Commutation Techniques of Thyristors.

- Commutation is defined as the process of turning-off a thyristor.

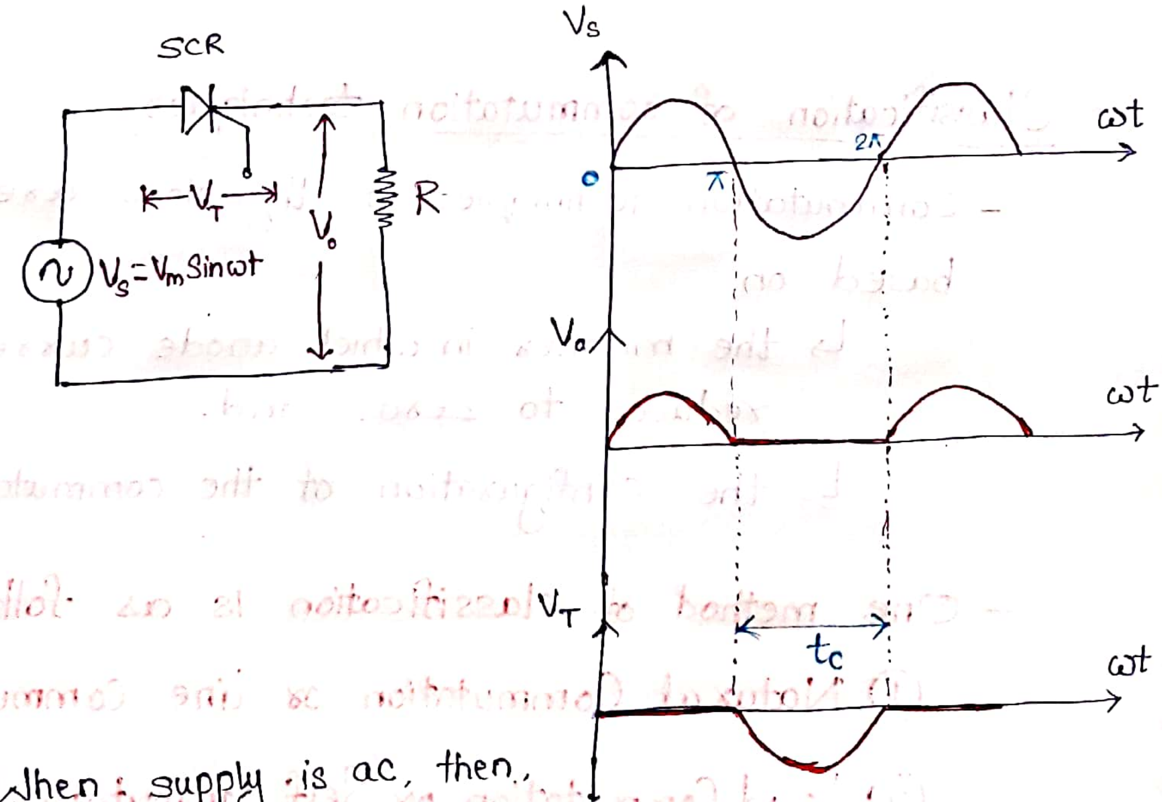
- Turn-off of a thyristor means bringing the device from forward-conduction mode to forward-blocking mode.

- Turn-off process of thyristor requires
  - ↳ (a) Anode current to be reduced below holding current
  - ↳ (b) application of a reverse voltage to remove the extra charge carriers and regain its blocking state.

- Classification of commutation techniques.
  - Commutation techniques of thyristors are classified, based on
    - ↳ the manner in which anode current is reduced to zero. and.
    - ↳ the configuration of the commutating circuits.
  - One method of classification is as follows.
    1. Natural Commutation or line Commutation (Class F)
    2. Load Commutation or Self commutation (class A)
    3. Forced Commutation.
       - ↳ (a) Resonant-Pulse Commutation (class B)
       - ↳ (b) Complementary Commutation (class C)
       - ↳ (c) Impulse commutation (class D)

① Natural Commutation or Line Commutation (Class F)

- Natural commutation of thyristor occurs only when the supply is ac. Nature of supply automatically takes care of commutation. So, it is known as natural commutation or line commutation.



- When supply is ac, then, the anode current through the thyristor automatically pass through zero at the end of every positive half cycle i.e. at $\omega t = \pi$.

- So, anode current becomes zero after positive half cycle.
- The supply voltage also applies a reverse bias voltage across the SCR in the negative half cycle. This reverse bias ensures that SCR regains its blocking capability.

Applications:

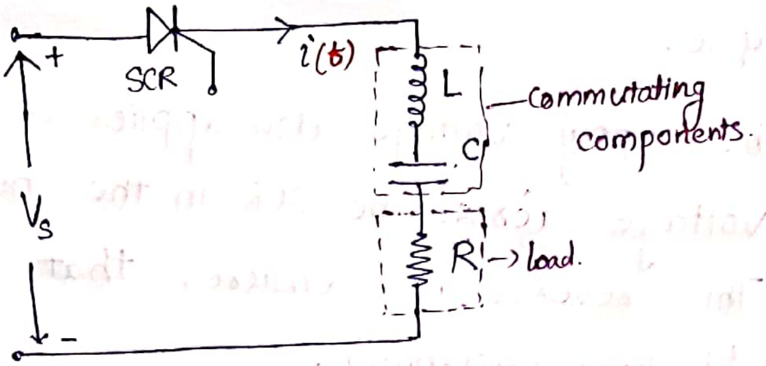
- Phase - controlled converters.
- line - commutated inverters.
- ac - voltage controllers.
- step-down cyclo-converters.

② Load Commutation or Self commutation (Class A).

- Load commutation or class-A commutation is possible in thyristor circuits supplied from dc source. It is not possible in ac circuits.
- For load commutation to occur, the nature of load circuit should be such that, when it is energized from a dc source, the current has a tendency to decay to zero value, due to load.

⇓

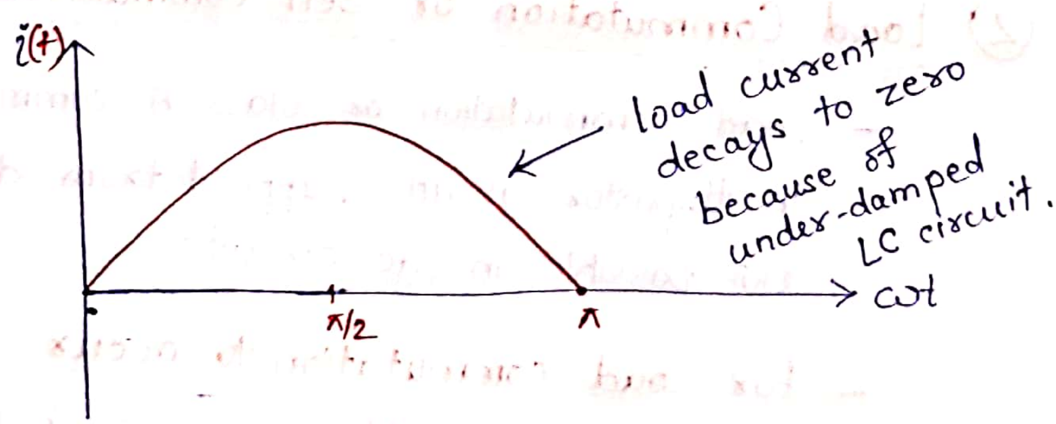
It is possible when load contains R, L and C parameters and satisfy underdamped condition.

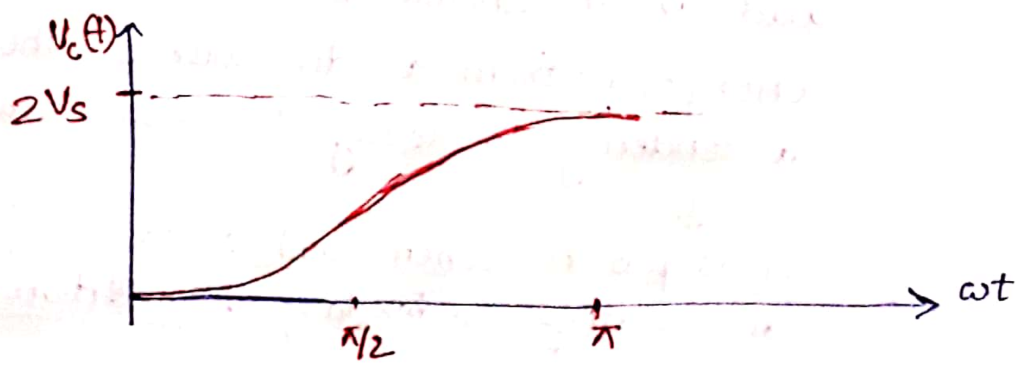


- When the circuit is energised from dc source, the current first rises to maximum value and then decays to zero. So, thyristor gets turned-off. Voltage of capacitor applies a reverse bias across the thyristor after turn-off.
- Load commutation is also known as <u>resonant commutation</u> or <u>self-commutation</u>.

- <u>Application</u> :- Series inverter circuit.

<u>Waveforms</u> :-





- Load current is like charging current of capacitor. So, initially after turning on of thyristor, current $i(t)$ increases, then it reaches maximum value and then decays to zero.

- At $\omega t = \pi$, when thyristor current decays to zero, the voltage stored in capacitor is $2V_s$. So, at $\omega t = \pi$, Voltage across thyristor is,

$$V_T = -2V_s + V_s = -V_s$$

↓

So, net reverse voltage appears across the thyristor when current decays to zero.

→ Conduction angle of thyristor, $\omega_o t_o = \pi$.

→ Conduction time of thyristor, $t_o = \frac{\pi}{\omega_o}$

Here, ω_o is known as resonant frequency of the LC circuit.

$$\boxed{\omega_o = \frac{1}{\sqrt{LC}}}$$

→ ∴ Conduction time, $\boxed{t_o = \frac{\pi}{\omega_o} = \pi\sqrt{LC}}$

→ For satisfying the condition of under-damping.

$$\boxed{\frac{R}{2} < \sqrt{\frac{L}{C}}} \quad \text{or} \quad \boxed{R^2 < \frac{4L}{C}}$$