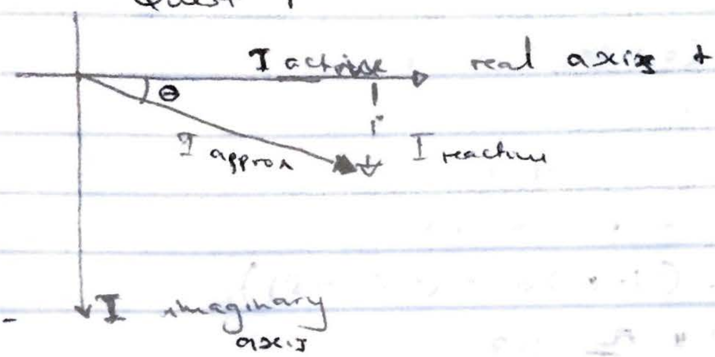
MATRIC NUMBER : 18/ENG 04/051

DEPARTMENT : Elect/Elect Eng

LEVEL : 300

Quest 1



V = 415V, 3-ϕ, 4 wire f - 50 Hz , P = 74.6

cos θ = 0.7 , % efficiency = 85%

4 wire - Y - connection

$V_L = 415$ & $V_L = \sqrt{3}\, V_P$

$\therefore V_P = V_L/\sqrt{3} = 415/\sqrt{3}$

$= 239.600$ V ≈ 239.6 V

i) Unity of

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

Recall

KVAR = P (tan actual pf - tan target p.f)

actual p.f = cos θ = 0.7

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

$= 45.57$

$\therefore \tan 45.57 = 1.0201$

target pf = cos θ = 1

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

$\theta = 0$

$\therefore \tan 0 = 0$

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

~~Recalling KVAR~~

$$KVAR = \frac{74.6(1.0201 - 0)}{2\pi \times 50 \times (239.600)^2}$$

$= 4.2195 \times 10^{-6}$ F

0.9 lagg = 0.9

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

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

$\theta = 154.16$

$\tan = -0.48$

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

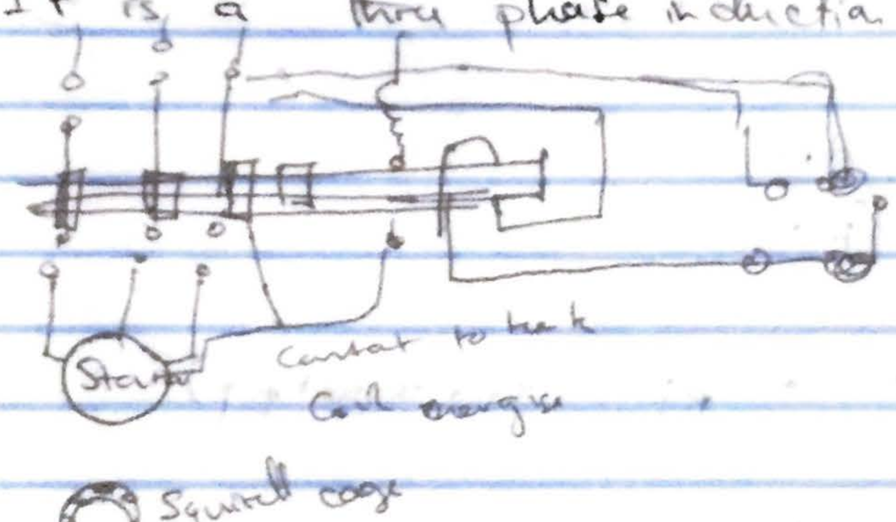
$= 111.9 \approx 112$

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

$= \frac{112}{2\pi \times 50 \times (2376)^2}$

$= 6.2 \times 10^{-6}$ F

It is a three phase induction motor



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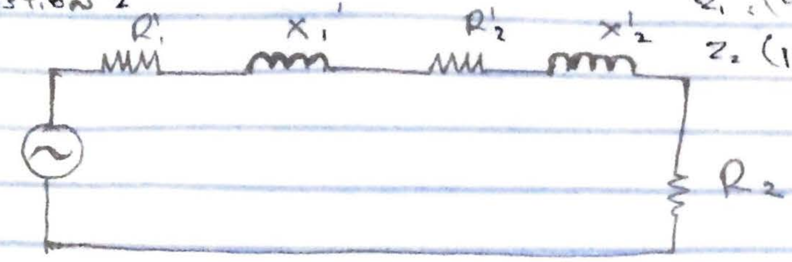
$V_L = 415$, No of poles $= 6$, $f = 50Hz$, $k = 5/6 = 0.83$

QUESTION 2

$Z_1 = (0.25 + j0.75)$ Stator

$Z_2 = (1.173 + j0.52)$ rotor



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

Re[illegible]ing to the rotor

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

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

$R_{02} = 1.347\,\Omega$

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

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

$= j1.047$

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

$= 1.347 + j1.041$

$Z_{02} = \sqrt{1.347 + j1.041}$

$= 1.7\,\Omega$

To find rotor current recall

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

Recall $E_2 = kV$

$= 239.6 \times 0.83$

$= 199.67V$

$\therefore$ ~~[illegible]~~ $I_2 = \frac{199.67}{1.7} =$ ~~117.45A~~ $117.453A$

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QUESTION 3

~~a~~ ~~Dc~~ Supply

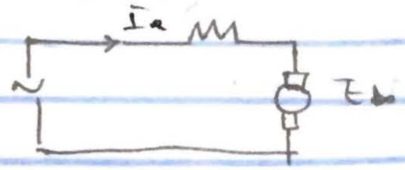
$f = 50Hz$ 1/2 hp, $N_s = 2000rpm$ $V = 220V$

$R = 15\Omega$ and $X = 0.25H$

On DC supply

Supply voltage = 220V.

current drawn $I = 0.7A$



$V - E_b = I_2 \times R$

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

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

$= 209.5V.$

Speed on Dc

$N_{dc} = 2000rpm$

On AC supply

Supply voltage = 220V

Current drawn $I_L = 0.7A$

Reactance drop $= I_L \times R = 0.7 \times 15$

$= 10.5V$

Reactance voltage drop $= I_L \times X_L$

~~where~~ $= 0.7 \times 2\pi f L$

where $XL = j\omega L = 2\pi f L$

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

$= 54.98V$

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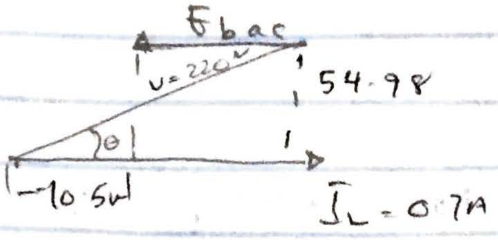

$$\therefore E_{bac} = \sqrt{V^2 - [X]^2} - IR$$

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

$$= 202.52V.$$

i) Recalling that speed constant, equation

$$\frac{N_2}{N_1} = \frac{Eb_2}{Eb_1}$$

making Nac subject of the formular

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

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

$$\therefore N_{ac} = 1933.37 \text{ rpm}$$

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

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

$$= 0.968 \text{ (lagging)}$$

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3) The torque developed $T\omega = E_{bac} \times I$

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

where ω is speed in rad/s

Recalling $\omega = 2\pi n$ where n = speed (rpm)

$$\therefore \quad T_{ac} = \frac{E_{bac} \times I_L}{2\pi \times \frac{N_a}{60}}$$

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

$$= 0.700 \text{ Nm}$$

ii) ~~It is~~ A universal motor can be used.