Silicon Controlled Rectifier (SCR)

Lecture – 21

TDC PART – I
Paper - II (Group - B)
Chapter - 5

by:

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- **SCR Turning-OFF Methods (PART – 9)**
- **Lecture Content :-**

➢ **(2) Forced Commutation**

➢ **(V) Class-F Commutation - AC Line Commutated**

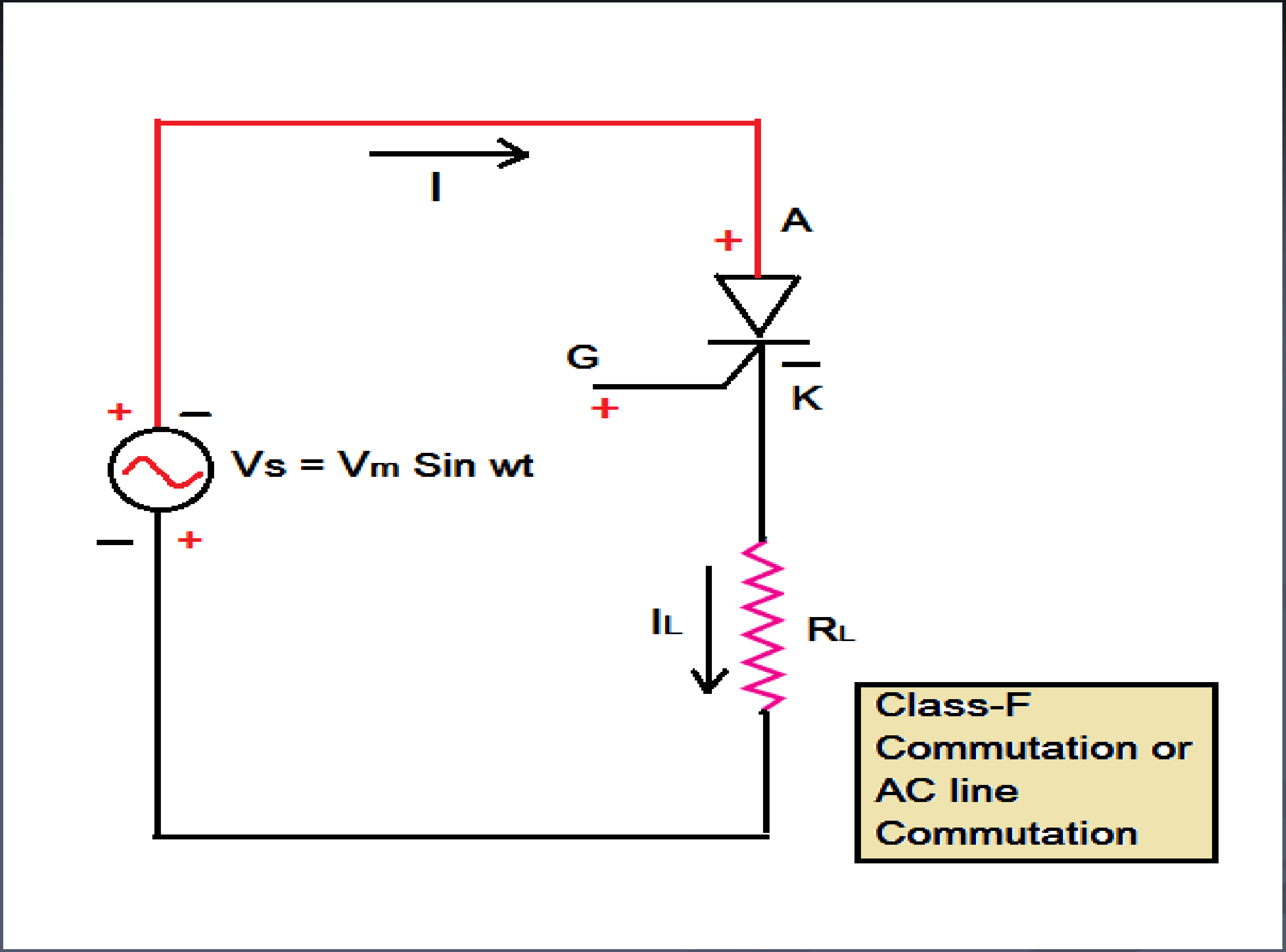
Class-F Commutation : AC Line Commutated

- **Natural or Line commutation** is a **Class-F SCR-Commutation-type** in which, a **SCR (thyristor)** is **Turned OFF** due to **Natural Current Zero** and **Voltage Reversal** after **every Half Cycle.** This commutation method is only applicable for **AC circuit** and mostly used in **Phase-Controlled Converters, Line-Commutated Inverters, AC Voltage Controllers and Step-down Cyclo-Converters.**

Why it called Natural Commutation?

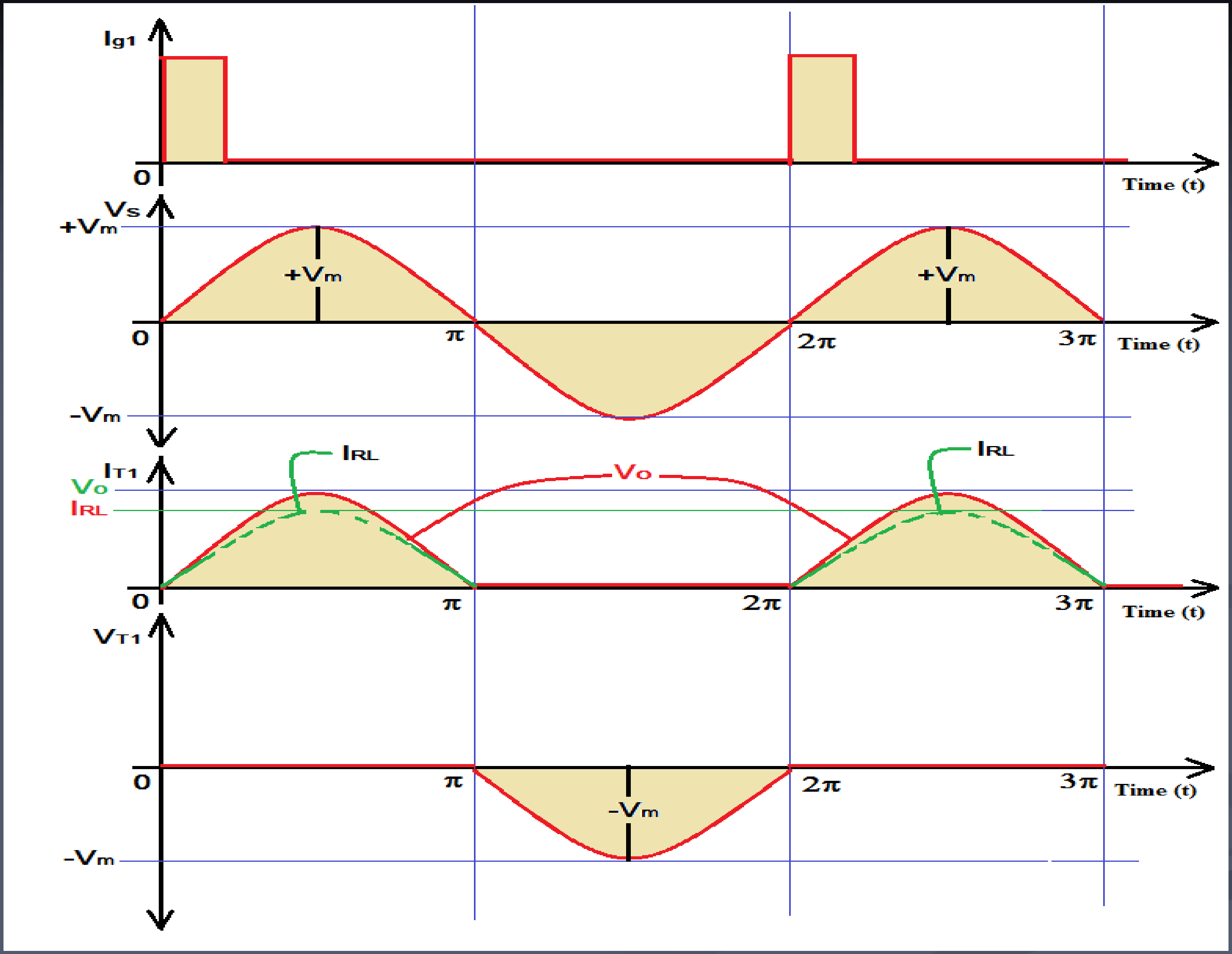
- The **Commutation of SCR (thyristor)** does not involve any **External Circuit. SCR (thyristor)** is **Commutated** just because of the **Natural Reversal** of **AC Load Current (I_{RL})** and **Source Voltage (V_s),** this is the reason it is **Called Natural Commutation.**

- **Figure (101)** shows below the **Class-F Commutation** and it is **Voltage and Current Waveforms** are depicted in **Figure (102)** below. This type of commutation is also known as **Natural Commutation** or **AC Line Commutation.** This type of commutation only occurs when the **Input Voltage is AC.**



- **Fig (101)** Shown **Class-F Commutation or AC Line Commutation** Circuit Diagram.

- When the **SCR (thyristor)** based converter circuit is energised by an **AC Source Voltage** and the **Gate (G) signal** is applied to **SCR (thyristor)** T1 during **Positive Half-Cycle of supply voltage, SCR (thyristor) T1** becomes **Turn ON** and **Current I_L flows** through **SCR** (thyristor) T1 and **Load Resistance R_L.**



- **Fig (102)** Shown Class-F Commutation or AC Line Commutation **Voltage and Current Waveforms.**

- At the end of each **Positive Half-Cycle** of **supply voltage, Current passes through its Natural Zero** and then **AC source** applies a **Reverse Voltage** across **SCR (thyristor) T1 automatically.** Consequently, **SCR (thyristor) T1** will be **Turned OFF.**

- There are **no Commutating Components** used in this method therefore it is not called as **Forced Commutation method.** This commutation technique is called **Natural Commutation** as no **External Circuit** is required to **Turn OFF the SCR (thyristor) T1.** Usually, this commutation method is commonly used in **Controlled Rectifiers, Line Commutated Inverters, AC Voltage Controllers and Cyclo-Converters.**

Principle of Class-F or Natural or Line Commutation

- When an **SCR (thyristor)** circuit is energized from an **AC source, Current** has to pass through its **Natural Zero** at the end of **every Half Cycle.** The **AC source** then applies a **Negative Voltage** across **Cathode and Anode** terminals of **SCR (thyristor)**.

- As we know that, the required conditions for **SCR (thyristor)** to **Turn OFF** are,

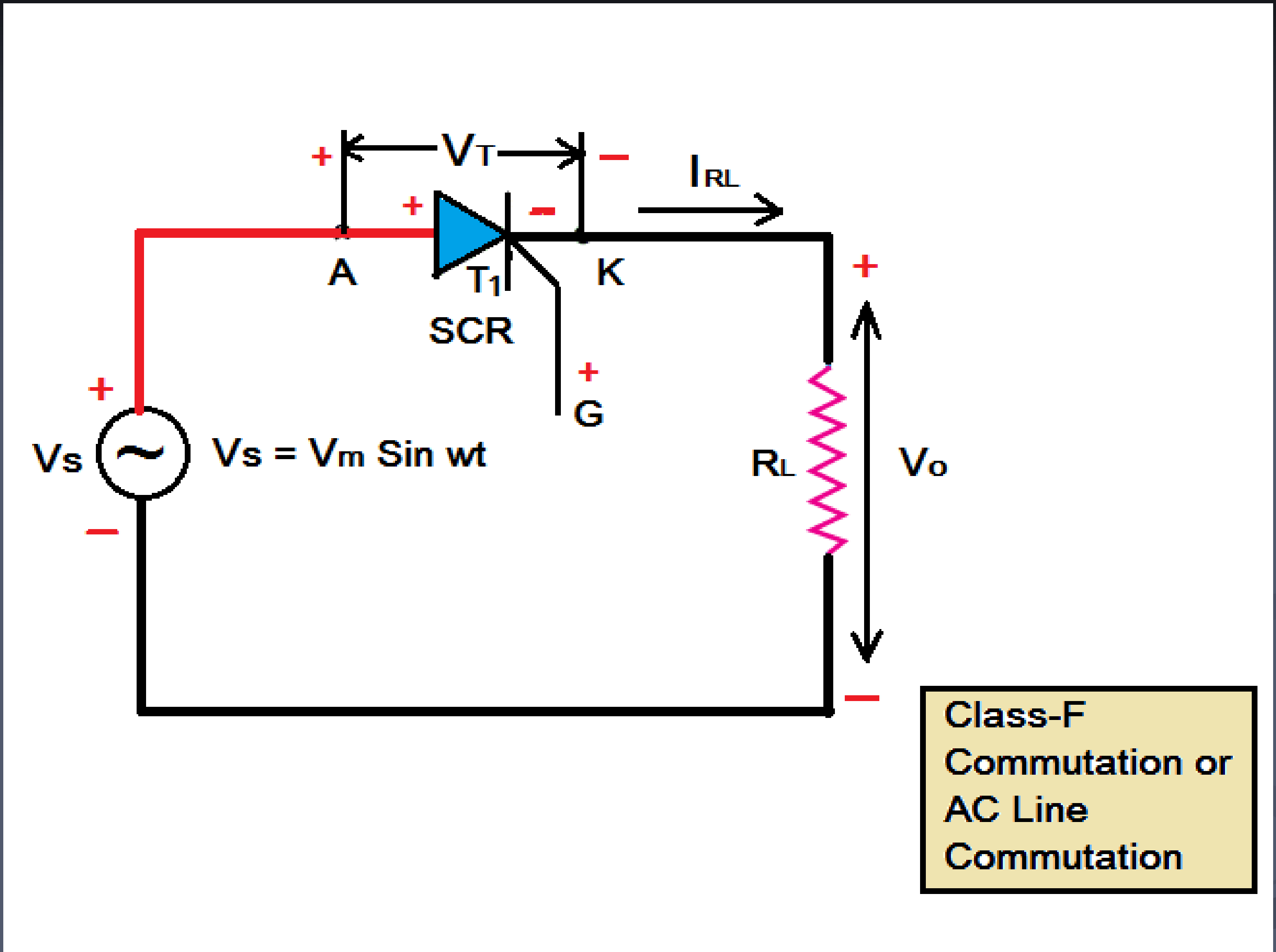
- Current through **SCR (thyristor)** must reach below its **Holding Current,** and

- **SCR (thyristor)** must be **Reversed Biased** for a time more than its **Turn OFF time (t_q)** so that it may recover the stored charges.

- Since, **Current reaches zero** at the end of **every Half Cycle** and **Voltage** across the **SCR (thyristor)** is **Negative,** hence **SCR (thyristor)** will **Turn OFF** provided the **Half time period** must be greater than **SCR (thyristor) Turn OFF time t_q.**

Circuit Diagram of Natural or Line Commutation

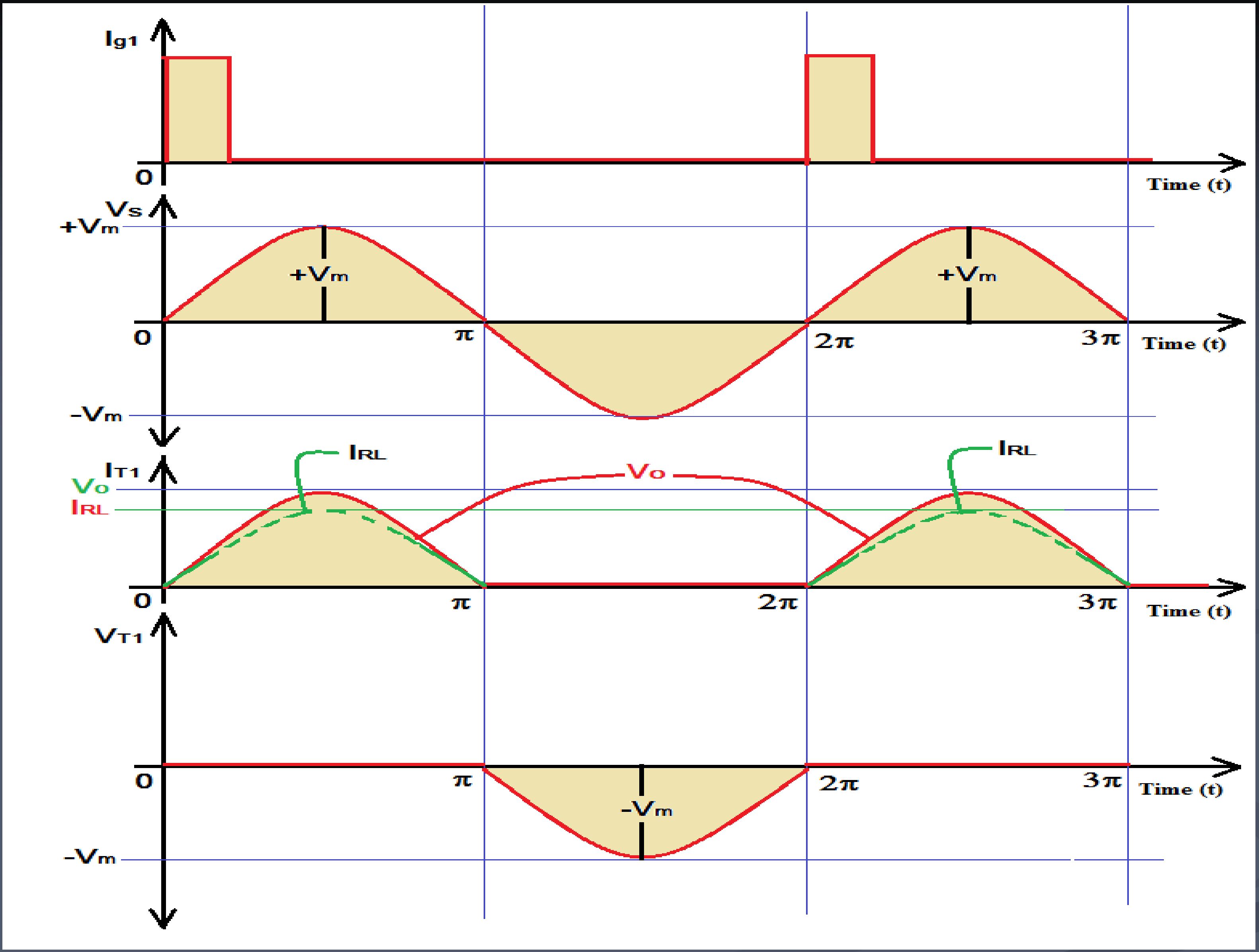
- Let us consider a simple circuit as shown in **Figure (103)** below. The circuit is energized by an **AC Source Volatge (Vs).**



- **Fig (103)** Shown **Class-F Commutation or AC Line Commutation** Circuit Diagram.

- Let us also assume that, **SCR (thyristor) T1** is **Fired or Gated at Firing Angle equal to Zero** **i.e.** $\omega t = 2n\pi$ **where n is** 0, 1, 2, 3…..,. Since **Load is Resistive,** with **Zero degree Firing Angle,** the **SCR (thyristor)** behaves like a **Diode**. During **Positive Half Cycle,** the **SCR (thyristor)** will **Conduct** as it is **Forward Biased.**

- The **Output Voltage** **$V_o = (V_s/R)$** will have **same Wave Shape** as that of **Source Voltage (V_s). Load Current (I_{RL})** will be **in Phase with the Load Voltage (V_o),** hence **Load Current (I_{RL})** will have **Wave Shape similar to Load Voltage (V_o) & Source Voltage (V_s).**



- **Fig (104)** Shown Class-F Commutation or AC Line Commutation **Voltage and Current Waveforms.**

- **At $\omega t = \pi$, Source Voltage $V_S = 0$, Load Voltage $V_O = 0$** and **Load Current $I_{RL} = 0$.** Therefore, the **Current through the SCR (thyristor)** becomes **Zero** at this instant and it is **Reversed biased form $\omega t = \pi$ to 2π.** Refer the **Voltage Profile Curve V_T** across **SCR (thyristor)** in the **Figure (104).** This means, **SCR** (**thyristor**) is **Reversed Biased for a time of $t = (\pi/\omega)$.**

- If this **time t** is more than **SCR (thyristor) Turn OFF time t_q**, the **SCR (thyristor)** will **Turn OFF or Commutated. Time t** for which **SCR (thyristor)** is **Reversed Biased** is called **Circuit Turn OFF time t_c.**

- **Hence Circuit Turn OFF time for Natural or Line or Class-F Commutation is $t_c = (\pi/w)$.**

to be continued ....