17/ENG04/043 ELECTRICAL ELECTRONICS ENGINEERING 300LEVEL

QUESTION 3.

$R = 15\Omega$

$L = 0.25H$

for DC	for AC
$f = 50Hz$	$f = 50Hz$
$N = 2000rpm$	$V = 220V$
$I = 0.7A$	$I = 0.7A$
$V = 220V$	

(i) Speed of the motor i.e N_{ac}

$$\frac{E_{b\,ac}}{E_{b\,dc}} = \frac{N_{ac}}{N_{dc}}$$

for dc

$V - E_b = I_L R$

$220 - E_b = 0.7 \times 15$

$220 - E_b = 10.5$

$220 - 10.5 = E_b$

$E_b = 209.5V$

for ac

$E_b = \sqrt{V^2 - [IX_L]^2} - IR$

$X_L = 2\pi f_L = 2\pi \times 50 \times 0.25$

$= 78.54$

$E_b = \sqrt{220^2 - [0.7 \times 78.54]^2} - 0.7 \times 15$

$E_b = 213.02 - 10.5$

$E_b = 202.52V$

$$\frac{202.52}{209.5} = \frac{N_{ac}}{2000}$$

$$N_{ac} = \frac{2000 \times 202.52}{209.5}$$

$N_{ac} = 1933.17rpm$

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(ii) $\cos\theta = \frac{I_R + E_b}{V}$

$\cos\theta = \frac{(0.7 \times 15) + 202.52}{220}$

$\cos\theta = 0.9683$

$\cos\theta \simeq 0.97$.

(iii) Torque developed = $\frac{9.55 \times \text{power}}{\text{Speed}}$

given power as 1/4 hp to KW : 1hp = 0.7457kW

$N_{ac} = 1933.37$ rpm 1/4hp = ?

$1/4 \times 0.7457 = 0.1864$ kW

$\therefore T = \frac{9.55 \times 0.1864}{1933.37} = 9.207 \times 10^{-4}$ Nm

(iv) The type of motor used in this application is the UNIVERSAL MOTOR.

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QUESTION 2

Stator impedance = $0.25 + j0.75$

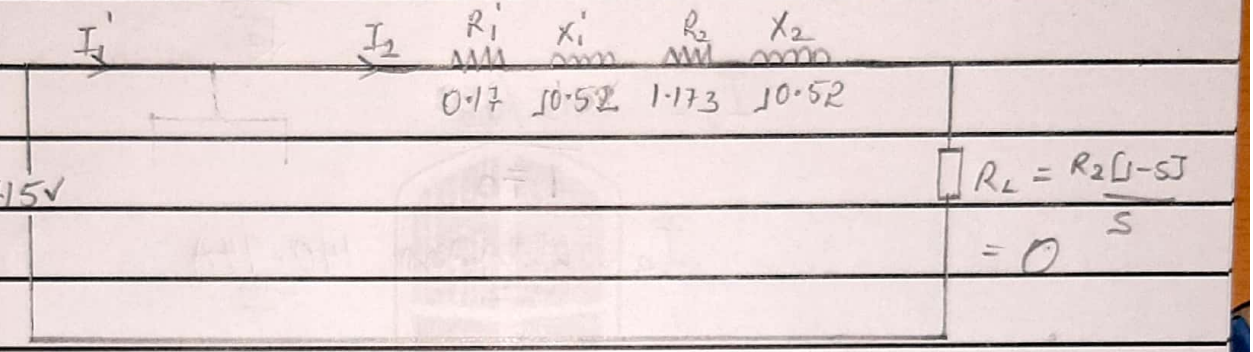
rotor impedance = $1.173 + j0.52$

pole = 6

f = 50Hz

stator/rotor phase voltage ratio = 6/5 = K since 1 to rotor = 5/6

Slip = 1



Referred To The Rotor Side VERSION 2

$K = 5/6$

$R_1' = K^2 R_1 = (5/6)^2 \times 0.25$

$= 0.17\Omega$

$X_1' = K^2 X_1 = (5/6)^2 \times 0.75$

$= j0.52\Omega$

$R_L = \frac{R_2[1-S]}{S}$ as $S = 1$ (unity)

$= 1.173 \frac{[1-1]}{1} = 0$

$R_{02} = R_2 + R_1'$

$= 1.173 + 0.17$

$= 1.343\Omega$/phase

$X_{02} = X_2 + X_1'$

$= j0.52 + j0.52$

$= j1.04\Omega$/phase

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$Z_{02} = \sqrt{1.343^2 + 1.07^2} = 1.699$

$\simeq$ 1.7 Ω

(11) Rotor current $I_2 = \frac{V}{Z_{02}}$

because it a star $V_L = \sqrt{3}\, V_{phase}$

$V_{phase} = \frac{V_L}{\sqrt{3}}$

$I_2 = \frac{415/\sqrt{3}}{1.70}$

$I_2 = 140.94A$

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QUESTION 1

$V = 415V = 415/\sqrt{3} = 239.6 V_{phase}$

$f = 50Hz$

$P_{mech} = 74.6KW$

$P.f = 0.7$ lagging

efficency $= 85\%$

(a) The drive motor type is

(b) (i) Unity $= 1$

$C = \frac{KVAR}{2\pi f V^2}$ $\cos\theta = 0.7$

$\theta = \cos^{-1} 0.7 = 45.57$

$KVAR = P \times \tan 45.57$

$\tan(45.57) = 1.02$

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

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

$\tan 0 = 0$

(c) $85 \times P_{in} = 74.6 \times 100$

$$P_{in} = \frac{74.6 \times 100}{85} \qquad P_{in} = 87.76\,kW$$

$P_{in} = \sqrt{3} \times V_L \times I_L \times \cos\phi$

for Unity

$$87.76 = \sqrt{3} \times (415) \times I_L \times 1$$

$$I_L = \frac{87.76}{\sqrt{3} \times 415 \times 1}$$

$$I_L = 0.12A$$

for 0.9 lagging

$$87.76 = \sqrt{3} \times 415 \times I_L \times 0.9$$

$$I_L = \frac{87.76}{\sqrt{3} \times 415 \times 0.9}$$

$$I_L = 0.14A$$

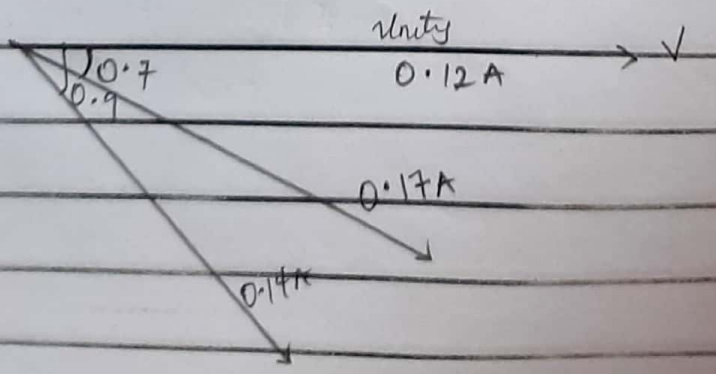
for 0.7 lagging

$$87.76 = \sqrt{3} \times 415 \times I_L \times 0.7$$

$$I_L = \frac{87.76}{\sqrt{3} \times 415 \times 0.7}$$

$$I_L = 0.17A$$

Phasor Diagram



KVAR = 74.6 × (-1.02 - 0)

= -76.092

≈ -76.1

$C = \frac{-76.1}{2\pi \times 50 \times 239.6^2}$

$C = -4.22 \times 10^{-6}$ C

=

(ii) 0.9 lagging

actual p.f = -1.02 (as seen before)

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

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

$\theta = 25.84$

$\tan\theta = \tan(25.84) = -0.48$ (its lagging)

KVAR = 74.6 × (-1.02 - (-0.48))

= -40.28

$C = \frac{-40.28}{2\pi \times 50 \times 239.6^2}$

$= -2.23 \times 10^{-6}$ C

=

$\text{efficiency} = \frac{P_{out}}{P_{in}} \times 100$

$85 = \frac{74.6}{P_{in}} \times 100$