1

17/ENG06/008

800L

Question 1

V = 415V, 3-ϕ, 4 wire, f = 50Hz

P = 74.6, P.f = 0.7, eff = 85%

Unity = 1

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

KVAR = P × (tan actual PF × tan tar

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 × (1.0201 − 0)

= 76.0995

= 76.1

2 17/ENG06/008

300L

$$C = \frac{76.10}{2\pi \times 50 \times \left(\frac{415}{\sqrt{3}}\right)^2}$$

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

(iii) 0.9 lagging

actual p.f = 1.0201

target p.f = $\cos\theta$ = −0.9

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

$\theta = 154.16$

$\tan\theta = \tan(154.16)$

$= -0.48$

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

$= 119.90 \simeq 112$

$$C = \frac{112}{2\pi \times 50 \times \left(\frac{415}{\sqrt{3}}\right)^2}$$

$$= 6.21 \times 10^{-6} \text{ C}$$

3

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Question 2

$V_L = 415\ V$

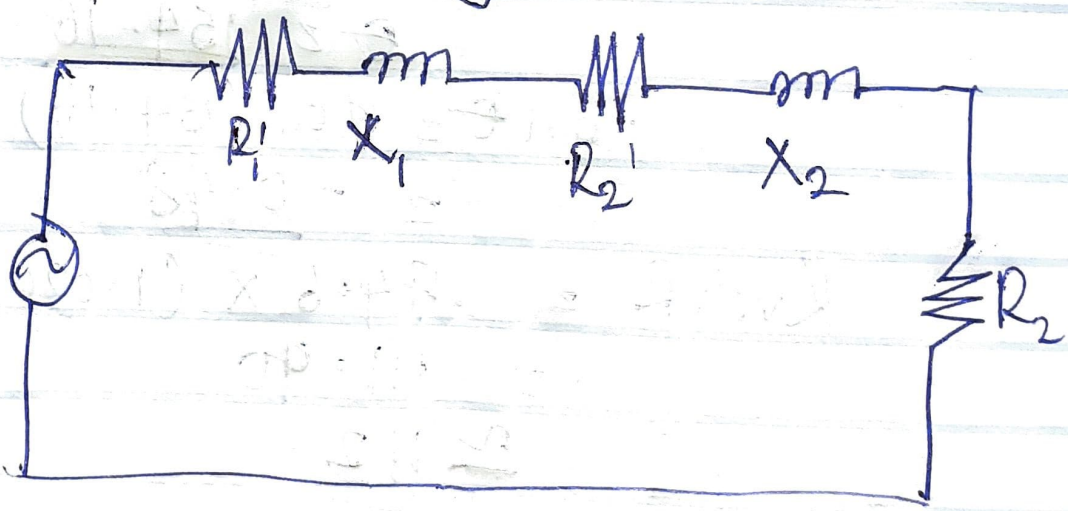
No of Poles = 6

$f = 50\ Hz$

$K = 5/6 = 0.83$

$Z_1 = 0.25 + j\,0.75$ — Stator

$Z_2 = 1.173 + j\,0.52$ — rotor



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

$= 239.60\ V$

referring to rotor

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

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

$= \underline{1.347\ \Omega}$

4

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$X_{O_2} = (X_2 + K^2 X_1)$

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

$= 1.041$

$Z_{O_2} = R_{O_2} + X_{O_2}$

$= 1.347 + j\,1.041$

$= \sqrt{(1.347)^2 + (j\,1.041)^2}$

$= 1.7\Omega$

to find rotor current

$I_2 = \frac{E_2}{Z_{O_2}}$

Recall that $E_2 = KV_1$

$= 239.60 \times 0.85$

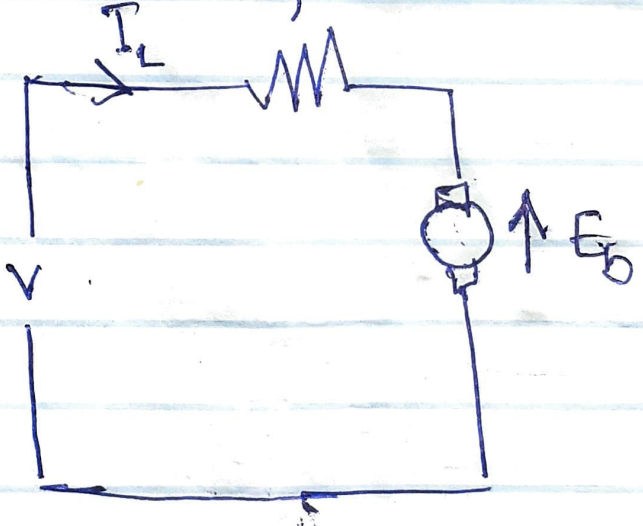
$= 199.67\,V$

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

Question 3

f = 50Hz, 1/4 hp, N_s = 2000rpm, V = 220V
15Ω and 0.25H

On DC supply,
Supply voltage = 220V
Current draws, I = 0.7A



$V - E_b = I_L * R$

$V - [I_L * R] = E_b$

$E_b = 220 - [0.7 * 15]$

$= \underline{209.5\,V}$

Speed on DC,

N_{dc} = 2000 rpm

6 IT/ENG06/008

300 L

Question 3

On AC supply

Supply voltage = 220 V

Current drawn, $I_L = 0.7A$

Reactance drop = $I_L * R = 0.7 \times 15 =$

$= \underline{10.5 V}$

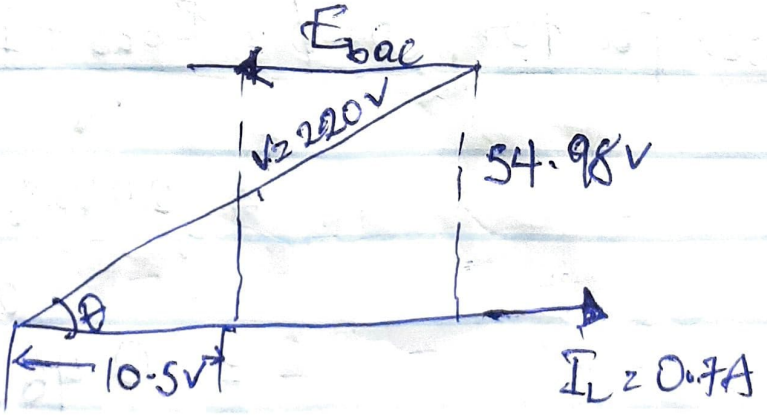
Reactence voltage drop = $I_L \times X_L$

$= \underline{0.7 \times 2\pi fL}$

where $X_L = j\omega L = 2\pi fL$

$= 0.7 \times 2\pi \times 50 \times 0.25$

$= \underline{54.98 V}$



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

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

$= 202.52 V$

7

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300L

3 (i) Recall Speed - constant equation

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

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

making N_{ac} subject of the formular

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

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

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

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

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

$$= 0.968\ lagging$$

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

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

where w is speed in rad/s

8

11/ENG/06/008

300L

$\omega = 2\pi n$, where n is speed in revs

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

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

$= 0.700\ Nm$

3(iv) Universal motor