SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EC309 ELECTRICAL MACHINES AND POWER SYSTEMS

II YEAR / 03 SEMESTER MECH & MCT

Unit 3 – INDUCTION MOTORS

Speed Control of Induction Motor

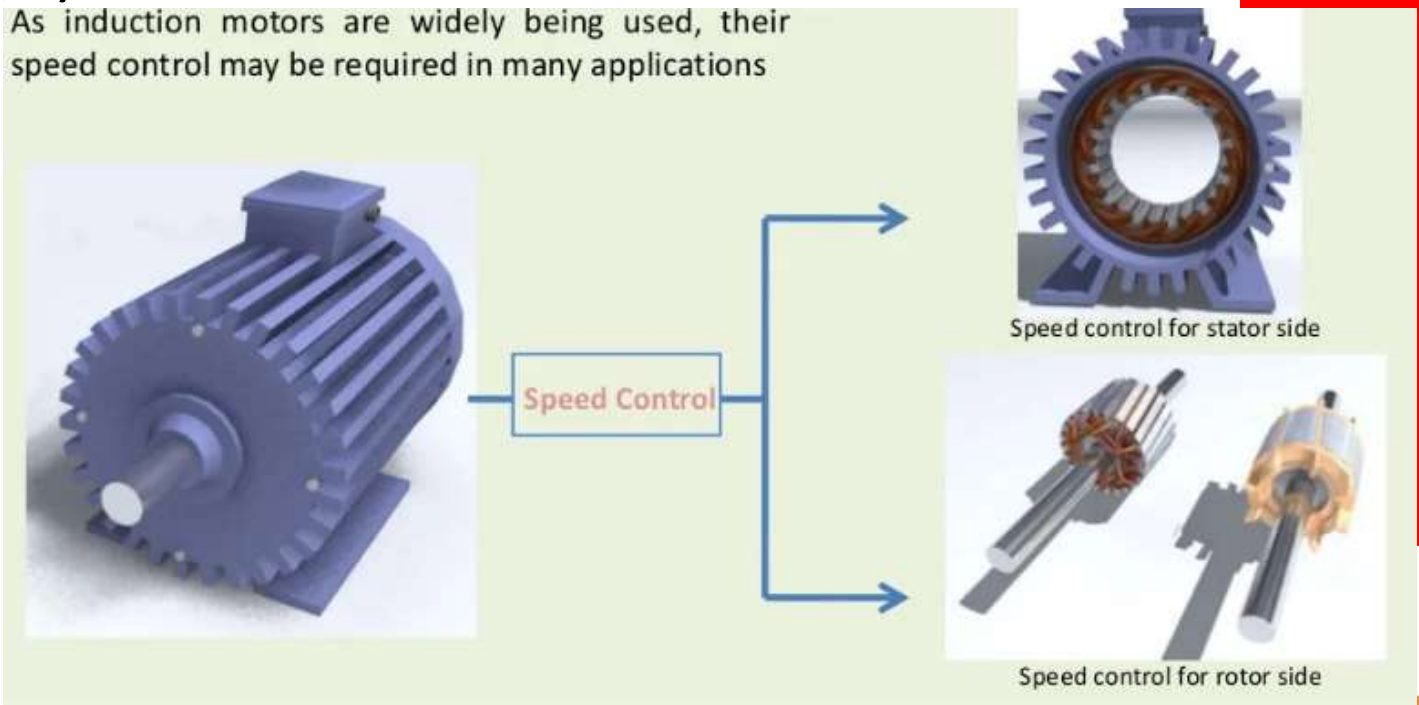
Speed Control of Induction Motor

For Squirrel Cage Induction Motor:

- ✓Stator Voltage Control
- ✓Stator Frequency Control
- ✓Stator Voltage / Frequency (V/f) control
- ✓Pole Changing Method

For Slip ring Induction Motor:

- ✓Rotor Resistance Control
- ✓Cascade Control
- ✓Slip-power Recovery Scheme



Stator Voltage Control

- By Changing The Applied Voltage

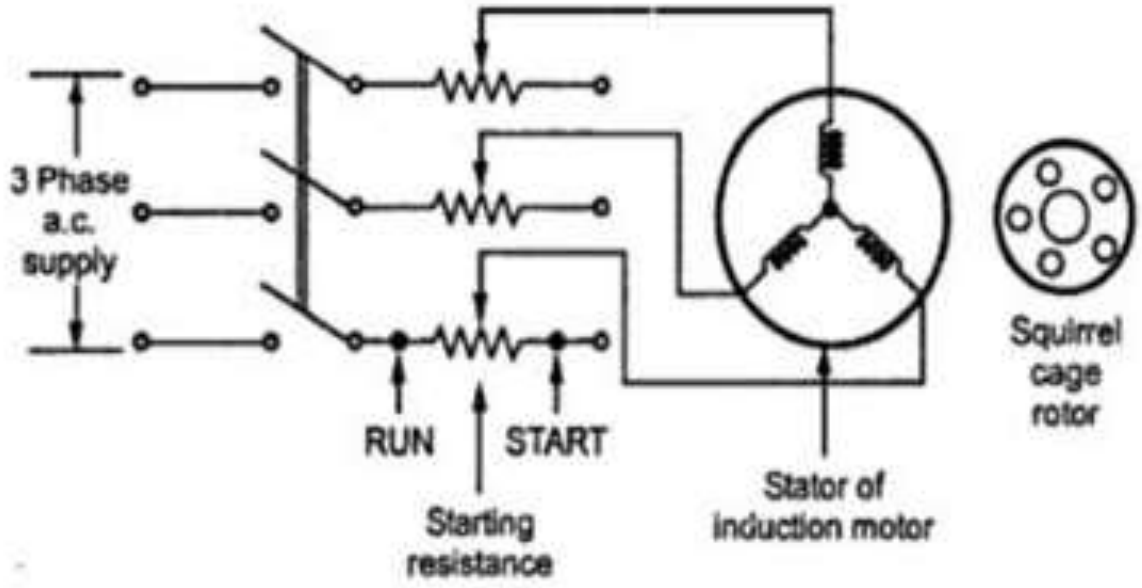
$$T = \frac{k_1 s E_2^2 R_2}{\sqrt{(R_2^2 + (s X_2)^2)}} = \frac{3}{2\pi N_s} \frac{s E_2^2 R_2}{\sqrt{(R_2^2 + (s X_2)^2)}}$$

$T \propto sE_2^2$ $\quad E_2 \propto V$ $\quad T \propto sV^2,$

- Applied voltage can be varied by using a three phase auto transformer
- Auto transformer also helps in safe starting

By Changing The Applied Voltage

- Applied voltage can be varied by using a Rheostat in each input line conductor
- Also helps in safe starting of motor
- Very inefficient method



Stator Frequency Control & V/f Control

In three phase induction motor emf is induced by induction similar to that of transformer which is given by

$$E \text{ or } V = 4.44\phi K.T.f \text{ or } \phi = \frac{V}{4.44KTf}$$

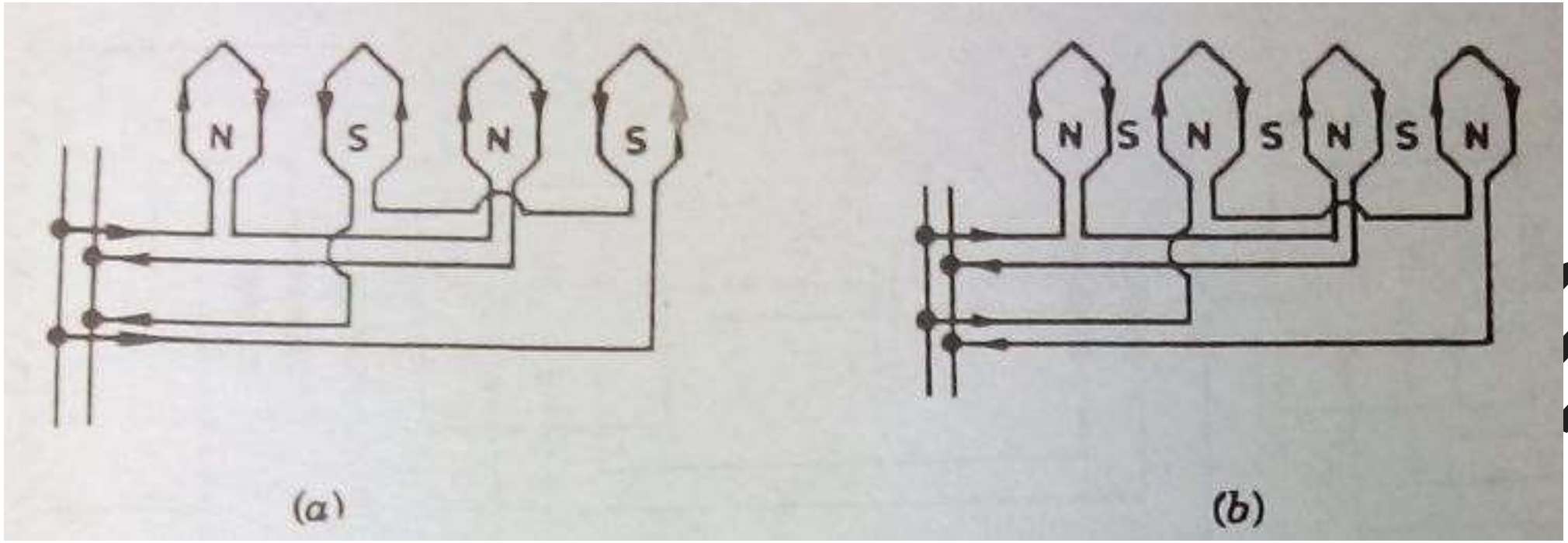
- By Changing The Applied Frequency

$$Ns = \frac{120\,f}{P} \quad (RPM)$$

- **Constant V/F Control**
  Frequency of applied voltage cannot be varied alone otherwise it will change the flux density in the core and lead to the wastage of energy. Voltage is varied inversely to the frequency so that flux density in the motor core remain maintained and the magnetic material of the motor get fully utilized.

Pole Changing Method

- The Synchronous speed = 120f / P
- If P=4, Ns = (120*50) / 4 = 1500 rpm
- If P=8, Ns = (120*50) / 8 = 750 rpm

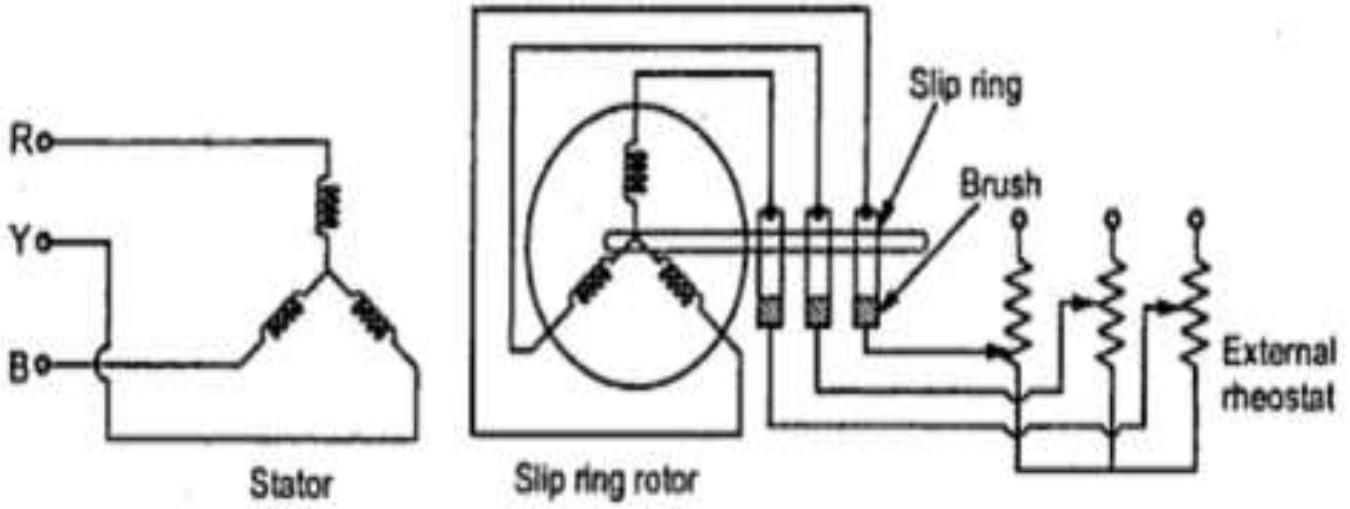


Rotor Resistance Control / Adding external resistance on rotor side

- In this method of speed control of three phase induction motor external resistance are added on rotor side. The equation of torque for three phase induction motor is $T \propto \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$

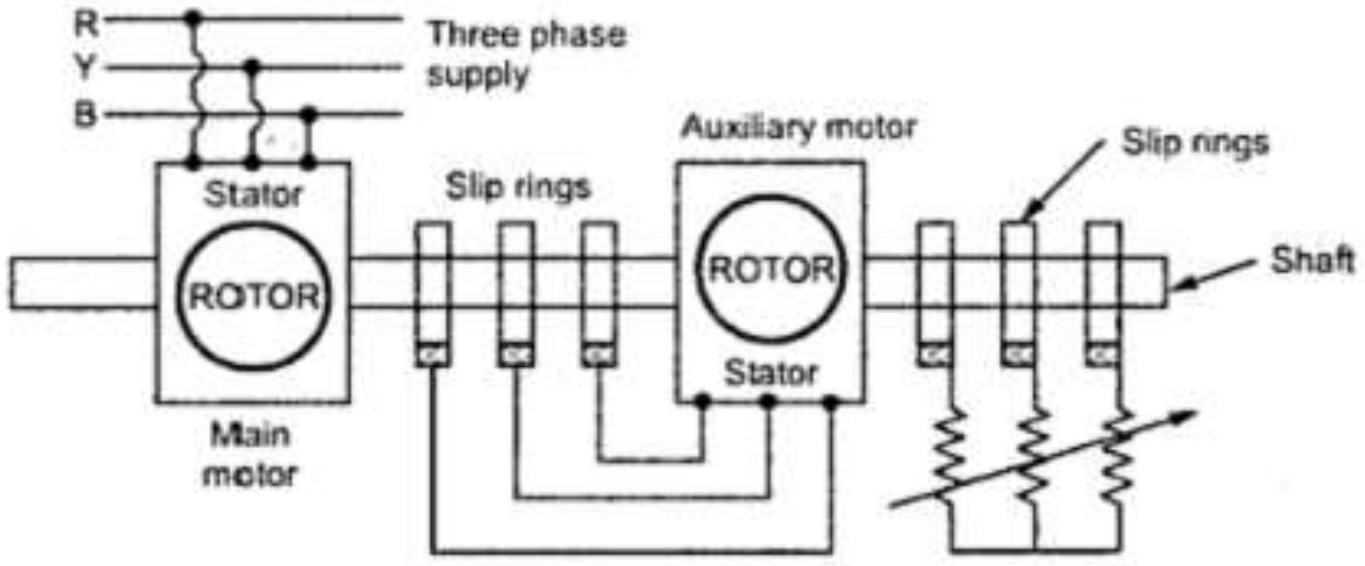
The three-phase induction motor operates in a low slip region. In low slip region term $(sX)^2$ becomes very very small as compared to R_2. So, it can be neglected. and also E_2 is constant. So the equation of torque after simplification becomes,

$$T \propto \frac{s}{R_2}$$



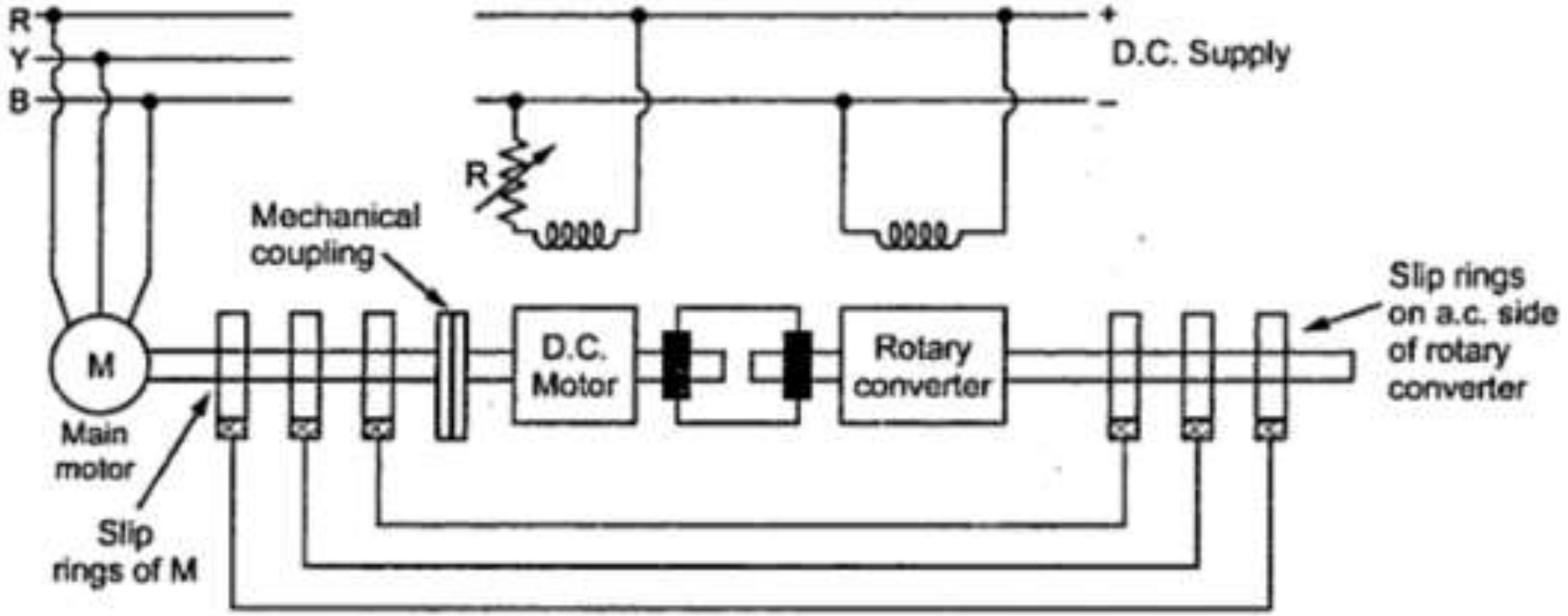
Cascade Control

- When only main induction motor work, having speed corresponds to, Ns1 = 120f/P1
- When only auxiliary induction motor work, having speed corresponds to, Ns2 = 120f/P2
- When cumulative cascading is done, then the complete set runs at a speed of N=120f(P1+P2)
- When differential cascading is done, then the complete set runs at a speed of, N=120f(P1-P2)



Slip Power Recovery Scheme

Kramer System:



Scherbius System: