## Calculation of Step Angle (Stepper motor) →

$$\beta = \frac{N_S - N_R}{N_S N_R} \times 360^\circ$$

$N_R$ = Rotor Poles (teeth)

$N_S$ = Stator " ( " )

$\beta$ = Step Angle.

$$\text{Resolution} = \frac{360^\circ}{\text{Step Angle}} = \frac{\text{No. of steps}}{\text{revolution}}$$

30.1, 392 → Book (Theresa → Page-1537)

A hybrid VR stepping motor has 8 main poles which have been cartleated to have 5 teeth each. If the rotor has 50 teeth. Calculate the stepping Angle and Resolution.

Here,

$N_R$ = 50 teeth (poles)

$N_S$ = $(8 \times 5) = 40$ " "

$$\therefore \beta = \frac{40 - 50}{40 \times 50} \times 360^\circ$$

$$= -1.8^\circ$$

$$\therefore \text{Resolution} = \frac{360^\circ}{-1.8^\circ}$$

$$= -200 \text{ steps/revolution.}$$

(Theraja → 1283 page)

The power input of the stator of 440V, 50Hz, 6 pole, 3-phase, induction motor is 80 kW. The rotor emf is observed to make 100 complete alternation per minute. Calculate →

i) slip ii) the rotor speed iii) rotor cu (copper losses per phase)

i)

Here,

$$\text{Pole} = 6 \; ; \; f = 50\,\text{Hz}$$

$\therefore$ Slip, $f' = sf$

Rotor 100 complete alternation mean rotor frequency $(f') = \frac{100}{60}$ cycle/s $= 1.6667\,\text{Hz}$

$$\therefore \quad s = \frac{f'}{f} = \frac{1.6667\,\text{Hz}}{50\,\text{Hz}} = 0.333 = 3.33\%$$

ii)

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{6} = 1000\ \text{rpm}$$

Motor speed, $N = (1 - s)\,N_s$

$= (1 - 0.333)\,1000 = 966.67\ \text{rpm}$

iii) we know,

rotor cu losses = $s \times$ rotor inpd (single phase)

$\therefore$ " " " per phase $= \frac{s \times \text{rotor input}}{3}$

Here, rotor input power = 80 kW.

$\therefore$ rotor cu loss per phase $= \frac{1}{3}(0.333 \times 80)$

$= 0.8888\,\text{kW}$

Ex → 6.1 (chapman page- 335)

A 208–V, 10-hp, 4 (four pole), 60 Hz, Y-connected ind motor has a full load slip of 5%

a) What is the synchronous speed of this motor.

b) What is the rotor speed of this motor at rated load?

c) What is the rotor frequency of this motor at rated load?

d) What is the shaft torque of this motor at the rated load?

a).

We know,

$$N_S = \frac{120f}{P}$$

$$= \frac{120 \times 60}{4}$$

$$= 1800 \text{ rpm.}$$

Here,

$f = 60\text{Hz}$

$P = 4$

$S = 5\%$

$= 0.05$

b) We know,

$$N = (1-S)N_S$$

$$= (1-0.05)\,1800$$

$$= 1710 \text{ rpm.}$$

c) We know,

$$f_r = Sf$$

$$= 0.05 \times 60$$

$$= 3\text{Hz.}$$

rotor →

d) We know,

$P = \omega\tau$

$\therefore \tau = \frac{P}{\omega}$

$= \frac{7460 \text{ watt}}{179.071 \text{ rad/s}}$

$= 41.7 \text{ N.m}$

$P = 10 hP$

$= (10 \times 746) \text{ watt}$

$= 7460 \text{ watt}$

$\omega = \frac{2\pi N}{60}$

$= \frac{2 \times \pi \times 1710}{60}$

$= 179.071 \text{ rad/s}$

$N = 1710 \rightarrow$ rotor speed

Rotor shaft

Stator

Rotor.

Difference between synchronous and induction motor →

| | Synchronous motor | Induction motor |
|---|---|---|
| 1. | Construction is complicated | 1. Construction is simpler. |
| 2. | Not self starting | 2. Self starting |
| 3. | Seperate D.C. source is required for rotor excitation. | 3. Rotor gets excited by the induced e.m.f. so seperate source is not necessary. |
| 4. | The speed is always synchronous irrespective of the load. | 4. The speed always less than synchronous but never synchronous. |
| 5. | As load increases, load angle increases, keeping speed constant at synchronous | 5. As load increases, the speed keeps on decreasing. |
| 6. | It can be used as synchronous Condenser for power factor improvement. | 6. It can not be used as synchronous Condenser |
| 7. | This is Comparatively more efficient than induction motor. | 7. It is Comparatively less efficient. |
| 8. | It's torque is more sensitive to change in supply voltage. | 8. It's torque is less sensitive to change in supply voltage. |