17/ENG06/038

MECHANICAL ENG

300L.

ELECTRICAL MACHINES.

①

V = 4154, 3-ϕ, 4 wire, f = 50Hz P = 74.6 MW

P.f = 0.7 eff = 85%

(a) unity = 1

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

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

actual p.f = $\cos\theta = 0.7$

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

$= 45.57$

$\tan(45.57) = 1.021$

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

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

$\tan 0 = 0$

KVAR = 74.6 × (1.201 − 0)

≈ 76.10

~~C = 76.10 / (2π × 50 × 415²) = 1.40 × 10⁻⁶ C~~

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

$C = \frac{76.10}{18035359.83}$

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

~~$C = \frac{76.10}{2\pi \times 50 \times \left(\frac{415}{\sqrt{3}}\right)^2} =$~~ ~~76~~

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4) 0.9 lagging

actual p-f = 1.0201

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

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

$= 154.16$

$\tan\theta = -0.48$

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

$= 111.90$

$\simeq 112_{//}$

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

$= \frac{112}{2\pi \times 50 \times 415^2}$ $= 7.07 \times 10^{-6} C$

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

$= \frac{112}{2\pi \times 5 \times \left(\frac{415}{\sqrt{2}}\right)^2}$

$= 6.21 \times 10^{-5} C$

Type of motor

3-phase induction motor.

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QUESTION 3 MECH ENG

3 801

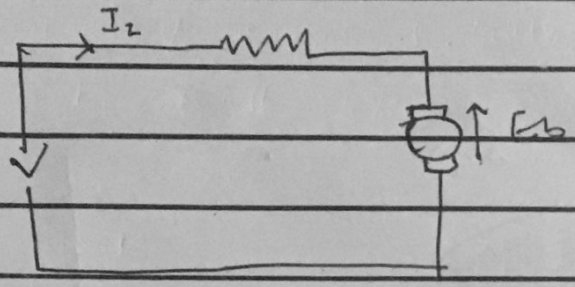
$f = 50Hz$, $1/4hp$, $N_s = 2000rpm$, $V = 220V$

15Ω and $0.25H$

On Dc supply

Supply voltage = 220V

Current draws, $I = 0.7A$



$V - E_b = I_L \times R$

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

$E_b = 220 - [0.7 * 15]$

$= 209.5V$

Speed on DC;

$N_{dc} = 2000rpm$

On Ac Supply

Supply voltage = 220V

Current drawn, $I_L = 0.7A$

Reactance drop $= I_L * R = 0.7 \times 15 = 10.5V$

Reactance voltage drop $= I_L \times X_L$

$= 0.7 \times 2\pi fL$

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

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

$= 54.98V$

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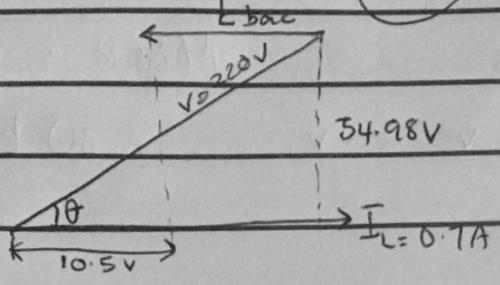

$$E_{bac} = \sqrt{V^2 - [X_L]^2} - I_R$$

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

$$= 202.52\,V$$

(i) Speed of the motor

Recall speed constant equation

$$\frac{N_2}{N_1} = \frac{E_{b_2}}{E_{b_1}}$$

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

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

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

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

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

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

$$= 0.9682 \quad \text{(Lagging)}$$

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

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

where w is speed in rad/s

$w = 2\pi n$

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

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

$T_{ac} = 0.700\ Nm$ //

iv) Universal motor

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QUESTION 2

$V_{(L-L)} = 415V$

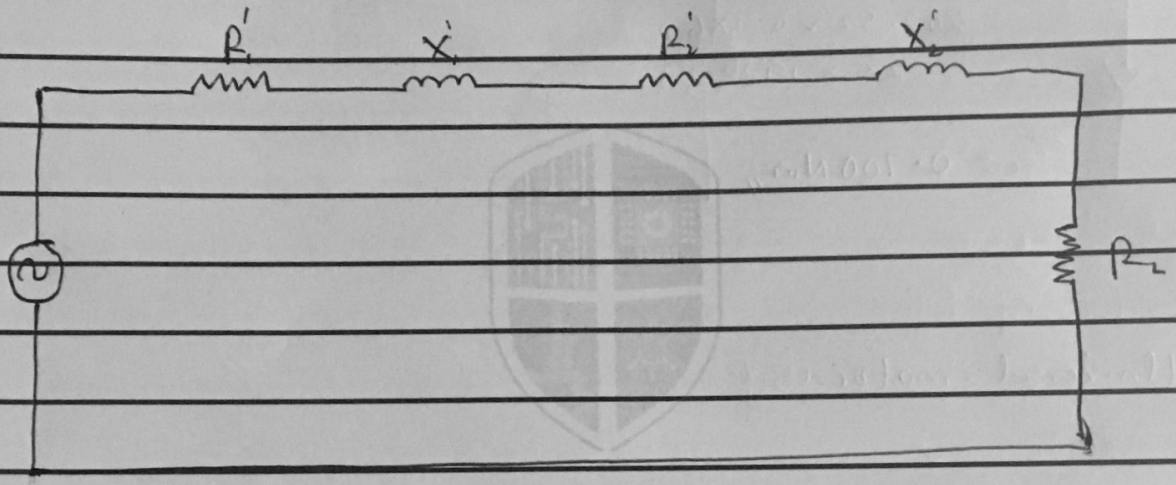
No of poles = 6

$f = 50Hz$

$K = 5/6 =$

$Z_1 = 0.25 + j0.75$ ——— stator

$Z_2 = 1.173 + j0.52$ ——— rotor



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

Referring to rotor

$R_{o_1} = (R_a + K^2 R_1)$

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

$R_{o_1} = 1.347\Omega$

$X_{o_2} = (X_2 + K^2 X_1)$

$= j(0.52 + (5/6)^2 \times 0.75)$

$= 1.041\Omega$

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$Z_{o_2} = R_{o_2} + X_{o_2}$

$= 1.347 + j1.041$

$Z_{o_2} = \sqrt{1.347^2 + 1.041^2}$

$= 1.70\,\Omega$

To find rotor current, I_2

$$I_2 = \frac{E_2}{Z_{o_2}}$$

Recall; $E_2 = kV_1$

$= 239.6 \times 0.833$

$= 199.58\,V$

$$\therefore I_2 = \frac{199.58\,V}{170} = 117.4\,A$$