Induction motor:

A 220-V three-phase six-pole 50-Hz induction motor is running at a slip of 3.5 percent. Find:

(a) The speed of the magnetic fields in revolutions per minute

(b) The speed of the rotor in revolutions per minute

(c) The slip speed of the rotor

(d) The rotor frequency in hertz

SOLUTION

(a) The speed of the magnetic fields is

$$n_{sync} = \frac{120 f_{se}}{P} = \frac{120(50\text{ Hz})}{6} = 1000\text{ r/min}$$

(b) The speed of the rotor is

$$n_m = (1-s)\, n_{sync} = (1-0.035)(1000\text{ r/min}) = 965\text{ r/min}$$

(c) The slip speed of the rotor is

$$n_{slip} = s n_{sync} = (0.035)(1000\text{ r/min}) = 35\text{ r/min}$$

(d) The rotor frequency is

$$f_{re} = \frac{n_{slip} P}{120} = \frac{(35\text{ r/min})(6)}{120} = 1.75\text{ Hz}$$

Synchronous machine:

A three phase, 2000 KVA, 11 KV, 1800 rpm synchronous generator has a resistance of 1.5 ohms and synchronous reactance of 15 ohms per phase.

a) The filed current is adjusted to obtain the rated terminal voltage at open circuit.
   i) Determine the excitation voltage E_t.
   ii) If a short-circuit is applied across the machine terminals, find the stator current

b) The machine is connected to an infinite bus and is delivering the rated current at 0.8 power factor lagging. Determine

   i) Excitation voltage E_t
   ii) Determine the percentage change in the filed current (relative to the filed current of part a)

Solution:

(a) (i) Rated Voltage $V_t = \frac{11}{\sqrt{3}} = 6.35\,kV$

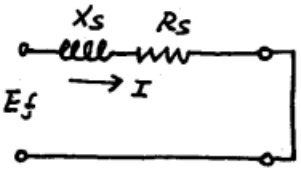
$E_f = V_t = 6.35\,kV$

(ii) $Z_S = 1.5 + j15 = \sqrt{2.25 + 225} \angle \tan^{-1} 10°$

$= 15.06 \angle 84.3°\ \Omega$

$I_a = \frac{6350}{15.06} = 421.65 A$

$I_a|_{rated} = \frac{2000}{\sqrt{3} \times 11} = 105 A$



(b) (i) $E_f = 6350 + 105 \angle -37 \cdot 15.06 \angle 84.3°$

$= 7510 \angle 9°\ V$

(ii) $E_f \propto I_f$

% increase in $I_f = \frac{7510 - 6350}{6350} \times 100 = 18.27\%$