This type of commutation circuits are most suitable for high frequency operation, i.e., above 1000 Hz, because of the need for an *L–C* resonant circuit which carries the full load current. This commutation circuit is used in series inverter.

Design Considerations

(a) Load in parallel with capacitor C Let us consider the resonant circuit of Fig. 2.12 (a). Let E_{dc} be the applied d.c. voltage, V be the load voltage, and i be the load current.

The circuit equation is

$$E_{dc} = L \frac{di}{dt} + V$$

The load resistance R_L and the commutating components are so selected that their combination forms an underdamped resonant circuit. When such a circuit is excited by a d.c. source, a current of the nature shown in Fig. 2.14 will be obtained across the device. This current, as evident from its shape, has zero value at the point K where the device is automatically turned OFF. Beyond point K, the current is reversed in nature which assures definite commutation of the device. The thyristor when ON carries only the charging current of capacitor C which will soon decay to a value less than the holding current of the device, when capacitor C is charged up to the supply voltage E_{dc}. This simultaneously switches off the thyristor. The time for switching off the device is determined by the resonant frequency which in turn depends on the values of the commutating components L and C and the total load resistance.

This type of commutation circuits are more suitable for high frequency operation, i.e., above 1000 Hz, because of the need for an L-C resonant circuit which carries the full load current. This commutation circuit is used in series inverter.

Design Considerations

(a) Load in parallel with capacitor C. Let us consider the resonant circuit of Fig. 2.12 (a). Let E_{dc} be the applied d.c. voltage, V be the load voltage, and i be the load current.

and $\qquad dt \qquad R$

By using Laplace transform, we can write

$$E_{dc}(s) - V(s) = S \cdot L\, I(s) \tag{2.15}$$

and
$$I(s) = \frac{V(s)}{R} + S \cdot C \cdot V(s) \tag{2.16}$$

From Eq. (2.15), we can write

$$V(s) = E_{dc}(s) - SL\, I(s) \tag{2.17}$$

But
$$E_{dc}(s) = \frac{E_{dc}}{S} \tag{2.18}$$

Substitute Eqs (2.17) and (2.18) in Eq. (2.16)

$$\therefore \qquad I(s) = \frac{E_{dc}}{R \cdot S} - \frac{SLI(s)}{R} + SC\left[\frac{E_{dc}}{s} - SLI(s)\right]$$

$$\ldots = \frac{E_{dc}}{R \cdot S} + \frac{E_{dc}SC}{S}$$

$$I(s) = \frac{E_{dc}}{RLCS}\left[\frac{1 + RCS}{S^2 + \frac{1}{RC}S + \frac{1}{LC}}\right] \tag{2.19}$$

Taking inverse Laplace transform of Eq. (2.19), we get

$$i(t) = \frac{E_{dc}}{R}\left[1 + \frac{1}{\sqrt{1-\varepsilon^2}}\frac{W_n^2}{\varepsilon}e^{-t/RC}\sin(\omega t + \phi)\right]$$

where $\varepsilon = \frac{1}{2R}\sqrt{\frac{L}{C}}$ = damping ratio

$W_n = \frac{1}{\sqrt{LC}}$ = undamped natural angular frequency.

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Taking inverse Laplace transform of Eq. (2.21), we get

$$V(t) = E_{dc}\,\frac{W_0}{\sqrt{1-\varepsilon^2}}\,e^{-t/2RC}\sin\omega t + E_{dc} \tag{2.22}$$

In this case, the triggering frequency of the thyristor must be less than W_0, so that the conduction cycle is completed.

(b) Load in series with capacitor C Let us consider the series resonant circuit of Fig. 2.12 (b). Let the thyristor be turned ON at $t = 0$ with the initial capacitor voltage zero.

The circuit equation is

$$E_{dc} = iR + L\frac{di}{dt} + \frac{1}{C}\int i\,dt \tag{2.23}$$

On differentiating and dividing by L, we get

$$\frac{d^2 i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{i}{LC} = \frac{1}{L}\frac{d}{dt}E_{dc} \tag{2.24}$$

The circuit equation is

$$E_{dc} = iR + L\frac{di}{dt} + \frac{1}{C}\int i\,dt \tag{2.23}$$

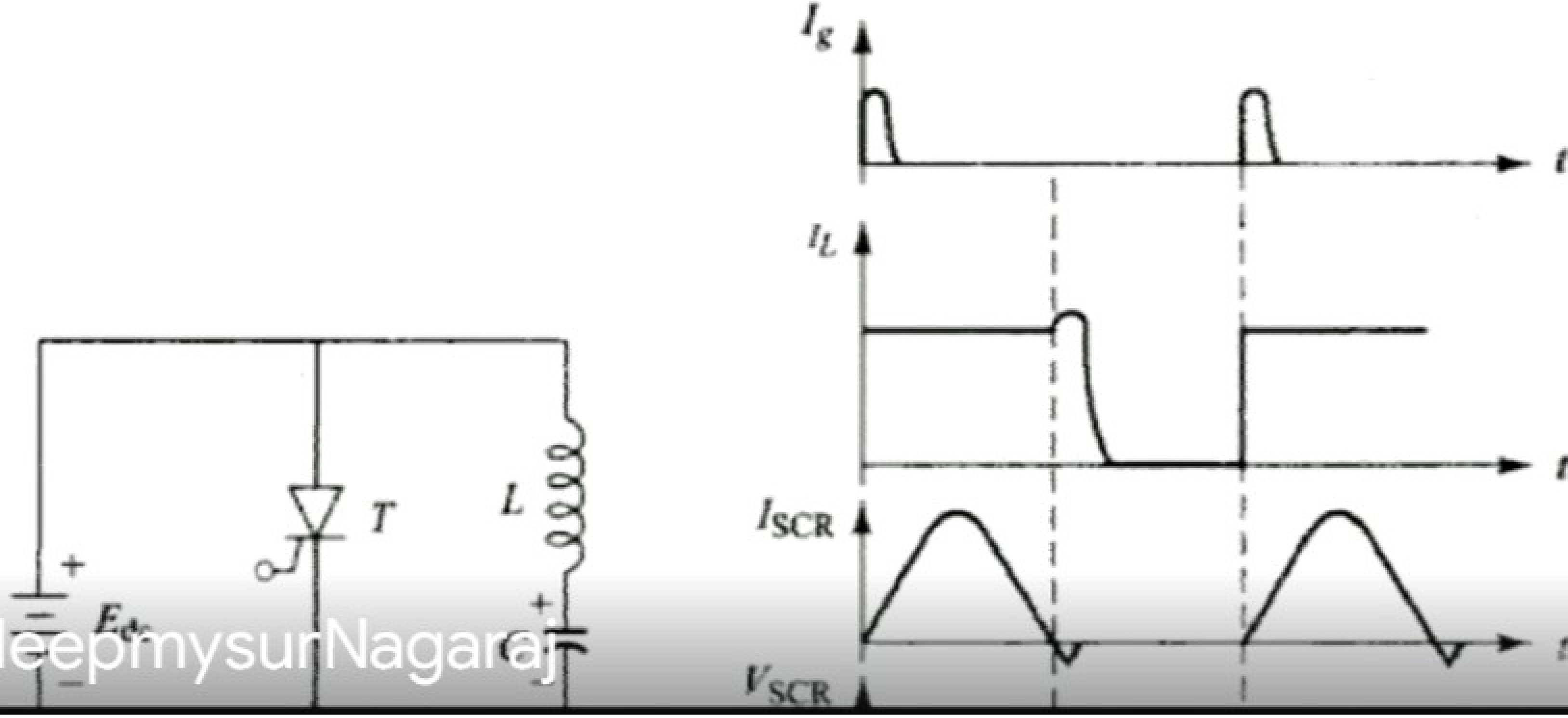
On differentiating and dividing by L, we get

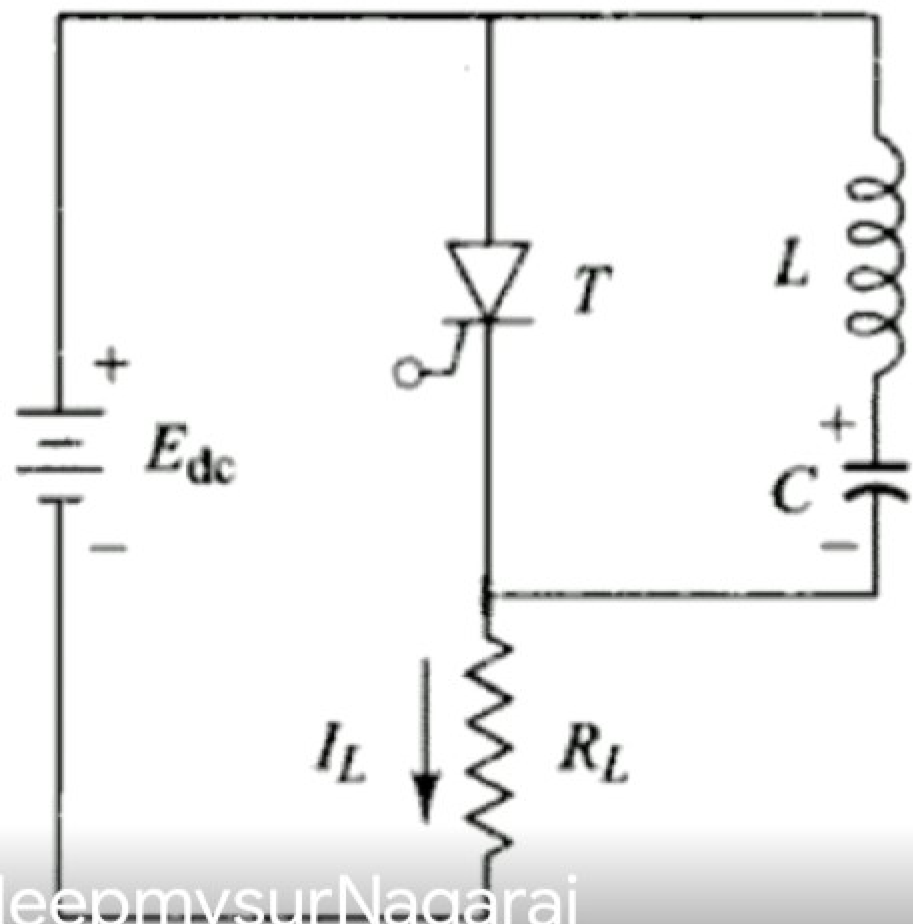
$$\frac{d^2 i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{i}{LC} = \frac{1}{L}\frac{d}{dt}E_{dc} \tag{2.24}$$

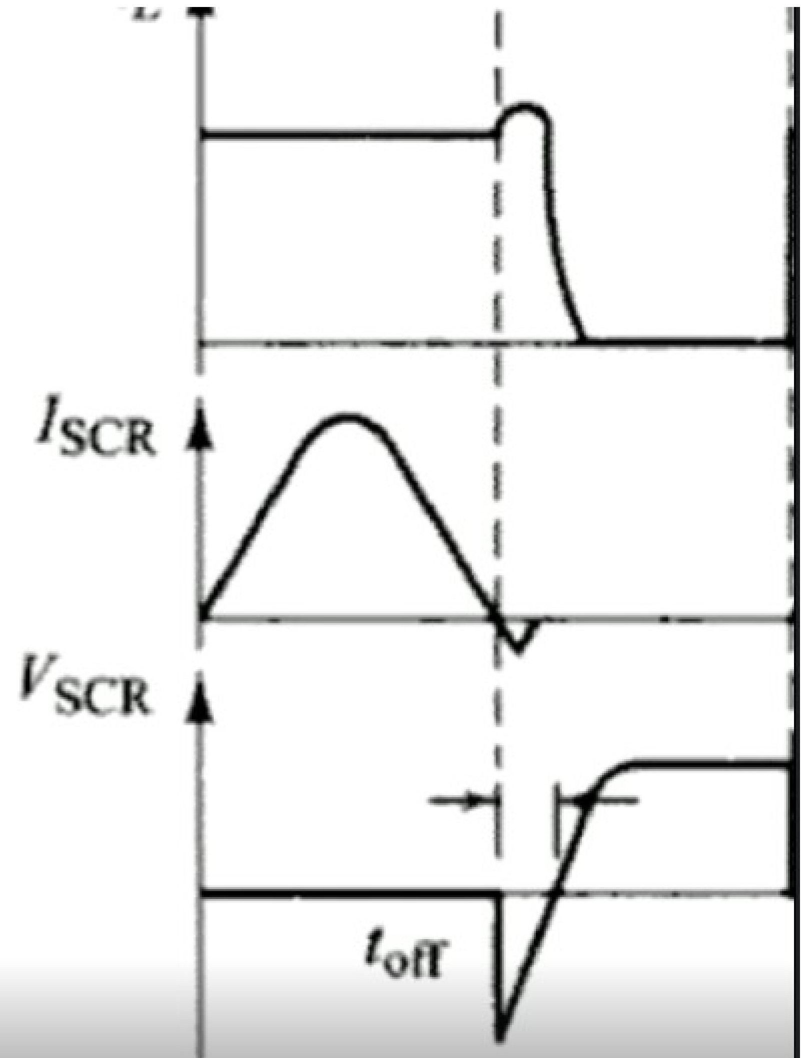
The corresponding homogeneous equation is of the second order and is as below.

$$\frac{d^2 i}{dt^2} + \frac{R}{L}\cdot\frac{di}{dt} + \frac{1}{LC}i = 0 \tag{2.25}$$

2. *Class B—Self Commutation by an LC Circuit* In this method, the *LC* resonating circuit is across the SCR and not in series with the load. The commutating circuit is shown in Fig. 2.15 and the associated waveforms are shown in Fig. 2.16.




T
L
E_{dc}
C
I_L
R_L


I_{SCR}
V_{SCR}
t_{off}