Test

Name: IJIGA OBEKPA

Mat No: 17/ENG04/030

Course Code: EEE 326

Course Title: ELECTRICAL MACHINES 2

Date: 17/06/20

Answer

①

V = 415V, 3-Ø, 4-wire

f = 50Hz, P = 74.6, P.f = 0.7

% eff = 85%

i.) Unity = 1

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

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

actual P.f ⇒ Cos θ = 0.7

θ = cos⁻¹ 0.7

= 45.57

tan (45.57) = 1.0201

target P.f ⇒ cos θ = 1

θ = cos⁻¹ 1 = 0

tan 0 = 0

KVAR = 74.6 × (1.0201 − 0)

= 76.10

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

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(1)

$= 0.0000014$

$\simeq 1.4 \times 10^{-6}$ C/f

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

$= 111.90$

$\simeq 112$

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

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

$= 0.00086$

$\simeq 8.6 \times 10^{-4}$ C/f

(1) $V = 415V$

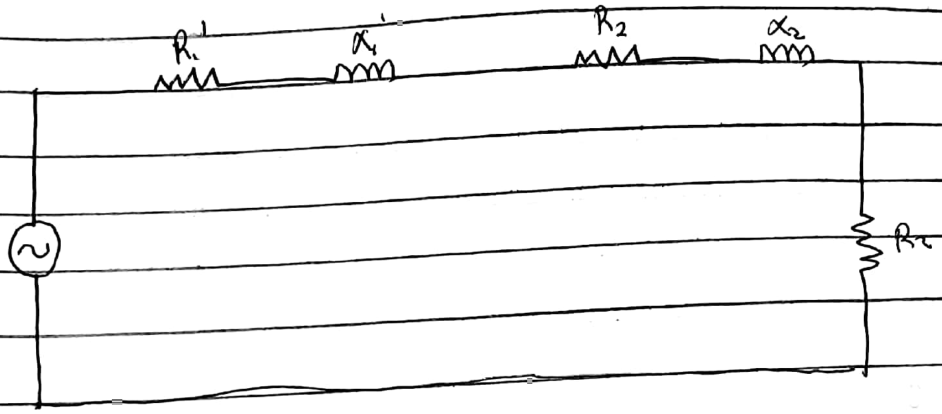
No of poles = 6

$f = 50Hz$

$K = 5/6 = 0.83$

$R = Z_1 = 0.25 + j0.75$ — (Stator)

$Z_2 = 1.173 + j0.52$ — (Rotor)



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

The Rotor

$R_O = (R_2 + k^2 R_1)$

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

$R_{O_2} = 1.347 \Omega$

$X_{O_2} = (X_2 + k^2 x_1)$

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

$X_{O_2} = 1.041$

$Z_{O_2} = R_{O_2} + X_{O_2}$

$= 1.347 + j1.041$

$Z_{O_2} = \sqrt{1.347^2 + 1.041^2}$

$= 1.7 \Omega$

(2)

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(ii) To get the rotor current

$= I_2 = \frac{E_2}{Z_2}$

Recall $E_2 = KV_1$

$= 239.6 \times 0.85$

$= 199.67V$

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

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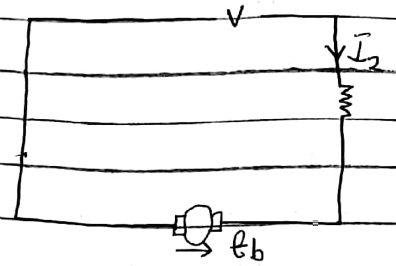
(3)

3) f = 50Hz ; 1/4 Hp ; N_2 = 2000 rpm ; V = 220 ;
~~150Ω~~ 15 Ω ; 0.25 H

The Dc Supply

Supply voltage : 220V

Current = 0.7A



∴ V − Eb = I_2 * R

V − [I_2 × R] = Eb

Eb = 220 − [0.7 × 15]

= 209.5V

Speed on Dc

On Ac Supply

Supply voltage = 220V

Current = 0.7A

Reactance drop = I_a × R = 0.7 × 15 = 10.5V

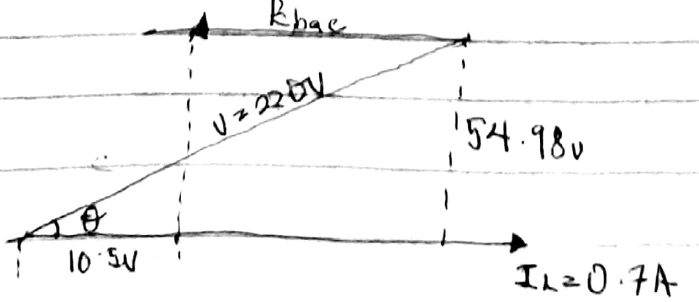
Reactance Voltage drop = I_2 × X_L

= 0.7 × 2πfL

In this case, X_L = jωL = 2πfL

= 0.7 × 2π × 50 × 0.25

= 54.98V//



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

(ii) Recall the speed constant equation

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

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

We make N_{ac} subject of the equation

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

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

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

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

$E_{bac} = 202.52$
$IR = 10.5$
$V = 220$

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

$$= 0.968 \text{ Lagging}$$

Torque developed = ~~9.55 × P~~ $T_w = E_{bac} \times I$

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

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

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

$$= 0.700Nm$$