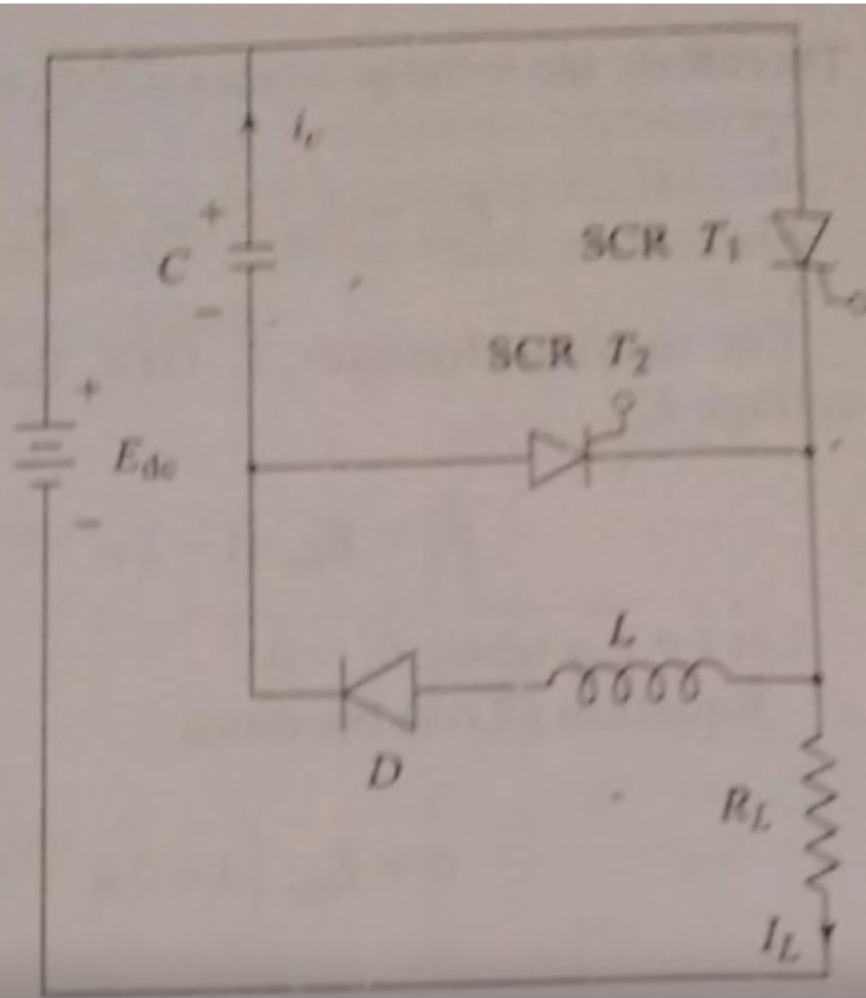
$$\left.\frac{dV}{dt}\right|_{(max)} > \frac{2E_{dc}}{R_1 C} \tag{2.47}$$

4. Class D—Auxiliary Commutation (An Auxiliary SCR Switching a

(b) Mode 1: Initially, SCR T_2 must be triggered first in order to charge the capacitor C with the polarity shown. This capacitor C has the charging path E_{dc+} — C_+ — C_- — T_2 — R_L — E_{dc-}. As soon as capacitor C is fully charged, SCR T_2 turns-off. This is due to the fact that, as the voltage across the capacitor increases, the current through the thyristor T_2 decreases since capacitor C and thyristor T_2 form the series circuit.

Hence the state of circuit components at the end of Mode 1 becomes,

$T_1 \longrightarrow$ OFF, $T_2 \longrightarrow$ OFF, $E_C = E_{dc}$



(c) Mode 2: ... or T_1 is

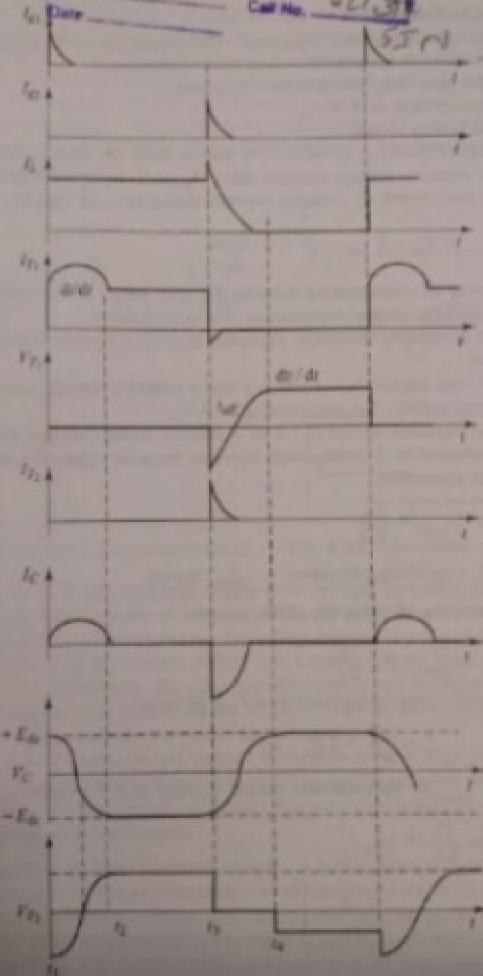


Fig. 2.20 Associated waveforms

$$C E_{dc} = I_L t_{off} \quad \therefore \; C = \frac{I_L t_{off}}{E_{dc}} \tag{2.48}$$

(b) Designing of commutating inductor L The design of the inductor L is actually dependent on two contradictory criteria as follows:

(i) The acceptable maximum capacitor current, I_C, when thyristor T_1 is fired.

(ii) The time interval $(t_2 - t_1)$ during which capacitor voltage must reset to correct polarity for commutating SCR T_1.

Since the capacitor current (I_C) is an oscillatory current through SCR T_1, L, D, and C when SCR T_1 is triggered, therefore the peak value of current I_C is given by the expression,

$$I_{C_{(peak)}} = \frac{E_{dc}}{W_r L} \tag{2.49}$$

...ncy = $\frac{1}{\quad}$ rad/sec. (2.50)