MATRIC NO: 17/ENG06/002
DEPARTMENT: MECHANICAL ENGR.
COURSES: ELECTRICAL MACHINES (EEE 326)
LEVEL: 300L

1

V = 415V,
Induction motor = 3-phase
f = 50Hz
Power = 74.6
P.F = 0.7
Efficiency = 85%

i) Unity of slip = 1

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

KVAR = P × (tan of the actual P.F − tan of target P.F)

To get actual P.F = cos θ = 0.7
θ = $\cos^{-1}(0.7)$
= 45.57°

tan (45.57°) = 1.0201

For the target P.F = cos θ = 1
θ = $\cos^{-1}(1)$ = 0°
tan 0° = 0

KVAR = 74.6 × (1.0201 − 0)
= 76.0995
≃ 76.10

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

= 0.0000014

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

ii) 0.9 Lagging

Actual P.F = 1.0201

Target P.F = $\cos\theta$ = -0.9

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

$\theta = 154.16^\circ$

$\tan\theta = -0.48$

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

$\simeq 111.90$

$\simeq 112$

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

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

~~$= 2.068 \times 10^{-6}$ C~~

$= \frac{112}{2\pi \times 50 \times \left(\frac{415}{\sqrt{3}}\right)^2}$

$= 6.21 \times 10^{-6}$ C

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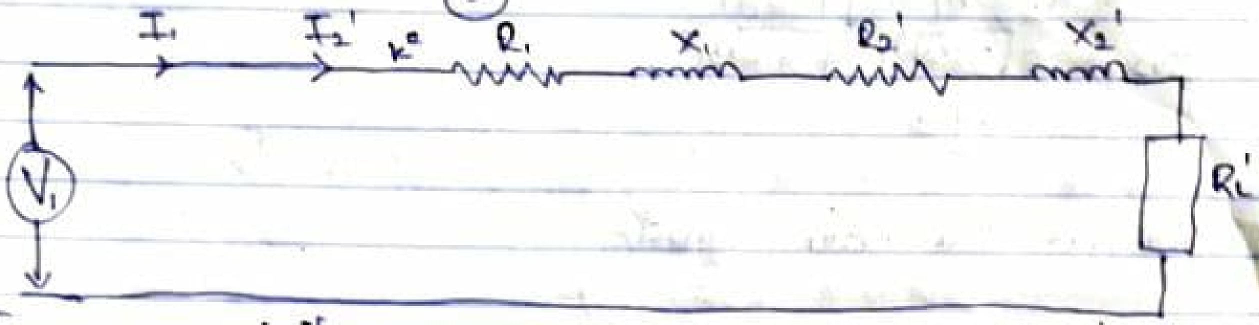
(2)

i)



For version 2: You ignore the core, ∴ $I_1 = I_2'$

ii) $V_{line} = 415V$

No of Poles = 6-poles

$k = 6/5 = 1.2$

$R_1 = 0.25\Omega$

$X_1 = 0.75\Omega$

$R_2' = 1.173\Omega$

$X_2' = 0.52\Omega$

Frequency = 50Hz

$Z_1 = 0.25 + j0.75$

$Z_2 = 1.173 + j0.52$

$$\text{Slip} = \frac{N_s - N}{N_s}$$

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{6}$$

$N_s = 1000$ rpm

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

Referring to rotor,

$RO_2 = (R_2 + k^2 R_1)$

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

$R_{02} = 1.347\Omega$

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

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(2) contd

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

$= 1.041$

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

$= 1.347 + j1.041$

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

$= 1.7\Omega$

To get the rotor current

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

Recall that $E_2 = kV_2$

$= 239.6 \times 0.83$

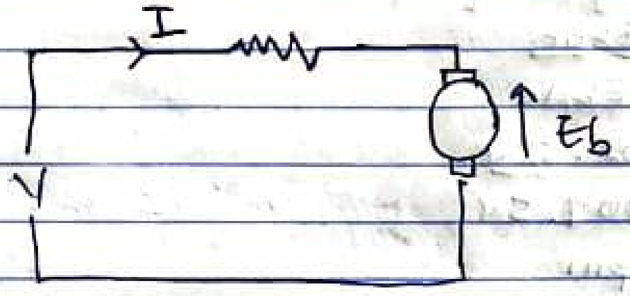
$= 199.67$

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

$= 117.45A$

$f = 50\,Hz$, $P_{ower} = 1/4\,hp$, $N = 2000\,rpm$.
$V = 220V$, $R_1 = 15\Omega$, $X_1 = 0.25H$

1) On DC supply
Supply voltage $= 220V$
Currents, $I = 0.7A$

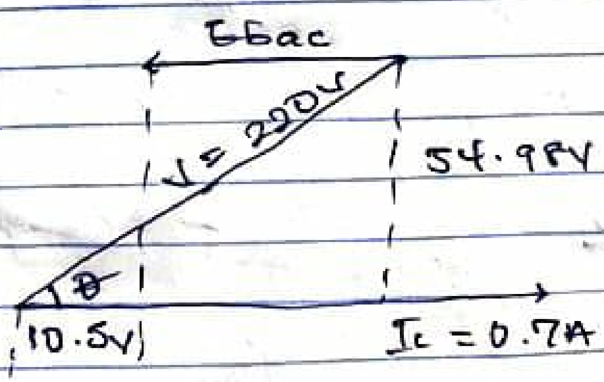


$V - E_b = I_L \times R$
$V - (I_L R) = E_b$

$E_b = 220 - (0.7 \times 15)$
$= 209.5V$

Speed for DC, $N = 2000\,rpm$

On AC supply, supply voltage $= 220V$
Current, $I_L = 0.7A$
Reactance drop $= 0.7 \times 15 = 10.5V$
Reactance voltage drop $= 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98$



$E_{bac} = \sqrt{V^2 - (XL)^2} - IR$
$= \sqrt{220^2 - (54.98)^2} - 10.5$

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$= 202.52V$

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

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

Making N_{ac} the subject of formular

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

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

$N_{ac} = 19.33.37 \text{ rpm}$

$P.F = \cos\phi = \frac{E_{bac} + IR}{V}$

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

$= 0.9.68$ (Lagging)

The torque developed,

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

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

where ω is speed in rad/s

$\omega = 2\pi N$

where N is speed in rev

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

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

$= 0.700 Nm$