Mat No: 17/ENG04/022
Dept.: Electrical/Electronics Engineering
Level: 300Level. Test ENG 326

Question 11

a) V = 415 V, 3-Ø, 4-wire
f = 50Hz, P = 74.6, Pf = 0.7 ~~% of efficiency = 95%~~
% of Efficiency = 85%

bi) Unity = 1

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

= kVAR = P x [tan actual p.f - Tan 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]

= 76.0995

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$$C = \frac{76.0995}{2\pi \times 50 \times 415^2}$$

$$= 0.0000014 \simeq 1.4 \times 10^{-6} \text{ C/.}$$

to 0.9 Logging

actual p.f = 1.0201

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

$\theta = \cos^{-1}[-0.9] = 154.16$

$\tan\theta = \tan[154.16] = -0.48$

$$\text{KvAR} = 74.6 \times [1.0201 - [-0.48)]$$

$$= 111.90 \simeq 112$$

$$C = \frac{\text{KvAR}}{2\pi f V} = \frac{112}{2\pi \times 50 \times 415^2}$$

$$= 8.6 \times 10^{-4} \text{ C/.}$$

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Question 2:

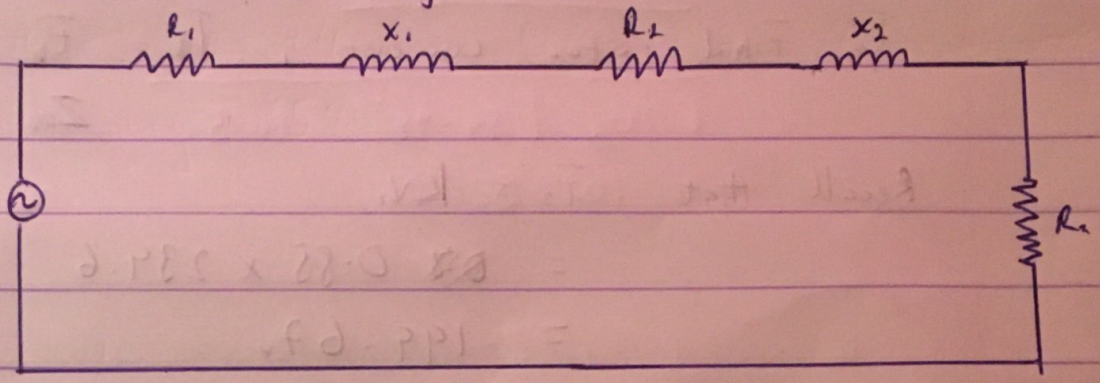
$V = 415\ v$

$h = \frac{5}{6} = 0.83$

No of poles = 6

$Z_1 = 0.25 + j0.75$ ---- Stator

$Z_2 = 1.173 + j0.52$ ---- rotor



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

For rotor

$R_{o2} = [R_2 + h^2 R_1]$

$= [1.173 + [\frac{5}{6}]^2 \times 0.25]$

$R_{O2} = 1.347\ \Omega$

$X_{o2} = [X_2 + h^2 X_1]$

$= j[0.52 + [\frac{5}{6}]^2 \times 0.75]$

$X_{o2} = j1.041\ \Omega$

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$Z_{o2} = R_{o2} + X_{o2}$

$= 1.347 + j1.041$

$Z_{o2} = \sqrt{1.347^2 + j1.041^2}$

$= 1.7\Omega$

To find rotor current, $I_2 = \frac{\bar{E}_2}{Z_{o2}}$

Recall that $\bar{I}_2 = KV_1$

$= 0.85 \times 239.6$

$= 199.67v$

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

Question 3)

$F = 50Hz$, $\frac{1}{4}Hp$, $N_{dc} = 2000rpm$

$V = 220v$, $R = 150\Omega$ and $L = 0.25H$

DC supply

Supply voltage = 220v

Current draws, $I = 0.7A$

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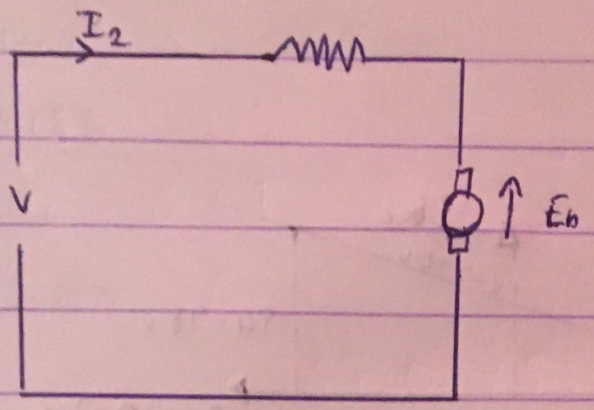

$V - E_b = I_2 * R$

$V - [I_2 \times R] = E_b$

$E_b = 220 - [0.7 \times 15]$

$= 209.5\ V$

Speed on DC supply

$N_{dc} = 2000\ rpm$

On AC supply

Supply voltage = 220v

Current drain, $I = 0.7A$

Reactance drop $= I_2 \times R = 0.7 \times 15 = 10.5v$

Reactance voltage drop $= I_2 \times X_L = 0.7 \times 2\pi fL$

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

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

$= 54.98\ v$.

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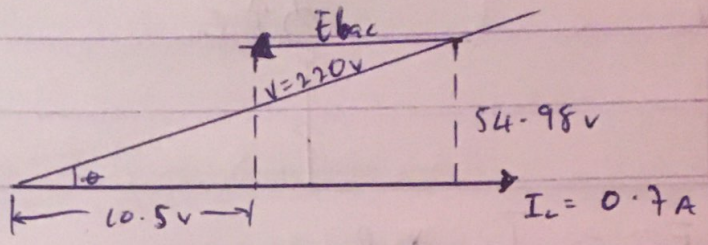

$$E_{bac} = \sqrt{V^2 - [X_L]^2} - IR$$

$$= \sqrt{[220]^2 - [54.98]^2} - 10.5v$$

$$= 202.52\ v$$

(i) Recall speed constant equation

$$\frac{N_2}{N_1} = \frac{\bar{E}_{b2}}{\bar{E}_{b1}}$$

Therefore; $\frac{\bar{E}_{bac}}{\bar{E}_{bdc}} = \frac{N_{ac}}{N_{dc}}$

Making N_{ac} subject of the formular

$$N_{ac} = N_{dc} \times \frac{\bar{E}_{bac}}{\bar{E}_{bdc}}$$

$$= 2000 \times \frac{202.52\ v}{209.5\ v}$$

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

(ii) Power factor, $\cos\theta = \bar{E}_{bac} + IR / V$

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(f)

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

$$= 0.968 \text{ lagging} //$$

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

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

where w is speed in rad/s

$w = 2\pi n$; where n is speed in rev/s

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

$$= \frac{202.52 \times 0.7 \times 60}{2\pi \times 1733.37}$$

$$= 0.700 \text{ Nm} //$$

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