17-6-2020 17/ENG06/010

Mechanical engineering.

(1.) $V = 415V$,

$f = 50Hz$.

$P = 74.6$.

$Pf = 0.7$.

efficiency = 85%.

3-ϕ

∴ unity = 1.

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

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

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

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

$= 45.57$. ∴ $\tan 45.57 = 1.0201$.

target P.f = $\cos\theta = 0.1$.

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

$\tan \theta = 0$.

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

$= 76.14$.

$$C = \frac{76.1}{2\pi \times 50 \times 415^2}.$$

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= 0.0000014

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

ii) 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 × (1.0201 + 0.48)

= 111.90

= 112.

$C = \frac{KVAR}{2\pi f v}$

$= \frac{111.90}{2\pi \times 50 \times 415^2}$ $\frac{112}{2\pi \times 50 \times 415^2}$

$= 2.071 \times 10^{-6}$

3. $f = 50hz$ $\frac{1}{4}hp$

$N_L = 2000rpm.$

$V = 220$

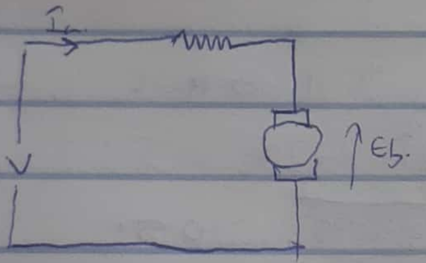
resistance = 15Ω

inductance = 0.25h.

On DC supply

Supply voltage = 220

Current drawn = 0.7A.



$V - Eb = I_L \times R.$

$V - (I_L \times R) = Eb.$

$Eb = 220 - (0.7 \times 15).$

$= 209.5v.$

Speed on Dc.

$N_{dc} = 2000rpm$

On A.C supply

Supply voltage = 220V.

Current drawn $I_L = 0.7A.$

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

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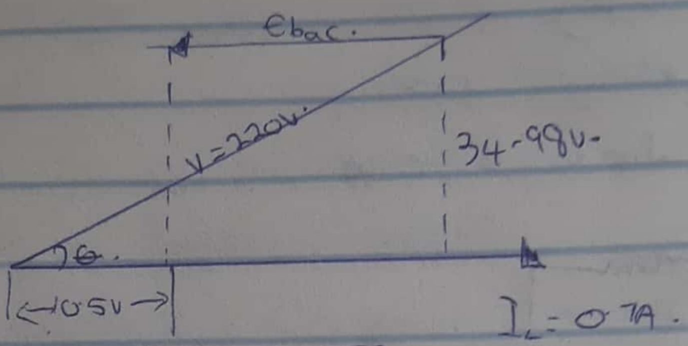
Reactance voltage drop = $I_L \times X_L$

$= 0.7 \times 2\pi f L$

where $X_L = jWL = 2\pi f L$

$= 0.7 \times 2 \times 3.14 \times 50 \times 0.25$

$= 54.98V$



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

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

$= 202.52V$

recall

$\frac{N_2}{N_1} = \frac{Eb_a}{Eb_1}$

$\therefore \frac{Ebac}{Ebdc} = \frac{Nac}{Ndc}$

making Nac subject of formular.

$Nac = Ndc \times \frac{Ebac}{Ebdc}$

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

$N_{ac} = 1933.37 rpm$

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

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

$= 0.97$ lagging

iii Torque developed $\tau\omega = E_{bac} \times I$

$\tau_{ac} = \frac{E_{bac} \times I}{\omega}$

where ω = speed in rad/secs

$\omega = 2\pi n$

where n = sped in rev/sec

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

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

$= 0.7 Nm$

iv Universal motor.

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2. No of poles = 6.

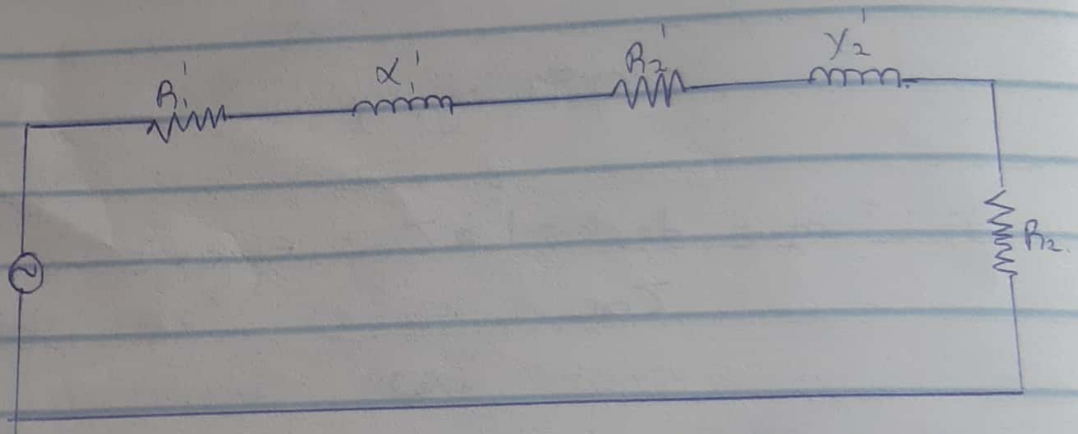
$f = 50Hz$.

$V = 415V$

$K = 5/6 = 0.83$

$Z_1 = 0.25 + j0.75$ for stator.

$Z_2 = 1.713 + j0.52$ for rotor.



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

wrt the rotor.

$R_{02} = (R_2 + K^2 R_1)(0.83)^2$.

$= (1.173 + (0.83)^2 \times 0.25)$.

$R_{02} = 1.347 \Omega$.

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

$= (0.52 + (0.83)^2 \times 0.75)$

$= 1.041$

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

$= 1.533 + j1.6$

$Z_{02} = \sqrt{1.533^2 + 1.6^2}$

$= 2.22\,\Omega$.

$= 1.347 + j\,1.041$

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

$= 1.7\,\Omega$.

To find rotor current

$I_2 = \dfrac{E_2}{Z_{02}}$.

Recall $E_2 = KV_1$

$= 329.6 \times 0.83$

$= 199.67\,V$.

$\therefore I_2 = \dfrac{199.67}{1.7} = 117.5\,A$//.