SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

19EET301 / POWER ELECTRONICS AND DRIVES

V SEM EEE

Unit 2: DC CONVERTERS

TOPIC – Single Phase Controlled Converters (1)

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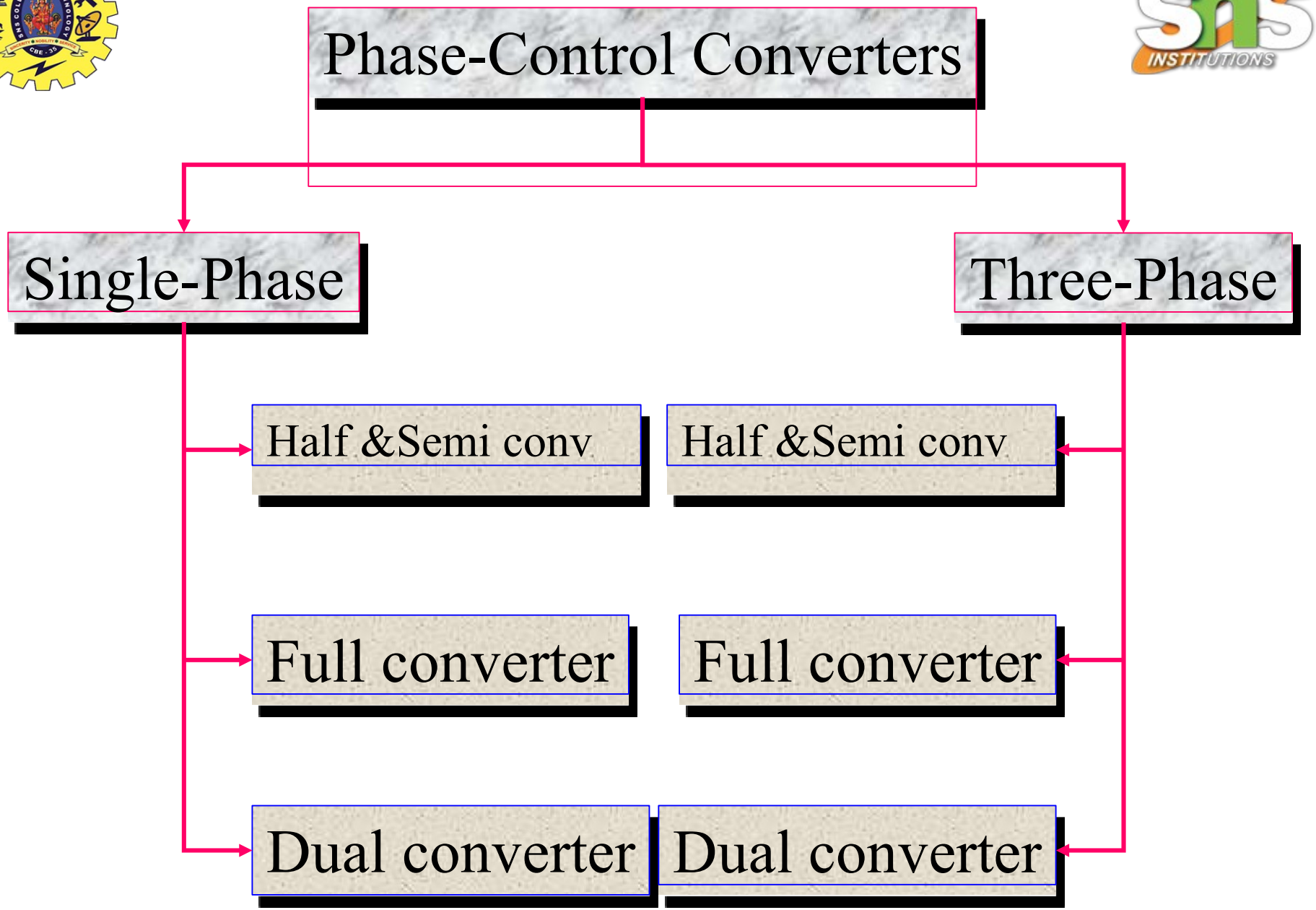

Phase-Control Converters
Single-Phase
Three-Phase
Half &Semi conv
Half &Semi conv
Full converter
Full converter
Dual converter
Dual converter

Semiconverter

..is a one-quadrant converter and it has one polarity

Full converter

..is a two-quadrant converter and the polarity of its output can be either positive or negative.

However

the output current of full converter has one polarity only

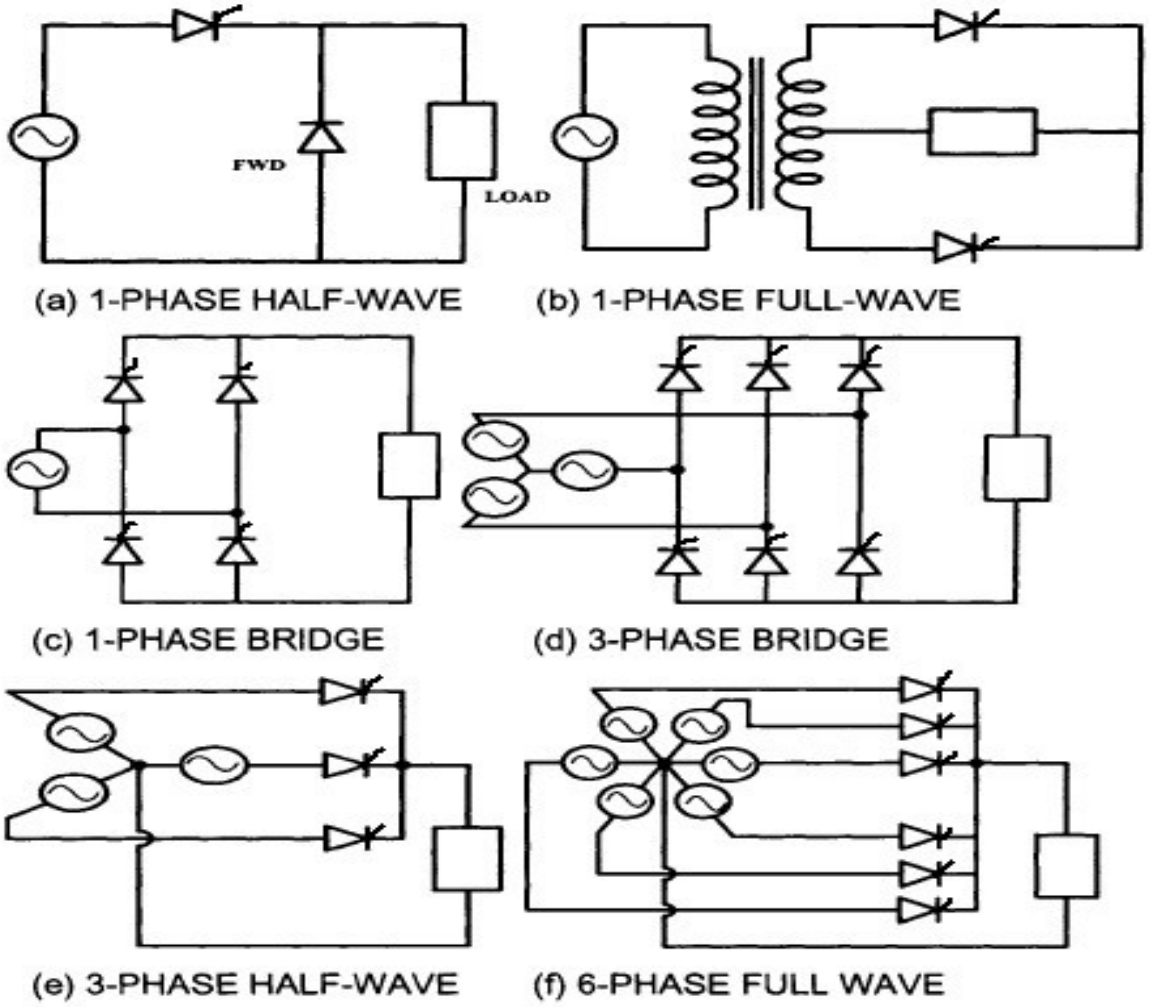
Dual converter

..can operate in four quadrants ; both the output voltage and current can be either positive or negative

CLASSIFICATION OF RECTIFIERS

- BASED ON INPUT SUPPLY
  - SINGLE PHASE
  - THREE PHASE
- BASED ON QUADRANT OPERATION
  - 1 QUADRANT
  - 2 QUADRANT
  - 4 QUADRANT
- BASED ON NO. OF PULSES
  - ONE PULSE
  - TWO PULSES
  - THREE PULSES
  - SIX PULSES

PHASE CONTROLLED RECTIFIERS



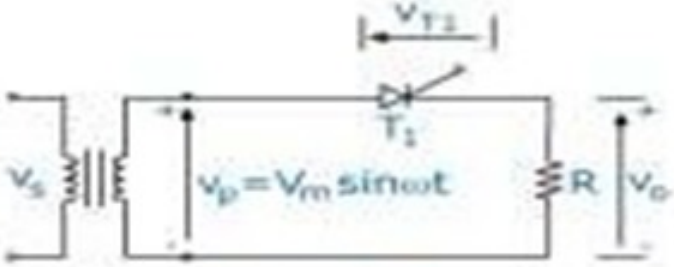
APPLICATIONS OF RECTIFIERS

- DC MOTOR SPEED CONTROL
- DC SUPPLY FOR INVERTERS
- ELECTROCHEMICAL PROCESSES
- DC TRACTION
- HVDC TRANSMISSION

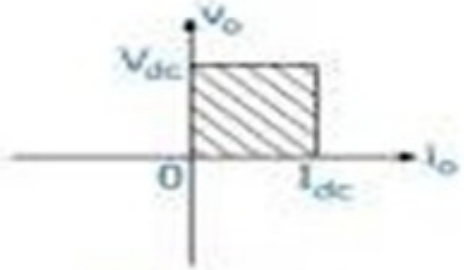
TOPICS

1. Single Phase Half Wave Converter – R Load
2. Single Phase Half Wave Converter – RL Load
3. Single Phase Half Wave Converter – RL Load with FD
4. Single Phase Semi Converter
5. Single Phase Full Converter

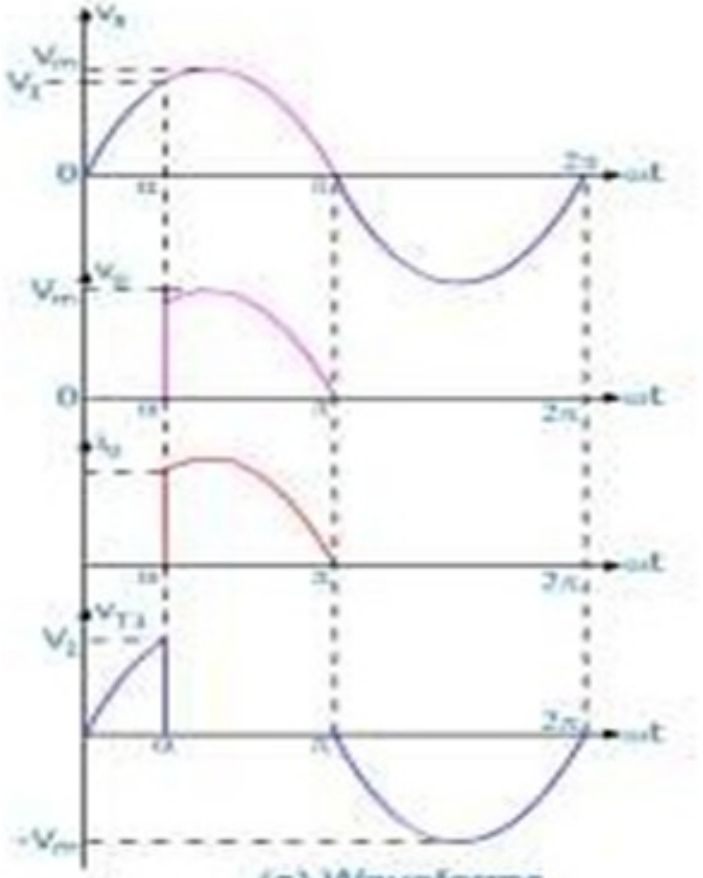
1. SINGLE PHASE HWC WITH R LOAD



(a) Circuit



(b) Quadrant



(c) Waveforms

FIRING ANGLE α

- Angle between the zero crossing of the input voltage and the instant thyristor is fired.

AVERAGE OUTPUT VOLTAGE- R LOAD

The average output voltage V_{dc} is given by

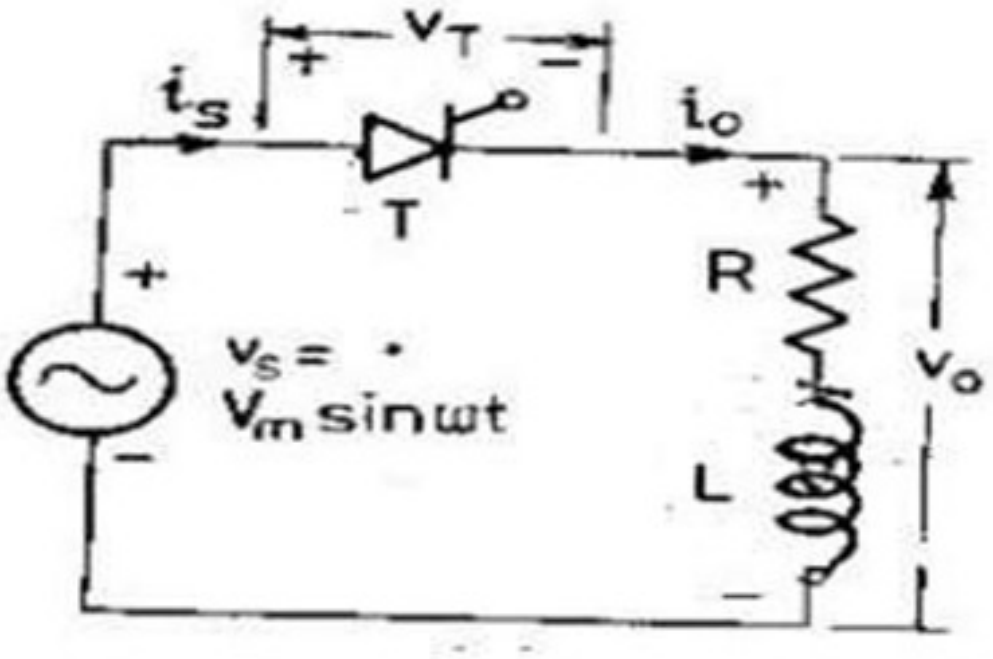
$$V_{dc} = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \sin\omega t \, d(\omega t)$$

$$V_{dc} = \frac{V_m}{2\pi}\left[-\cos\omega t\right]_{\alpha}^{\pi}$$

$$V_{dc} = \frac{V_m}{2\pi}\left(1+\cos\alpha\right)$$

The output voltage V_{dc} can be varied from V_m/π to zero as the firing angle α varies from zero to π.

2. SINGLE PHASE HWC WITH RL LOAD



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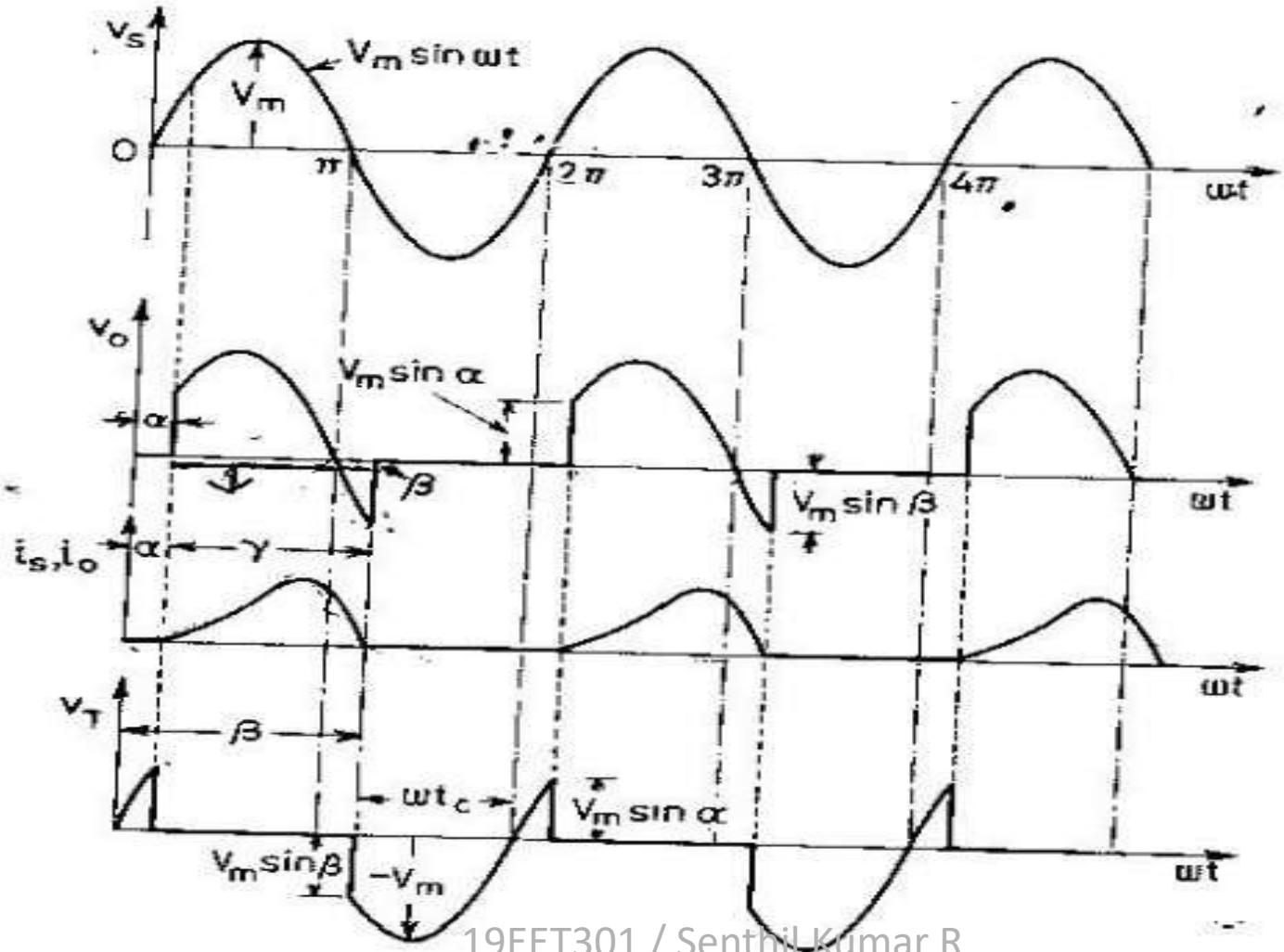
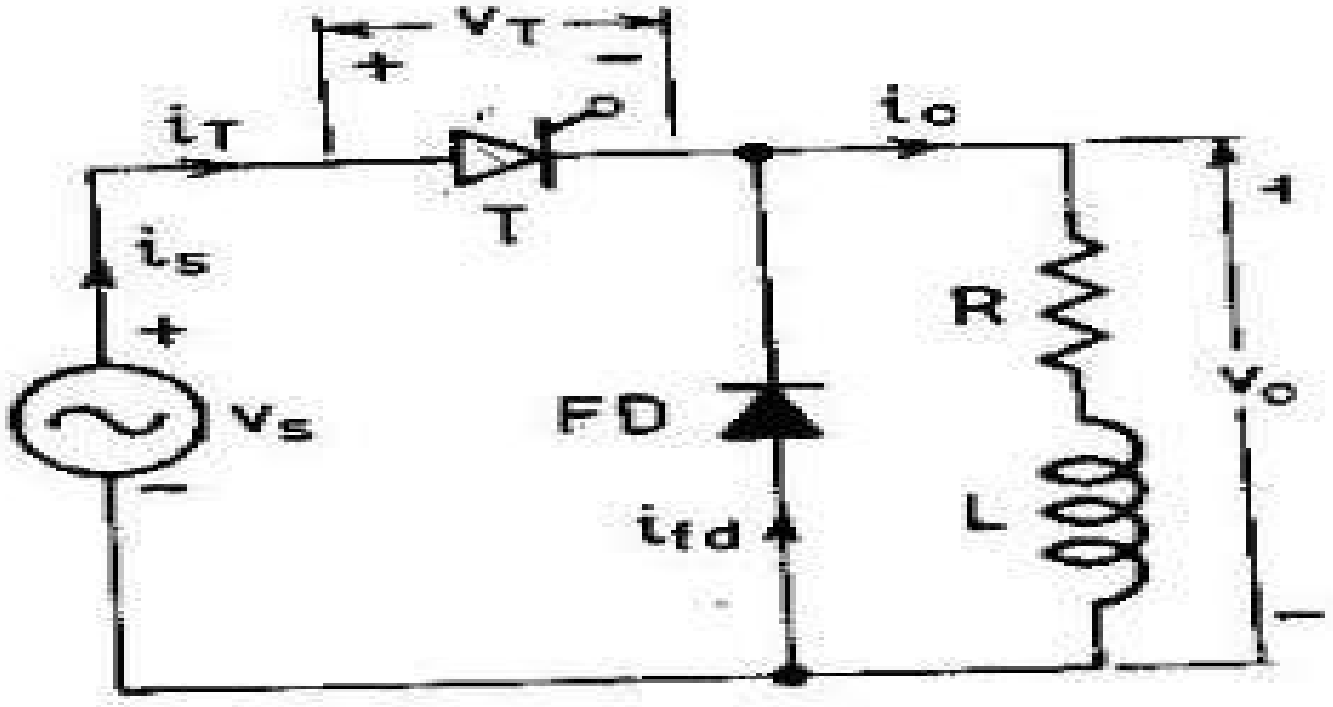


3. SINGLE PHASE HWC WITH RL LOAD AND FD



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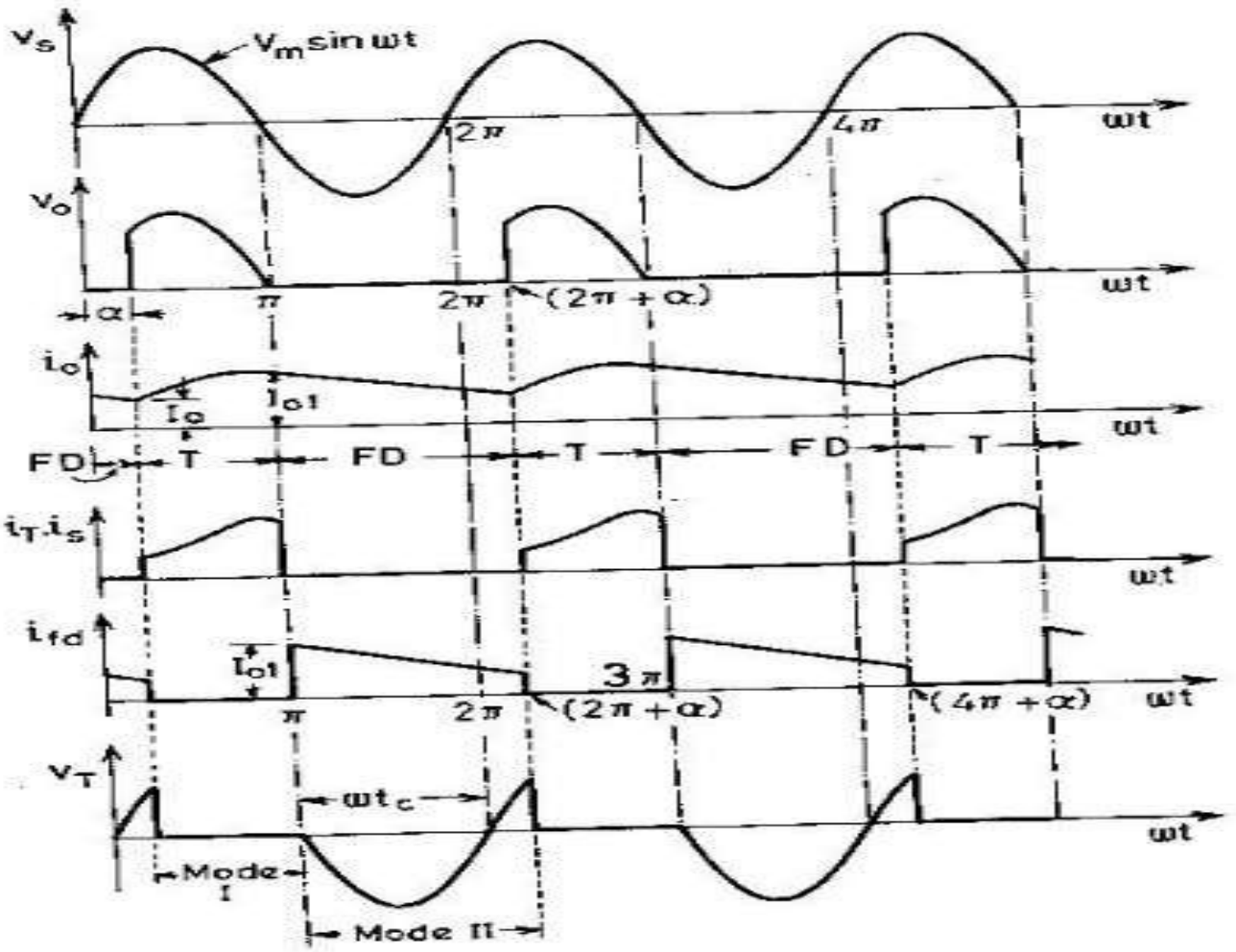

ADVANTAGES OF USING FREEWHEELING DIODE

- Input power factor is improved
- Load current waveform is improved and load performance is better.

Main functions of **fwd**

- It prevents the reversal of load voltage except for a small voltage drop
- It transfers the load current away from the main rectifier thereby allowing all the thyristors to regain their blocking states

Average Output Voltage

$$V_{dc} = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \sin(\omega t)\, td(\omega t) = \frac{V_m}{2\pi}(1+\cos\alpha)$$

Maximum Output Voltage

$$V_{dm} = \frac{V_m}{\pi}$$

Normalizing Output Voltage

$$V_n = \frac{V_{dc}}{V_{dm}} = 0.5(1+\cos\alpha)$$

RMS Output Voltage

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_{\alpha}^{\pi} V_m^2 \sin^2(\omega t)\, td(\omega t)} = \frac{V_m}{2}\sqrt{\frac{1}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{2}\right)}$$

EVALUATION