17/ENG06/064. Olayide Ango Alex. (1)
Mechanical
300 Level.

Solution.

Question 1

Given data: Eff = 85%.
P. factor = 0.7.
f = 50Hz
P = 74.6
V = 415V

A.P.f = Actual power factor.
T.P.f = Target power factor.

(i) unity = 1

formula.

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

$$\therefore KVAR = P \times [(\tan A.P.f) - (\tan T.P.f)]$$

$$A.P.f = \cos\theta = 0.7$$

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

$$\theta = 45.57$$

$\therefore$ tangent of $45.57 = 1.0201$

$$T.P.F = \cos\theta = 1$$

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

$$\tan\theta, \tan 0 = 0$$

$$\therefore KVAR = 74.6 \times (\tan A.P.f - \tan T.P.f).$$

$$= 74.6 \times (1.0201 - 0).$$

$$= 76.0995.$$

$$= 76.10$$

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

$$C = \frac{76.10}{54,113,097.}$$

$$C = 0.0000014$$

(ii) A.p.f = 1.0201 Given = 0.9 lagging.

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

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

$= 154.16.$

$\tan\theta = -0.48.$

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

$= 111.90.$

Appro = 112 //.

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

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

$$= \frac{112}{54,113,097.}$$

$= 0.000002070$

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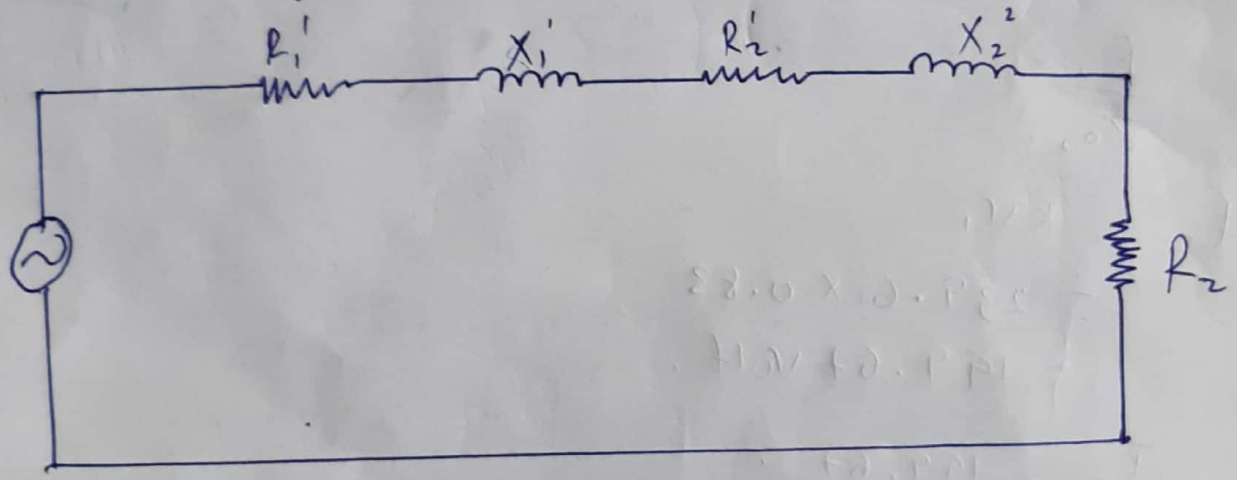
Electrical Machines II — Question (2)

Solutions:

(1) $V_1 = 415V$.
N. pole $= 6$.
$k = 0.83$.
$f = 50Hz$.
$R_x = Z_1 = 0.25 + j0.75$ for stator.
$= Z_2 = 1.173 + j0.52$ for rotor.

Diagram:



S.V per phase $V = \frac{415}{\sqrt{5}} = 239.60V$.

Rotor.

$R_{O_2} = (R_2 + k^2 R_1)$.
$= (1.173 + (5/6)^2 \times 0.25)$
$R_{O_2} = 1.347$ Ohms.

$X_{O_2} = (X_2 + k^2 X_1)$
$= j(0.52 + (5/6)^2 \times 0.75)$.
$= 1.041$ "

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

$= 1.347 + j1.041$.

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

$Z_{O_2} = 1.7$ ohms.

(ii) Rotor current.

$I_2 = \frac{E_2}{Z_{O_2}}$.

$E_2 = KV_1$

$= 239.6 \times 0.83$

$= 199.67$ volt.

$\therefore I_2 = \frac{199.67}{1.7}$.

$= 117.45$ Ampere.

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Solutions

Question 3.

Given data: $f = 50Hz$.

$\frac{1}{4}hp$.

$N_{DC} = 2000rpm$

DC Supply

S.V = 220V.

Current drawn. $I = 0.7A$.

$V - E_b = I_2 \times R$.

$V - [I_2 * R] = E_b$.

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

$= 209.5V$

AC Supply

S.V = 220V

Current drawn $I_2 = 0.7A$.

Reactance drop $I_2 \times R = 0.7 \times 15$

$= 10.5V$.

Reactance voltage drop $= I_2 \times X_2$.

$= 0.7 \times 2\pi fl$

$= 0.7 \times 2 \times 3.142 \times 50 \times 0.25$

$= 54.98V$

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Electrical Machine.

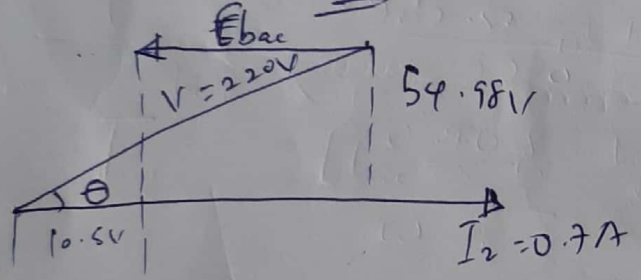
Solution

Continuation.

where $X_L = j\omega l = 2\pi f l$

$X_L = 2\pi f l$

$X_L = 54.98V$.



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

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

$$= 202.52V.$$

)Speed.

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

$$\frac{Ebac}{Ebdc} = \frac{Nac}{Ndc}.$$

$$Nac = Ndc \times \frac{Ebac}{Ebdc}.$$

$$= 2000 \times \frac{202.52V}{209.54}, \quad Nac = 1933.37 \text{ rpm}.$$

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(7).

(ii) Power factor, $\cos\phi = \frac{E_{bac} + I_R}{V}$.

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

$= 0.968$ lagging.

(iii) Torque developed ω = speed in rad/s.
n = speed in rev/s

$T_w = E_{bac} \times I$.

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

$\omega = 2\pi n$

$T_{ac} = \frac{E_{bac} \times I_L}{2\pi \times \frac{N_{ac}}{60}}$ to convert to rad/sec.

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

$= 0.700$ Nm.

$= 0.7$ Nm.