ASADU CHUKWUEBUKA
17/ENG06/012

MECHANICAL

(7)

QUESTION THREE

$F = 50Hz$, $1/4hp$

$N = 2000rpm$

$V = 220V$

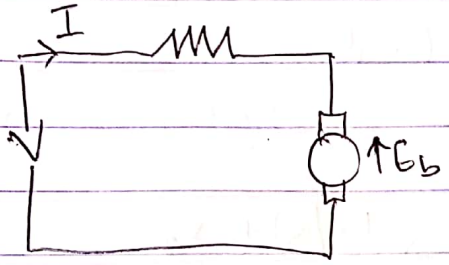
$R = 15\Omega$

$X = 0.25H$

On DC supply

Supply volt = 220V

current draws = 0.7A



$V - E_b = I_L \times R$

$E_b = V - [R \cdot I_L]$

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

$= 209.5V$

~~(a) Speed of motor~~

Speed on DC

$N_{dc} = 2000rpm$

On AC supply

Supply voltage = 220V

current, $I_L = 0.7A$

Reactance drop $= I_L \times R$

$= 0.7 \times 15$

$= 10.5V$

Reactance voltage drop

$= I_L \times X_L$

$= 0.7 \times 2\pi fL$

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

$= 54.98V$

$$E_{bac} = \sqrt{V^2 - (X_L)^2} - I_L \cdot R$$

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

$= 202.52V$

(i) Rel speed eqn

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

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

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

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

$N_{ac} = 1933.37rpm$

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(ii) power factor, $\cos\phi$

$= \frac{E_{bac} + IR}{V}$

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

$= \underline{0.968}$

(iii) Torque developed

$T_w = E_{bac} \times I$

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

$w = 2\pi n$

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

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

$= \underline{0.70\ Nm}$

(iv) Universal motor

(2)

QUESTION TWO

$V_{L-L} = 415V$

No. of poles = 6

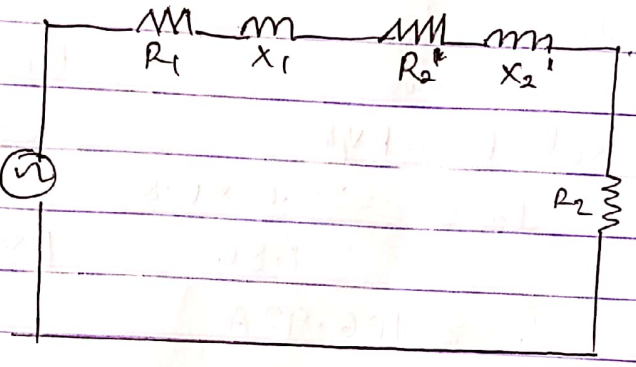
$F = 50Hz$

$k = 5/6 = 0.83$

$Z_1 = 0.25 + j0.75\Omega$

$Z_2 = 1.173 + j0.52\Omega$

a) Diagram



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

$= 239.6V$

Referring to rotor

$R_{O2} = R_2 + k^2 R_1$

$= 1.173 + (0.83)^2 (0.25)$

$= 1.35\Omega$

$X_{O2} = X_2 + k^2 X_1$

$= j(0.52 + 0.75(\frac{5}{6})^2)$

$= j1.04\Omega$

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(3)

QUESTION TWO CTD

$Z_{o1} = \sqrt{R_{o1}^2 + X_{o1}^2}$

2

$Z_{o2} = 1.54 + j1.04$

$= \sqrt{1.54^2 + 1.04^2}$

$= 1.86\ \Omega$

(ii) Rotor current

$I_2 = \frac{E_{o2}}{Z_{o2}}$

Rel $E_{o2} = kV_1$

$I_2 = \frac{239.6 \times 0.83}{1.86}$

$I_2 = 106.92A$

QUESTION ONE

$V = 415V$

4-wire

3ϕ

$F = 50Hz$

$P = 74.6KW$

$p.f = 0.7$

$eff = 85\%$

B) Unity = 1

$C = \frac{KVAR}{2\pi FV^2}$

KVAR = P x (tan actual p.f − tan target p.f)

Actual p.f $\Rightarrow \cos\theta = 0.7$

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

$= 45.57$

$\tan 45.57 = 1.0201$

Target p.f $\Rightarrow \cos\theta = 1$

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

$= 0$

$\tan 0 = 0$

$KVAR = 74.6 \times (1.0201 - 0)$

$= 76.0995$

≈ 76.10

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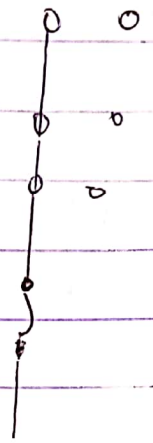
(4) (4)

QUESTION 4 (a)

$$C = \frac{76.10}{2\pi \times 50 \times 415^2}$$

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



(ii) 0.9 lagging

actual p.f = 1.201

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

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

$= 154.16$

$\tan(154.16) = -0.48$

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

$= 111.90$

$$C = \frac{111.90}{2\pi \times 50 \times 415^2}$$

$$= 2.068 \times 10^{-6} C$$

A) The drive motor is the ~~induction~~ shaded pole motor