

Electric Traction & Control

Vishal D Devdhar

Lecturer,

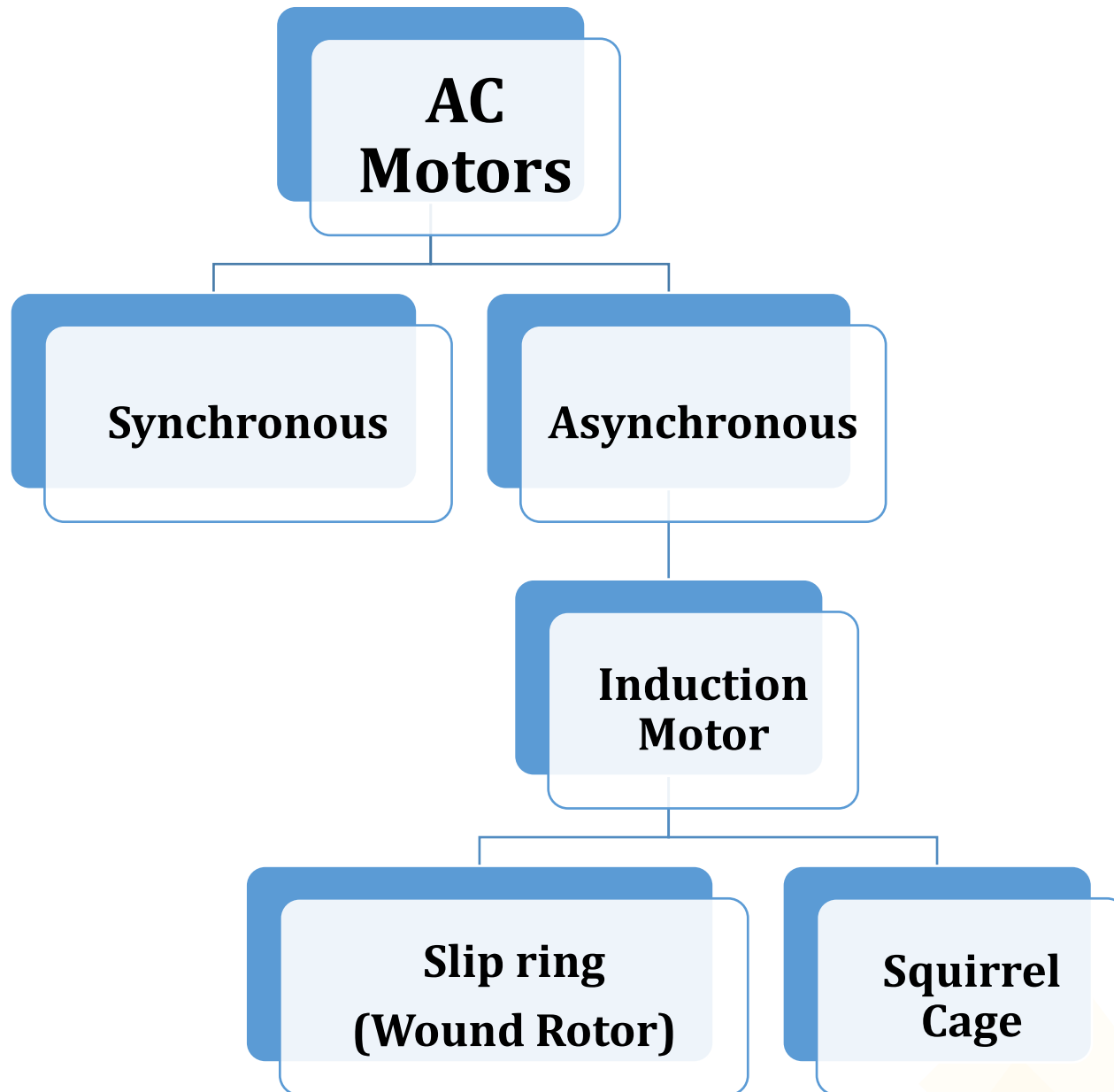
Government Polytechnic,

Rajkot.

www.vishaldevdhar.org



Induction Motor



Induction Motor :

Advantages

- **Most widely used motor (90%)**
 - Residential
 - Commercial
 - Industrial
- **Features:**
 - simple design
 - Robust construction
 - Low-price
 - Easy maintenance
 - Singly excited

Induction Motor : Advantages

- **Power ratings**
 - Fractional kW to 10 MW
- **Speed**
 - Constant speed motor
 - Speed depends upon frequency

Induction Motor : Disadvantages

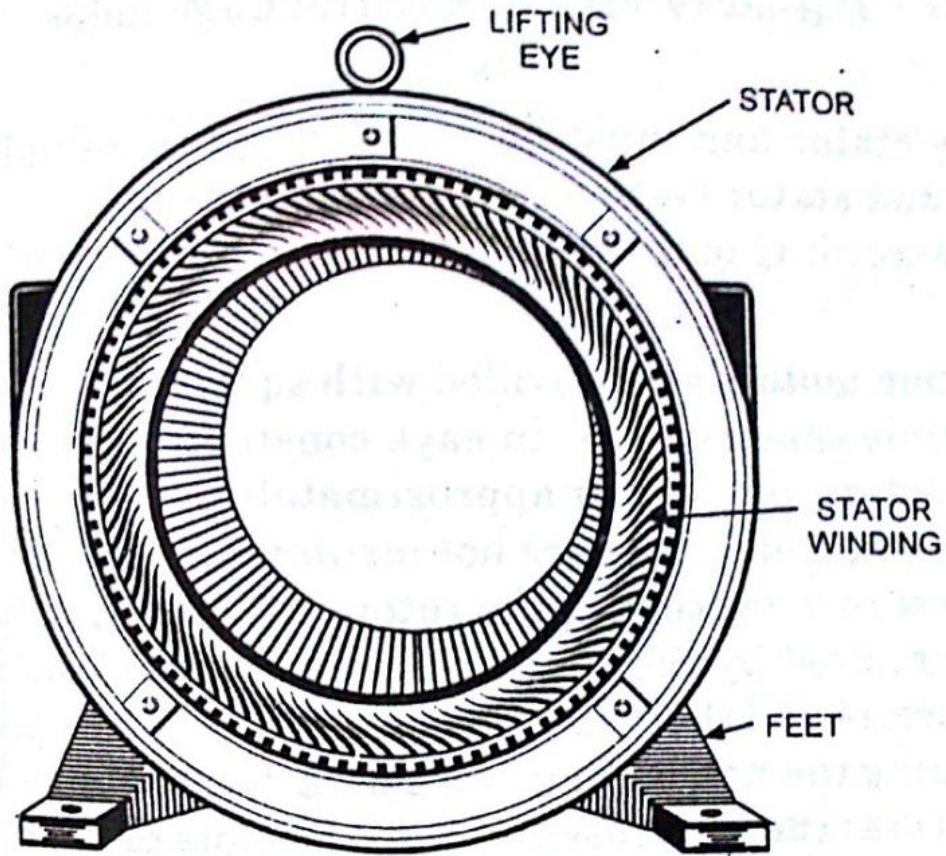
- **Difficult Speed Control**
 - Speed depends upon frequency
 - Variable frequency drives is required

Construction

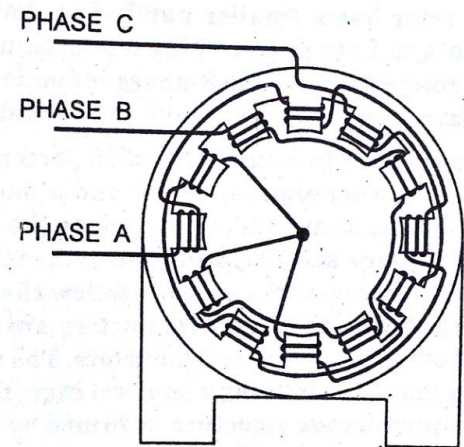
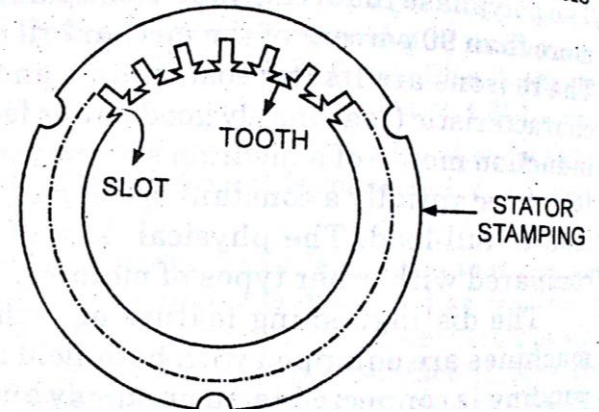
- **Stator**
- **Rotor**
- **Frame (Silicone-Aluminium Alloy)**
- **Shaft & Bearings**

Construction

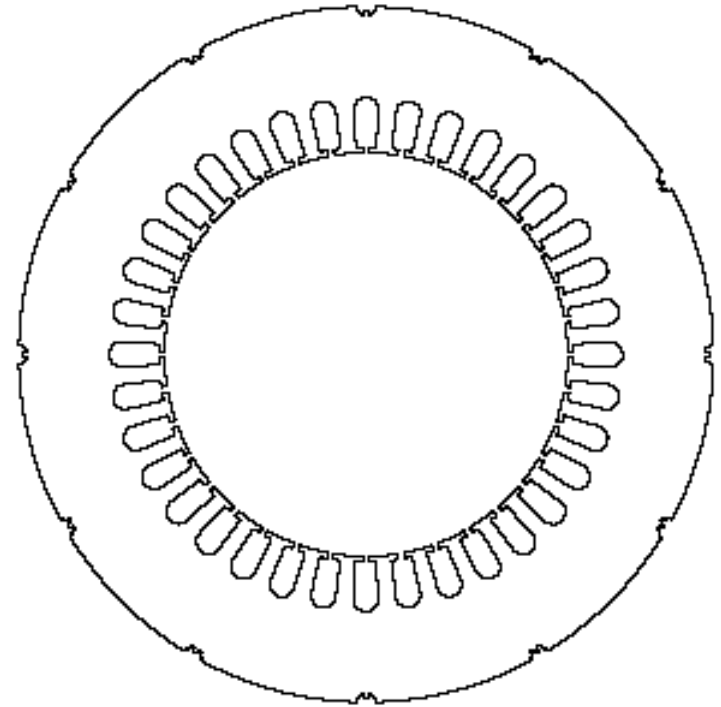
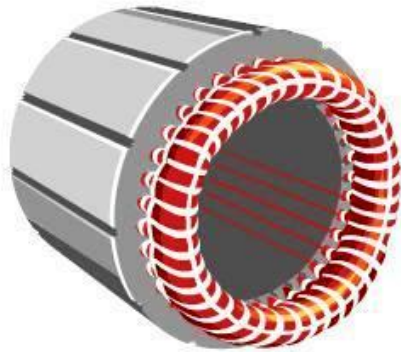
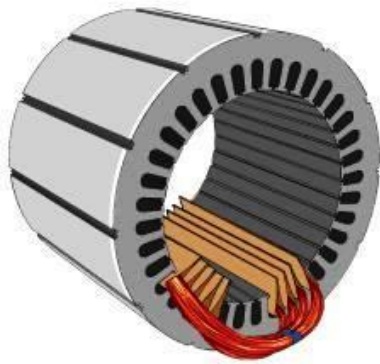
- **Stator**
 - Stationary part
 - Steel frame
 - Constructed from stacked laminations
 - Having a number of evenly spaced slots
 - Providing the space for the stator winding
 - Laminations 0.35 mm to 0.65 mm thick



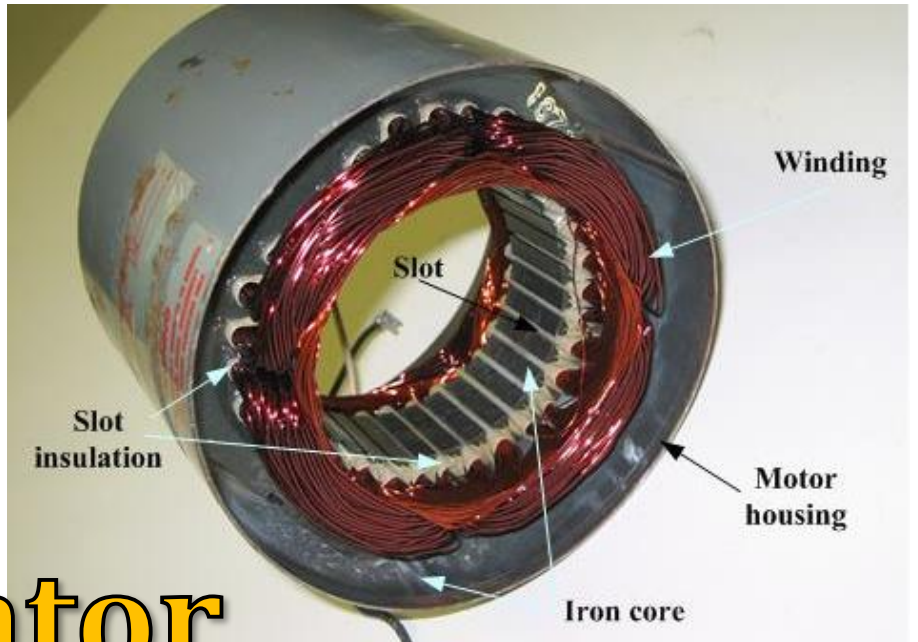
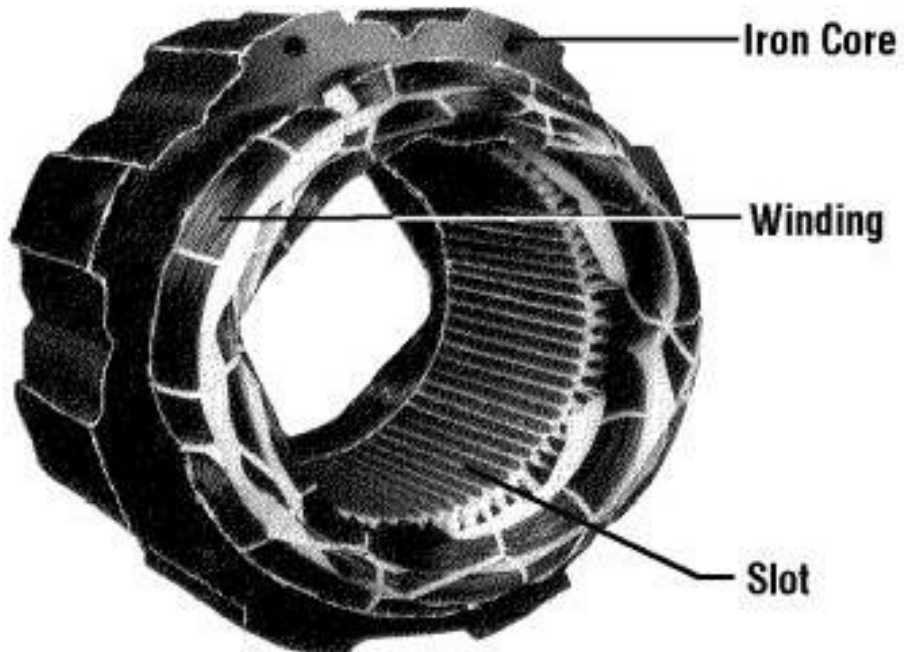
Stator of a 3-Phase Induction Motor



3-Phase, 4-Pole, Star-Connected Stator Winding



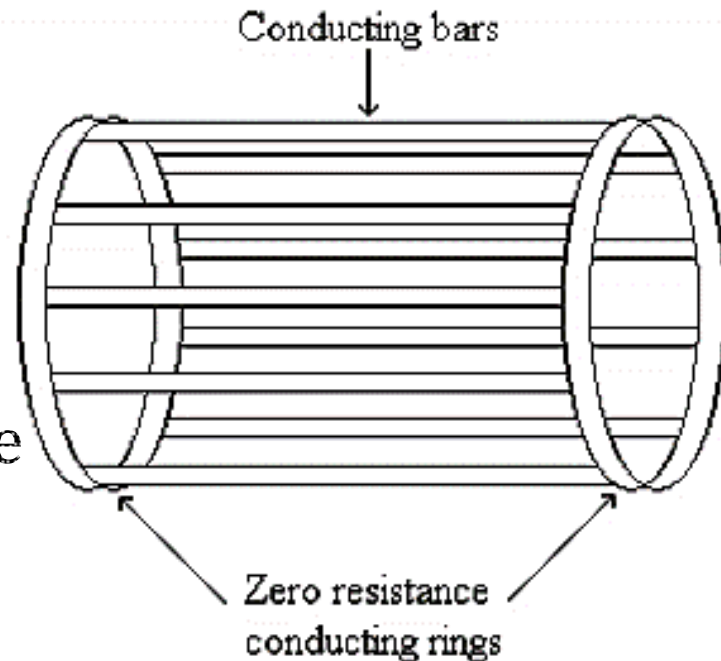
Stator



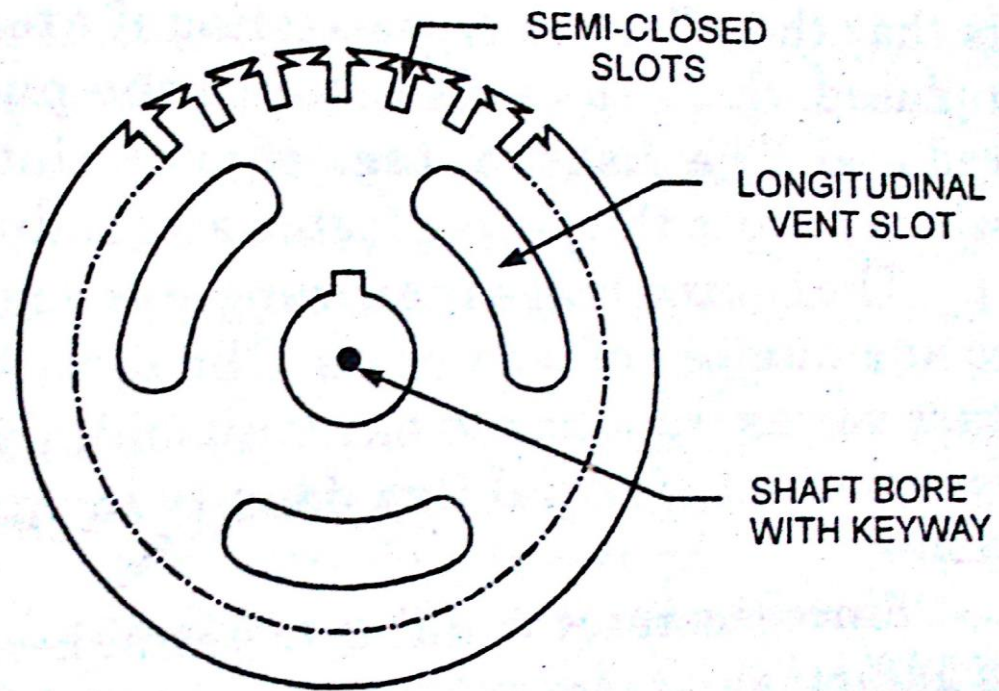
Stator

Construction

- Rotor (Rotating part)
 - **Squirrel cage type:** Rotor winding is composed of copper bars embedded in the rotor slots and shorted at both end by end rings
 - Simple
 - low cost
 - Robust
 - low maintenance

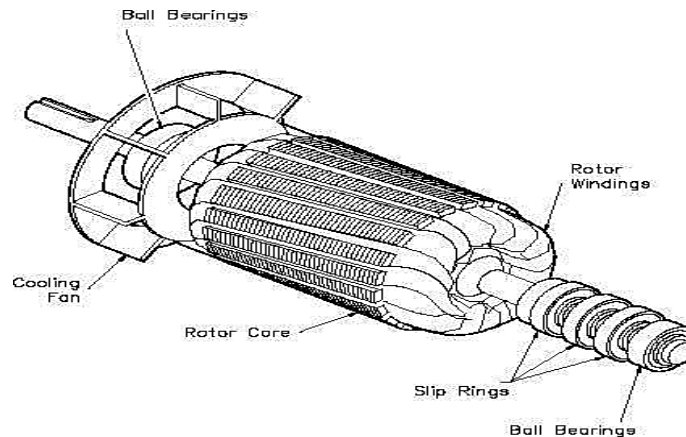


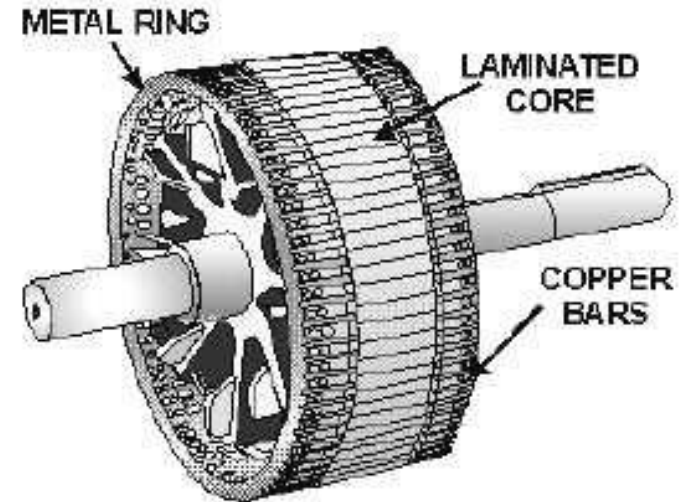
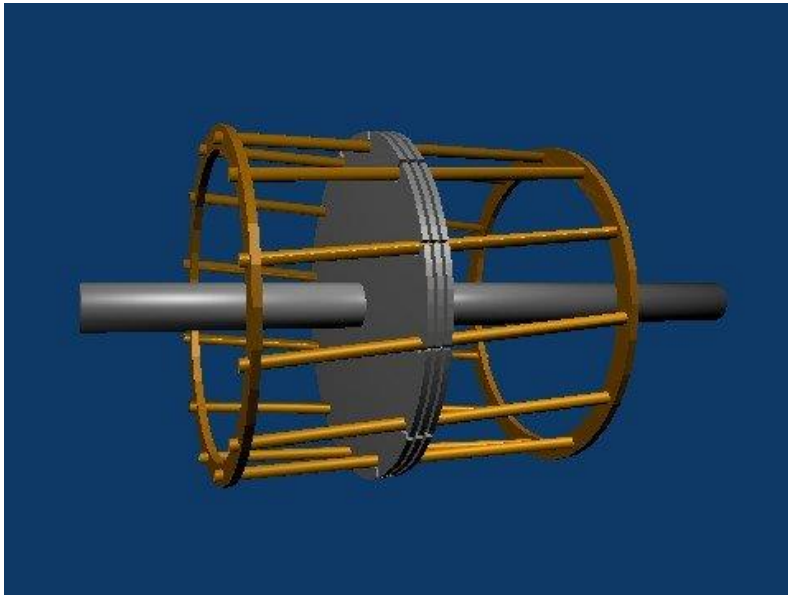
Rotor Stamping



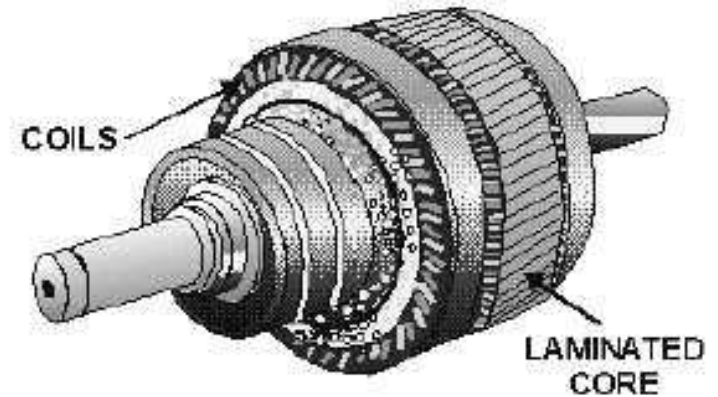
Construction

- **Rotor (Rotating part)**
- **Wound rotor type:**
 - Rotor winding is wound by wires.
 - The winding terminals can be connected to external circuits through slip rings and brushes.
 - Easy to control speed, more expensive.



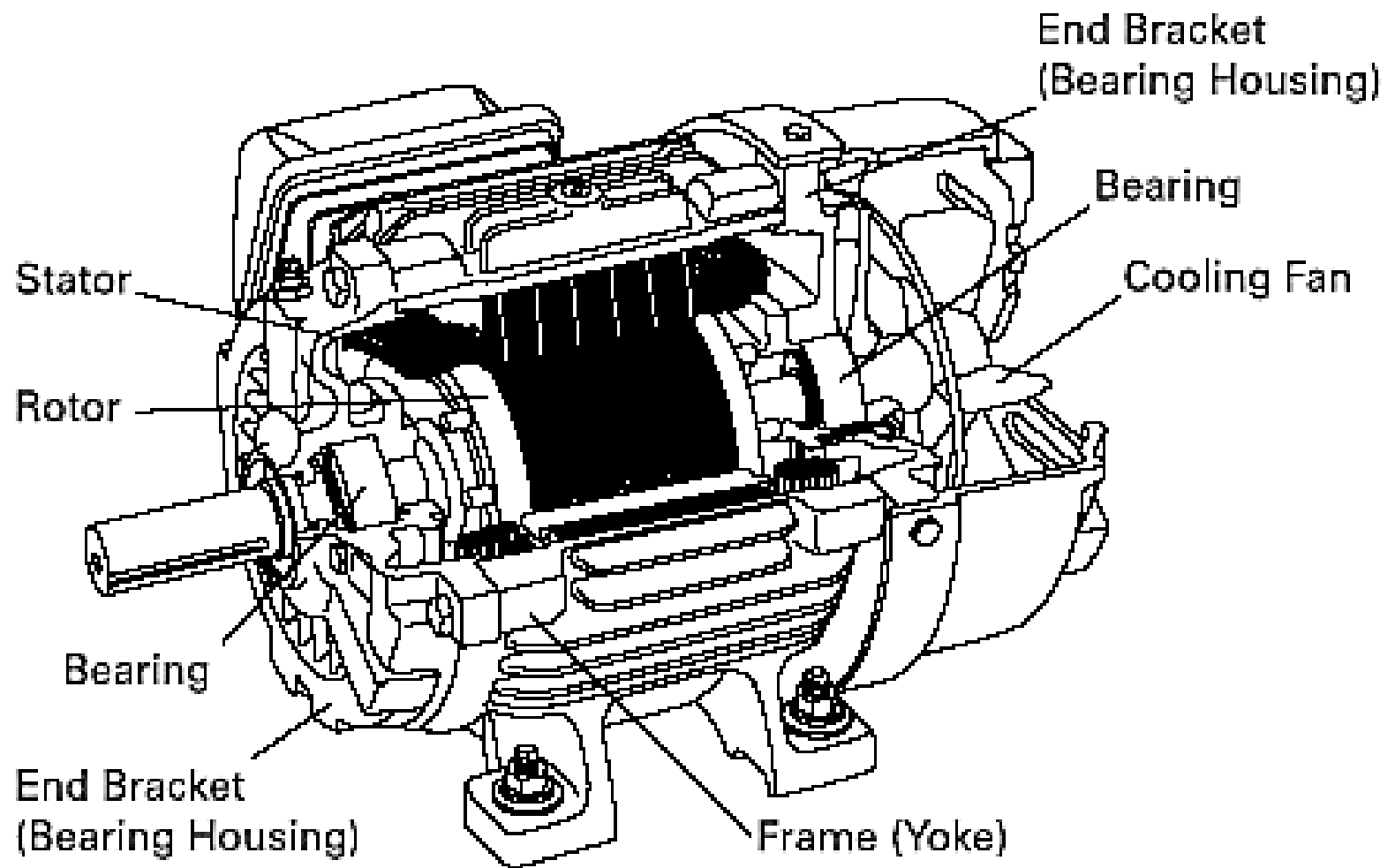


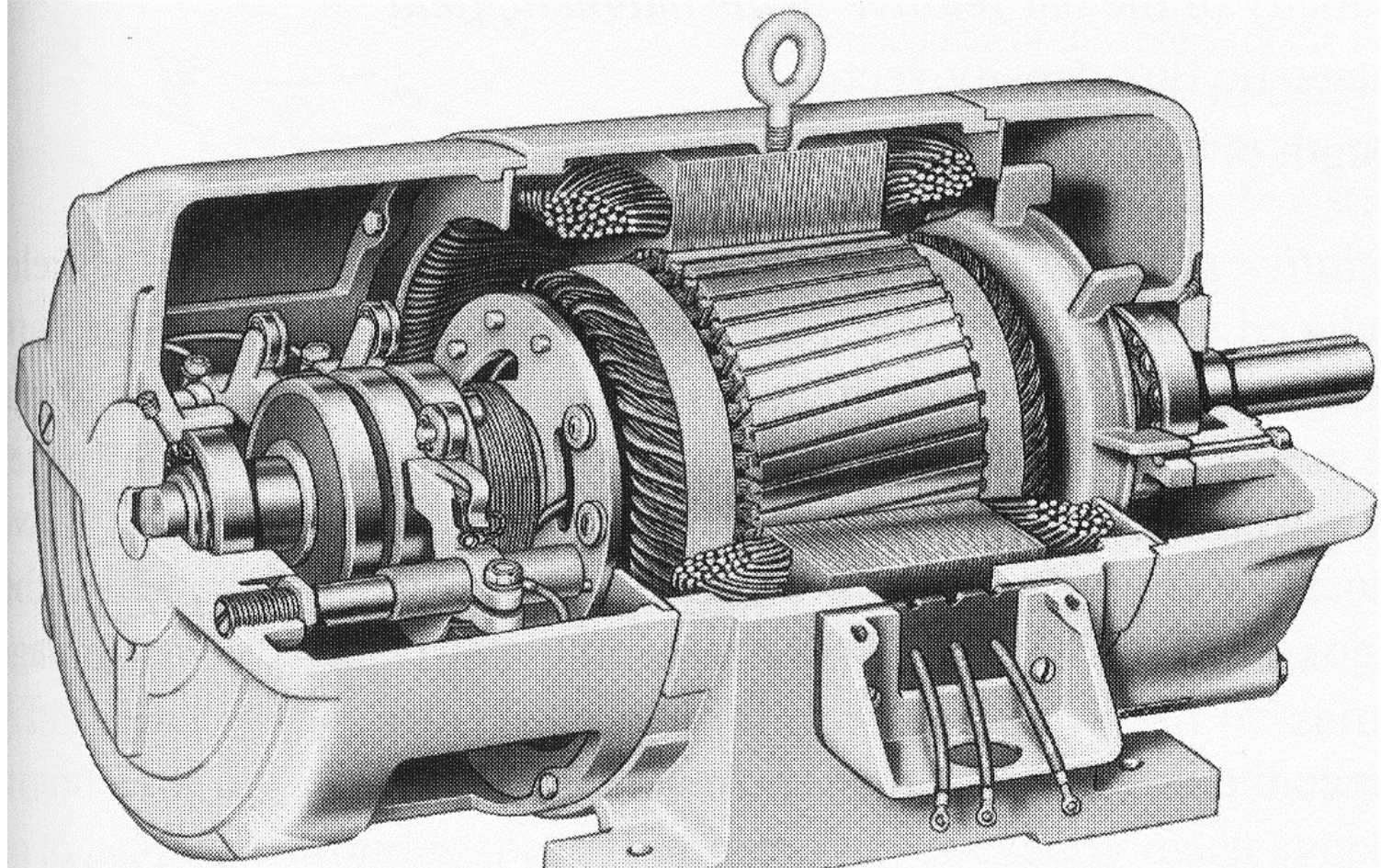
SQUIRREL-CAGE ROTOR



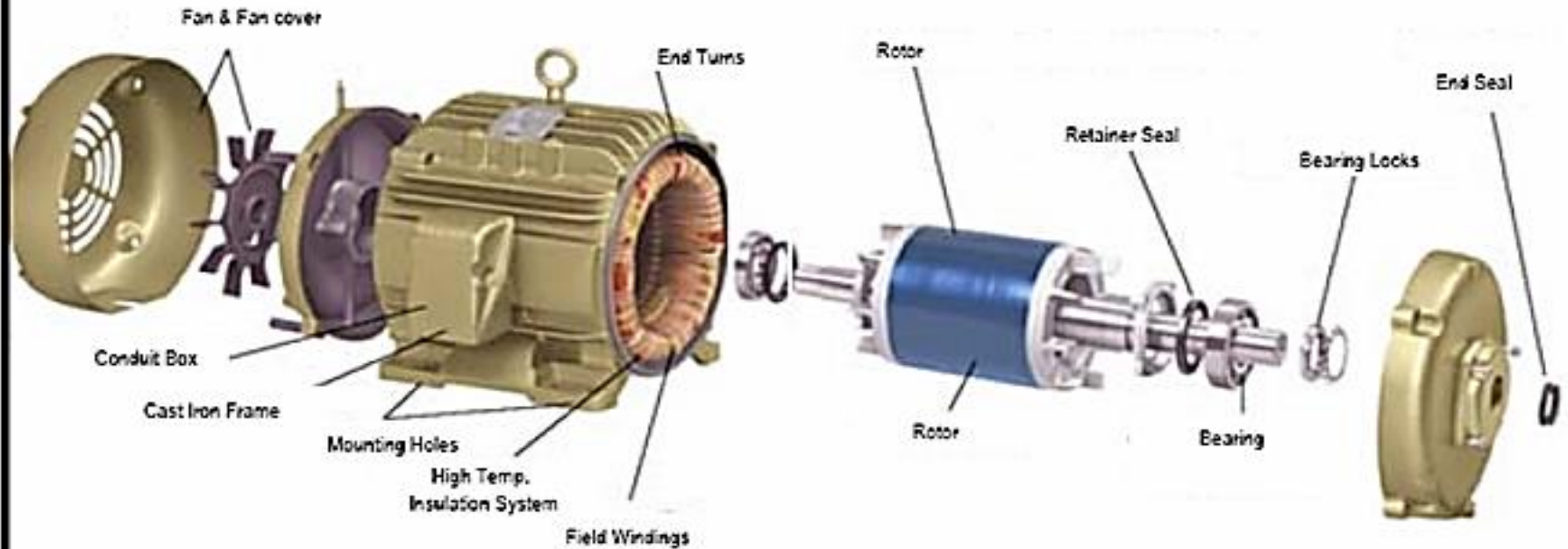
WOUND ROTOR

Rotor





Parts of AC Motor



Comparison between Squirrel cage & Slipring (Wound Rotor) IM

- **Advantages of Squirrel Cage Rotor**
 - **No sliprings, brush gear, short circuiting device, rotor terminals for starting**
 - **Slightly higher efficiency**
 - **Cheaper and rugged construction**

Comparison between Squirrel cage & Slipring (Wound Rotor) IM

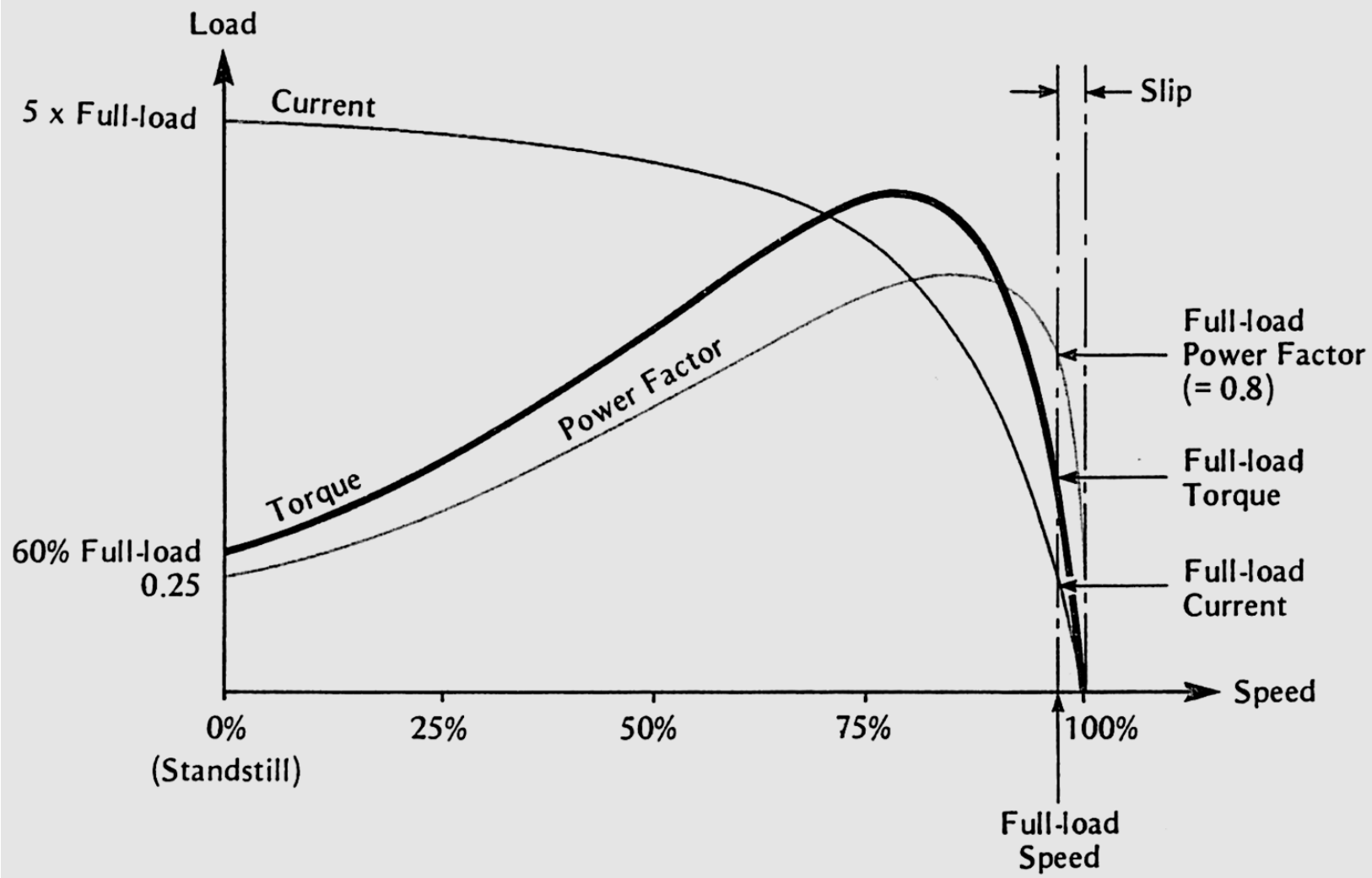
- **Advantages of Squirrel Cage Rotor**

- **Better space factor for rotor slots, shorter overhang and less copper losses**
- **Bare end rings and larger space for fans thus good cooling conditions**
- **Better power factor, torque and overload capacity**

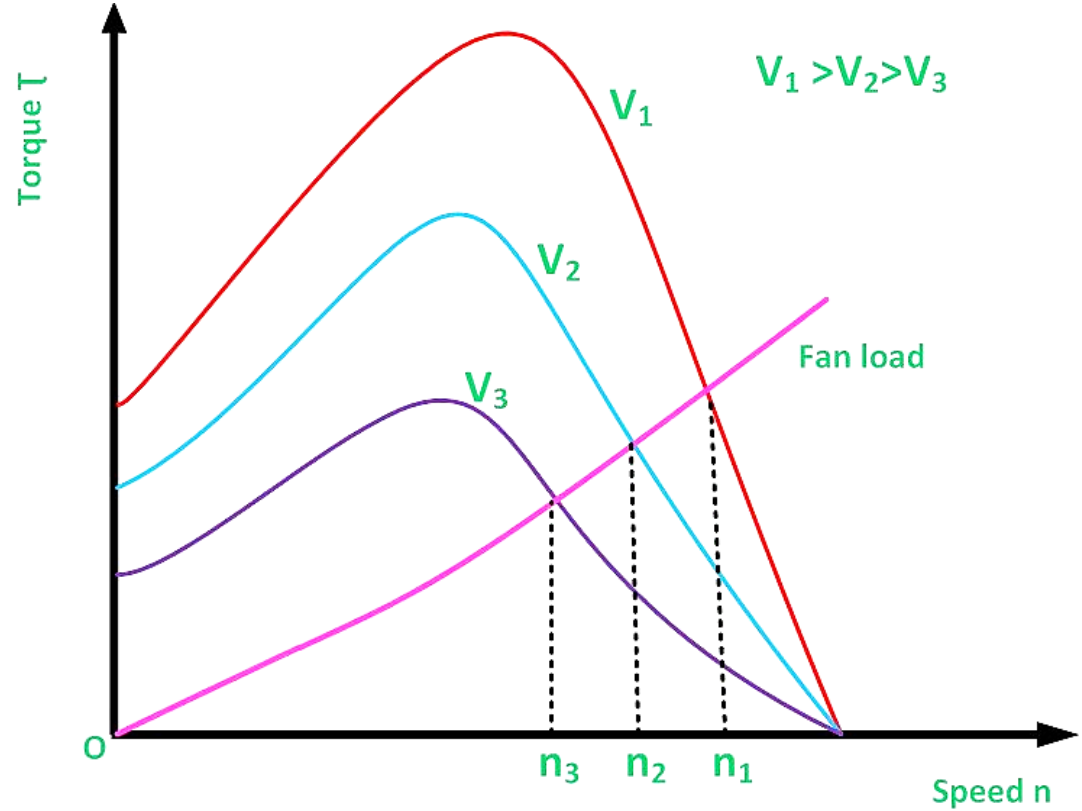
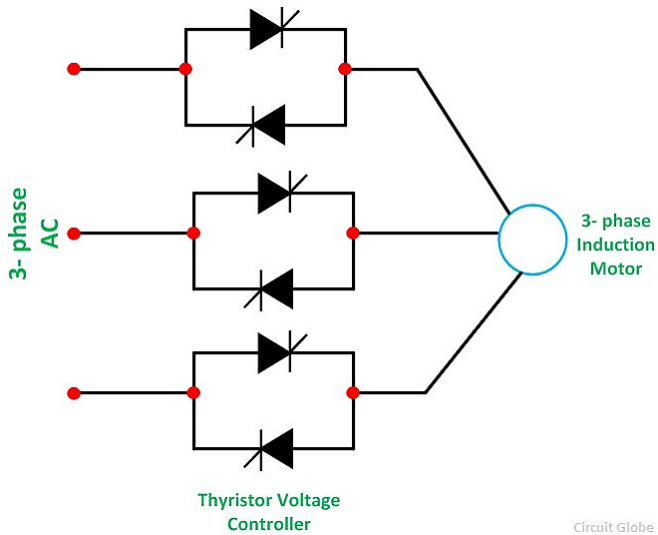
Induction Motor Speed Control

- Pole Changing Method
- Stator Voltage Control
- Variable Voltage Variable
Frequency Control
- Rotor Resistance Control





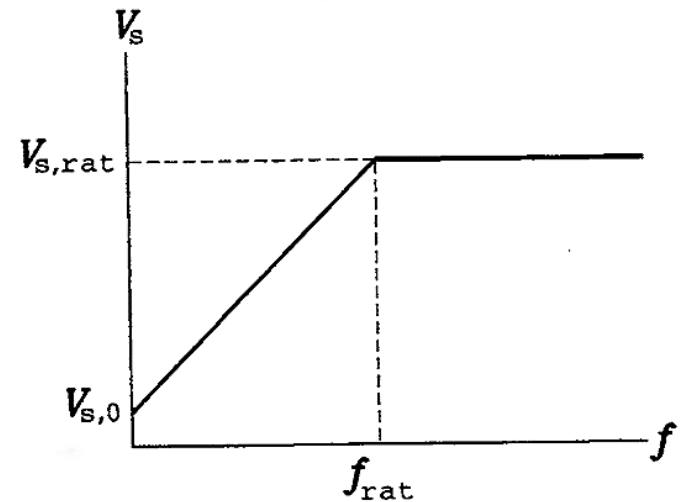
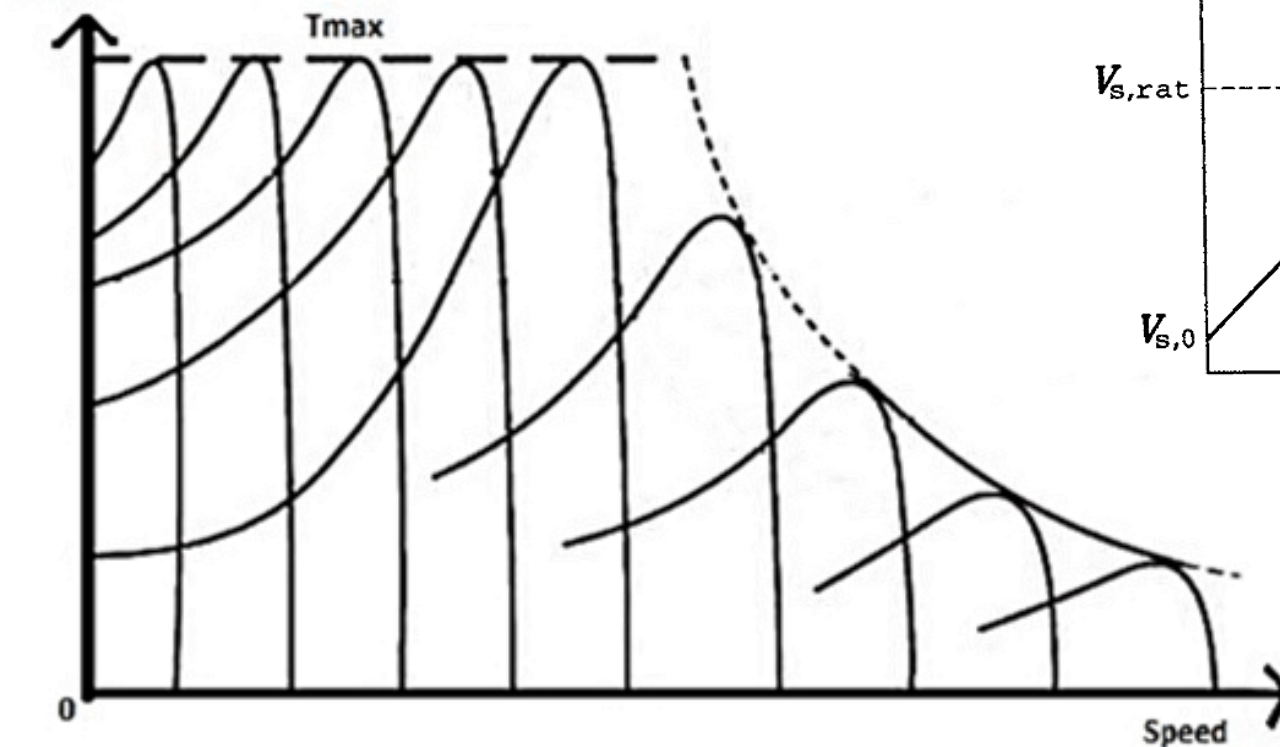
Stator Voltage Control

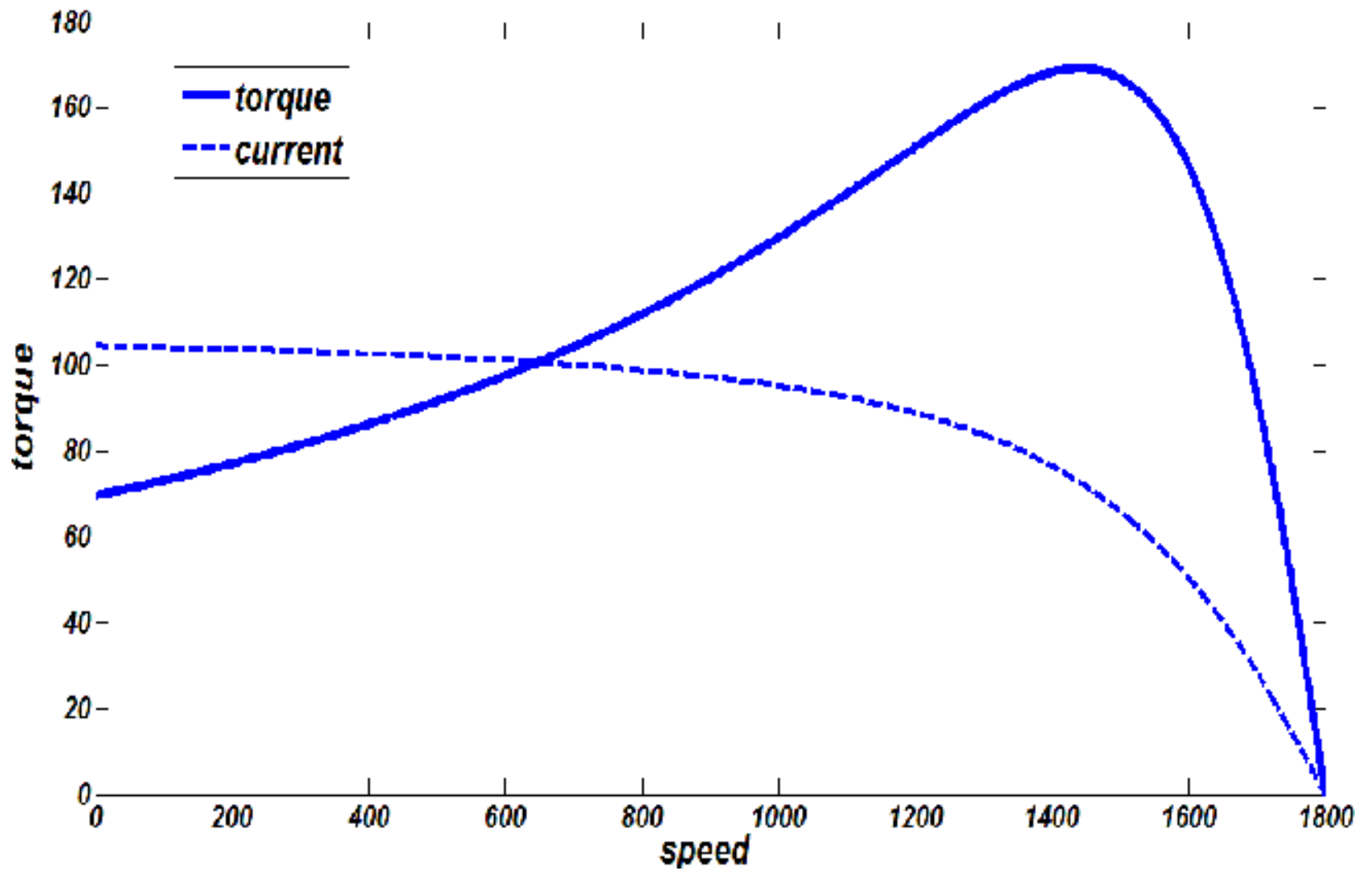


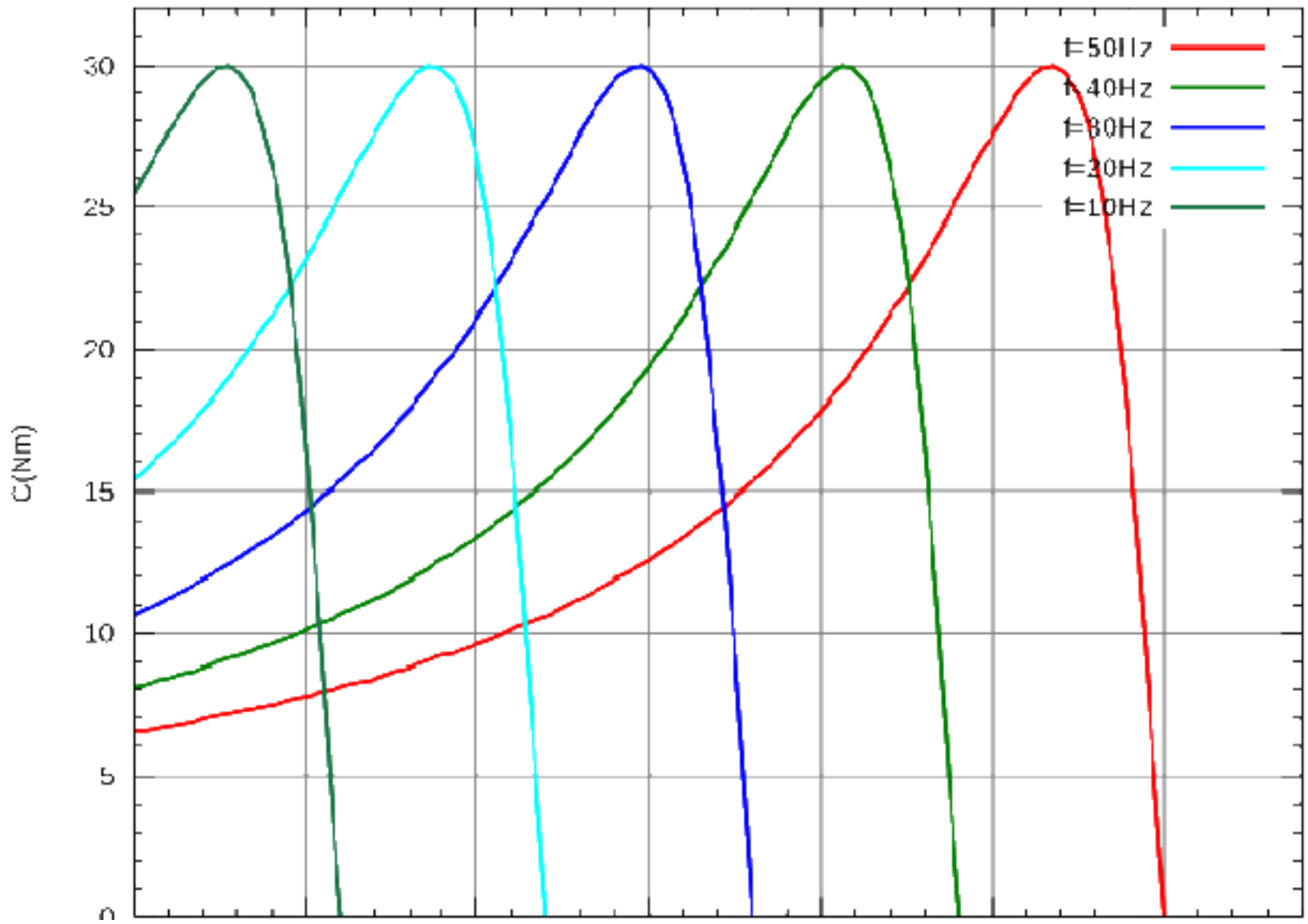
V/f Control of Induction Motor

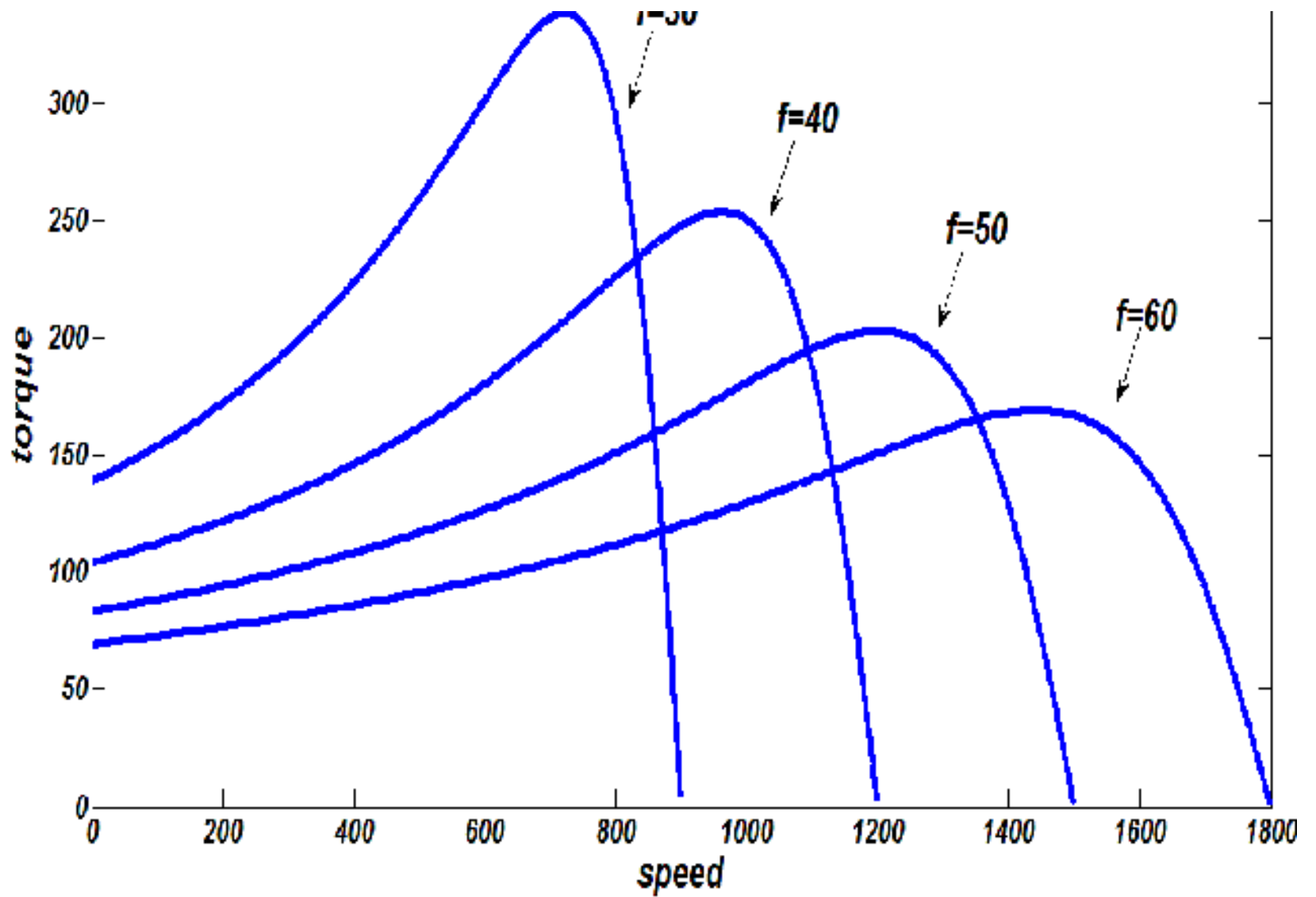
$$E = 4.44f\phi_mTK \quad \frac{V}{f} = 4.44\phi_mTK \quad \frac{V}{f} \propto \phi_m$$

Torque Speed Characteristics for V/f control









Control Of Chopper

1. Time Ratio Control

This method based on output voltage control by varying duty cycle $d=T_{ON}/T$

There are further two types of this method.

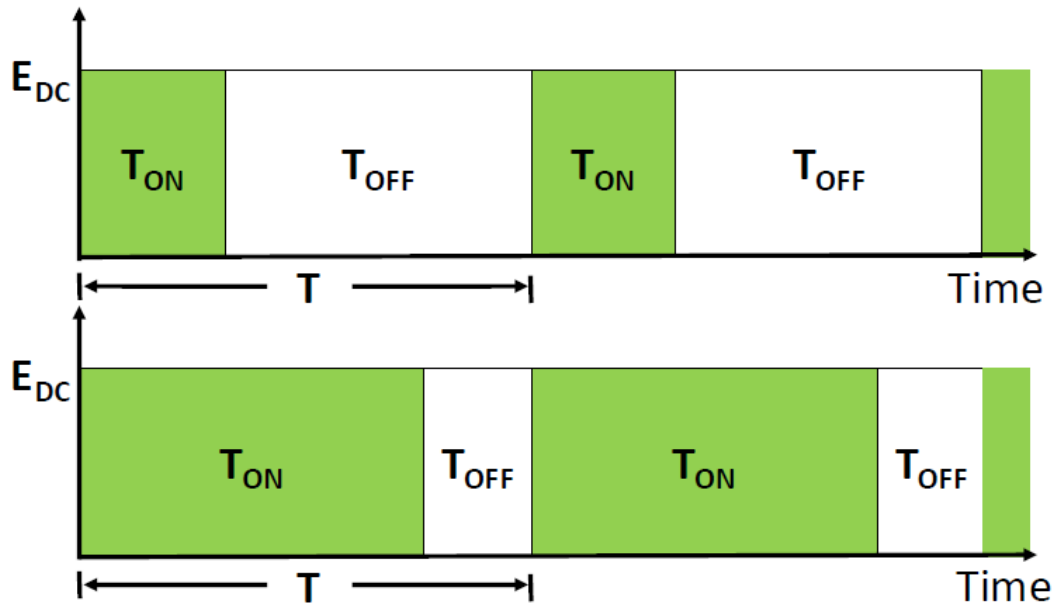
- I. Constant frequency control
- II. Variable frequency control



Control Of Chopper

1. Time Ratio Control

I. Constant frequency control



- In this method frequency is kept constant.
- Only T_{ON} is varied.
- This method is very simple and circuit is easy to design
- This method is also known as **pulse width modulation** method.

$$\text{Total Time, } T = T_{ON} + T_{OFF}$$

T_{ON} = On Time

T_{OFF} = Off Time

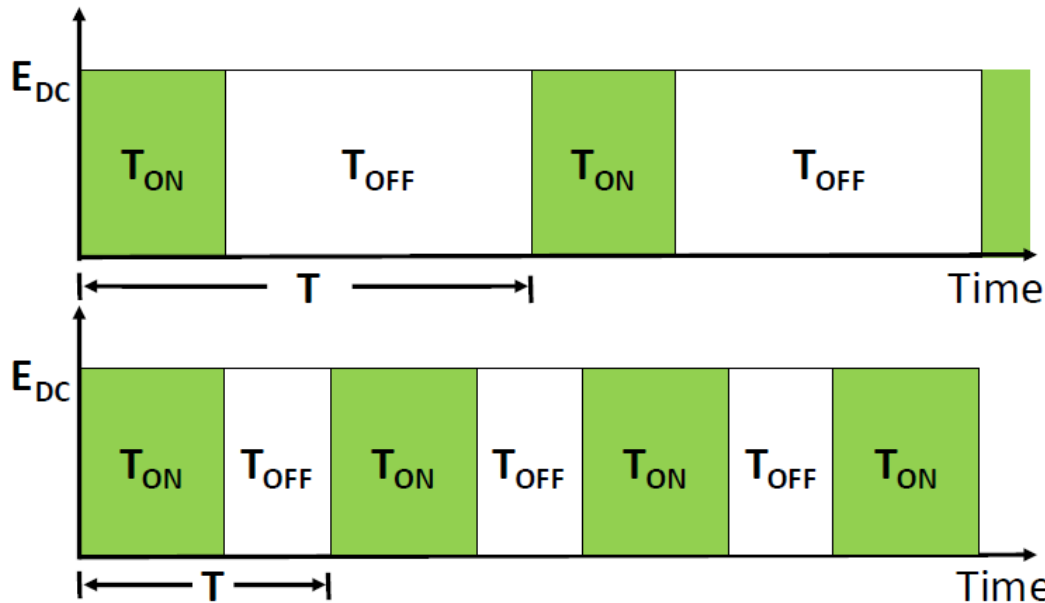
$$\text{Duty Cycle, } \delta = \frac{T_{ON}}{T}$$

$$\text{Duty Cycle, } \delta = \frac{T_{ON}}{T_{ON} + T_{OFF}}$$

Control Of Chopper

1. Time Ratio Control

ii. Variable frequency control



- In this method frequency is changed.
- Only T_{ON} or T_{OFF} kept constant.

Disadvantages

- Chopping frequency is to be changed in large range so filter circuit design is difficult.
- Due to change in frequency it causes disturbance in telephone lines near to this.
- If turn-off time is high then we get discontinuous load current.

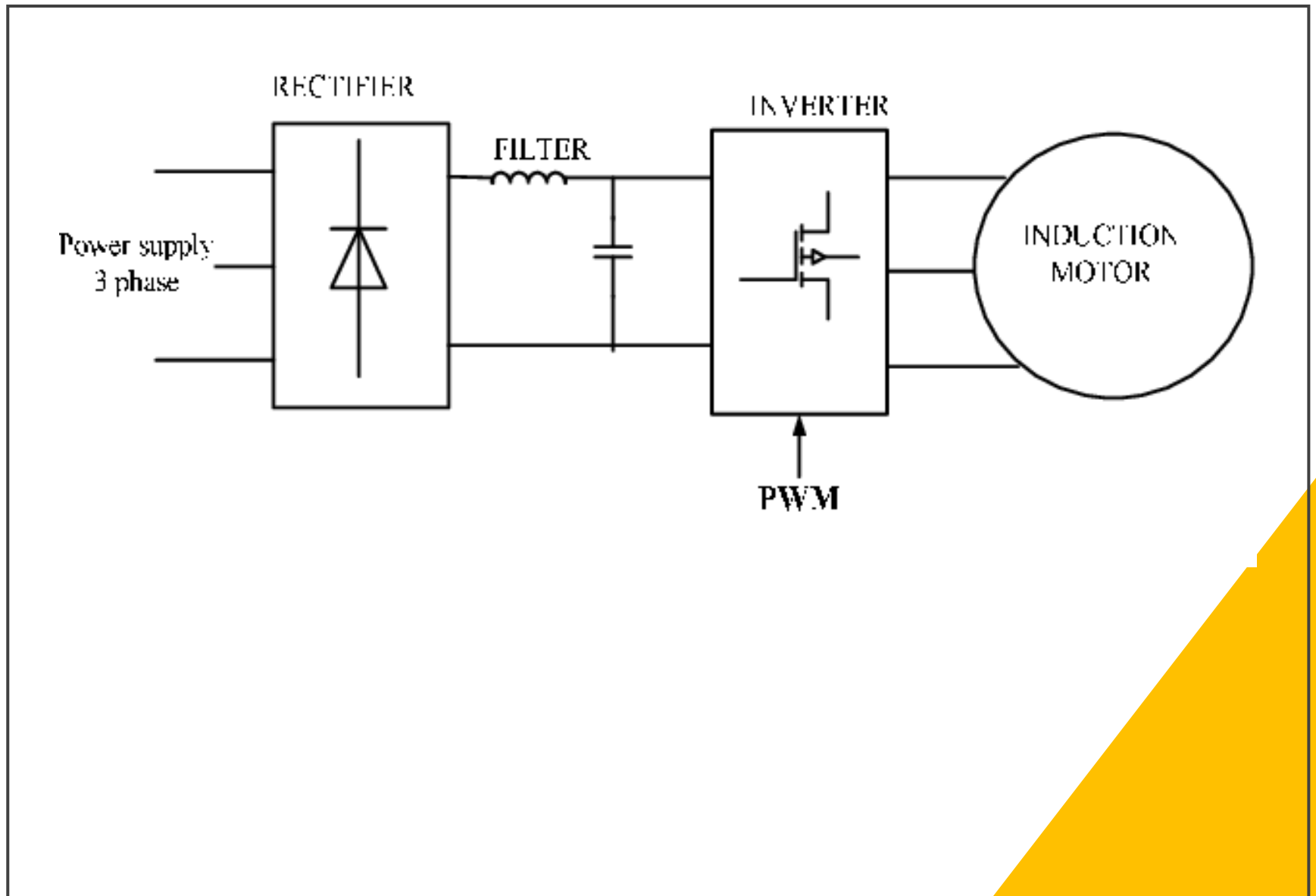
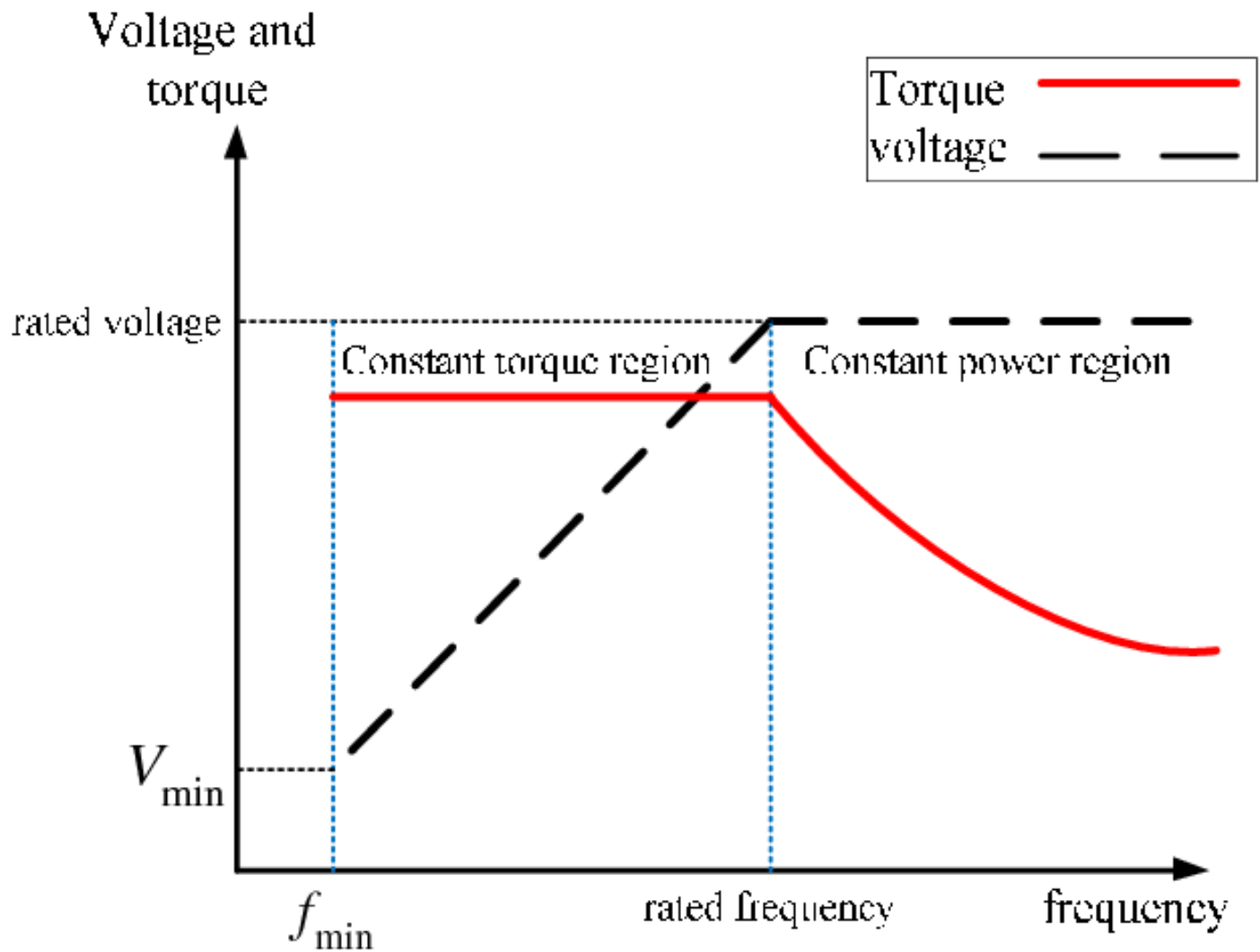


Fig. 5.





Thank You

[Vishal D Devdhar](#)

www.vishaldevdhar.org