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Answer to Question (1)

(i)

(ii) V = 415V , % efficiency = 85%
F = 50Hz P = 74.6 KW

When P.F unify, P.F = 1

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

KVAR = P x C tan of actual P.F ~~-~~ tan of target P.F)

Actual P.F

$\cos\theta = 0.7$

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

$\tan 45.57 = 1.0201$

Target P.F

$\cos\theta = 1$

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

$\tan 0 = 0$

KVAR = 74.6 x (1.0201 - 0)

KVAR = 76.10

$$\therefore C = \frac{KVAR}{2\pi f V^2} = \frac{76.10}{2 \times 3.142 \times 50 \times (415)^2}$$

$\therefore C = 0.0000014$ or $C = 1.4 \times 10^{-6} C$

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(i) When P.F is at 0.9 Lagging

actual P.F = 1.0201
target P.F = $\cos\theta = -0.9$ (Lagging)

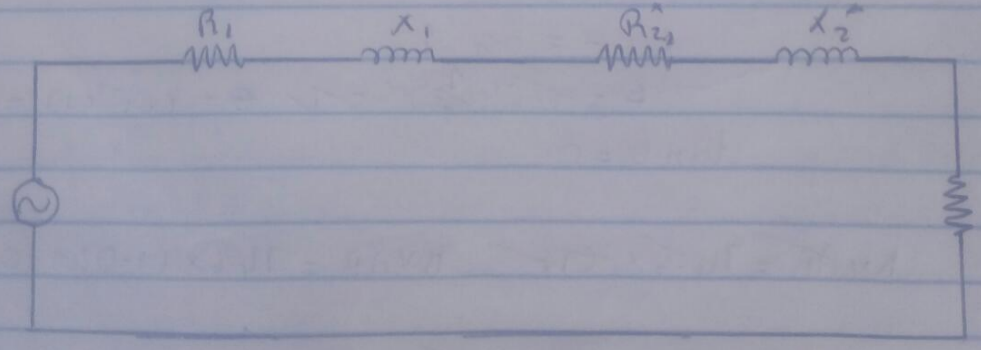
$\theta = (\cos^{-1} -0.9)$
$\theta = 154.16$
$\tan(154.16) = -0.48$
$KVAR = 74.6 \times (1.0201 - (-0.48))$
$= 111.9$

$C = \frac{KVAR}{2\pi f V^2} = \frac{111.9}{2 \times 3.142 \times 50 \times (415)^2}$

$C = 0.00086$ or $C = 8.6 \times 10^{-4}$
$\therefore C = 8.6 \times 10^{-4} C$

Question (2)

V = 415V 6Pole, 3Ø
f = 50Hz



Supply voltage per phase, $V = \frac{415}{\sqrt{3}} = 239.60\,V$

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Referring to rotor

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

$R_{02} = (1.173 + (5/6)^2 \times 0.25)$

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

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

$X_{02} = j(0.52 + (5/6)^2 \times 0.75)$

$X_{02} = j1.041$

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

$Z_{02} = 1.347 + j1.041$

$Z_{02} = \sqrt{1.347^2 + 1.041^2}$

$Z_{02} = 1.7\,\Omega$

To find rotor current

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

Recall that $E_2 = aV_1$

$= 239.6 \times 0.85$

$= 199.67\,V$

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

$$\therefore I_2 = 117.45\,A$$

(2)

$V = 220\,V$ DC $I = 0.7\,A$ $N_{dc} = 2000\,rpm$ $L = 0.25\,H$ } DC

$f = 50\,Hz$ $R = 15\,\Omega$

$V = 220\,V$ AC $I = 0.7\,A$ } AC

$f = 50\,Hz$

For DC

$V - E_b = IR$

$E_b = V - IR$

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$E_{bdc} = 220 - (0.7 \times 15)$

$E_{bdc} = 209.5V$

Speed on DC

$N_{dc} = 2000$ rpm

$E_{bac} = \sqrt{V^2 - (X_L)^2} - IR$

$E_{bac} = \sqrt{220^2 - (54.48)^2} - 10.5V$

$E_{bac} = 84.48 \quad 202.52V$

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

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

$$N_{ac} = \frac{N_{dc} \times E_{bac}}{E_{bdc}} = 2000 \times \frac{202.52}{209.5V}$$

$N_{ac} = 1933.4$ rpm

(i) P.F, $\cos\varphi = \frac{E_{bac} + IR}{V} = \frac{202.52 + 15 \times 0.7}{220}$

$= 0.968$ Lagging

(ii) Universal motor