Special Electrical Machines

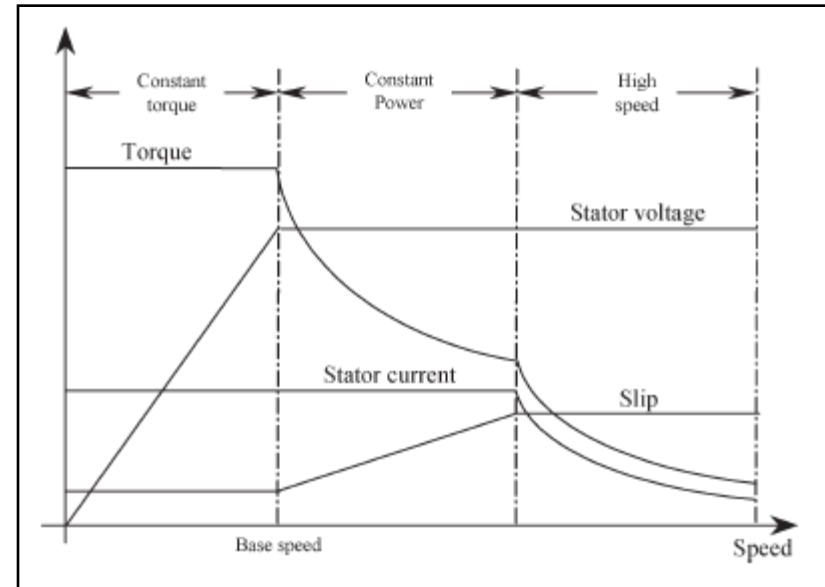# The Slip

Slip = (Ns-N)/Ns

Where *s* is the *slip*. Slip is one of the most important variables in the control and operation of induction machines.

$s = 0$: if the rotor runs at synchronous speed

$s = 1$: if the rotor is stationary

s is −ve   : if the rotor runs at a speed above the synchronous speed

s is +ve   : if the rotor runs at a speed below the synchronous speed

Frequency

- The frequency of the voltage induced in the rotor is given by

$$f_r = \frac{P \times n}{120}$$

Where f_r = the rotor current frequency (Hz)
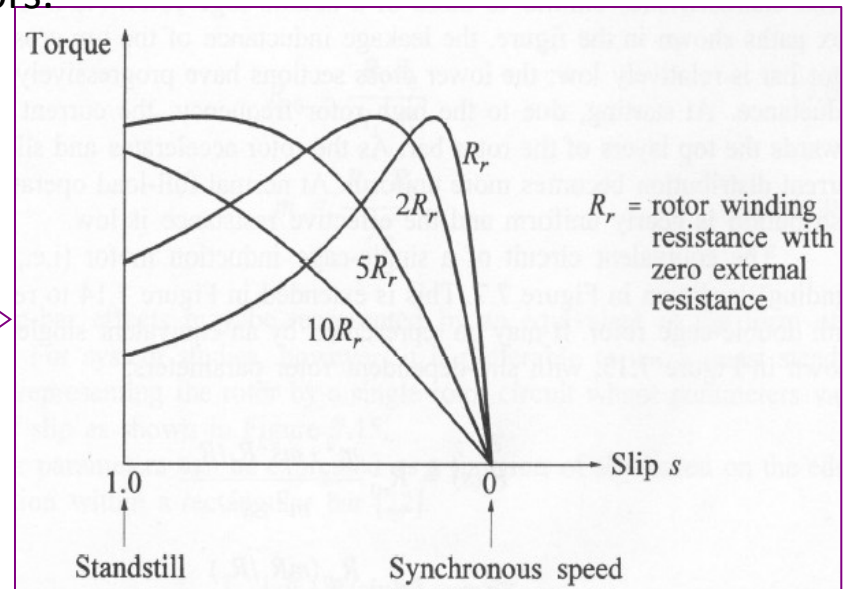
P = number of stator poles

n = slip speed (rpm)

$$f_r = \frac{P \times (n_s - n_m)}{120}$$

$$= \frac{P \times s n_s}{120} = s f_e$$

Alternative Rotor Constructions

- High efficiency at normal operating conditions requires a low rotor resistance.

- On the other hand, a high rotor resistance is required to produce a high starting torque and to keep the magnitude of the starting current low and the power factor high.

- The wound rotor is one way of meeting the above mentioned need for varying the rotor resistance at different operating conditions. Wound-rotor motors are, however, more expensive than squirrel-cage motors.

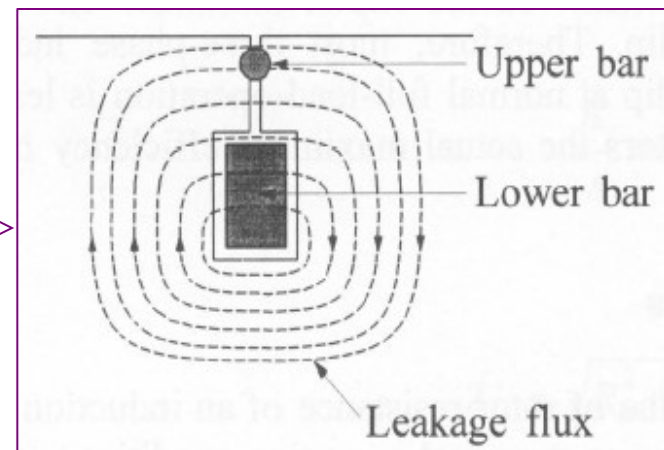Effect of the rotor resistance the torque-slip curves.

Torque

R_r

$2R_r$ R_r = rotor winding resistance with zero external resistance

$5R_r$

$10R_r$

1.0   0   Slip s

Standstill   Synchronous speed

Torque Produced

$$Torque = \frac{k\, s\, R_2\, E_2^2}{R_2^2 + (s\, X_2)^2}$$

Double Cage Squirrel-Cage Rotor Construction

- Following double squirrel-cage arrangements can also be used to obtained a high value of effective resistance at starting and a low value of the resistance at full-load operation.

- It consists of two layers of bars, both short-circuited by end rings.

- The upper bars are small in cross-section and have a high resistance.

- They are placed near the rotor surface so that the leakage flux sees a path of high reluctance; consequently, they have a low leakage inductance.

- The lower bars have a large cross-section, a lower resistance and a high leakage inductance. Permeability of upper cage is low so most of flux lies around inner cage, little flux around outer cage. Permeability is reciprocal of Conductivity.

Double squirrel-cage rotor bars

THANKS....

Queries Please...