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17/Eng04/053
Elect/Elect.
Electrical Machines. (EEE 326)
Test 2

Question 1

$V_L = 415V$, $3-\phi$, $f = 50Hz$, $P = 74.6$
$p.f = 0.7$, $eff = 85\%$

(i) Unity = 1

$$C = \frac{KVAR}{2\pi f V^2}$$

$$\Rightarrow KVAR = P \times (\tan \text{actual } p.f - \tan \text{target } p.f)$$

actual $p.f \Rightarrow \cos\theta = 0.7$

$\theta = \cos^{-1} 0.7$

$= 45.57$

$\tan(45.57) = 1.0201$

target $p.f \Rightarrow \cos\theta = 1$

$\theta = \cos^{-1} 1 = 0$

$\tan 0 = 0$

$KVAR = 74.6 \times (1.0201) - (0))$

$= 76.0995$ $\quad \cdot 0.01 \quad 1 \times 10$

$\cong 76.10$

$$C = \frac{76.10}{2 \times \pi \times 50 \times 415^2}$$

$= 0.000000014$

1.4×10^{-8}

$= 1.4 \times 10^{-6} C$

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(iv) 0.9 lagging

actual $pf_1 = 1.0201$

but $pf = \cos\theta = 0.9$

$\theta = \cos^{-1}(-0.9)$

$= 154.16$

$\tan\theta = -0.48$

$KVAR = 74.6 \times (1.0201 - (0.48))$

$= 111.90$

$\simeq 112$

$C = \frac{KVAR}{2\pi f}$

$= \frac{112}{2 \times \pi \times 50 \times 415^2}$

$= 0.000086$

$\simeq 8.6 \times 10^{-4} C$

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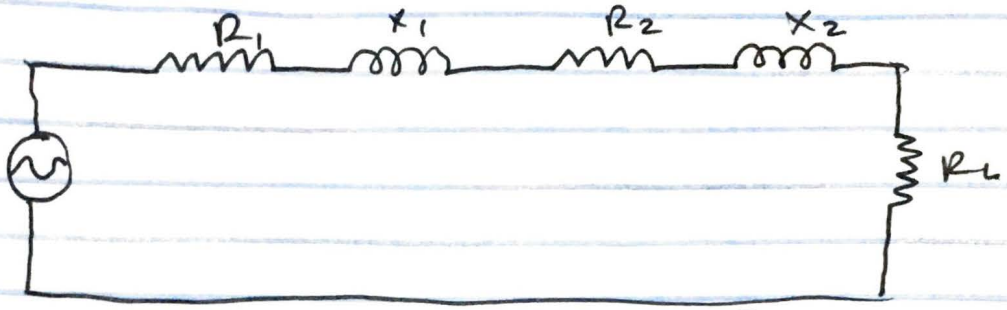
Question 2

$V_{ph} = 415V$ $K = 5/6 = 0.83$

No. of poles = 6 $Z_1 = 0.25 + j0.75$ — Stator

$f = 50Hz$ $Z_2 = 1.173 + j0.52$ — Rotor



Supply voltage per phase, $V_2 = 415/\sqrt{3}, = 239.80V$

Referring to rotor

$R_{02} (R_2 + K^2 R_1)$

$= (1.173 + (5/6)^2 \times 0.25)$

$R_{02} = 1.347\Omega$

$X_{02} = (X_2 + K^2 X_1)$

$j(0.52 + (5/6)^2 \times 0.75)$

$= 1.041$

$Z_{02} = R_{02} + X_{02}$

$= 1.547 + j1.041$

$Z_{02} \sqrt{1.547^2 + 1.041^2}$

$= 1.7\Omega$

Rotor current

$I_2 = E_2/Z_{02}$ [Recall $E_2 = 80\%$]

239.6×0.83

$= 199.67V$

$\therefore I_{22} \frac{199.67}{1.7} = 117.45A$

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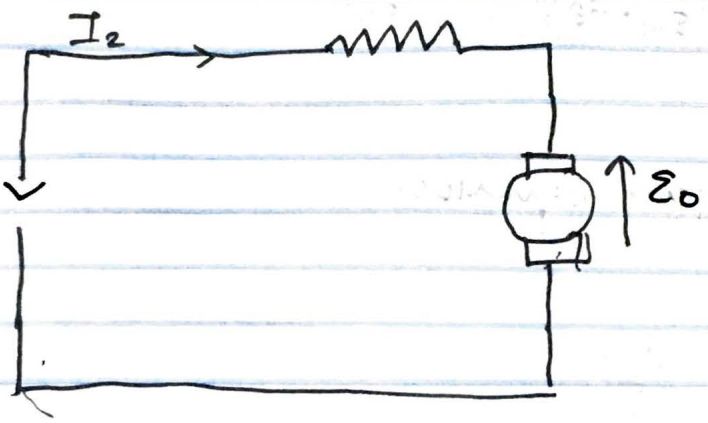
Question 3

$f = 50Hz$, $1/4hp$, $N = 2000rpm$, $V = 220$
13Ω and $0.25H$

On DC supply
supply voltage 220V
&
current flows, $I_1 = 0.7A$



$V - \varepsilon_b = I_2 * R$

$V - [I_2 * R] = \varepsilon_b$

$\varepsilon_b = 220 - [0.7 * 15]$

$= \underline{209.5V}$

Speed on DC
$N_{DC} = 2000rpm$

On AC supply
Supply voltage = 220V
current drawn = $I_L = 0.7A$
Reactance drop = $I_L * R = 0.7 \times 15$
$= \underline{10.5V}$

Reactance voltage drop = $I_L \times X_L$
$= 0.7 \times 2\pi fL$

where $X_L = j\omega L = 2\pi fL$
$= 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98V$

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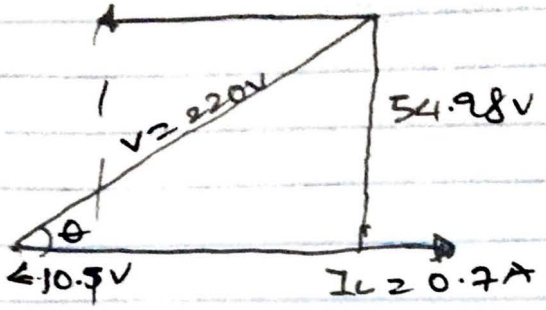

$$E_{bac} = \sqrt{V^2 - [X_s]^2} - IR$$
$$\sqrt{(220)^2 - (54.98)^2} - 10.5V$$
$$= 202.52V$$

Second speed constant equation

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$

$$\delta_0 = \frac{E_{bac}}{E_{b\delta c}} = \frac{N_{ac}}{N_{\delta c}}$$

$$N_{ac} = N_{\delta c} \times \frac{E_{bac}}{E_{b\delta c}}, \quad 2000 \times \frac{202.52V}{209.5V}$$

$$N_{ac} = 1933.37 \text{ rpm}$$

Power factor, $\cos\phi = \frac{E_{bac} + IR}{V}$

$$= \frac{202.52 + 10.5}{220}, \quad = 0.968 \text{ lagging}$$

Torque developed [$W = E_{bac} \times I$]

$$I_{ac} = \frac{E_{bac} \times I}{\omega} \quad \{\text{where } \omega \text{ is rad/s for speed}\}$$

$\omega = 2\pi n$, ~~where A is~~

$$I_{ac} = \frac{E_{bac} \times I_a}{2\pi \times \frac{N_{ac}}{60}} = \frac{202.52 \times 0.7 \times 60}{2\pi \times 1933.37}$$

$$0.700 \text{ Nm}$$