Servomotor (Control Motors)

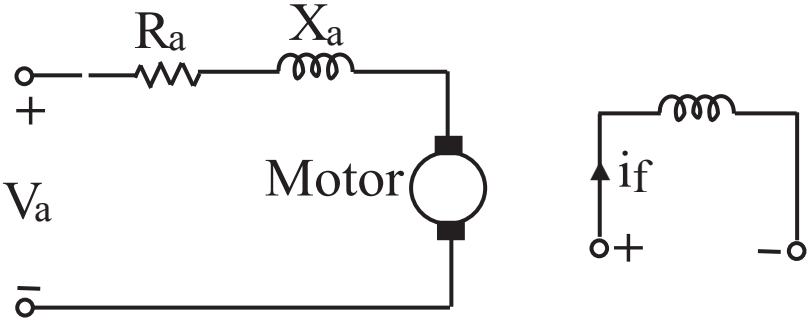
* Used in feedback control systems as output actuators.
* Not used for continuous energy conversion.
* The basic principle is same as that of other electromagnetic motors.
* Have low rotor inertia, high speed of response.
* The rotos of servomotors are designed with relatively long rotor length and smaller diameter.
* Generally operate at very low speed.
* Produces high torque at all speeds including zero speed.
* Accelerate and deaccelerate quickly.
* Withstand higher temperature at lower speeds or zero speed. Dissipation of heat is quick.

Applications :

Radars, computers, robots, machine tools, tracking.

DC Servomotors

* The armature has a large resistance so that the torque-speed characteristic is linear and has a large negative slope.
* A step change in the armature voltage or current produces a quick change in the position or speed of the rotor.
* Most high-power servomotors are dc servomotors.



(a)

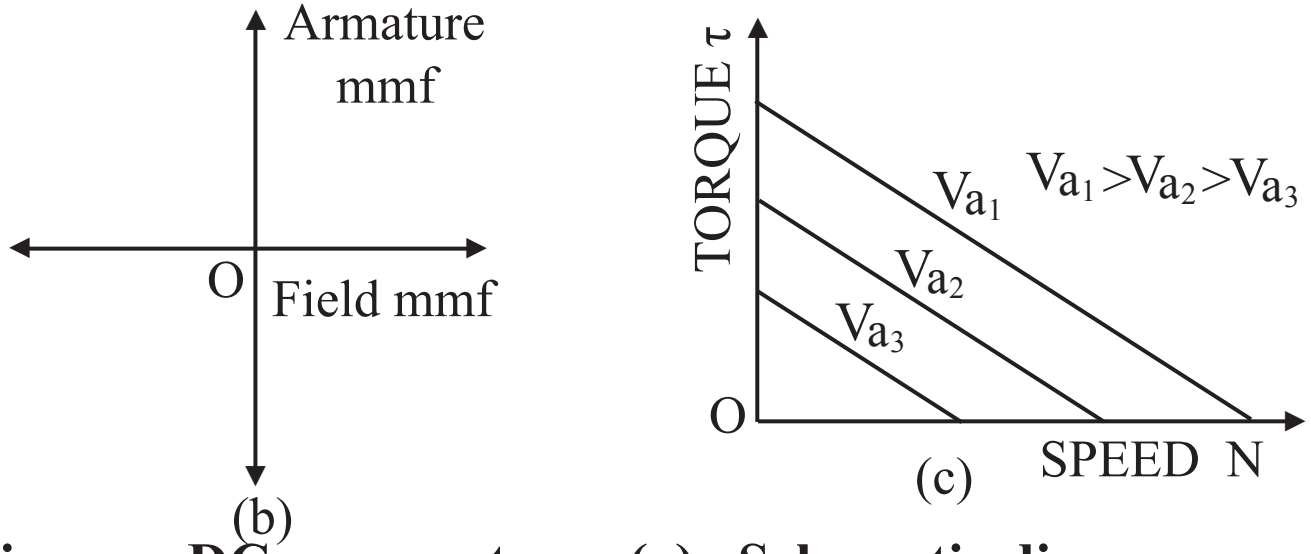


Figure : DC servometer (a) Schematic diagram
(b) Armature mmf and field mmf
(c) Torque-speed characteristics

* **AC Servomotors**

* **Two-phase AC servomotors**

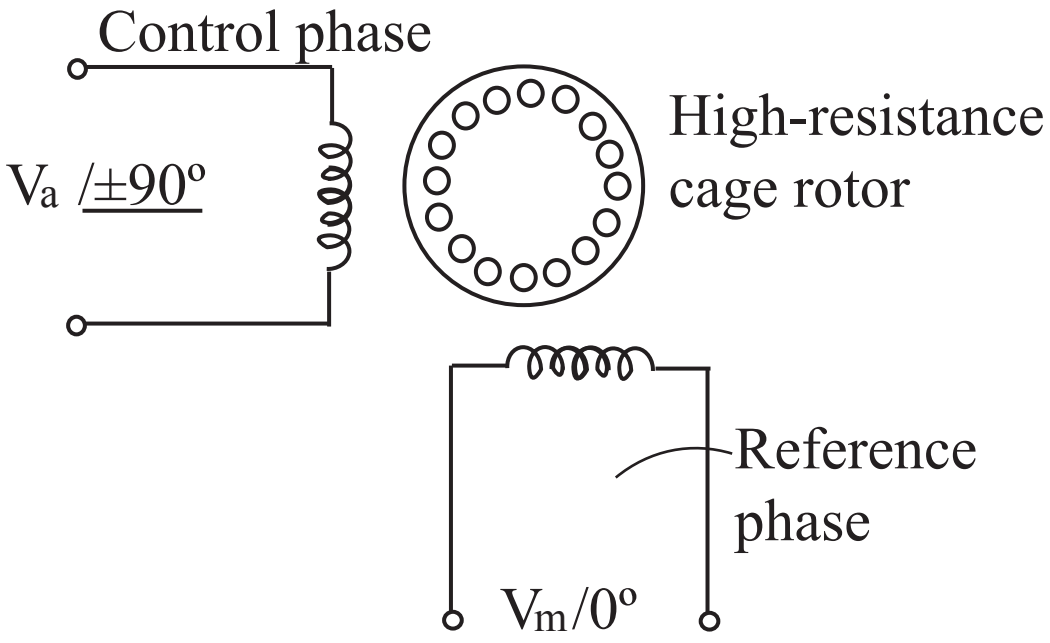


Figure : Schematic diagram of two-phase AC servomotors

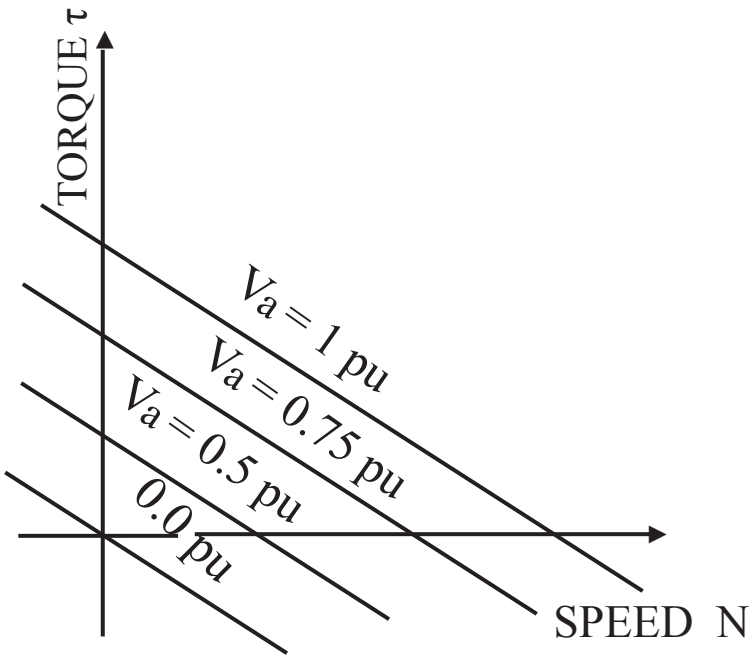


Figure : Torque-speed characteristics

The stator has two distributed windings which are displaced from each other by 90 electrical degrees. A high rotor resistance keeps a negative slope for the torque-speed characteristics over its entire operating range.

* **Three-phase AC servomotors**

It is normally, a highly nonlinear coupled circuit device. Using vector control/field-oriented control, it can be used as a linear decoupled machine.

The current in the machine are controlled in such a way that its torque and flux becomes decoupled as in dc machine

Linear Induction Motor (LIM)

A linear induction motor (LIM) is a motor which gives linear or translational motion instead of rotational motion as in the case of a conventional induction motor.

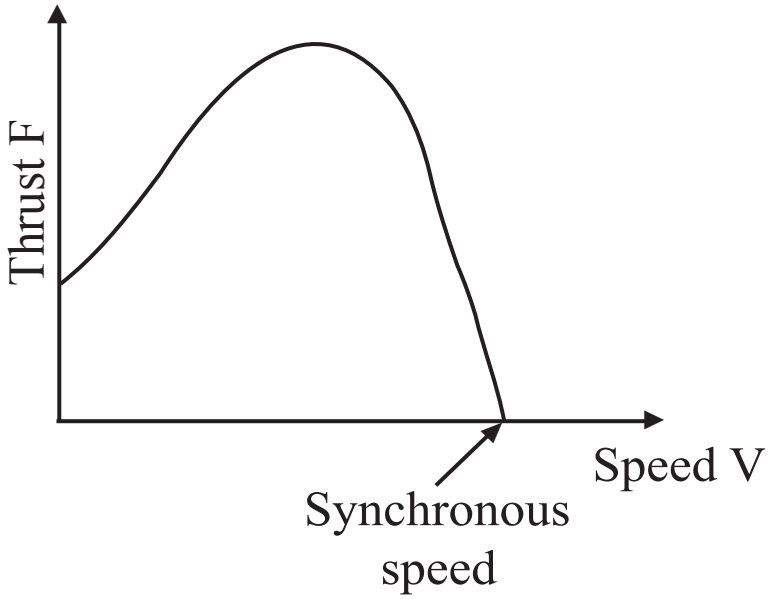


Figure : Thrust-speed curve of a linear induction motor

Linear synchronous speed, $V_s = 2f(\text{pole pitch})\text{m/s}$

Thrust or linear force,

$$F = \frac{\text{air gap power}}{\text{linear synchronous velocity, } v_s}$$

Stepper (or Stepping) Motors

* Stepper motor is a brushless electric motor, having a rotor movement in discrete steps. It divide a full rotation is determined by the number of pulses fed into the control circuit. Each input pulse initiates the drive circuit which produces one step of angular movement.
* Types of rotor arrangements :
  (a) Variable reluctance (VR) type
  (b) Permanent magnet (PM) type
  (c) Hybrid type (combination of VR and PM)

Advantages : Small stp length, greaeter torque per unit volume, less tendency to resonate, high efficiency at lower speeds and lower stepping rates, provides detent torque with winding de-energized.

Disadvantages : Costly, performance is affected by change in magnetic strength, higher inertia and weight due to presence of rotor magnet.

* Resolution of a motor $= \frac{\text{number of steps}}{\text{number of revolutions of the rotor}}$

* The angle by which the rotor of a stepper motor moves when one pulse is applies to the (input) stator is called step angle.
* A standard motor will have a step angle of 1.8° with 200 steps per revolution.

Reluctance Motors

. The rotor of a reluctance motor is basically a squirrel cage with some rotor teeth removed at the appropriate places such as to provide the desired number of salient rotor poles.

. The stator has the main winding and an auxiliary (starting) winding.

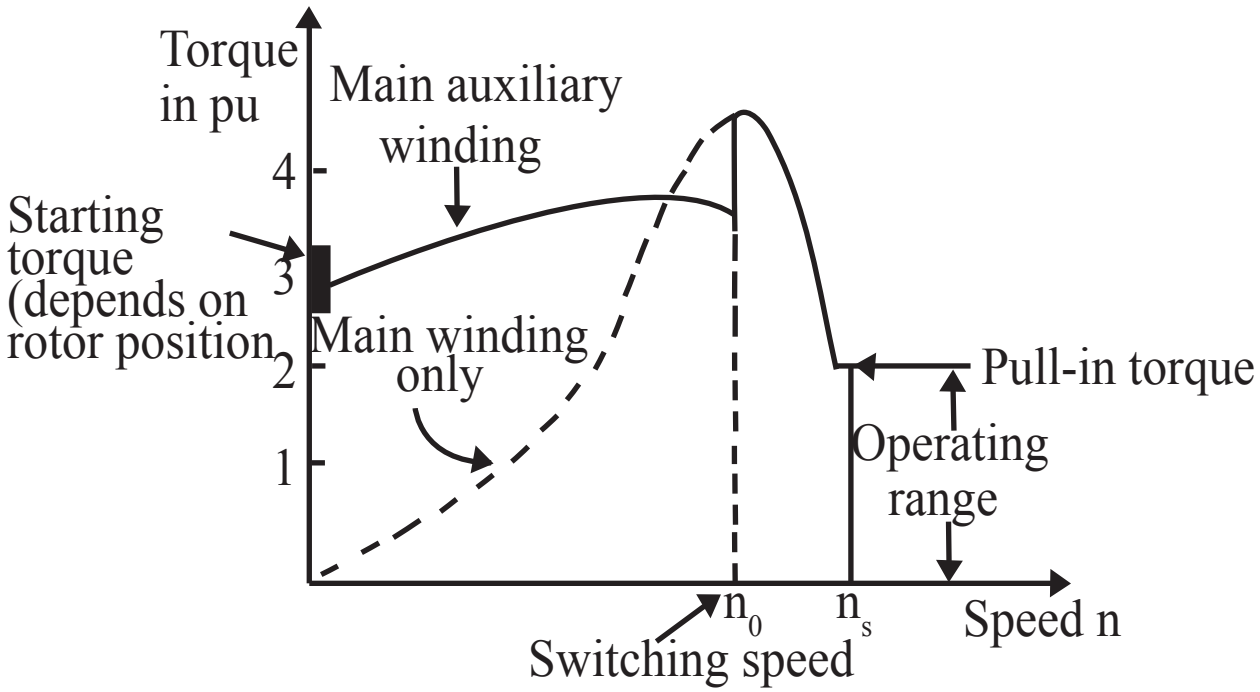


Figure: Torque-speed characteristic of reluctance motor

* Starting torque is dependent upon rotor position because of the salient pole rotor. The value of the starting torque is between 300 to 400 percent of its full-load torque.
* The rotor is unexcited and has sliency, the power factor is lower than that of the equivalent induction motor.
* The main advantages of a reluctance motor are its simple construction (no slip rings, no brushes, no dc field winding), low cost and easy maintenance.
* Used for many constant-speed applications such as electric clocks times, signalling devices, recording instruments and phonographs etc.

Hysteresis Motors

* Basically a synchronous motor with uniform air gap and without d.c. excitation.
* Torque is produced due to hysteresis and eddy current induced in the rotor by the action of the rotating flux of the stator windings.
* Very low noise level, operates at one speed, rotor is smooth (unslotted).
* Applications : Electric clocks and other timing devices.