RAMA UNIVERSITY

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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-ii

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STATOR VOLTAGE CONTROL

- Synchronous speed $N_s = \frac{120f}{P}$

- **Slip = $\frac{Ns - N}{Ns}$**

- **Torque =** $$T = \frac{3}{2\pi N_s} X \frac{E_2^2 R_2}{R_2^2 + X_2^2}$$

  - Where E_2 is the rotor emf
  - N_s is the synchronous speed
  - R_2 is the rotor resistance
  - X_2 is the rotor inductive reactance
  - Rotor resistance R_2 is constant and if slip s is small then sX_2 is so small that it can be neglected. Therefore, $T \propto sE_2^2$ where E_2 is rotor induced emf and $E_2 \propto V$

  And hence $T \propto V^2$, thus if supplied voltage is decreased, torque decreases and hence the speed decreases.

  - This method is the easiest and cheapest, still rarely used because- A large change in supply voltage is required for relatively small change in speed.
  - Large change in supply voltage will result in large change in flux density, hence disturbing the magnetic conditions of the motor.

- Given a load T–ω characteristic, the steady-state speed can be changed by altering the T–ω curve of the motor

$$T_e = \frac{3R_r^{'}}{s\omega_s} \frac{V_s^{\,2}}{\left[\left(R_s + \frac{R_r^{'}}{s}\right)^2 + \left(X_{ls} + X_{lr}\right)^2\right]}$$

$$\omega_s = \frac{2}{P}\omega = \frac{4}{P}\pi f$$

2. Varying voltage (amplitude)
3. Varying line frequency
1. Pole Changing

a) By changing the applied voltage:

Torque equation of induction motor is

$$T = \frac{k_1 s E_2^2 R_2}{\sqrt{(R_2^2 + (sX_2)^2)}} = \frac{3}{2\pi Ns} \frac{sE_2^2 R_2}{\sqrt{(R_2^2 + (sX_2)^2)}}$$

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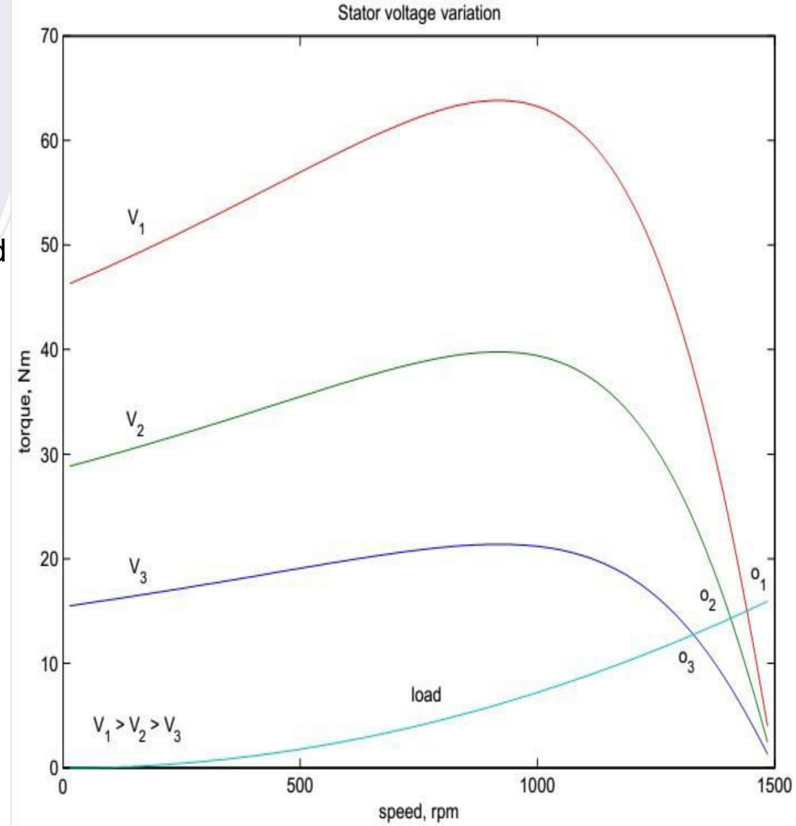

Variable Frequency Control of IM (v/f control)

- Speed control **above rated (base) speed**
  - Requires the use of PWM inverters to control frequency of motor
  - Frequency increased (i.e. ω_s increased)
  - Stator voltage held constant at rated value
  - Air gap flux and rotor current decreases
  - Developed torque decreases

$T_e \propto (1/\omega_s)$

- For control below base speed –

use Constant

Volts/Hz method