Question 1. The following catalog values are given for an 8-pole, three-phase asynchronous motor: 280 kW, 380V, 565A, cos=0.79, 740 rpm, 50Hz, Ik/In=7 (Ik, starting current), Mk/Mn=2.2 (Mk, starting torque). Determine the active and reactive power, shaft torque, efficiency, rotor frequency, starting current, and starting torque of the motor when operating at nominal load.

$$P = \sqrt{3}\, UI \cos\varphi = \sqrt{3} * 380 * 565 * 0.79 = 293{,}43\ kW$$

$$Q = \sqrt{3}\, UI \sin\varphi = \sqrt{3} * 380 * 565 * 0.61 = 222.858\ kW$$

$$M = \frac{P_m}{W_{geo}} = \frac{P_{catalog}}{2\,\pi \dfrac{740 * 4}{60}} = 903.77\ Nm$$

$$\%\,\eta = \frac{P_{out}}{P_{in}} * 100 = \frac{P_m}{P} * 100 = \frac{280000}{293430} = \%95$$

$$f_s = \frac{n_s p}{60} \rightarrow n_s = \frac{60 * 50}{4} = 750\ rpm$$

$$s = \frac{n_s - n}{n_s} = \frac{750 - 740}{750} = \%1.33$$

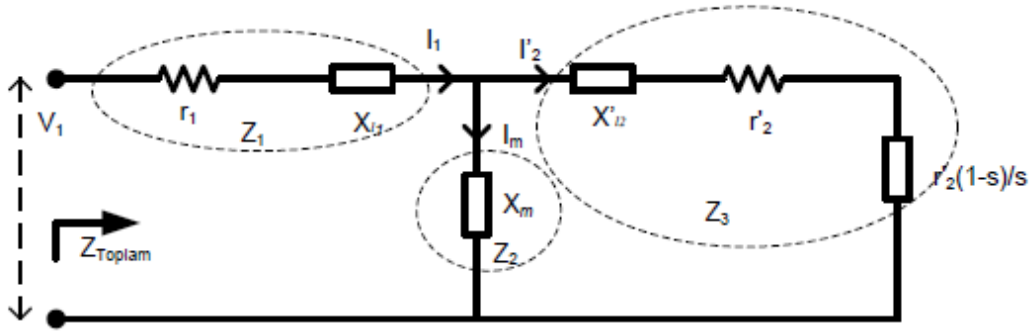
$$f_r = f_s s = 50 * 0.0133 = 0.66\ Hz$$

$$I_k = I_{yv} = 7 * I_n$$

$$M_k = M_{yv} = 2.2 * M = 1988.3$$

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Question 2. For a 10 HP, 50 Hz, 380 V, 6-pole, three-phase, squirrel-cage induction motor with the following parameters: R_1=0.294 Ω, R_2'=0.144 Ω, X_{l1}=0.503 Ω, X_{l2}'=0.209 Ω, X_M=13.25 Ω, draw the equivalent circuit of the induction motor operating with a slip of 2%. Then, find the stator current, rotor current referred to the stator, power factor, rotor frequency, and rotor speed



$$Z_1 = R_1 + jX_{l1}$$

$$Z_2 = j\,X_m$$

$$Z_3 = \frac{r_2'}{s} + jX_{l2}'$$

$$Z_{eq} = Z_1 + \frac{Z_2 Z_3}{Z_2 + Z_3}$$

$$Z_{eq} = R_1 + jX_{l1} + \frac{jX_M(\frac{r_2'}{s} + jX_{l2}')}{\frac{r_2'}{s} + j(X_M + X_{l2}')}$$

$$Z_{eq} = 0.294 + j0.503 + \frac{j\ 13.25\ (\frac{0.144}{0.02} + j0.209)}{\frac{0.144}{0.02} + j(13.25 + 0.209)}$$

$$Z_{eq} = 5.724 + j3.61$$

$$\overrightarrow{I_1} = \frac{380/\sqrt{3}}{5.724 + j3.61} = 32.4546\,|-32.23^\circ\ = 27.2 - j\ 17.36$$

$$V_1 = E_{20}' + I_1(r_1 + jX_n)$$

$$E_{20}' = V_1 - I_1(r_1 + jX_n) = \frac{380}{\sqrt{3}} - [(27.2 - j17.36) * (0.294 + j0.503)]$$

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$$E'_{20} = 203.18 - j8.73 = 203.37 \mid -2.46°$$

$$\overrightarrow{I_m} = \frac{E_{20}{}'}{jX_m} = \frac{203.18 - j8.73}{j13.25} = \frac{203.37 \mid -2.46°}{13.25 \mid 9°} = -0.66 - j15.33\ A$$

$$I'_2 = \overrightarrow{I_1} - \overrightarrow{I_m} = 27.2 - j17.36 - (-0.66 - j15.33) = 27.86 - j2.03\ A$$

$$\cos(\varphi) = \cos(32{,}23) = 0.84$$

$$f_s = \frac{n_s p}{60} \rightarrow n_s = \frac{60 * 50}{3} = 1000\ rpm$$

$$f_r = f_s * s = 50 * 0.02 = 1Hz$$

$$n_r = (1 - s) * n_s = 980\ rpm$$

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