17/ENG04/025 300 Level
Electrical/Electronics Engineering
EEE 326 Test

1. Ahmed Mayo owns a factory is served by a
V_L 415V
3φ 4 wire
f = 50Hz
output power = 76.4kw.
power factor = 0.7 lagging
efficiency = 85%

(a) Unity = 1
$C = \frac{KVAR}{2\pi f V^2}$
→ KVAR = P × (tan of actual pf − tan target pf)
actual p.f ⇒ $\cos\theta = 0.7$
$\theta = \cos^{-1} 0.7$
$= 43.57$
$\tan(43.57) = 1.0201$

target p.f → $\cos\theta = 1$
$\theta = \cos^{-1} 1 = 0$
$\tan\theta = 0$
KVAR = 74.6 × (1.0201 − 0)
= 76.0995
= 76.1

c. $\frac{76.1}{2\pi \times 50 \times 415^2}$
= 0.000014
$= 1.4 \times 10^{-6} C$

0.9 lagging

actual pf = 1.0201

target pf = $\cos\theta = -0.9$

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

$= 154.16$

$\tan\theta = -0.48$

KVAR = 74.6 × (1.0201 − 1.048)

= 111.90

= 112

$\frac{KVAR}{2\pi f V}$

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

~~$= 0.00086$~~

~~$= 8.6 \times 10^{-4}\,C$~~

$= \frac{112}{2\pi \times 50 \times 239.6^2}$

$\doteq 0.0000062$

$= 62 \times 10^{-6}\,C$ //

$V_{line} = 415V$

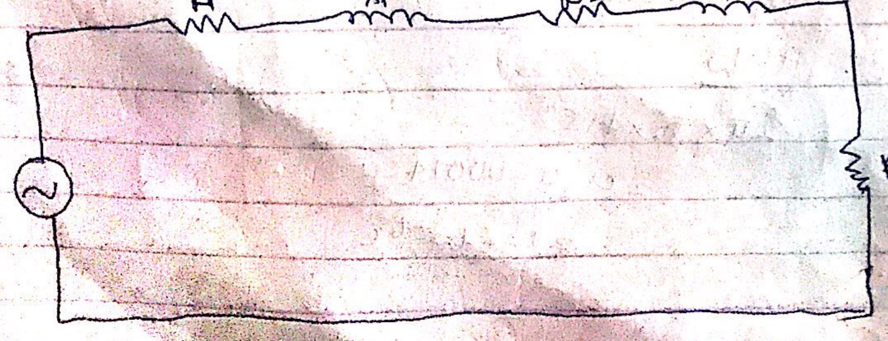
no of poles = 6

f = 50 Hz.

k = 5/6 = 0.83

R = $Z_1 = 0.25 + j0.75$ —— stator

$Z_2 = 1.173 + j0.52$ —— rotor.



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Supply voltage per phase, $V = \frac{415}{\sqrt{3}} = 239.50V$

referring to stator.

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

$= (1.143 + (5/6)^2 \times 0.25)$

$R_{02} = 1.347\Omega$

$X_{02} = (X_2 + K^2 R_1)$

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

$R_{02} = 1.347\Omega$

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

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

$= 1.041$

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

$= 1.3471 + j1.041$

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

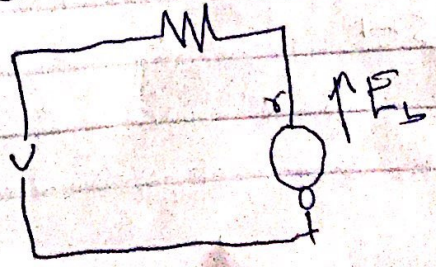
$= 1.7\Omega$

(3). $f = 50Hz$, $1/4$ hp; $N_3 = 2000$ rpm, $V = 220V$ DC, $R_2 = 15\Omega$, $I_2 = 0.25A$

a DC supply

Supply voltage = 220V

Current drawn, $I = 0.7A$



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$V - E_b = I_2 \times R$

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

$E_b = 220 - [0.7 * 15]$

$= 209.5V$

Speed on DC motor

$N_b = 2000 rpm$

on AC supply

Supply voltage = 220V

Current drawn $I = 0.7A$

Reactance drop $= I * R = 0.7 \times 15$

$= 10.5V$

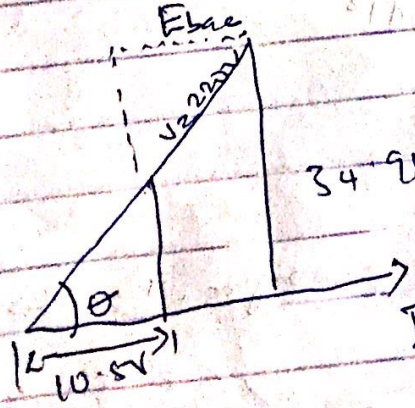
Reactance voltage drop $= I_2 \times X_2$

$= 0.7 \times 2\pi fL$

Where $X_2 = \omega L = 2\pi fL$

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

$= 34.98V$



$E_{back} = \sqrt{V^2 - [X]^2}$ — IR

$= \sqrt{(220)^2 - (34.98)^2} - 10.5V$

$202.52V$

A Universal Motor can be used for this application

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NO. 3 Continuation

c) Rated speed = Constant equation.

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

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

Making N_{ac} subject of the formular.

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

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

$N_{ac} = 1933.37 rpm.$

d) power factor, $\cos\phi = \frac{E_{bac} + I_a}{V}$

$$= \frac{202.52 + 0.5}{220}$$

$= 0.968$ Lagging

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

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

where ω is speed in rad/s

$\omega = 2\pi n$, where n is speed in ~~revolution/min~~

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

$$= \frac{202.52 \times 0.7 \times 60}{2\pi \times 1933.37} = 0.700 Nm.$$