19/ENG04/064

300 LEVEL ELECTRICAL & ELECTRONICS ENGINEERING

ELECTRICAL MACHINES II TEST

EEE 326

Question 2

$V = 415V$

Number of poles = 6

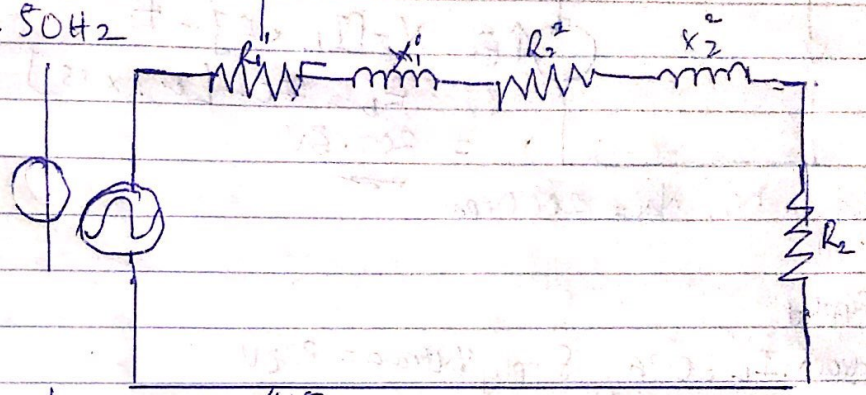
$K = 5/6 = 0.83$

$f = 50Hz$

$Z_1 = 0.25 + j0.75$ (Stator)

$Z_2 = 1.173 + j0.52$ (rotor)

i)



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

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

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

$R_{02} = 1.347\Omega$

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

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

$= 1.041$

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

$= 1.347 + j1.041$

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

$= 1.7\Omega$

ii) Rotor Secondary Current I_2

$I_2 = \frac{E_2}{Z_{02}}$ Recall $E_2 = KVL$

$= 239.6 \times 0.83$

$= 199.61V$

$\therefore I_2 = \frac{199.61}{1.7} = 117.45A$

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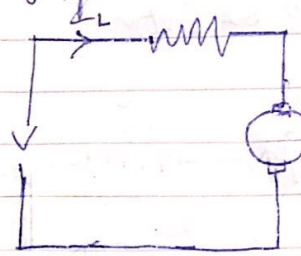
Question 3
N = 2000rpm, f = 50Hz, 4pole, V = 220V

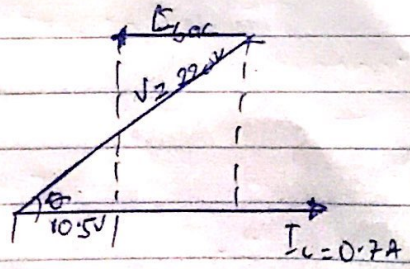
On DC supply
Supply voltage = 220V, Current = 0.7A



$V - E_b = I_L \times R$
$V - [I_L \times R] = E_b$
$E_b = 220 - [0.7 \times 15]$
$= 207.5V$

Speed on DC, N_{dc} = 2000rpm

On AC supply
Current drawn = I_L = 0.7A, Supply voltage = 220V
Reactance drop = $I_L \times R = 0.7 \times 15 = 10.5V$
Reactance voltage drop = $I_L \times X_L = 0.7 \times 2\pi fL$
where $X_L = j\omega L = 2\pi fL$
$= 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98V$



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

1) Actual Speed
Speed effect motor =
Real speed = $\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$ $\therefore \frac{E_{bac}}{E_{bdc}} = \frac{N_{ac}}{N_{dc}}$

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

$= \frac{200 \times 202.52V}{209.5V} = 1933.37rpm$

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ii) the power factor of the motor

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

$= \frac{202.52 + 10}{220} = 0.968$ (lagging)

iii) Torque developed by the motor

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

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

$\omega = 2\pi n$ (n speed in rev)

$T_{ac} = \frac{E_{bac} \times I_L}{2\pi \times \frac{N_{ac}}{60}} = \frac{202.52 \times 0.7 \times 60}{2\pi \times 933.37}$

$= 0.700 Nm$

iv) Universal Motor should be used for this application

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Question 1

$V_L = 415V$, 3phase 4wire $f = 50Hz$, $P = 74.6$

Coefficiency = 87%, 4-wire $\Rightarrow$ connected

$V_L = 415$

$V_L = \sqrt{3}\, V_p$

$V_p = \frac{415}{\sqrt{3}}$

$V_p = \frac{V_L}{\sqrt{3}}$

$= 239.6$

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

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

$= 45.57$

$\tan 45.57 = 1.0201$

i) Unity $= 1$

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

$\Rightarrow KVAR = P \times [\tan(\text{P.f})_{\text{actual}} \times \tan(\text{P.f})_{\text{target}}]$

target p.f:

$\Rightarrow 1 \therefore \cos\theta = 1$

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

$= 0$

and $\tan 0 = 0$

$\Rightarrow KVAR = 74.6[1.0201 - 0]$

$= 76.10$

$C = \frac{76.10}{2\times\pi\times 50 \times 239.6^2} = 0.00000422$

$\simeq 42.2 \times 10^{-6}\ C$

ii) 0.9 lagging

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

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

$\theta = 154.16$

$\tan\theta = -0.48$

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

$= 111.90 \simeq 112$

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

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

$= 0.00000662$

$\simeq 6.2 \times 10^{-6}\ C$