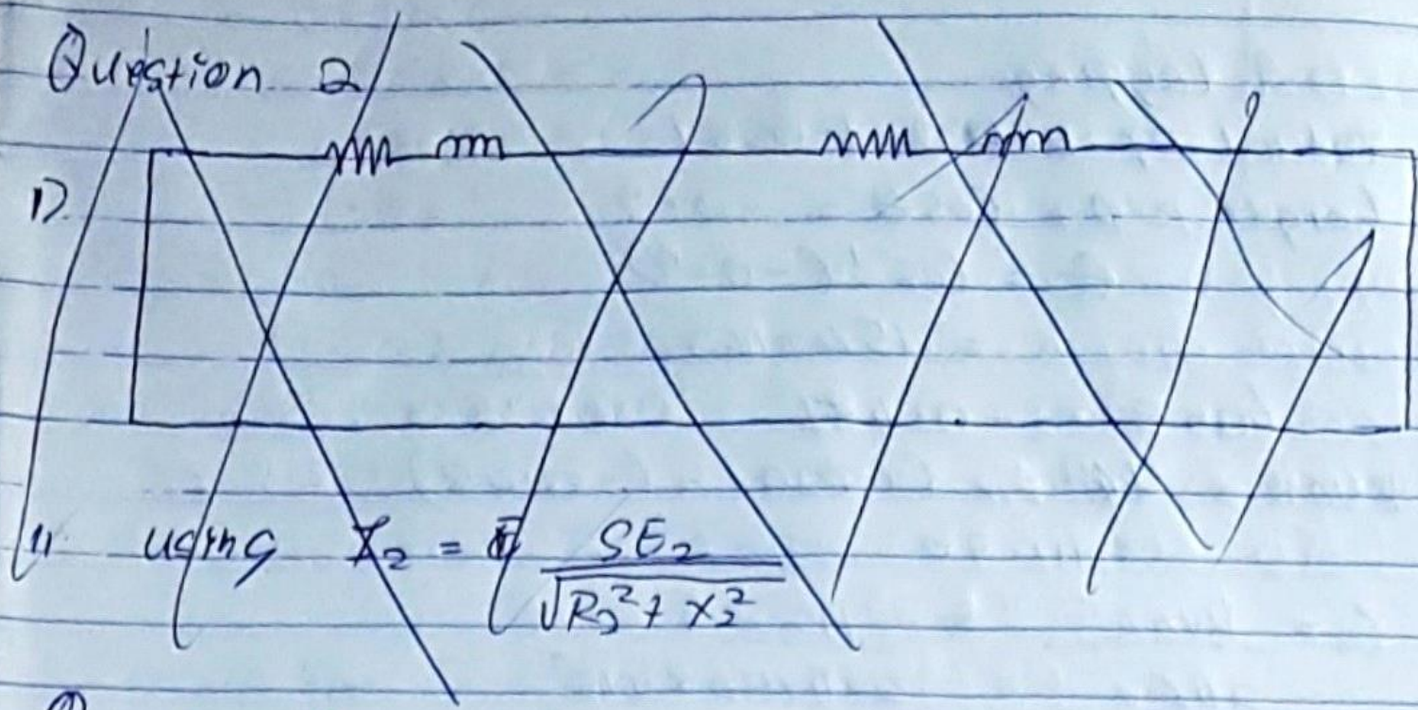
17/ENG04/072 Elect/Elect 300LVL

Question 2



ii) using $X_2 = \frac{SE_2}{\sqrt{R_2^2 + X_2^2}}$

Question 1

$V = 415V$, 3-ϕ, 4-wire $f = 50Hz$, $P = 74.6$

$Pf = 0.7$ % eff = 85 %

i Unity = 1

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

Kvar = P × (tan actual pf − tan target p.f)

actual pf ⇒ $\cos\theta = 0.7$

$\theta = \cos^{-1} 0.7 = 45.57$

$\tan(45.57 = 1.0201$

target p.f ⇒ $\cos\theta = 1$

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

$\tan 0 = 0$

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

$= 76.0995 \simeq 76.1$

$C = \frac{76.1}{2\pi \times 50 \times 415^2} = 0.0000014$

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

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ii) 0.9 lagging

actual p.f = ~~1.00~~ 1.0201

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

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

$= 154.16$

$\tan\theta = -0.48$

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

$= 111.90$

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

$= 0.00086$

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

Question 2

$V = 415V$

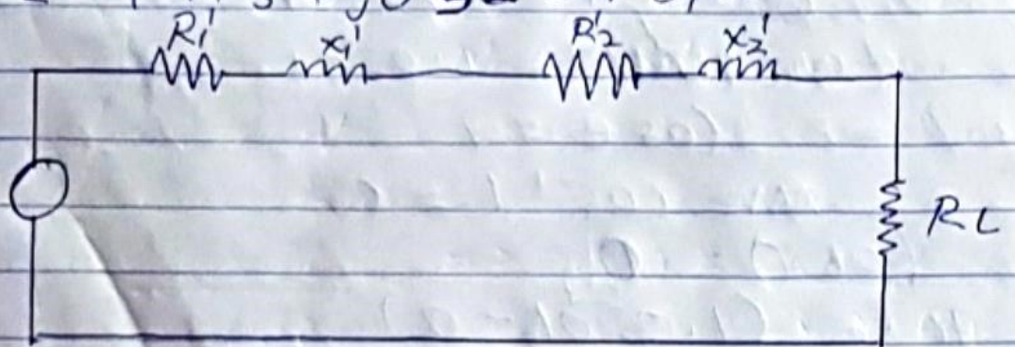
No of poles = 6

$F = 50Hz$

$K = 5/6 = 0.83$

$Z_1 = 0.25 + j0.75$ - stator

$Z_2 = 1.173 + j0.92$ - rotor



Supply voltage per phase, $V = \frac{415}{\sqrt{3}} = 239.6V$

Referring to the rotor

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

$= (1.173 + (0.83)^2 \times 0.25$

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$R_{OL} = 1.347\Omega$

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

$= j(0.52 + (0.83)^2 \times 0.75)$

$= 1.041$

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

$= 1.347 + j1.041$

$Z_{O_2} = \sqrt{(1.347)^2 + (1.041)^2}$

$= \underline{1.7\Omega}$

Rotor Current $I_2 = \frac{E_2}{Z_{O_2}}$

recall that $E_2 = KV_1$

$= 239.6 \times 0.83$

$= 199.67V$

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

Question 3

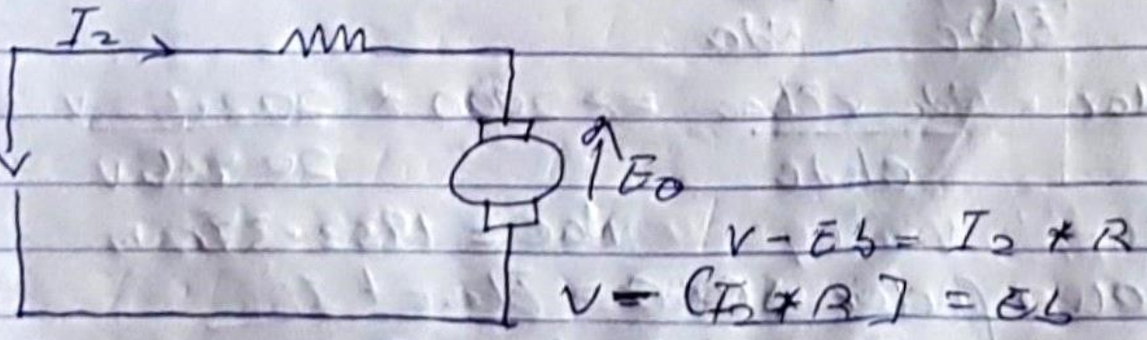
$f = 50Hz$, $1/4 HP$, $N = 2000rpm$, $V = 220$

13Ω and $0.25H$

on DC supply

Supply voltage 220V

Current flows, $I_1 = 0.7A$



$E_b = 220 - [0.7 \times 15]$

$= 209.5V$

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Speed on DC

$N_w = 2000$ rpm

On AC Supply

Supply Voltage $= 220V$

Current drawn $= I_v = 0.7A$

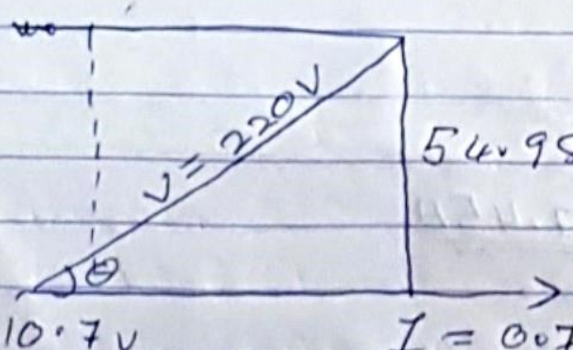
Reactance drop $= I_L * f = 0.7 \times 15 = 10.5V$

reactance voltage drop $= I_L \times X_L = 0.7 \times 2\pi fl$

Where $X_L = j\omega L = 2\pi fL$

$= 0.7 * 2\pi \times 50 * 0.25$

$= 54.98V$



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

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

$= 202.52V$

Using $\frac{N_2}{N_1} = \frac{Eb_2}{Eb_1}$

So $\frac{\bar{E}bac}{\bar{E}bdc} = \frac{Nac}{Ndc}$

$Nac = \frac{Ndc \times \bar{E}bac}{\bar{E}bdc} \Rightarrow 2000 * \frac{202.52V}{209.5V}$

$NaC = 1933.37$ rpm

Power factor $\Rightarrow \cos\theta = \frac{\bar{E}bac + IR}{V}$

$= \frac{202.52 + 10.5}{220}$ $= 0.968$ Lagging

Torque developed ($T_d = E_{bac} * I$)

$I_{ac} = \frac{E_{bac} \times I}{\omega}$ $\omega = B\pi n$

$I_{ac} = \frac{E_{bac} \times I_1}{2\pi \times \frac{N_{ac}}{60}}$ $= \frac{202.53 \times 0.7 \times 60}{1933.37 * 2\pi}$

$= 0.7 Nm$