300 Level 17/Eng04/1066 Elect/Elect

~~Ozoh Jachimike Francis~~

Question 1

b) $V = 415V$, $f = 50Hz$, $p.f = 0.7$, Efficiency $= 85\%$

Power $= 74.6kW$

1) For a power factor of unity

$$kVAr = P \times (\tan p.f_1 - \tan p.f_2)$$

To find θ of pf_1, $\cos\theta = 0.7$

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

To find θ of pf_2, $\cos\theta = 1$

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

$$\therefore kVAr = P \times [\tan(45.57) - \tan(0)]$$
$$= 74.6 [1.0201 - 0]$$
$$= 74.6 [1.021]$$
$$= 76.10$$

$$C = \frac{kVAr}{2\pi F V^2} = \frac{76.10}{2 \times \pi \times 50 \times (239.6)^2}$$

~~$$= \frac{76.10}{54106079.48} = 1.406 \times 10^{-6}$$~~

~~The capacitance required is 1.406×10^{-6} C~~

$$= 4.2 \times 10^{-6} F$$

300 Level Elect/Elect 17/Eng 04+066

Question 1

b) ii) For a power factor of 0.9 (lagging)

θ of the original p_f = 45.57°

θ of the required power factor = $\cos\theta$ = 0.9

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

= 154.16

$kVAr = 74.6 \times (\tan(45.57) - \tan(154.16))$

$= 74.6 \times (1.021 - (-0.48))$

$= 74.6 \times (1.021 + 0.48)$

$= 74.6 (1.501)$

$= 111.9746$

≈ 112

$C = \frac{kVAr}{2\pi F V^2} = \frac{112}{2 \times \pi \times 50 \times (239.6)^2}$

$= 6.2 \times 10^{-6}$ F

300Level Elect/Elect 17/ENG04/1066

Question 1 Continued

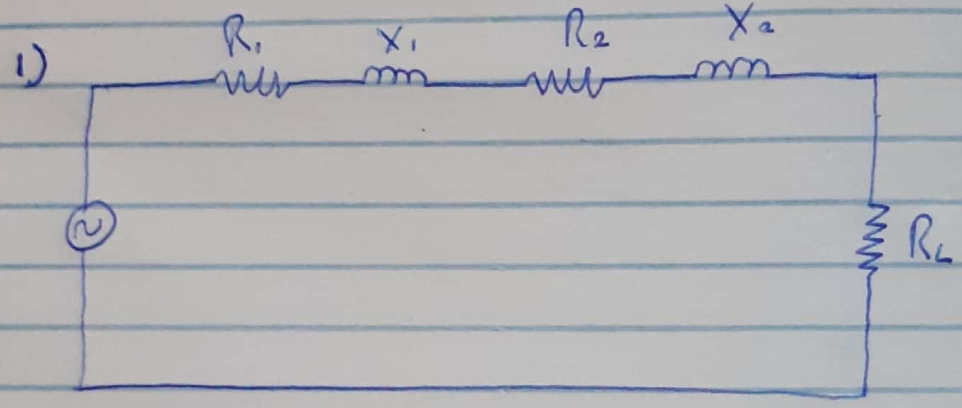
a) It is a 3 phase induction motor

300 Level Elect/Elect 17/Eng04/066

Question 2

$V_{rms} = 415$
No of poles = 6
$F = 50Hz$
$K = 6/5 = 1.2$
$Z_1 = 0.25 + j\,0.75$
$Z_2 = 1.173 + j\,0.52$

1)



Supply Voltage per phase $V = \frac{415}{\sqrt{3}} = 239.50$

Reffered to rotor

$R_{02} = (R_2 + K^2 R_1)$
$= (1.173 + (1.2)^2 \times 0.25)$
$R_{02} = 1.533\,\Omega$

$X_{02} = (X_2 + K^2 X_1)$
$= j\,(0.52 + (1.2)^2 \times 0.75)$
$= j\,1.6$

$Z_{02} = R_{02} + X_{02} = 1.533 + j\,1.6$
$= \sqrt{1.533^2 + 1.6^2}$
$= 4.91\,\Omega$

300 Level Bleak/Bleak 171/Eng 041066

Question 2 Continued

ii) To find I_2

$$I_2 = \frac{E_2}{Z_{02}}$$

Also, $E_2 = kV_1$

$= 239.6 \times 0.85$

$= 199.67\ V$

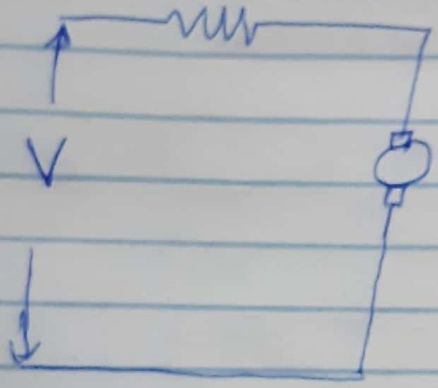
$$\therefore I_2 = \frac{199.67}{4.91} = 40.6A$$

300 Level Elect/Elect 17/Eng 04/066

Question 3

$F = 50Hz$, $N_s = 2000 rpm$, $\frac{1}{4} hp$, $V = 220$
$L = 0.25$, $R = 15\Omega$

On a Dc Supply
Voltage = 220V
$I = 0.7A$

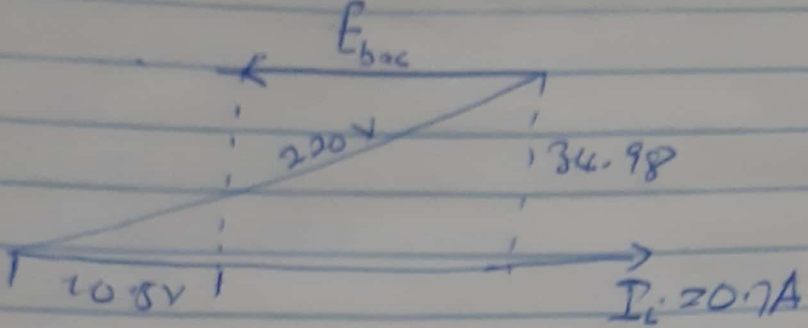


$V - E_b = I_L R$
$V - [I_L R] = E_b$
$E_b = 220 - [0.7 \times 5]$
$= 209.5V$

For an AC Supply
$V = 220V$
Current = 0.7A
Reactance drop = $I_L \times R = 0.7 \times 15$
$= 10.5$
Reactance Voltage drop = $I_L \times X_L$
$= 0.7 \times 2\pi fL$
$= 0.7 \times 25 \times 50 \times 0.25$
$= 54.98V$

300 Level · Elect/Elect 17/Eng04/066

Question 3 continued



$$E_{bac} = \sqrt{V^2 - [X^2]} - IR$$
$$= \sqrt{(220)^2 - (56.98)^2} - 10.5$$
$$= 202.52\ V$$

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

- To find "N_{ac}"

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

$$= 2000 \times \frac{202.52}{209.5} = 1933.37\ rpm$$

ii) Power factor $= \frac{E_{bac} + IR}{V} = \frac{202.52 + 10.5}{220}$

$= 0.968$ lagging

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

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

$$= \frac{202.52 \times 0.7 \times 60}{2\pi \times 1933.37} = 0.700\ Nm$$