Example 7.1 P 382

The following test data are obtained from a 1/4 hp, 4 pole, 1ϕ, 120V, 60 Hz, 1730 rpm induction motor.

Stator winding (main) resistance = 2.9 Ω

Block rotor (standstill) test: The rotor is prevented from rotating

$V = 34\ V$, $I = 5A$, $P = 140\ W$

No-load test : Motor is running freely

$V = 120\ V$, $I = 3.5\ A$, $P = 125\ W$

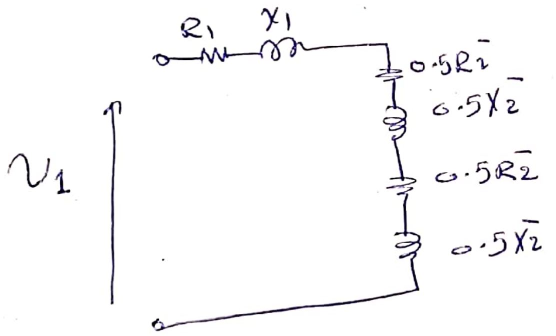
(a) Obtain the double revolving field equivalent circuit for the motor.

(b) Determine the rotational loss.

Solution

(a) at $s = 1$ (standstill)

$0.5 R_2 + j0.5 X_2 \ll j0.5 X_m$ hence the equ. cct is



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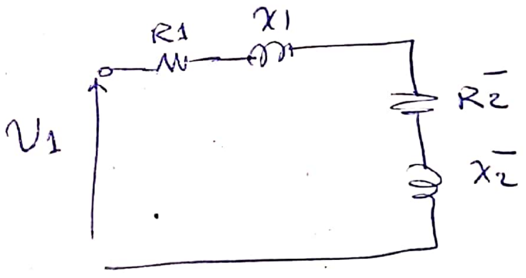


$P = I^2 (R_1 + R_2)$

$140 = 5^2 (2.9 + R_2)$

$\Rightarrow R_2 = 2.7\ \Omega$

$Z = \frac{V}{I} = \frac{34}{5} = 6.8\ \Omega$

$Z = \sqrt{(R_1 + R_2)^2 + (X_1 + X_2)^2}$

Singlephase Motors

$$(x_1 + \bar{x_2})^2 = Z^2 - (R_1 + \bar{R_2})^2$$

$$= 8.6^2 - (2.9 + 2.7)^2$$

$$x_1 + \bar{x_2} = 6.53 \ \Omega$$

assume $x_1 = \bar{x_2} = 6.53/2 = 3.26 \ \Omega$

at no load

$$\frac{0.5\bar{R_2}}{s} + j0.5\bar{x_2} \gg j0.5X_m$$

$$\frac{0.5\bar{R_2}}{2-s} + j0.5\bar{x_2} \ll j0.5X_m$$

$$\frac{0.5\bar{R_2}}{s} = 0.5\bar{R_2} + 0.5\bar{R_2}\left(\frac{1-s}{s}\right)$$

$$= R_{cuf} + R_{mech.f}$$

$$\frac{0.5\bar{R_2}}{2-s} = 0.5\bar{R_2} + 0.5\bar{R_2}\ \frac{1-(2-s)}{2-s}$$

$$= R_{cub} + R_{mech.b}$$

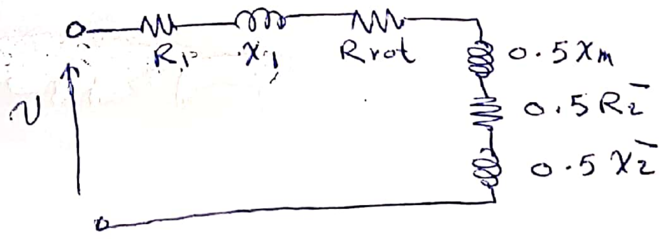
The mechanical power developed at no load represents rotational losses, which will include core loss.

ان $0.5\bar{R_2}\ \frac{1-(2-s)}{2-s}$ هنا تمثل خسائر ميكانيكية ولكن لا يوجد شيء

يمثل خسائر الحديد core loss لذلك نوجد مقاومة Rrot

لتمثل كل خسائر الدوران rotational loss = friction & windage + core loss

اما ($0.5\bar{R_2}$) فتمثل الخسائر النحاسية في الـ (rotor) في حالة اللاحمل



$$P_{NL} = I_{NL}^2 (R_1 + R_{rot} + 0.5 R_2')$$

$$= I_{NL}^2 R_{NL}$$

$$R_{NL} = \frac{125}{(3.5)^2} = 10.2\ \Omega$$

$$Z_{NL} = \frac{V}{I_N} = \frac{120}{3.5} = 34.3\ \Omega$$

$$Z_{NL} = \sqrt{R_{NL}^2 + (X_1 + 0.5X_m + 0.5X_2')^2}$$

$$X_1 + 0.5X_m + 0.5X_2' = \sqrt{(34.3)^2 - (10.2)^2} = 32.75\ \Omega$$

$$X_m = \frac{32.75 - 3.26 - 0.5 \times 3.26}{0.5}$$

$$= 55.72\ \Omega$$

(b)

$$P_{NL} = I_{NL}^2 (R_1 + R_{rot} + 0.5 R_2')$$

$$= I_{NL}^2 (R_1 + 0.5 R_2') + I_{NL}^2 R_{rot}$$

= cuppor loss + rotational loss

$$I_{NL}^2 R_{rot} = P_{NL} - I_{NL}^2 (R_1 + 0.5 R_2')$$

$$= 125 - (3.5)^2 (2.9 + 0.5 \times 2.7)$$

$$= 72.94$$