Okwong, David Victor
17/ENG06/063

EEE326 Electrical Machines II Test

Question 1 (b)

Given: V = 415 v, 3-ϕ, 4-wire, 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 $= \cos\theta = 1$

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

$\tan 0 = 0$

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

$= 76.0995$

$\simeq 76.10$

$$C = \frac{76.10}{2\pi f V^2} = \frac{76.10}{2 \times \pi \times 50 \times (415)^2}$$

$= 0.0000014$

$\therefore \simeq 1.4 \times 10^{-6} C$ //

ii) 0.9 lagging

actual P.f = 1.0201

target P.f = $\cos\theta = 0.9$

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

$= 154.16$

$\tan\theta = -0.48$

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

$= 111.90 \simeq 112$

OKwong David Victor
17/ENG06/063

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

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

$$= 0.00056$$

$$\simeq 5.6 \times 10^{-4} C$$

Question 2

$V = 415 V$

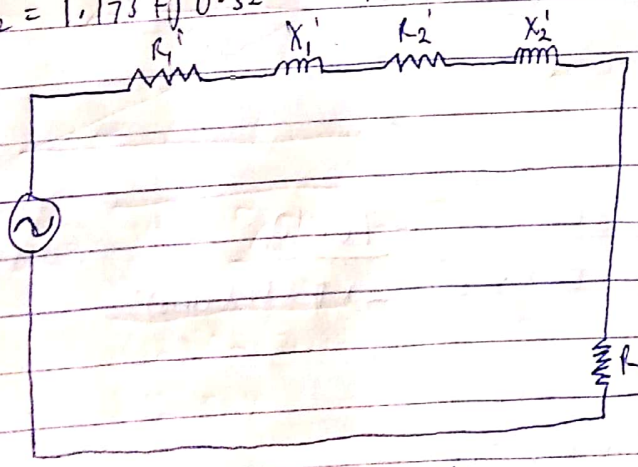
No. of Poles = 6

$f = 50 Hz$

$K = 5/6 = 0.83$

$R = Z_1 = 0.25 + j\,0.75$ — Stator

$Z_2 = 1.173 + j\,0.52$ — Rotor



Supply Voltage per Phase, $V = \frac{415}{\sqrt{3}} = 239.60 V$

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

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

$$R_{02} = 1.347 \Omega$$

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

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

$$= 1.041$$

Page 3
Okwong, David Victor
17/ENG06/063

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

$= 1.347 + j1.041$

$= \sqrt{1.347^2 + 1.041^2}$

$= 1.7\Omega$

ii) To find Stator Current

$I_2 = \frac{\mathcal{E}_2}{Z_{02}}$

$\boxed{\mathcal{E}_2 = KX_1}$

$= 239.6 \times 0.83$

$= 199.67V$

$\therefore I_2 = \frac{199.67}{1.7} = 117.45A$

Question 3

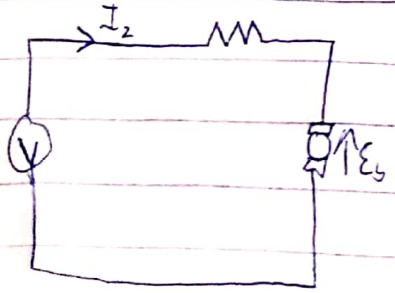
i) $f = 50Hz$, $1/4$ Hp, $N_r = 2$ poles rpm, $V = 220V$

$R = 15\Omega$, Inductance $= 0.25H$

DC Supply.

Supply Voltage $= 220V$

Current draw $I = 0.7A$



$V - \mathcal{E}_b = I_2 * R$

$V - [I_2 * R] = \mathcal{E}_b$

$\mathcal{E}_b = 220 - [0.7 * 15]$

$= 209.5V$

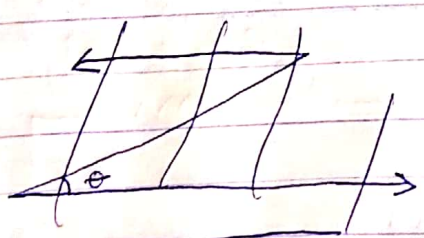
Page 4
Okwong, David Victor
17/ENG06/063

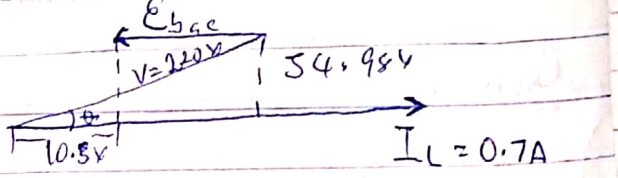
Speed on DC,
N_d = 8000 rpm

On AC Supply
Supply Voltage = 220 V
Current drawn = I_L = 0.7A
Reactance drop = $I_L * R = 0.7 * 15 = 10.5$ V

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

Where $X_L = j\omega L = 2\pi fL$
$= 0.7 \times 2\pi \times 80 \times 0.25$
$= 54.98$ V





$E_{bac} = \sqrt{V^2 - [X_L]^2} - IR$

$= \sqrt{(220)^2 - (54.98)^2} - 10.5$ V
$= 202.52$ V

Speed Constant Equation

$\frac{N_2}{N_1} = \frac{E_{b_2}}{E_{b_1}}$

$\therefore \frac{E_{bac}}{E_{bdc}} = \frac{N_{ac}}{N_{dc}}$

Making N_{ac} Subject of the formular

$N_{ac} = N_{dc} \times \frac{E_{bac}}{E_{bdc}}$

Okelong, David Victor
17/ENG06/063

$$2000 \times \frac{202.52\ V}{209.5\ V}$$

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

ii) Power Factor, $\cos\phi = \frac{E_{bac} + IR}{V}$

$$= \frac{202.52 + 10.5}{220}$$

$$= 0.968\ \text{Lagging}$$

iii) Torque developed $T_w = E_{bac} \times I$

$$T_{ac} = \frac{E_{bac} \times I}{w}$$

w is Speed in rad/s

$w = 2\pi n$, where n is Speed in

$$T_{ac} = \frac{E_{bac} \times I_L}{\frac{2\pi \times N_{ac}}{60}}$$

$$= \frac{202.52 \times 0.7 \times 60}{2\pi \times 1933.37}$$

$$= 0.700\ N_m$$

iv)