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17/ENG06/059
Mechanical Engineering
300 Level

Electrical Machines II Test.

Question 1

V = 415V 4-wire p.f = 0.7

3-Ø % eff = 85%

f = 50 Hz

P = 74.6

i.) Unity = 1 ∴ KVAR = P x (tan of actual p.f - tan tangent p.f)

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

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 x (1.0201 - 0) = 74.6(1.0201)

= 76.0995 ≈ 76.10

$C = \frac{76.10}{2\pi \times 50 \times 415^2} = 0.0000014 = 1.4 \times 10^{-6} C_{/}$

ii) 0.9 Lagging

actual p.f = 1.0201, target P.f = cos θ

target P.f = Cos θ = -0.9

∴ $\cos^{-1}(-0.9)$ = 154.16

tan θ = -0.48

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Question 1 cont.

KVAR = 74.6 × (1.0201 − (−0.45))
= 111.90

$C = \frac{KVAR}{2\pi f V} = \frac{112}{2 \times \pi \times 50 \times 415^2} = 0.00086$

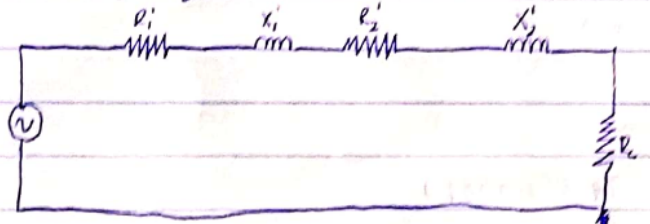
$\triangleq 8.6 \times 10^{-4} C_f$

Question 2

V = 415V, No pole = 6, f = 50Hz, $k = \frac{5}{6} = 0.23$

R = Z_1 = 0.25 + j0.75 ← for the stator

Z_2 = 1.173 + j0.52 ← for the rotor



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

Referring to the rotor

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

$X_{02} = (X_2 + k^2 X_1) = j(0.52 + (\frac{5}{6})^2 \times 0.25) = 1.041$

$Z_{02} = R_{02} + X_{02} = 1.347 + j1.041$

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

$= 1.7\Omega$

To find rotor Curren

$\therefore I_2 = \frac{E_2}{Z_{02}}$ Recall that $E_2 = kV_1$

$= 239.6 \times 0.85$

$= 1.79.67N$

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Question 2 Cont.

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

Question 3.

$f = 50Hz$, $I = 0.7A$, $R = 15\Omega$
$N = 1000rpm\ (dc)$, $V = 220V$, $L = 0.25H$

$E_{dc} = V - IR$
$= 220 - (0.7 \times 15)$
$= 209.5V$

$E_{ac} = \sqrt{V^2 - (I \times L)^2} - IR$
$= I \times L = 0.7 \times 2 \times \pi \times 50 \times 0.25$
$= 54.98V$

$IR = 0.7 \times 15 = 10.5V$
$\therefore E_{ac} = \sqrt{V^2 - (I \times L)^2} - IR$
$\Rightarrow \sqrt{(220)^2 - (54.98)^2} - 10.5$
$= 213.02 - 10.5$
$= 202.52V$

i) Speed of motor

$\frac{N_{ac}}{N_{dc}} = \frac{E_{ac}}{E_{dc}}$ $\quad N_{ac} = \frac{2000 \times 202.52}{209.5}$

$\frac{N_{ac}}{2000} = \frac{202.52}{209.5}$ $\quad \therefore N_{ac} = 1933.37rpm$

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Question 3 cont.

ii) Power factor

$$pf = \frac{E + IR}{V} = \frac{202.52 + 10.5}{220} = 0.97_{//}$$

iii) Torque developed

$$T = \frac{EI}{2\pi N/60} = \frac{202.52 \times 0.7}{2\pi \times 1933.37/60}$$

$$= 0.7 Nm_{//}$$

iv) Universal Motor