SNS COLLEGE OF TECHNOLOGY

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Coimbatore-641035

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

19EET301 / POWER ELECTRONICS AND DRIVES

III YEAR / V SEMESTER

UNIT – V : AC DRIVES

SYNCHRONOUS MOTOR DRIVE – Open Loop Control

TOPIC OUTLINE

What we'll discuss?

Permanent magnet classification

VSI fed syn. Motor drive

Control modes

1. Open loop mode

Speed torque characteristics in OLM

Recap

PERMANENT MAGNET CLASSIFICATION

1. **Permanent Magnet Synchronous Machine**
2. **Brush Less DC Machine**

Parameters	PMSM	BLDC
Flux Density	Sinusoidal distribution	Square distribution
Back EMF	Sinusoidal wave	Trapezoidal wave
Stator Current	Sinusoidal wave	Square wave
Torque	Constant	Constant
Power	Constant	Constant

VOLTAGE SOURCE INVERTER FED SYNCHRONOUS MOTOR

Three combinations in VSI fed drive:

- Square wave inverter
- PWM inverter
- Chopper with square wave inverter

Same as Induction motor drive…. as V/f control

CONTROL MODES

Frequency control (V/f) by inverter or cyclo converter.

- **Two control modes:**

1.Open loop mode.

The motor speed is controlled by the independent frequency control of the converter.

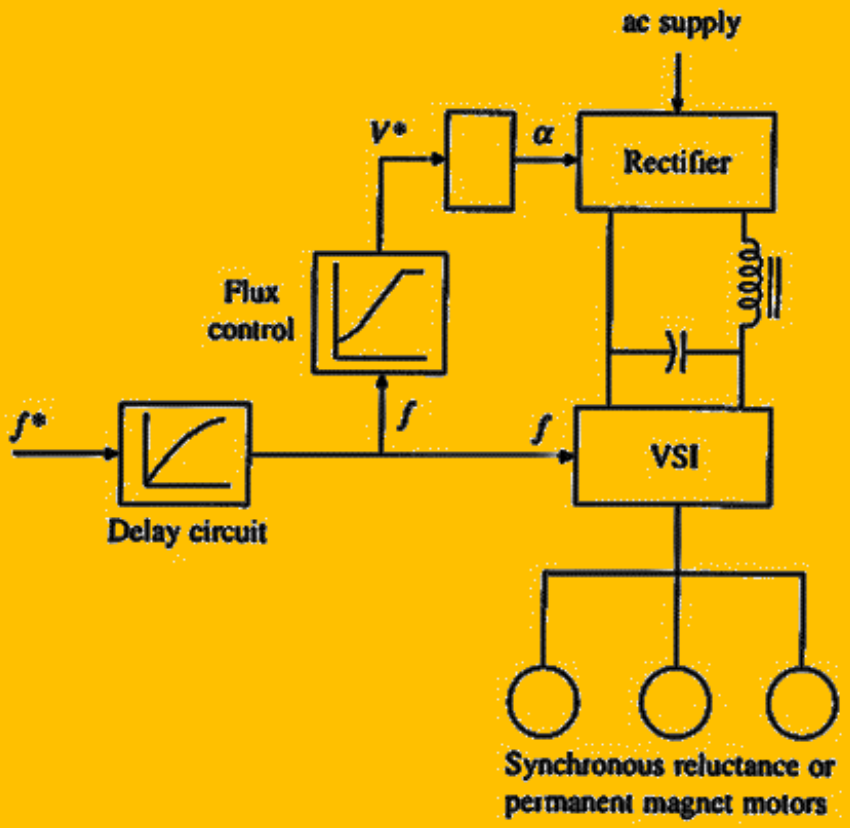
2. Self control mode.

The variable frequency converter control pulses are derived from an absolute rotor position encoder mounted on the machine shaft.

1.OPEN LOOP V/F MODE

- Scalar control method of synchronous machine.
- This speed control method is used in multiple synchronous reluctance motor or PM machine drives.
- Close speed tracking is essential among a number of machines.
- **Application :** Fibre spinning mill.

OPEN LOOP V/F MODE

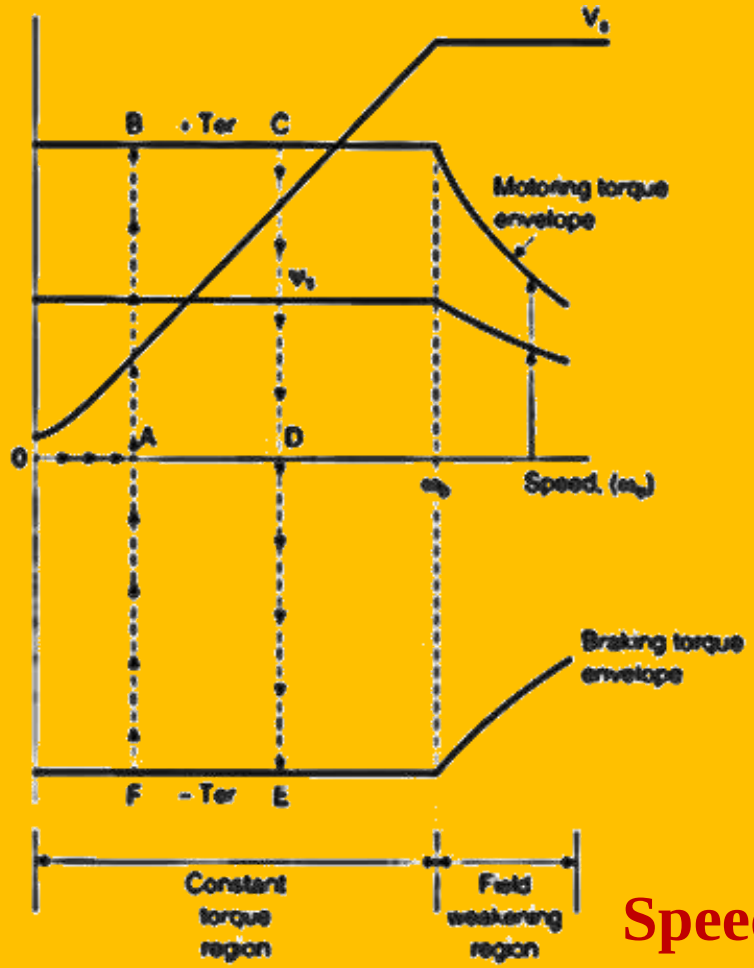


- Machines are connected in parallel to the same inverter.
- They move in synchronism corresponding to the command frequency ωe* at the input.
- The phase voltage Vs* is generated through a FG.

  where F∝V, Ψs is constant.
- Oscillatory or underdamping behaviour during the transient response is prevented using damper or cage winding.

Block diagram of SM drive (OLM)

V/F SPEED CONTROL CHARACTERISTICS



- Motoring mode and braking mode-forward direction.

$$T_e = 3\left(\frac{P}{2}\right)\frac{\Psi_s \Psi_f}{L_s}\sin\delta$$

$$T_e = 3\left(\frac{P}{2}\right)\Psi_s \cos\emptyset$$

- Where δ=torque angle,

  is the in-phase component of the stator current.

$$I_T = I_s \cos\emptyset$$

Speed torque characteristics

V/F SPEED CONTROL CHARACTERISTICS

- With constant Ψ_s the angle and stator current I_s will increase gradually until the rated torque is reached at point B.

- The operating point can be changed from B to C by slowly increasing the frequency. It is brought back to point D by gradually decreasing T_1

- Beyond D point the machine will enter into field weakening mode. Thus the available torque will decrease due to Ψ_s

$$J\left(\frac{2}{p}\right) d\omega_e / dt = T_e - T_L$$

where

- J = moment of inertia.,
- ω_e = p/2
  = synchronous (e) speed (r/s).
- P = number of poles,and
- ω_m = mechanical speed (r/s)