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17/ENG06/005
Mechanical - Engineering

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Test

EEE 326
Electrical Machines

Question 1

$f = 50Hz$; $P = 74.6$; efficiency $= 85\%$; power factor $= 0.7$; $V = 415V$; 3ϕ; 4-wire.

1) unity $= 1$

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

$\Rightarrow kVAR = P \times (\tan \text{actual } p.f - \tan \text{target } p.f)$

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

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

$= 45.57$

$\tan(45.57) = 1.0201$

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

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

$\tan 0 = 0$

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

$= 76.10$

$C = \frac{76.10}{2 \times \pi \times 50 \times 415^2} = 0.0000014$

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

b) 0.9 Lagging

actual p.f $= 1.0201$

target p.f $= \cos\theta = 0.9$

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

$= 154.16$

$\tan\theta = -0.48$

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~~Question~~ 1 (cont.d)

$KVAR = 74.6 \times (1.021 - C - 0.48)$

$= 111.90$

$\simeq 112$

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

$= 0.00086$

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

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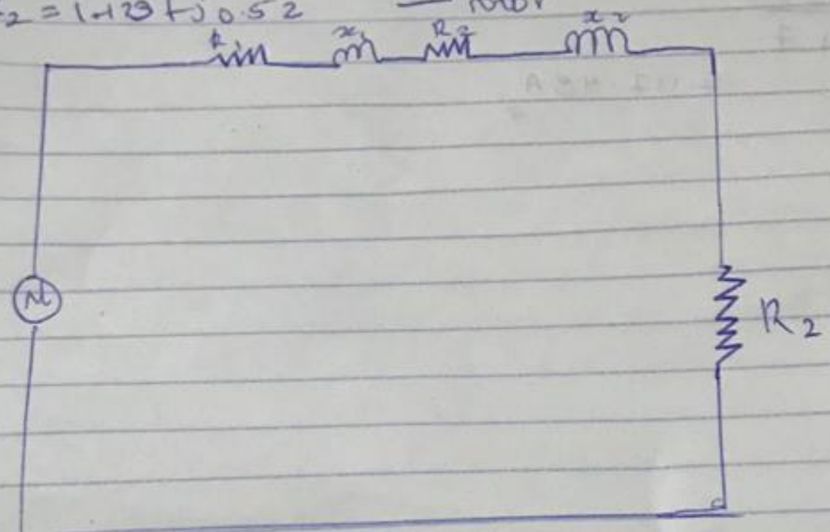
Question 2

V = 415V, No of poles = 6; f = 50Hz; k 5/6 = 0.83

$Z_1 = 0.25 + j0.75$ — stator

$Z_2 = 1.173 + j0.52$ — rotor



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

Referring to rotor

$R_{O_2} = (R_2 + k^2 R_1)$

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

$R_{O_2} = 1.347\Omega$

$X_{O_2} = (X_2 + k^2 X_1)$

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

$= 1.041.$

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

$= 1.547 + j1.041$

$= Z_{O_2} \sqrt{1.547^2 + 1.041^3}$

$= 1.7\Omega$

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Question (2)

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

Recall that $E_2 = kV_1$

$= 239.8 \times 0.85$

$= 199.67V$

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

$= 117.45A$

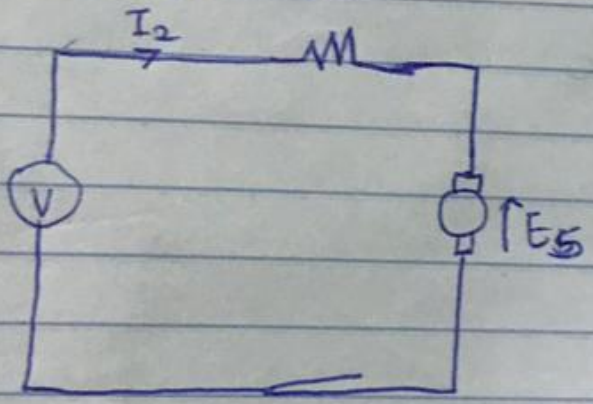
QUESTION 3

f = 50Hz, ¼hp, N 2000rpm; V = 220V 150L and 0.25

On DC supply

Supply Voltage = 220V

Current draws I = 0.7A



$V = E_b = I_L \times R$

$V = [I_L - R] = E_b$

$E_b = 220 - [0.7 \times 5]$

$= 209.5V$

Speed on DC

$N_{dc} = 2000rpm$

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Question (2)

Question 3 1716G06/005

On A C supply

Supply Voltage = 220V

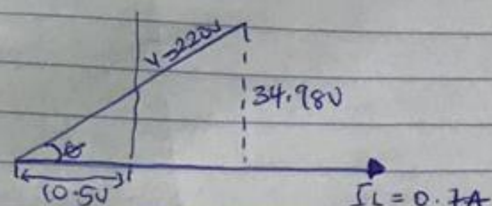
Current drawn $I_L = 0.7A$

Reactance drop = $I_L \times R = 0.7 \times 15 = 10.5V$

Reactance Voltage drop = $I_L \times X_L = 0.7 \times 2\pi f L$

where $X_L = \omega L \times 2\pi f L$

$= 0.7 \times 2\pi \times 50 \times 0.25 = 54.98V$



$E_{bac} = \sqrt{V^2 - [XL]^2} - IR$

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

$= 202.52V$

Recall speed . constant equation

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

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

making Nac subject of the formular

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

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

$= 1933.37$ rpm

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

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

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Question 3.

$= 0.968$ Lagging

Torque developed $T\omega = E_{bac} \times I$

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

~~Recall speed constant equation~~. where ω is speed in rad/s

$\omega = 2\pi n$

where n is speed in revolution

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

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

$= 0.700$ Nm.