

# Electric Motors

## BEE401

### Module-5

- a) Synchronous Motor
- b) Other Motor



**-Presented By**  
**Sowmyashree K S**  
**Assistant Professor**  
**Department of EEE**  
**ATMECE**

## Module-5

***Synchronous motor:*** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and damping. Methods of starting synchronous motors.

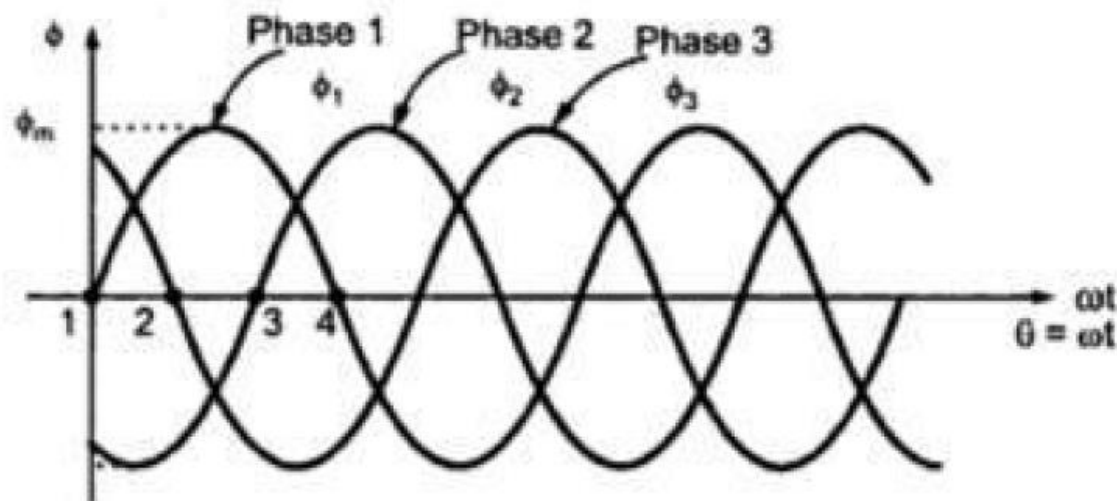
***Other motors:*** Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors.

## Rotating Magnetic Field:

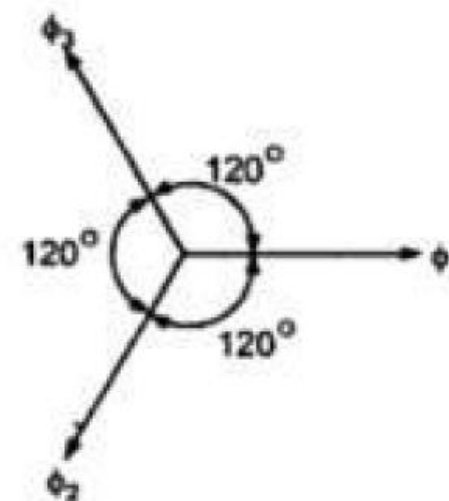
$$\Phi_1 = \Phi_m \sin(\omega t) = \Phi_m \sin \theta \dots \dots \dots (1)$$

$$\Phi_2 = \sin (\omega t - 120^\circ) = \Phi_m \sin (\theta - 120^\circ) \dots \dots \dots (2)$$

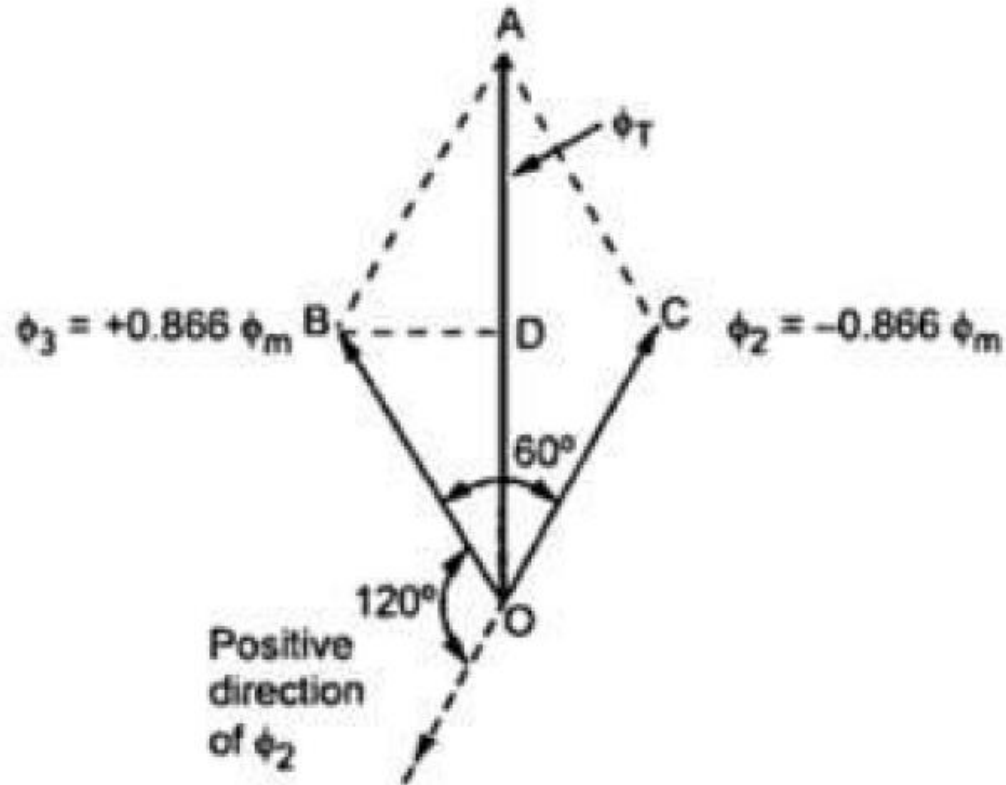
$$\Phi_3 = \Phi_m \sin (\omega t - 240^\circ) = \Phi_m \sin (\theta - 240^\circ) \dots \dots \dots (3)$$



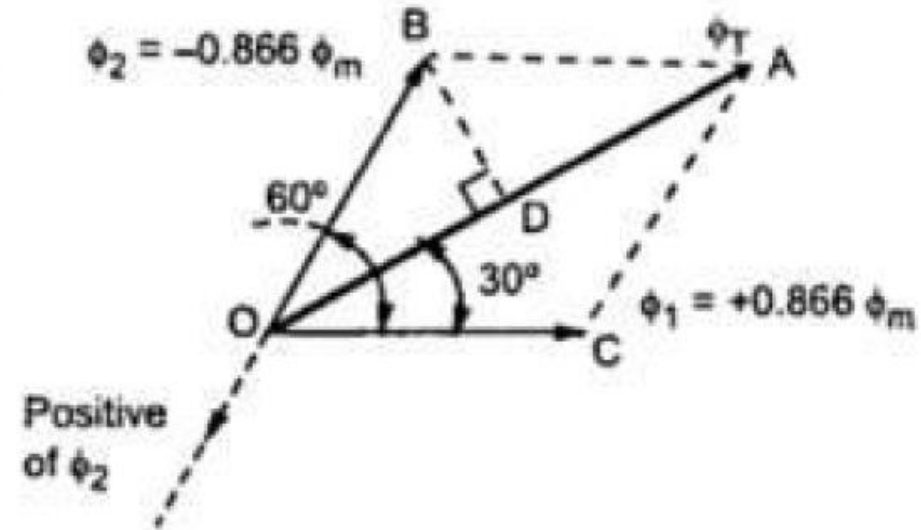
(a) Waveforms of three fluxes



(b) Assumed positive directions

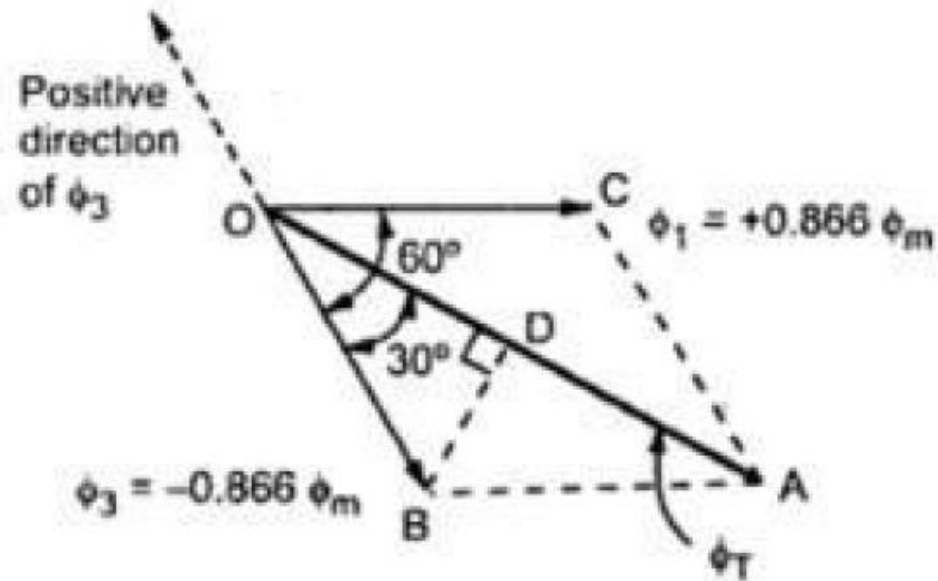


(a) Vector diagram for  $\theta = 0^\circ$

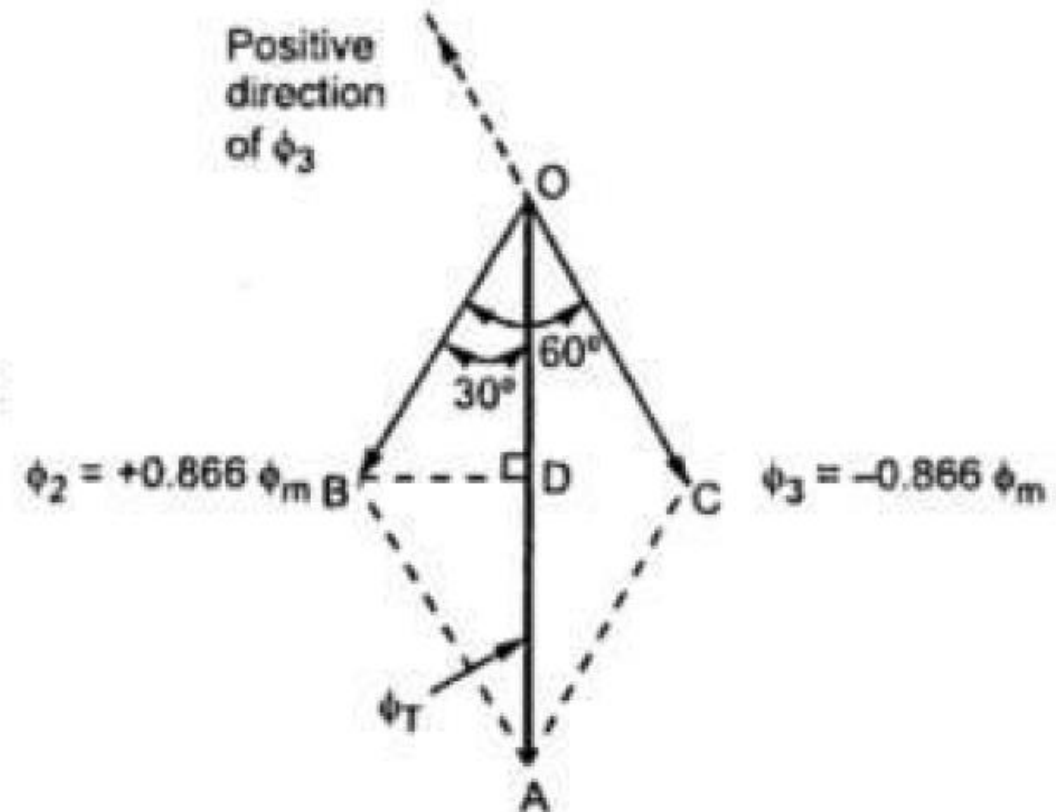


(b) Vector diagram for  $\theta = 60^\circ$



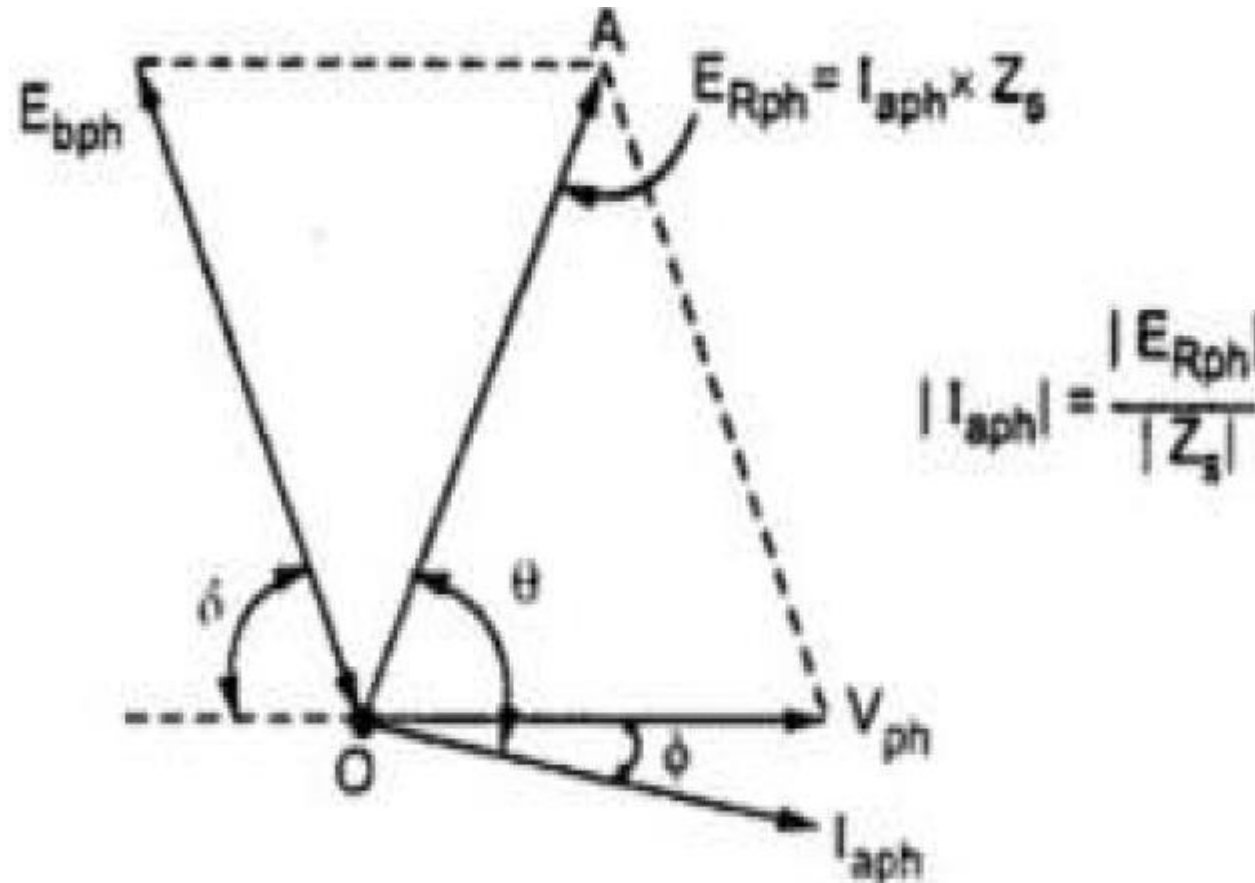


(c) Vector diagram for  $\theta = 120^\circ$

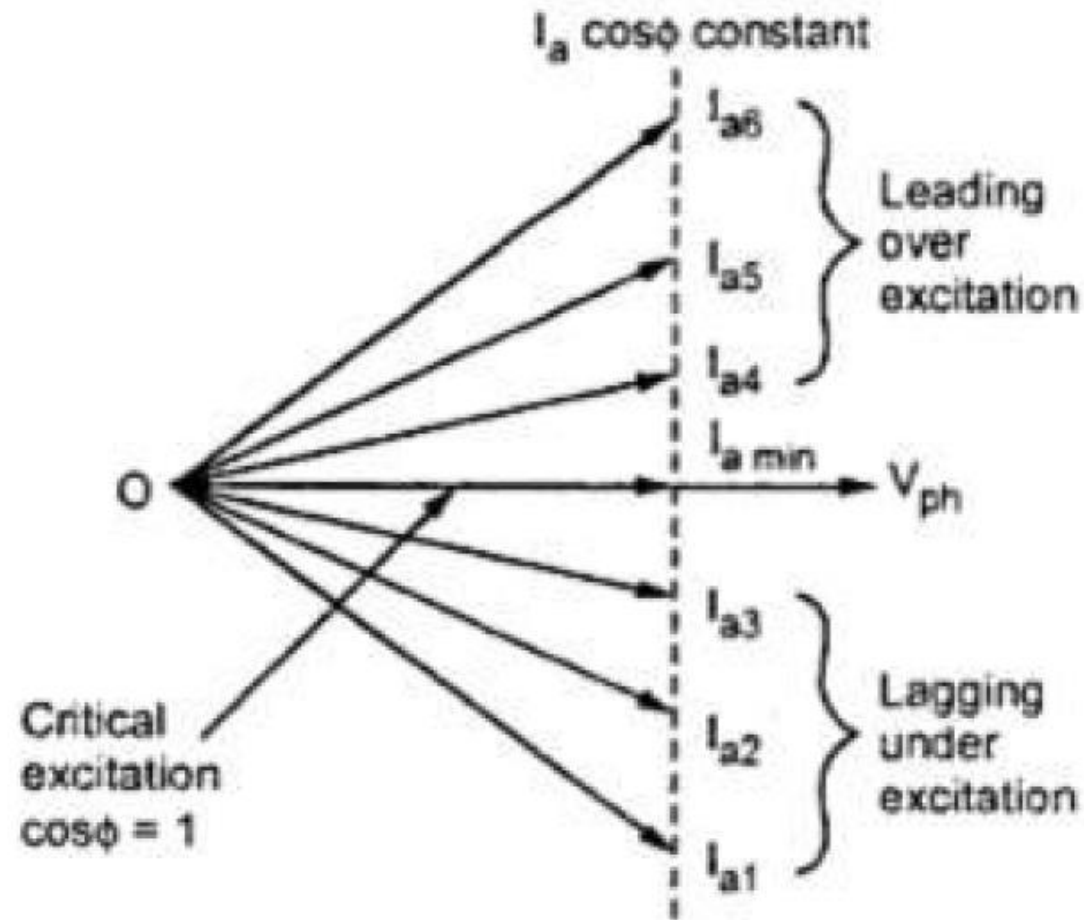


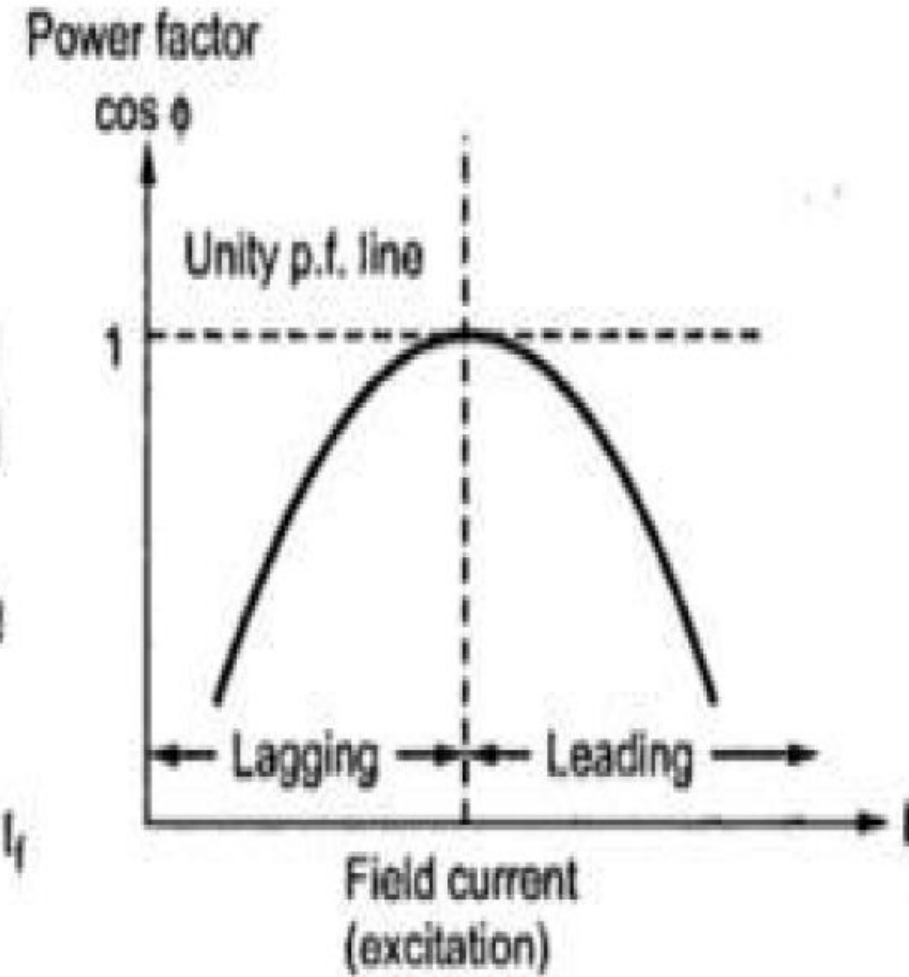
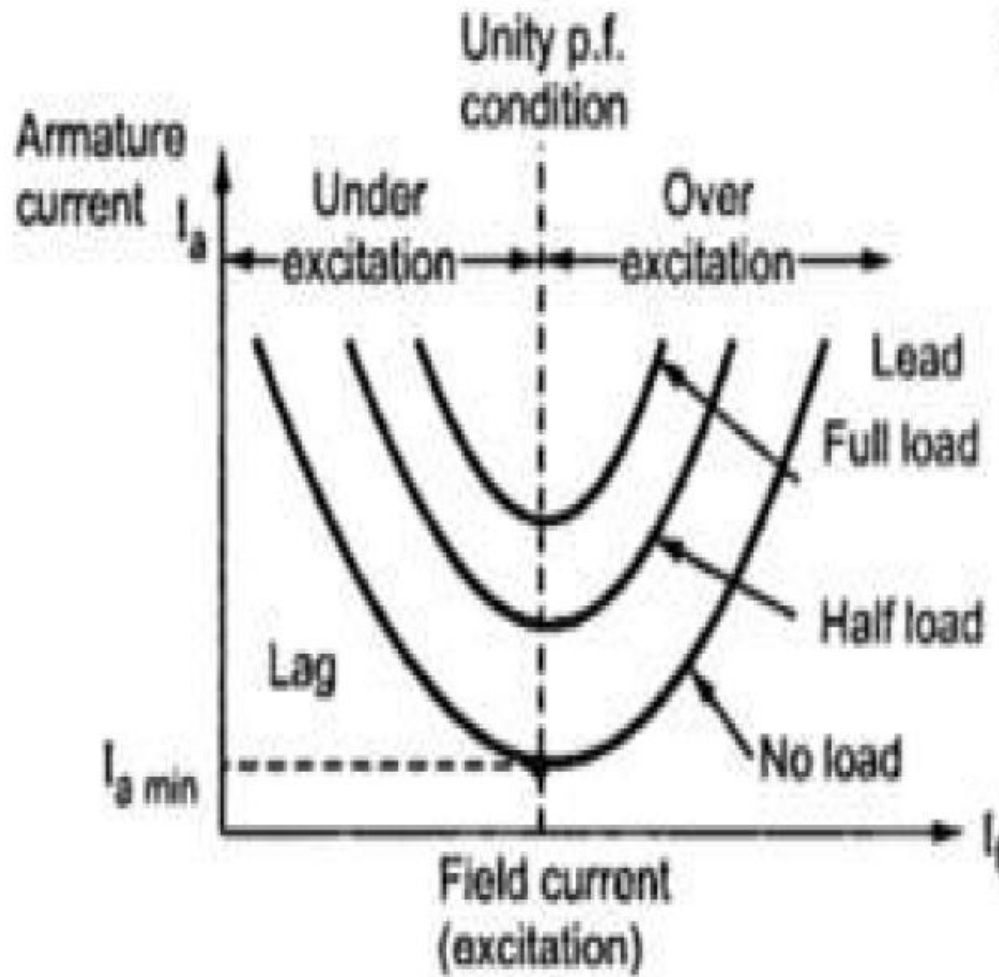
(d) Vector diagram for  $\theta = 180^\circ$

## Analysis of Phasor Diagram:



## V curves and Inverted V curves:

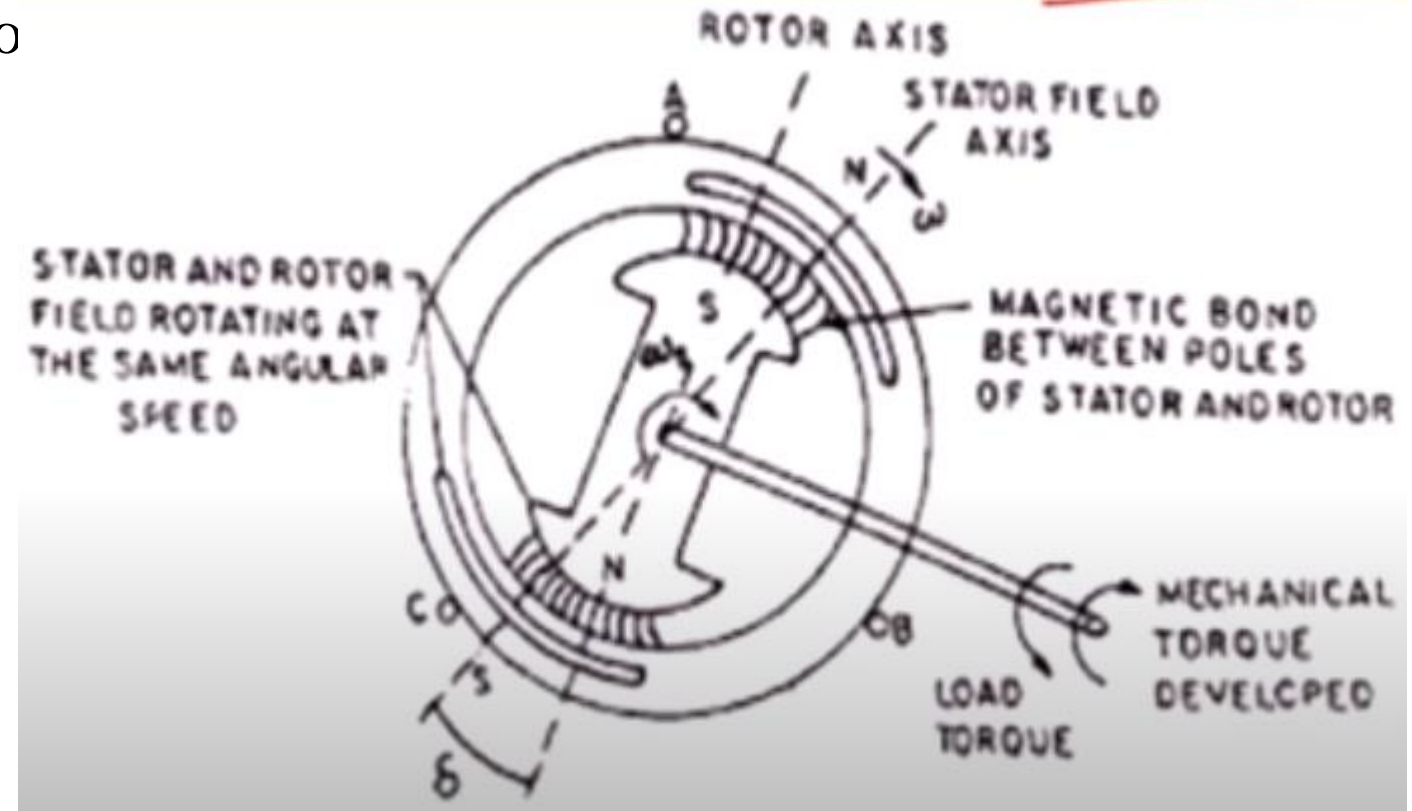
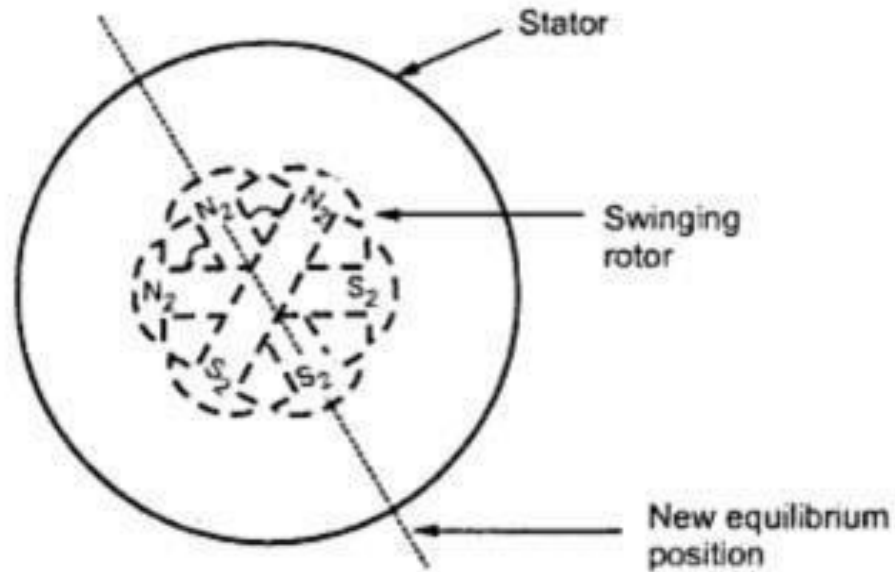






# Hunting in Synchronous Motor:

Hunting in Synchronous Motor o



## Causes of Hunting

- Sudden changes of Load
- Faults occurring in the system which the generator supplies
- Sudden changes in the field current

## Effect of Hunting

- Losses its synchronism
- Increase in losses and temperature
- Mechanical stress in the rotor shaft

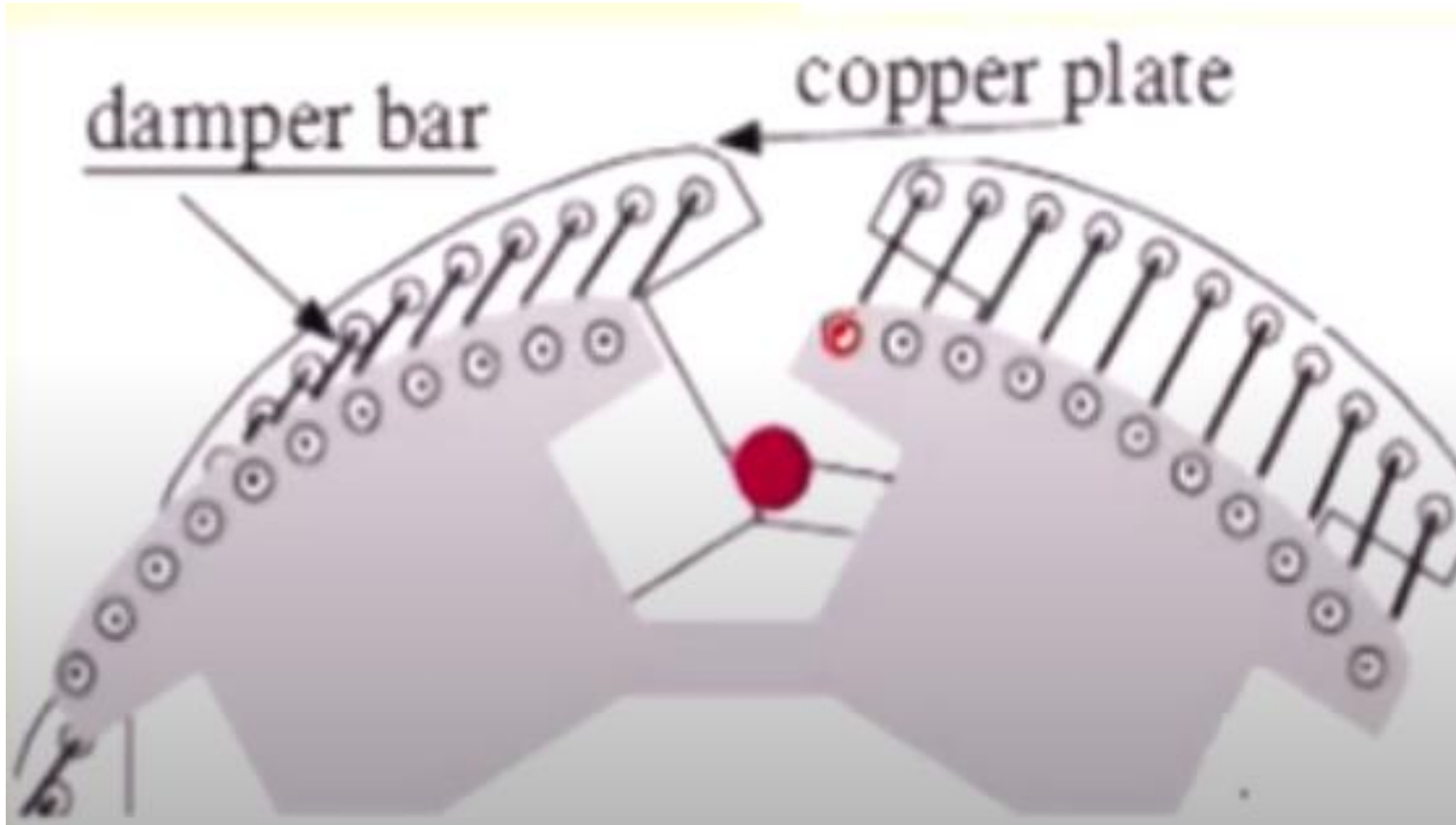
## Reduction of Hunting

- Using Damper windings
- Use of Flywheels

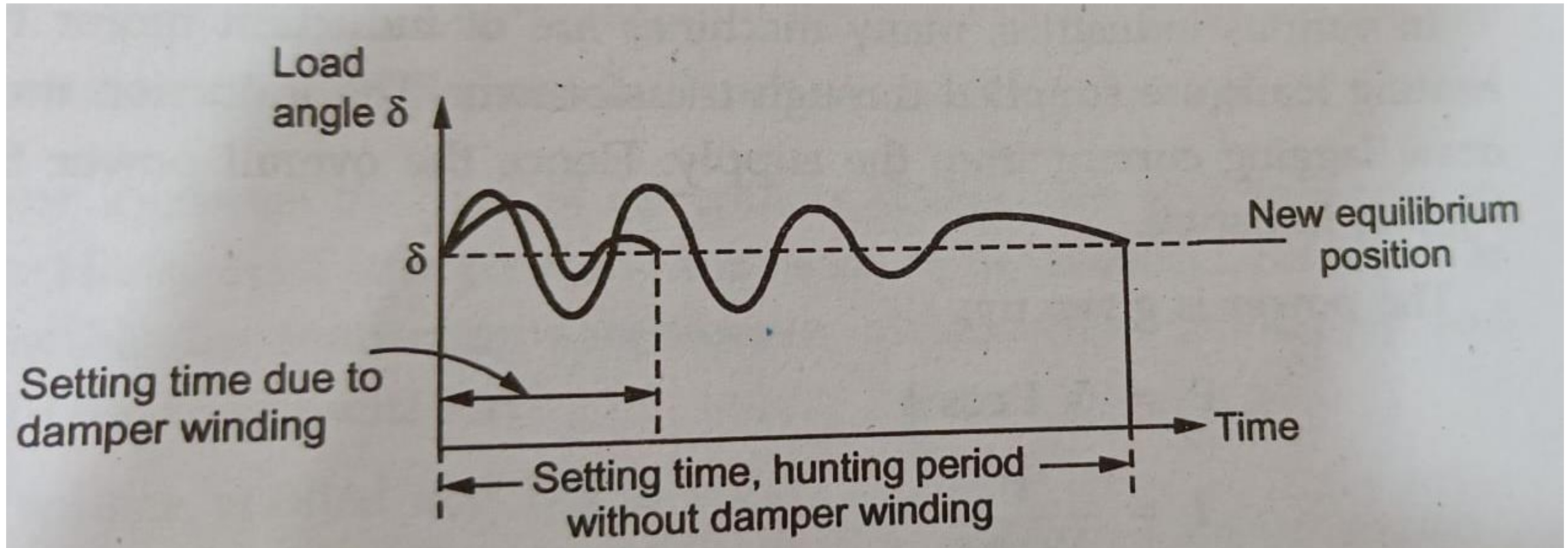
## Application of 3-phase synchronous motor

- Used in constant speed application
- Variable speed applications(high power & high speed):compressor, blowers servo drives etc.
- Synchronous condenser
- PF improvement

## Use of Damper Windings to prevent hunting:

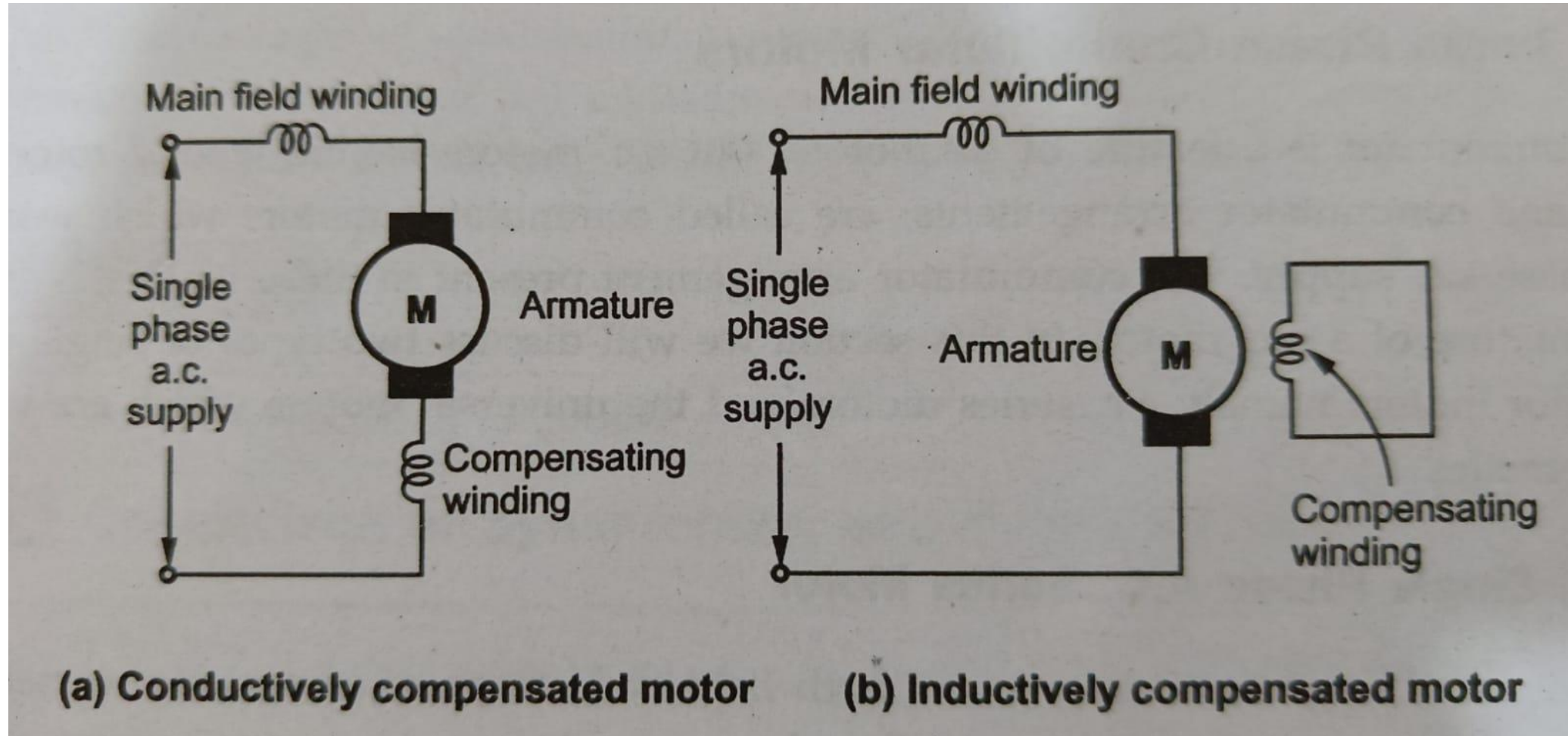


## Use of Damper Windings to prevent hunting:

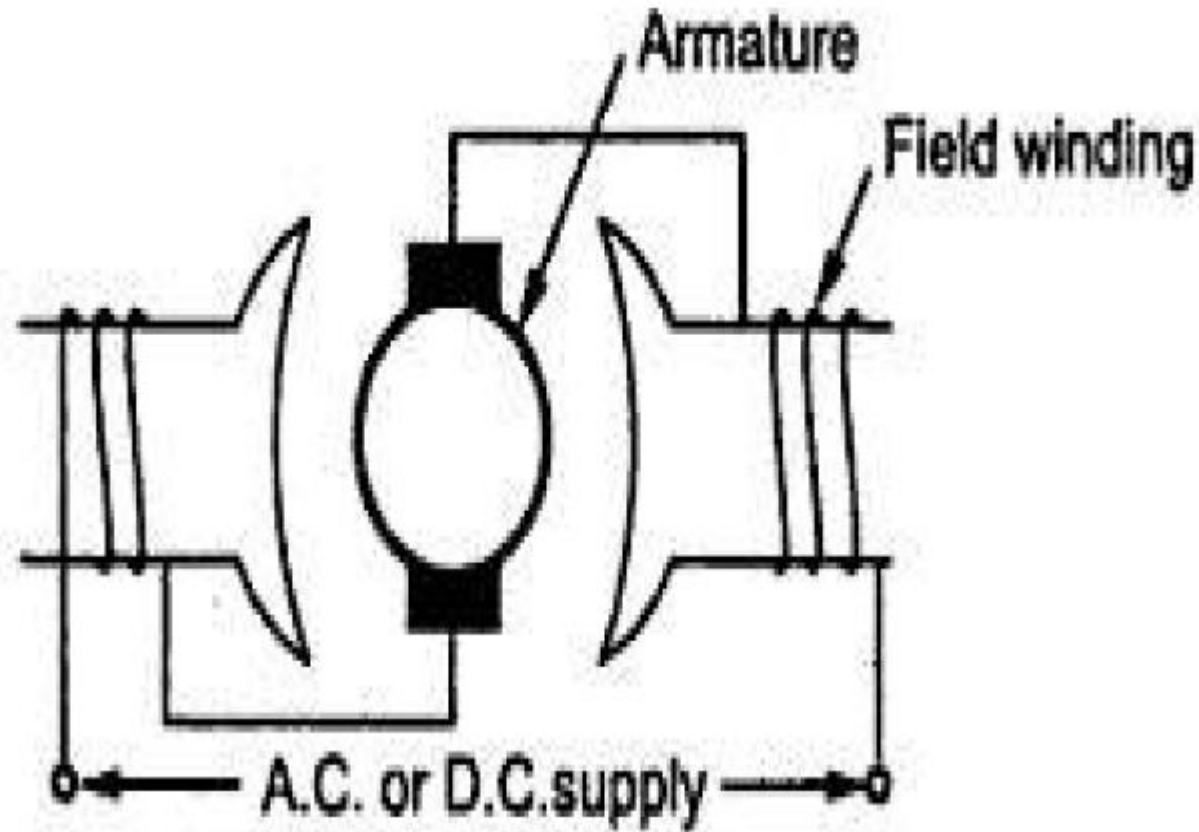


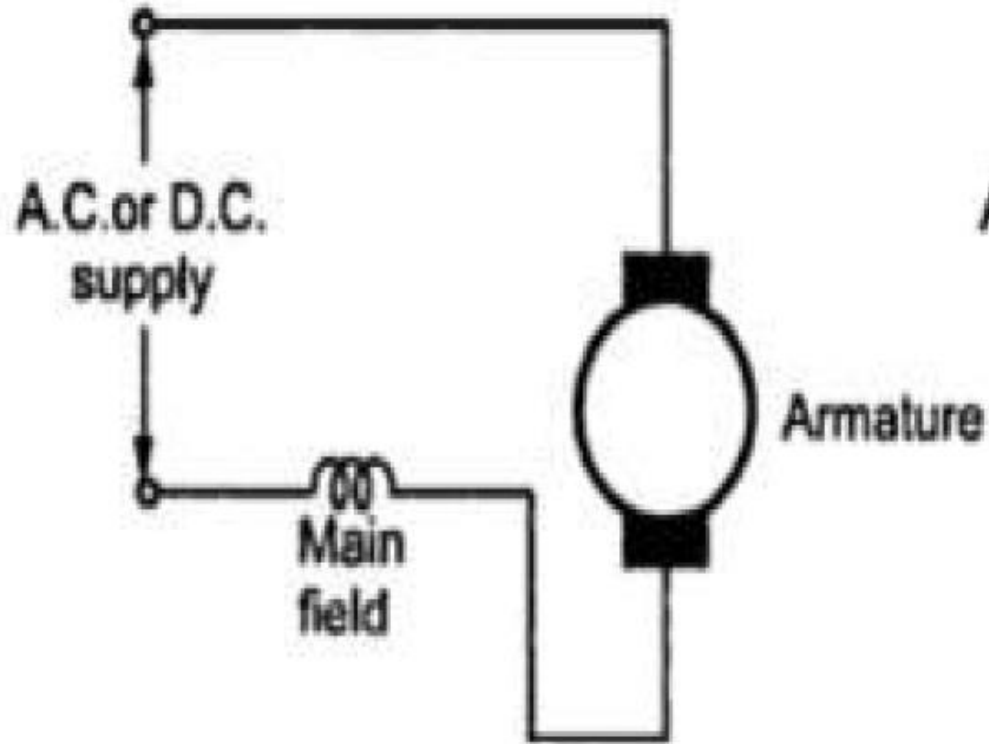


## AC Series Motor:

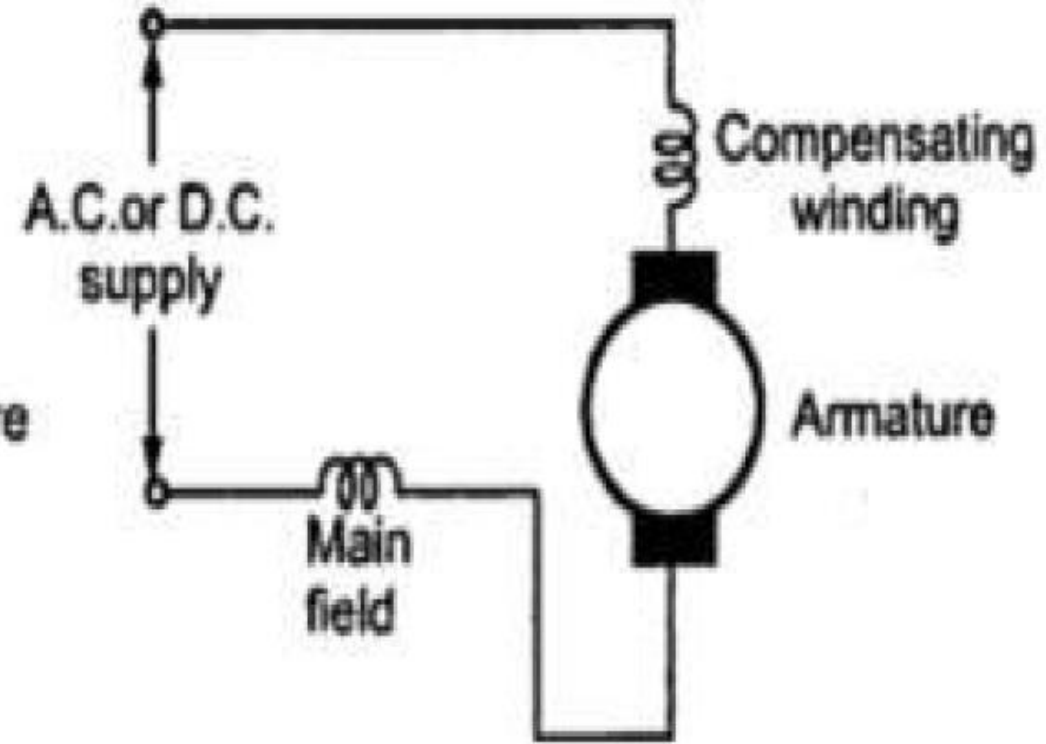


## Universal Motor:

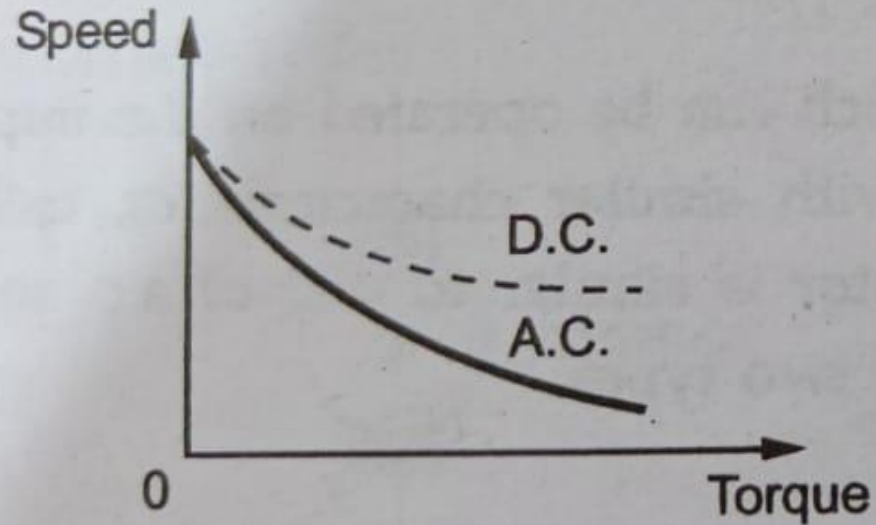




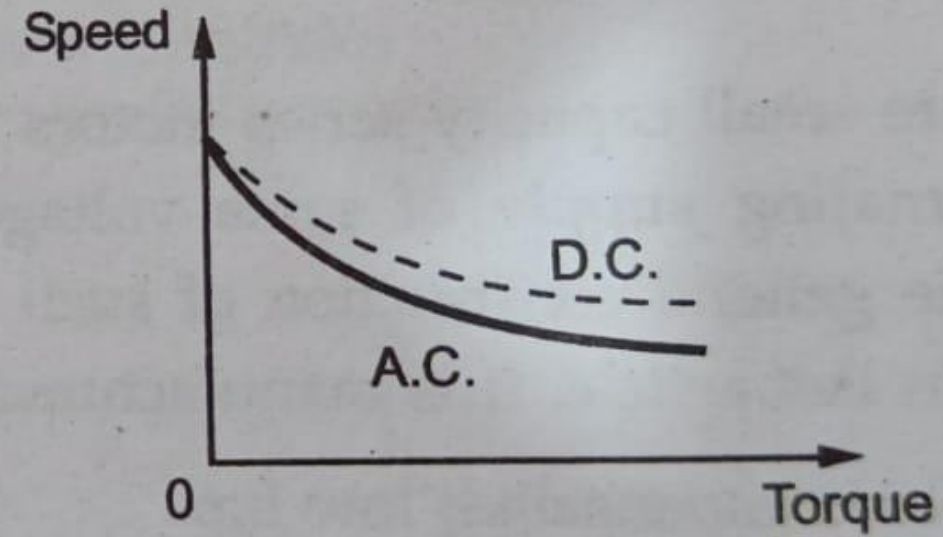
**(a) Non-compensated type**



**(b) Compensated type**



**(a) Non-compensated type**



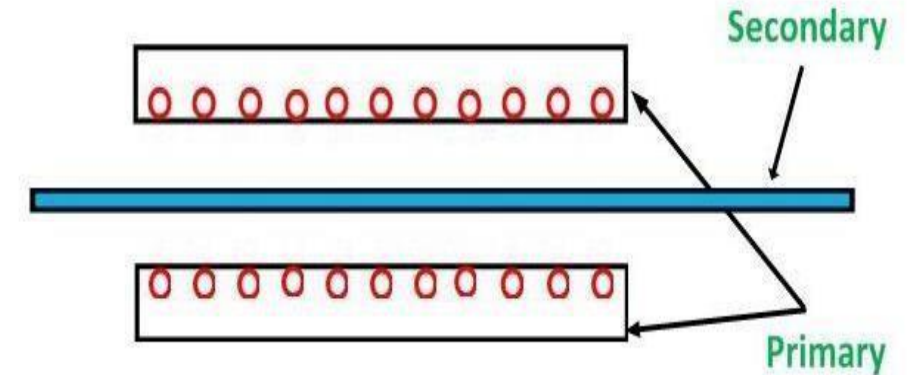
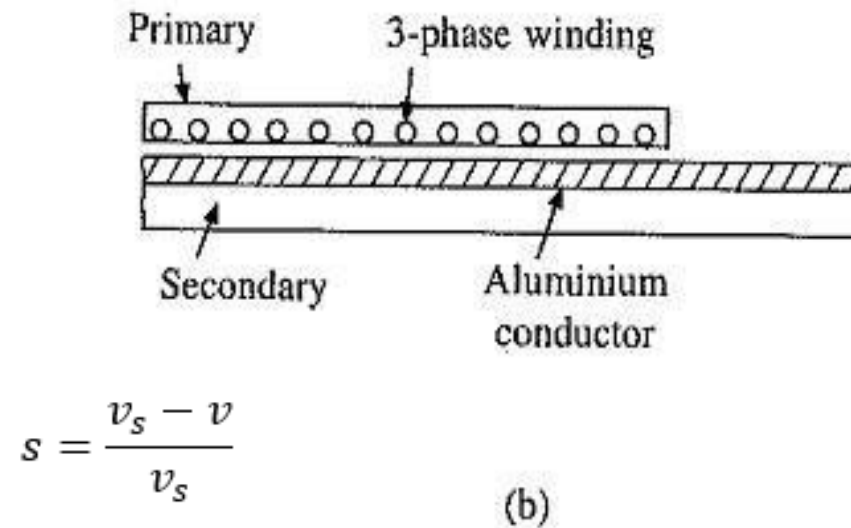
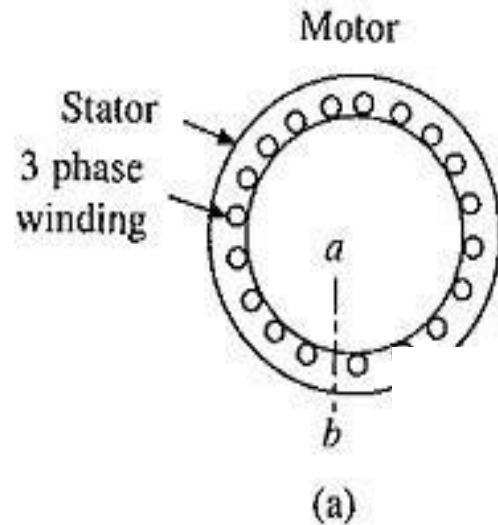
**(b) Compensated type**

**Applications:** Though compensated type characteristics are better, the non-compensated type is more preferred for low hp applications. While compensated types of universal motors are preferred for high hp applications. High starting torque is a feature of universal motors.

The motors are used for domestic applications like vacuum cleaners, food processors and mixers, hair dryers, coffee grinders, etc. Their other applications are blowers, portable drilling machines, and small drives.



# Linear Induction Motor:



$$s = \frac{v_s - v}{v_s}$$

$$F = \frac{P_2}{v_s}$$

$$P_{Cu} = sP_2$$

$$P_m = (1 - s)P_2$$

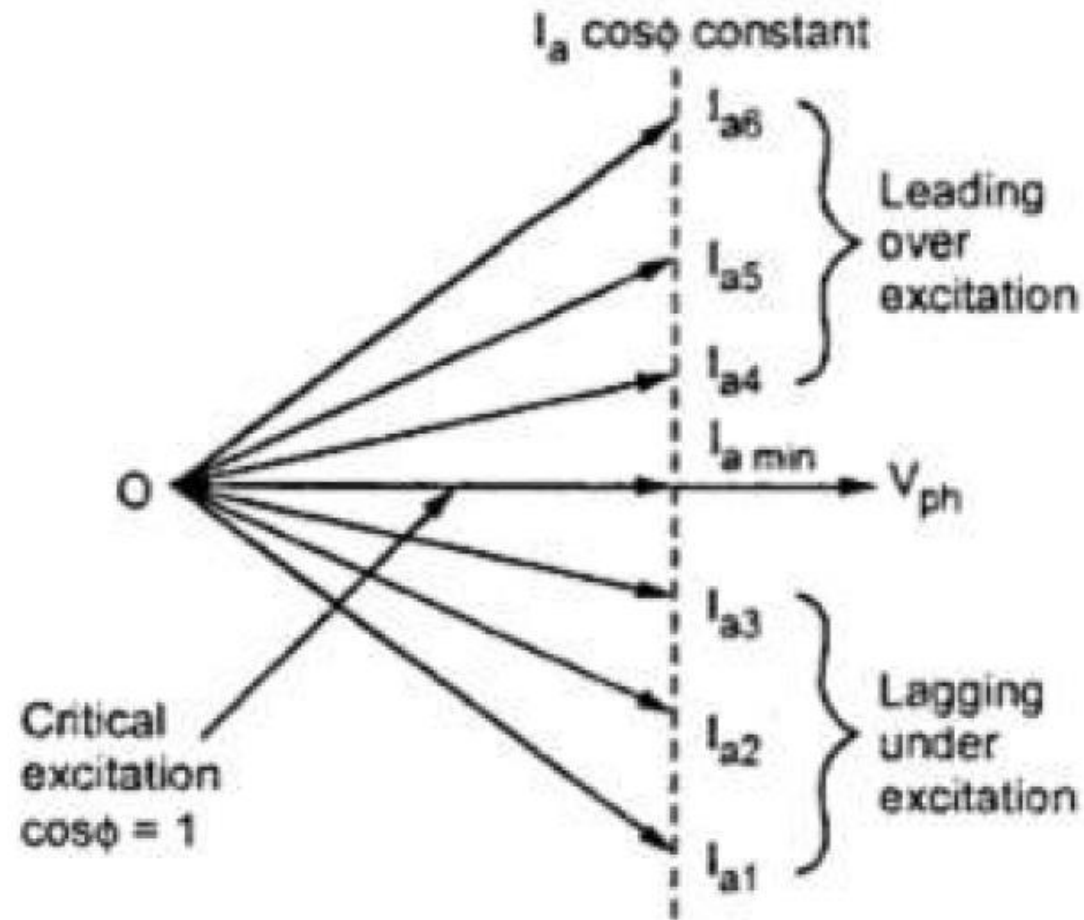
$$v_s = 2 W f$$

$v_s$  = Linear synchronous speed (m/s)

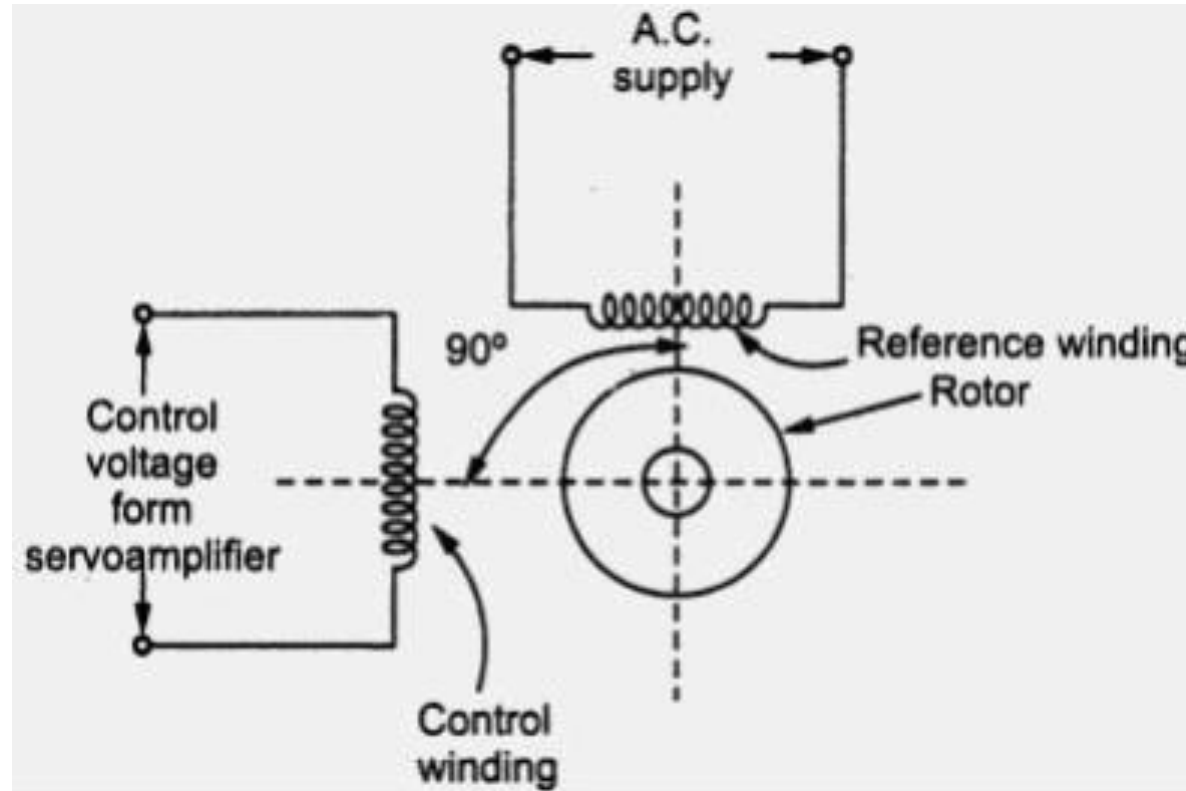
$W$  = Width of one pole pitch (m)

$f$  = Frequency of supply (Hz)

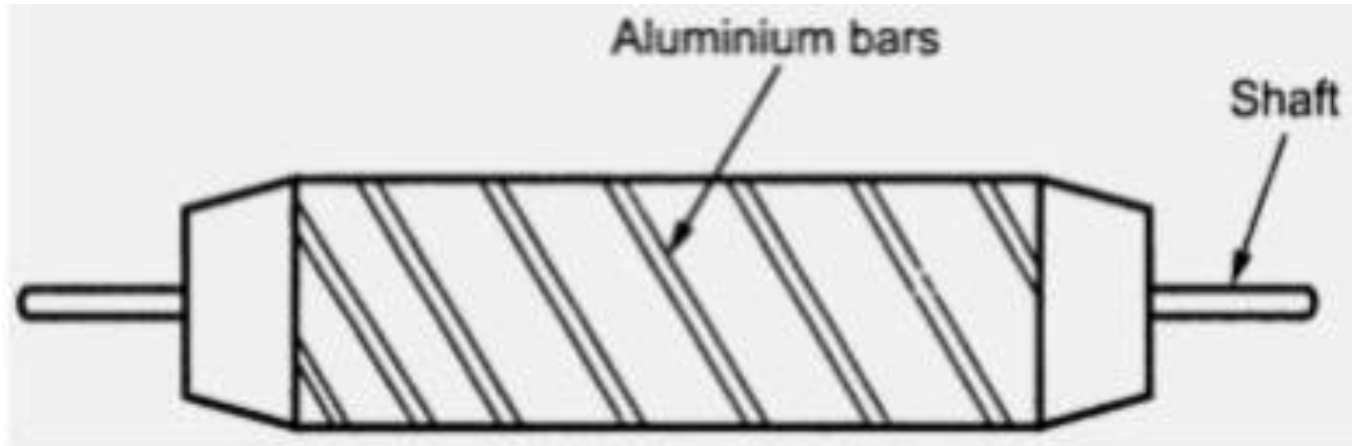
## V curves and Inverted V curves:



# Servomotor

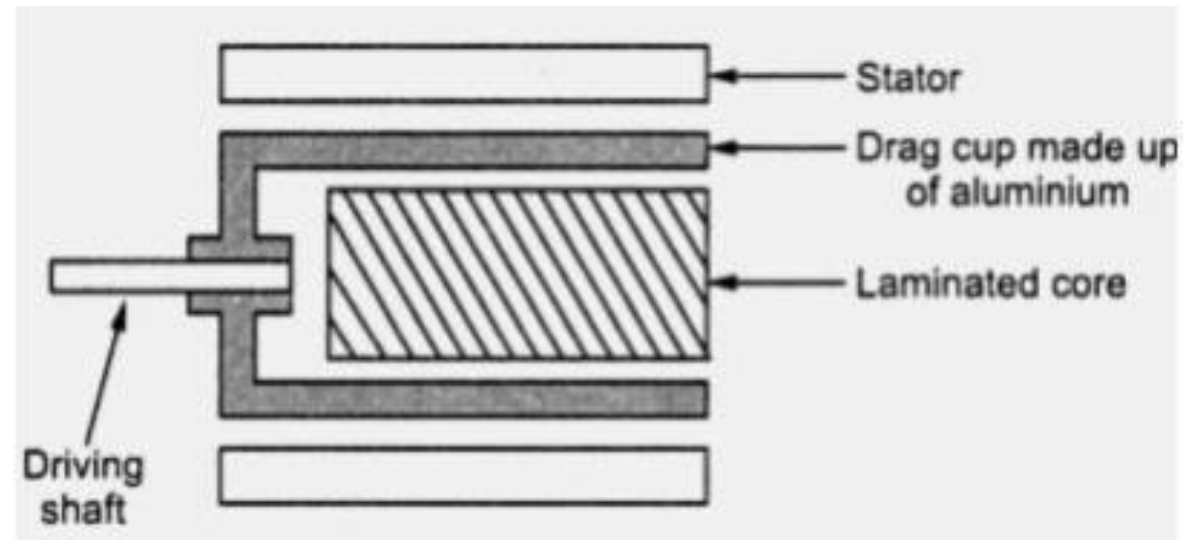


**Stator of a.c. servomotor**



**Cage-type rotor construction**

**Drag cup type rotor construction**

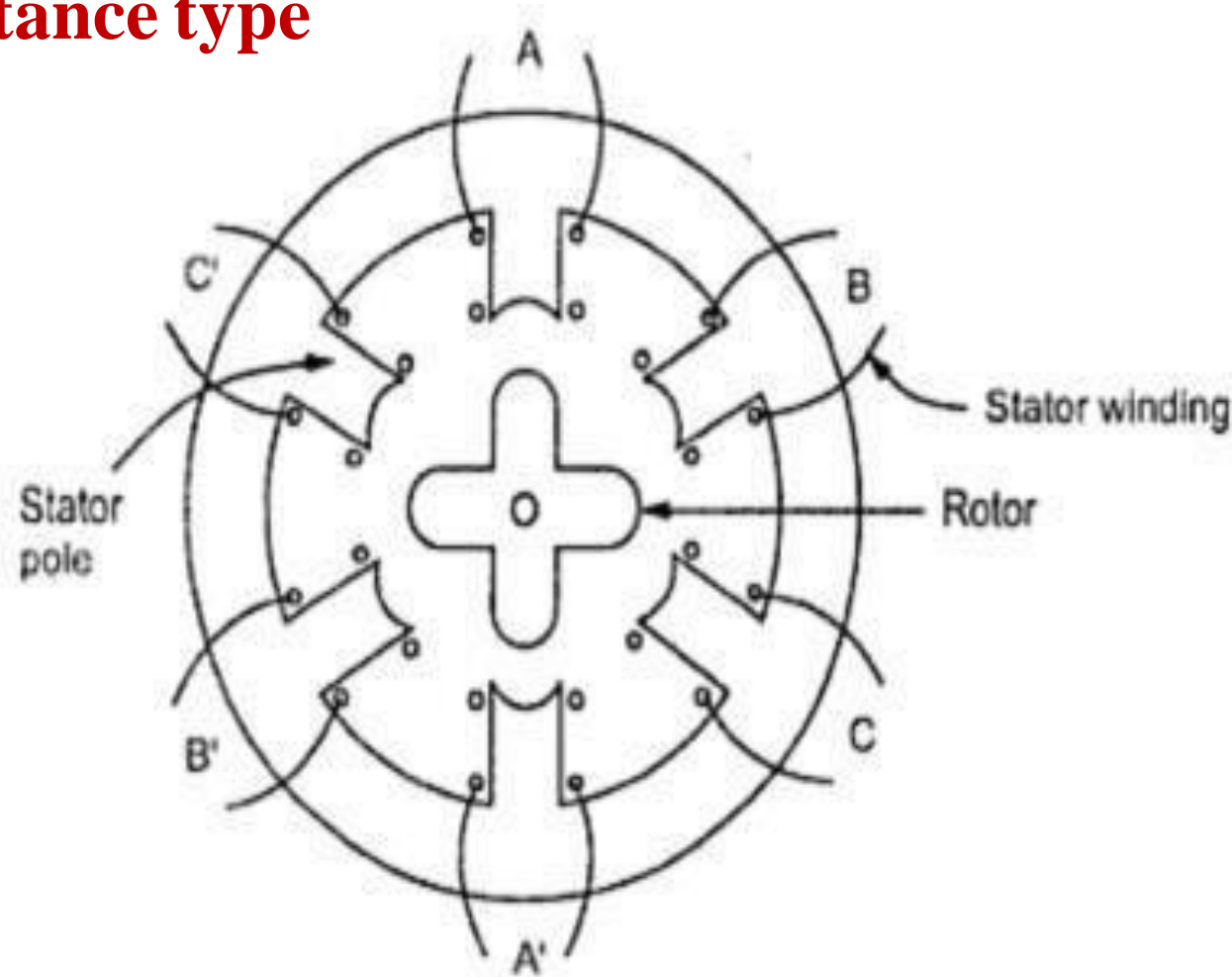


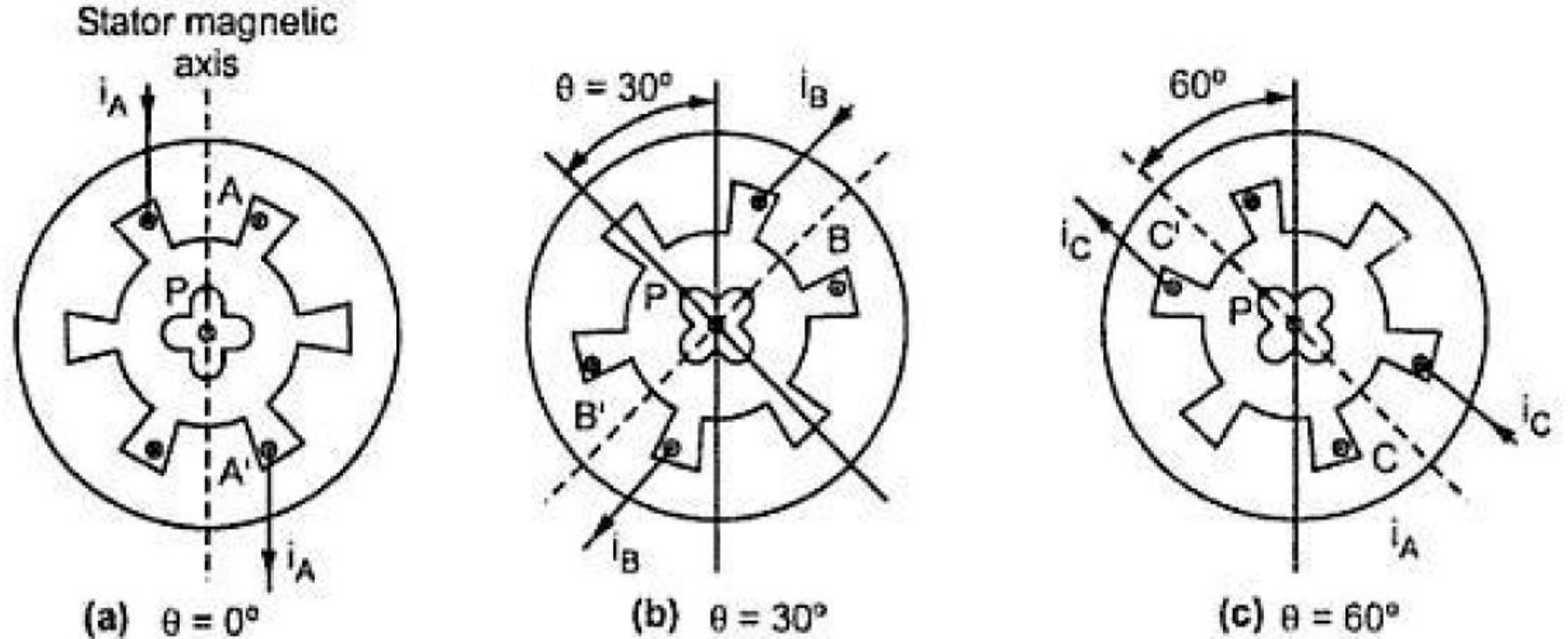
## Stepper Motors

- The stepper motor has a rotor movement in discrete steps. The angular rotation is determined by the number of pulses fed into the control circuit.
- There are three most popular types of rotor arrangements
  - Variable Reluctance (VR) types
  - Permanent magnet (PM) type
  - Hybrid type

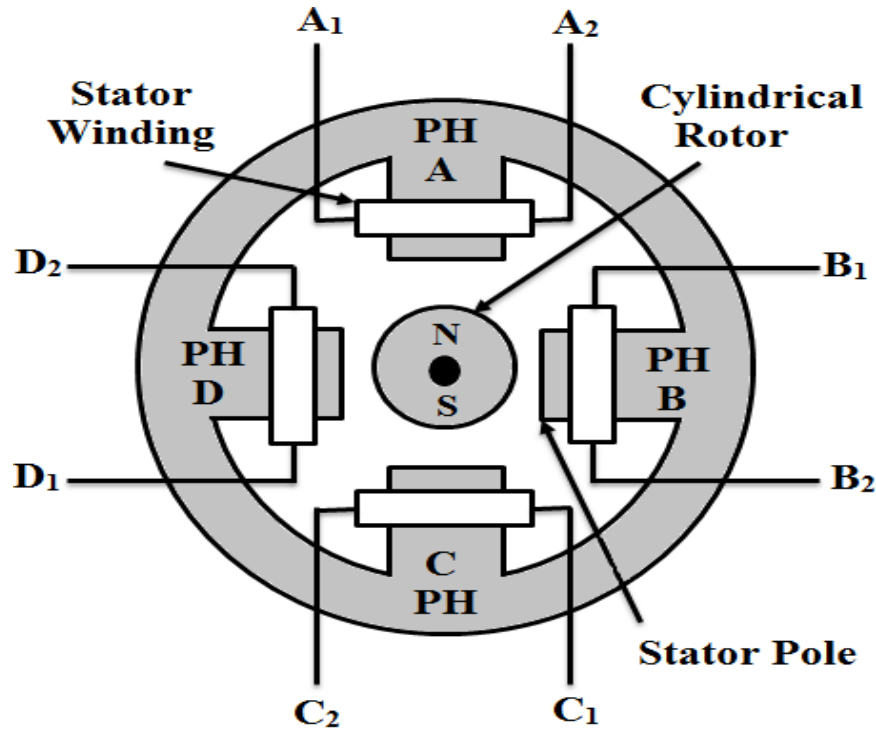


## Variable Reluctance type

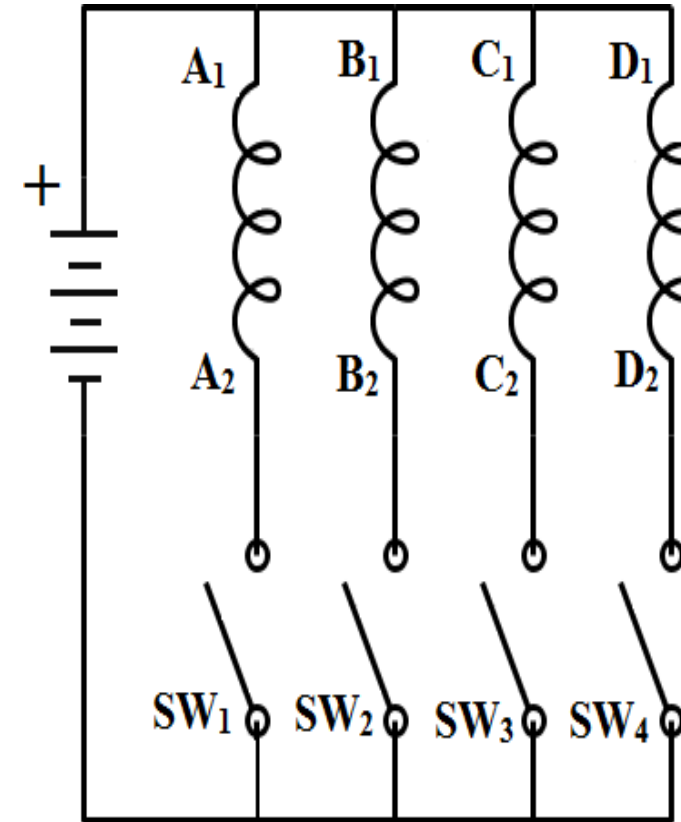




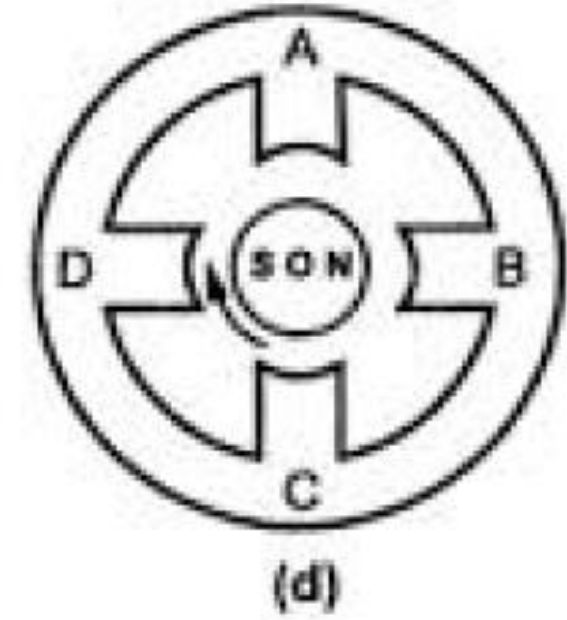
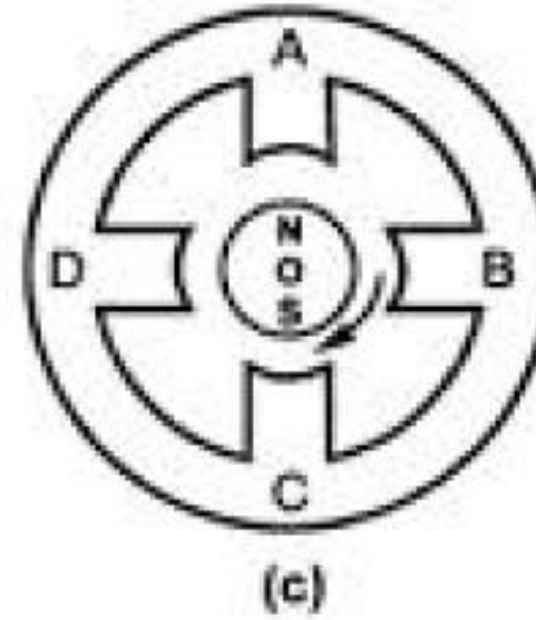
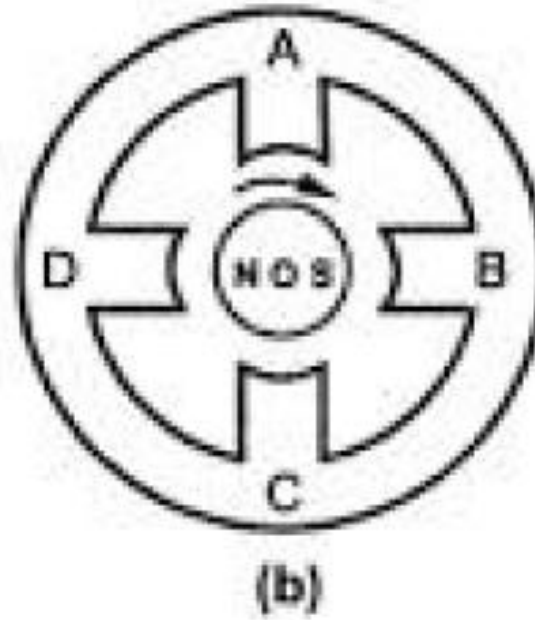
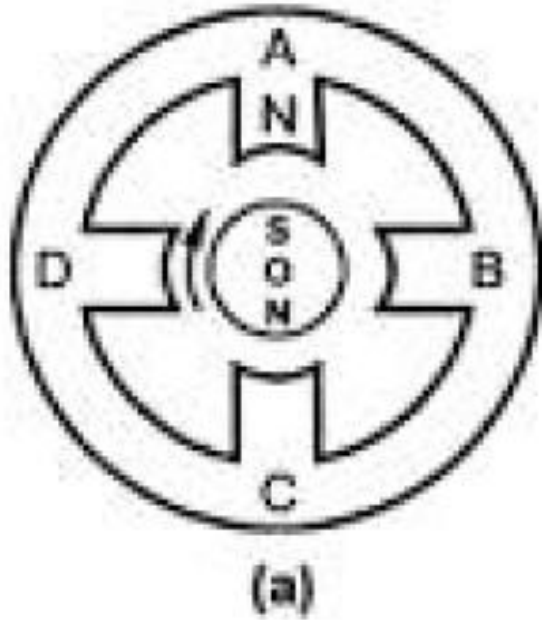
- Permanent magnet (PM) type



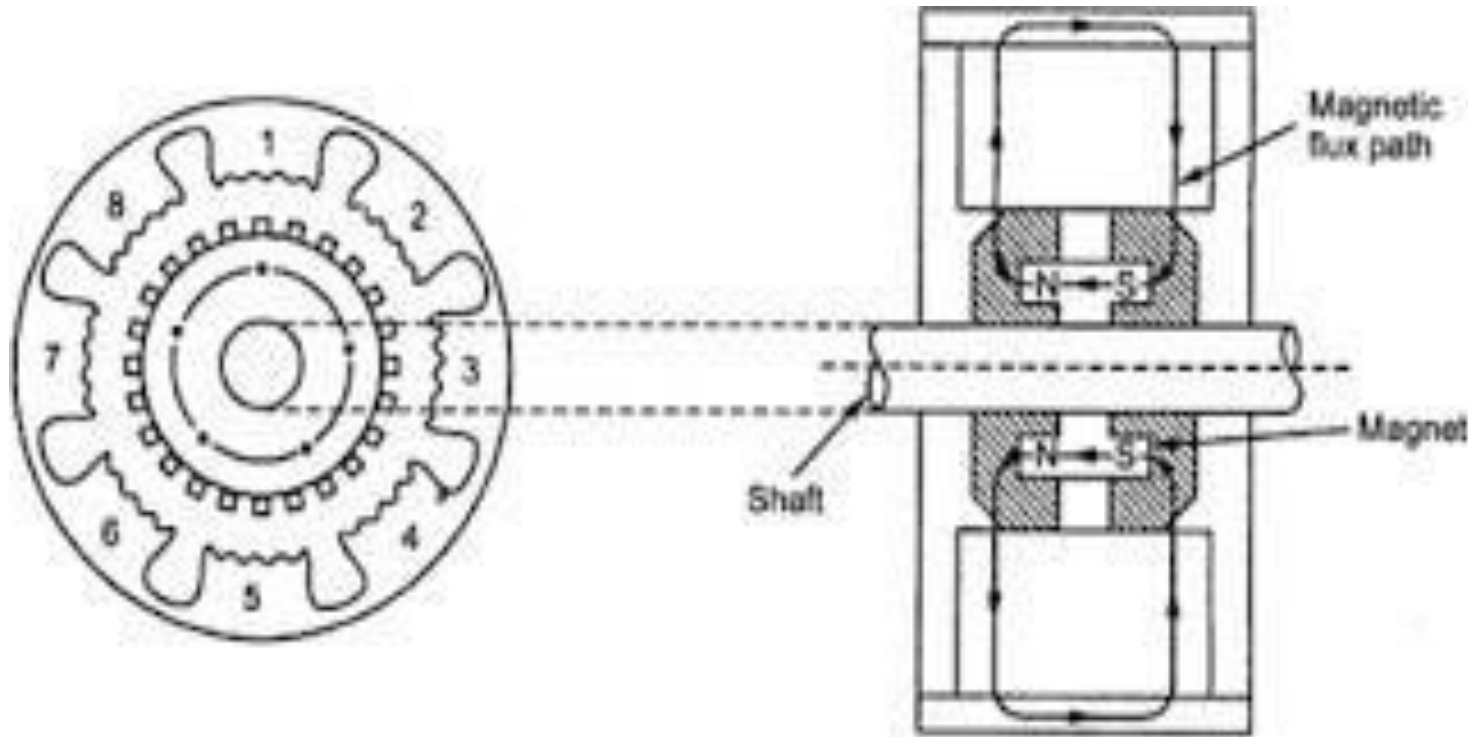
Four pole permanent magnet stepper motor



Basic drive circuit for permanent magnet 4 pole stepper motor



# Hybrid Stepper Motor





## Applications of Stepper Motors:

Due to the digital circuit compatibility of the stepper motors, they are widely used in computer peripherals such as serial printers, linear stepper motors to printers, tape drivers, floppy disc drivers, memory access mechanisms etc.

The stepper motors are also used in serial printers in typewriters or word processor systems, numerical control of machine tools, robotic control systems, a number of process control systems, actuators, spacecraft, watches, etc. X-Y recorders and plotters is another field in which stepper motors are preferred.

A decorative graphic on the left side of the slide, featuring a large orange curved shape and a yellow dashed line with a solid yellow circle at the bottom.

thank  
you

Department of Electrical and Electronics Engineering