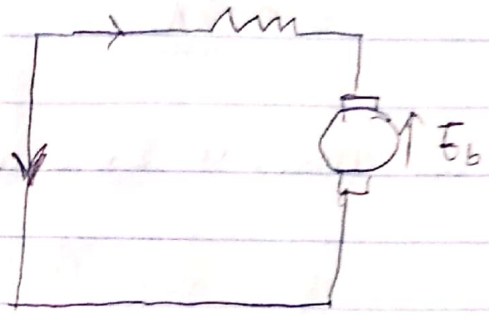
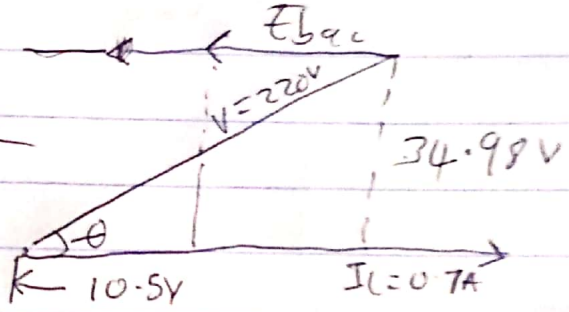
17/ENG04/009 ELECT/ELECT 300LVL

Question 3

F = 50hz R = 15Ω
N = 2000 rpm L = 0.25Ω
I = 0.7A
V = 220V



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



$E_{ac} = \sqrt{V^2 - (IX_L)^2} - IR$
$IX_L = 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98V$
$IR = 0.7 \times 15$
$= 10.5V$
$\therefore E_{ac} = \sqrt{220^2 - 54.98} - 10.5$
$E_{ac} = 202.52V$

i) Speed of the motor

$\frac{N_{ac}}{N_{dc}} = \frac{E_{ac}}{E_{dc}}$

$\frac{N_{ac}}{2000} = \frac{202.52}{209.5}$

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

$N_{ac} = 1933.37$ rpm

ii) power factor

$pf = \frac{E_a + IR}{V} = \frac{202.52 + 10.5}{220} = 0.97$

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iii) Torque developed

$$T = \frac{P_1}{2\pi N/60} = \frac{202.52 \times 0.7}{2\pi \times 1953.37/50}$$

$$= 0.7 \text{Nm}$$

iv) A Universal motor can be used for this application

17/ENG04/009 ELECT/ELECT June 11th, 2020

300 LVL

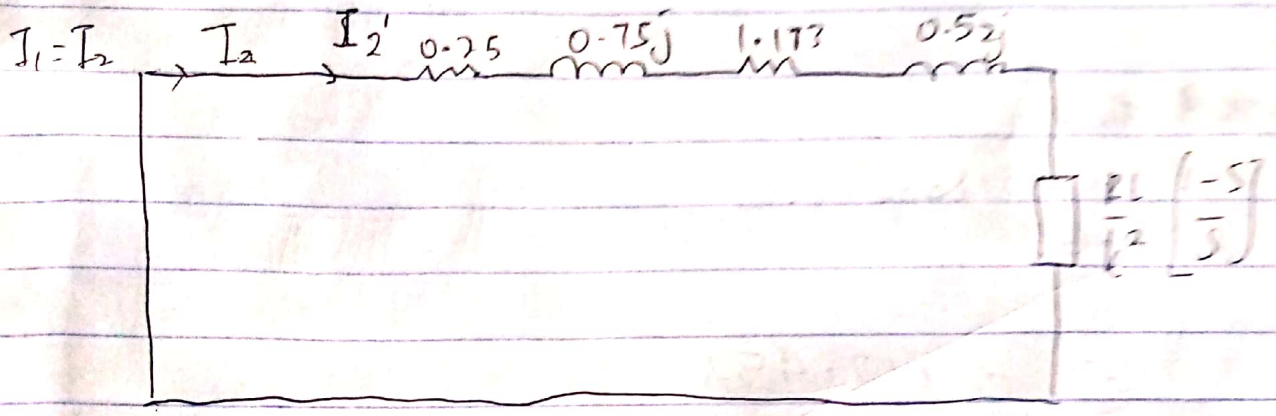
Question 2

$V_{line} = 415V$, $P = 6$, Frequency = 50Hz

3 ~~ph~~ stator – rotor → 6 : 5

$R_1 = 0.25$ $R_2 = 1.173$

$X_1 = 0.75j$ $X_2 = 0.52j$



$I_2 = \frac{V}{Z_1}$

$Z_1 = 0.25 + 0.75j + 1.173 + 0.52j$

$= 1.423 + 1.27j$

$I_2 = \frac{239.6}{1.423 + 1.27j}$ $415V = \frac{415}{\sqrt{3}} = 239.6$

~~$I_2 = 83.42 - 83.6j$~~

~~$= 125.62 \angle -41.75$~~

referring to rotor

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

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

$R_{02} = 1.347\ \Omega$

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

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

$= 1.041$

$V_L = 415V$

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Question 2 Contd

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

$= 1.347 + j1.041$

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

$= 1.7\Omega$

To find rotor current

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

$E_2 = kV_1$

$= 239.6 \times 0.8333$

$= 199.67V$

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

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300LVL

Question 1

$V_L = 415V$, 3-ϕ, 4-wire, $f = 50Hz$, $P = 74.6$, P.F = 0.7

% efficiency = 85 %

$V_L = 415$ $\quad V_L = \sqrt{3} V_p$

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

$$= \frac{415}{\sqrt{3}} = 239.6$$

actual pf : $\cos\theta = 0.7$

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

$= 45.57$

$\tan 45.57 = 1.0201$

i) Unity - 1

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

$KVAR = P[\tan pf \times \tan[pf_{target}]]$

target pf:

$\rightarrow 1 \therefore \cos\theta = 1$

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

$= 0$

$\therefore \tan 0 = 0$

$KVAR = 74.6[1.0201 - 0]$

$= 76.10$

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

$= 0.000004272$

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

ii) 0.9 lagging $= -0.9$

target pf $= \cos\theta = -0.9$

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

$\theta = 154.16$

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Question 1

Cont'd

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

$= 111.90 \simeq 112$

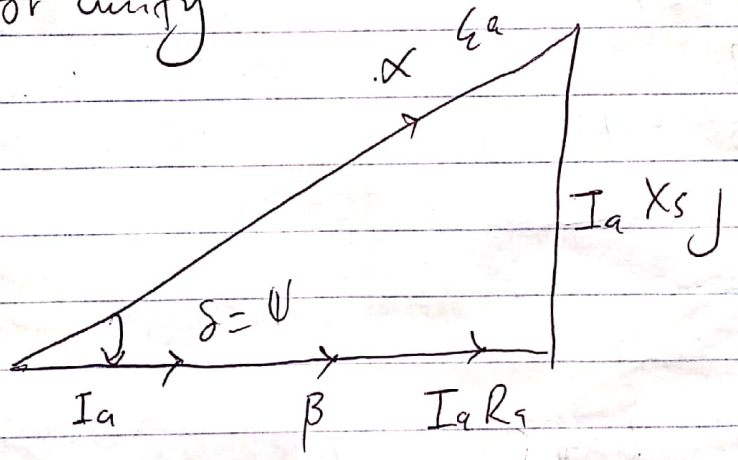
$C = \frac{KVAR}{2\pi f V^2}$

$= \frac{112}{2\pi \times 50 \times 235.6^2}$

$= 0.0000062$

$\simeq 62 \times 10^{-6}\ C$

for unity



for 0.9 lagging