Name: Ineobedion Andrew Odigie
Department: Electrical/Electronics Engineering.
Matric no: 17/ENG04H033 300 LEVEL

Question 1

ABUAD mango juice factory is serviced by a 415V, 3-phase, 4-wire, 50 Hz. This supply powers the main drive motor having an output of 74.6Kw and running on full load at a power factor of 0.7 lagging with an efficiency of 85%.

Identify the drive motor type and sketch the motor-supply circuit with a direct-online starter [5 marks]

Determine the capacitance per phase of a mesh-connected capacitor necessary to raise the power factor to

a) Unity.

b) 0.9 lagging [10 marks].

Sketch the phasor diagram using an appropriate scale showing the compound values of currents [5marks].

Solution

$V = 415V$, $3-\phi$, 4-wire, $f = 50Hz$, $P = 74.6$

$p.f = 0.7$, $\%\eta = 85\%$.

(b)

(i) unity $= I$

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

$\Rightarrow K_{VAR} = P\,(\tan \text{actual } p.f - \tan \text{target } p.f)$

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

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

$= 45.57$

$\tan(45.57) = 1.0201$.

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

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

Enegbedion Andrew Odigie
#ENG04/033.

Tan θ = 0
KvAR = 74.6 × (1.0201 − 0)
= 76.0995.
≈ 76.10

C = 76.10 / 2πf × 60 × 415²
= 0.0000014.
≈ 1.4 × 10⁻⁶ C.
(ii)

0.9 lagging.
actual p.f = 1.0201
target p.f = cos θ = −0.9
θ = cos⁻¹(−0.9)
= 154.16
tan θ = −0.48.

KvAR = 74.6 × (1.0201 − (0.48))
= 111.90
≈ 112

C = KvAR / 2πfv
= 112 / 2π × 60 × 415²
= 0.0086
≈ 8.6 × 10⁻⁴ C //

Name: Inegbedion Andrew Obigie
Department: Electrical/Electronics Engineering
Matric no: 17/ENG01/033 300 level.

Question 1

A 25 hp, 415V (Line-Line), 6-pole, 50Hz, star-star connected, 3-phase induction motor has used in the production factory of PZ cussons Stator/rotor phase voltage ratio of 6/5. The stator and rotor impedances per phase are $(0.25 + j0.75)$ ohms and $(1.73 + j0.52)$ ohms respectively using the approximate circuit version 2 referred to the rotor side ~~of~~ at a slip of unity. find the following.

(i) Draw the equivalent circuit diagram referred to the rotor side (version 2) [2 marks]

(ii) Rotor (Secondary) current: I_2 [8 marks]

solution

$V_{ll} = 415V$

No of poles = 6

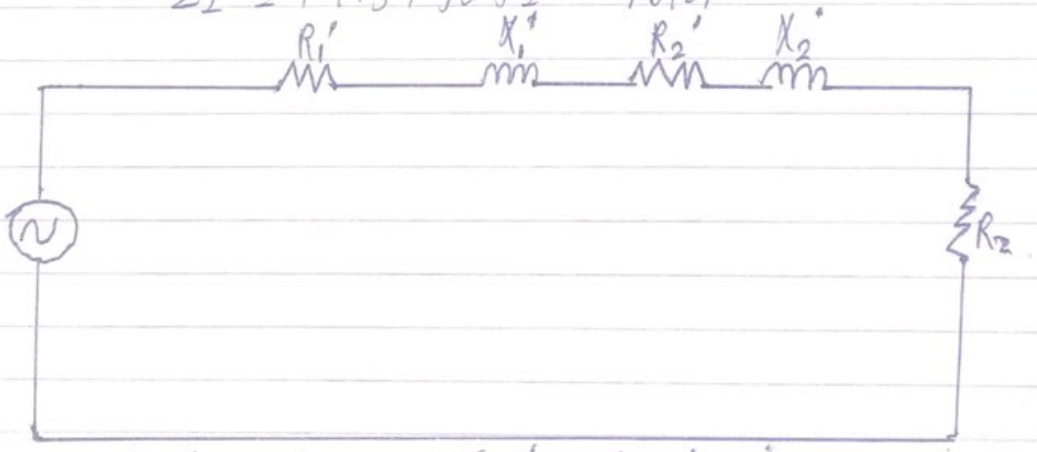
$f = 50Hz$

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

$Z_1 = 0.25 + j0.75$ - stator

$Z_2 = 1.73 + j0.52$ - rotor

(i)



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

Referring to rotor

Inegbedion Andrew Otigie.
17/ENG04/083

(11)

$R_{02} = (R_2 + K^2 R_1)$
$= (1.173 + (5/6)^2 \times 0.25)$
$R_{02} = 1.347\Omega$

$X_{02} = (X_2 + K^2 X_1)$
$= j(0.52 + (5/6)^2 \times 0.75)$
$= 1.041$

$Z_{02} = R_{02} + X_{02}$
$= 1.347 + j1.041$
$Z_{02} = \sqrt{1.347^2 + 1.041^2}$
$= 1.7\Omega$

To find rotor current

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

Recall that $E_2 = KV_1$
$= 239.6 \times 0.83$
$= 199.67V$

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

Name: Ineghedion Andrew Odigie.
Department: Electrical/Electronics Engineering.
Matric no: 17/ENG04/033. 300 level

Question 3.

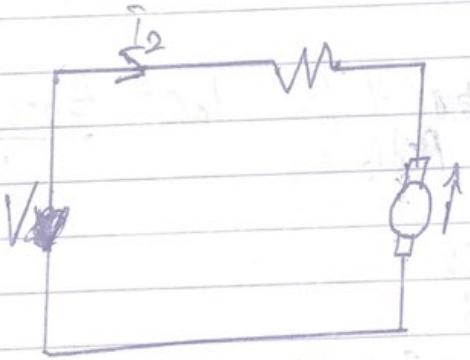
A 50Hz, 1/4hp motor runs at 2000rpm and takes 0.7A when connected to a 220v Dc source. If the resistance and inductance of the machine are given as respectively. Determine the following when the motor is connected to a 220V, 50Hz AC supply and is loaded to take 0.7A of current;

(i) speed of the motor.
(ii) The power factor of the motor
(iii) Torque developed by the motor
(iv) What type of motor could be used for this application?

Solution.

F = 50Hz, 1/4hp, N_f = 2000rpm, V = 220
15Ω and 0.25H

On Dc supply.
Supply voltage = 220V
Current draws, I = 0.7A



$V - E_b = I_2 * R$
$V - [I_2 * R] = E_b$
$E_b = 220 - [0.7 * 15]$ = 209.5V
Speed on Dc, N_{do} = 2000rpm

Ineghedion Andrew Odigie 17/ENG04/033

(3I)

Recall ~~the~~ Speed · constants equation

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

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

Making N_{ac} Subject of the formular

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

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

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

(3II)

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

$$= \frac{202.52 + 10}{220}$$

$$= 0.968$$ ~~lagging~~ lagging

(3III)

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

∴ where w is speed in Rad/s

On Ac supply.

Supply voltage = 220V

Current drain, $I_2 = 0.7A$

Resistance ~~drop~~ drop $= I_2 * R = 0.7 \times 15 =$

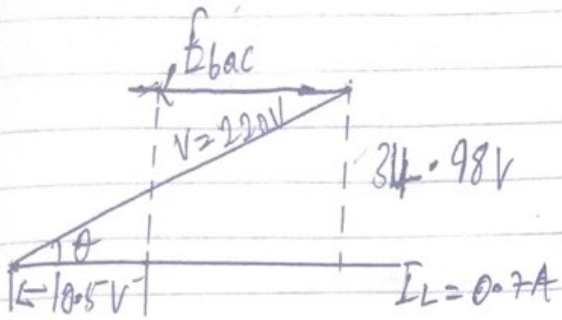
$= 10.5V$

Where $X_L = j\omega L \times 2\pi fL$

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

Ineghedion Andrew Odigie
171ENG04/033

$= 54.98V$



$$E_{bac} = \sqrt{V^2 - [X_L]^2} - IR$$
$$= \sqrt{(220)^2 - (54.98)^2} - 10.5V$$
$$= 202.52V$$