171ENG06/1084

MECHANICAL ENGINEERING

V = 415V, 4-wire, f = 50Hz, P = 74.6 pf = 0.7,

% eff = 85%

1) unity = 1

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

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~~ $\tan(45.57) = 1.0201$

target pf = $\cos\theta = 1$

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

$\tan\theta = 0$

kVAR = 74.6 x (1.0201 − 0)

= 76.10

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

$= 0.0000014$

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

0.9 lagging

actual P.f = 1.0201

target p.f = Cos = 0.9

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

$= 54.16$

$\tan\theta = 0.48$

kVAR = 74.6 x (1.0201 − (−0.48))

= 111.90

= 112

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

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

$= 0.00056$

$3.6 \times 10^{-4} C$

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MECHANICAL ~~ENGINEERING~~ ENGINEERING

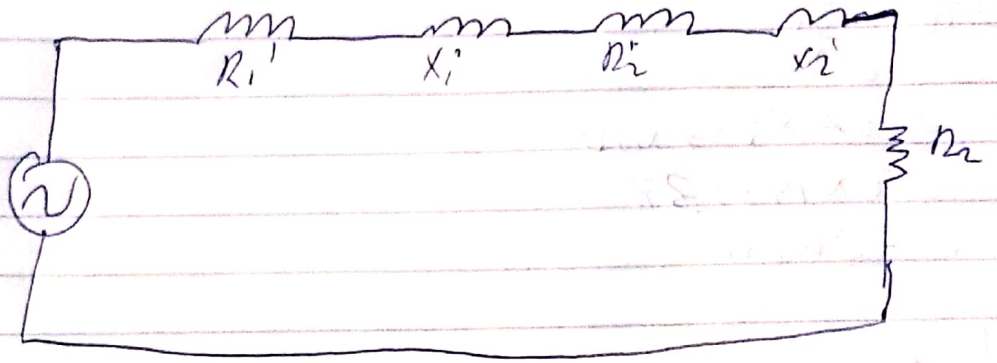
2) No. of poles = 6

$f = 50Hz$

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

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

$Z_2 = 1.73 + j0.52$ --- Rotor



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

$= 239.60V$

Referring to rotor

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

$= (1.173 + (\frac{5}{6})^2 \times 0.25)$

$R_0 = 1.347\Omega$

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

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

$= 1.041$

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

$= 1.547 + j1.041$

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

$Z_{02} = 1.7$

To find rotor current

$I_2 = \frac{E_2}{Z_{02}}$

Recall that $E_2 = kV_1$

$= 239.6 \times 0.85$

$= 199.67V$

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

12/ENG06/024

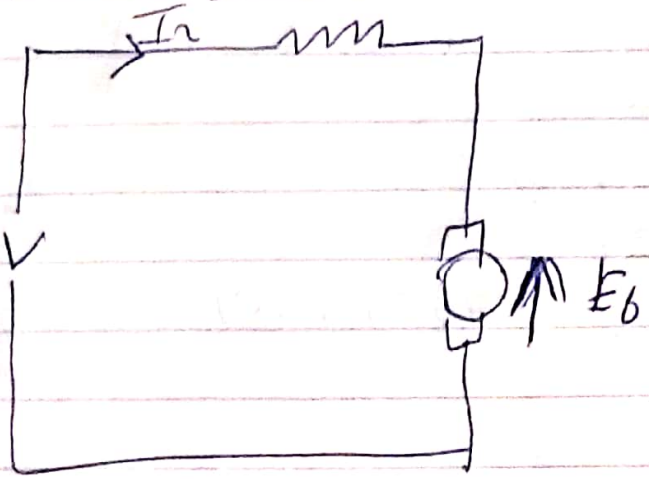
MECHANICAL ENGINEERING

3) f = 50Hz ½hp N_2 = 2000rpm, V = 220V

On DC Supply

Supply voltage = 220V

Constant down I = 0.7A



$V - E_b = I_L * R$

$V - [I_2 * R] = E_b$

$E_b = 220 - [0.7 * 15]$

$= 209.5V$

Speed on DC

$N_{dc} = 2000rpm$

On AC Supply

Reactance drop = $I_L * R = 0.7$

$= 10.5V$

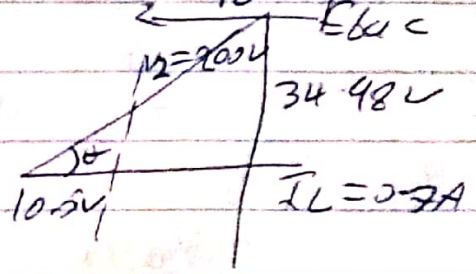
Reactance voltage drop = $I_L \times X_L$

$= 0.7 \times 2\pi f L$

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

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

$= 54.98V$



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

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

$= 202.52V$

i) Recall Speed Constants equation

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

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

making N_{ac} Subject of the formular

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

$$= 200 \times \frac{202.52V}{209.5V}$$

$N_{ac} = 1933.37$rpm

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

ω is speed in radis

$\omega = 2\pi(n)$ where n is

$T_{ac} = E_{bac} \times I_L$

$= \frac{2\pi \times N_{ac}}{60}$

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

$= 0.700 Nm$

3.iv) ~~universal~~ universal motor