17/EHG04/031
ELECT/ELECT
300 LVL

QUESTION 1

$V = 415V$ $3-\phi$ $F = 50Hz$ $P.F = 0.7$ $P = 74.6$

$V_{Line} = 415$ $V_{Line} = \sqrt{3} V_{phase}$

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

→ actual $P.F = \cos\theta = 0.7$

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

$= 45.57$

$\tan 45.57 = 1.0207$

~~i) Unity 45.57 = 1.0~~

i) Unity = 1

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

$KVAR = P \times (\tan(\text{P Factor: actual}) - \tan(\text{P.F target}))$

target $P.F = \cos\theta = 1$

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

$= 0$

$\tan 0 = 0.$

$KVAR = 76.4 (1.0207 - 0)$

$= 76.10$

$C = \frac{76.10}{2 \times 3.142 \times 50 \times 239.6^2}$

$= 42.2 \times 10^{-6} F.$

17/ENG04/031
ELECT/ELECT
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ii) 0.9 lagging

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

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

$\theta = 154.16$

$\tan\theta = -0.481$

$KVAR = 74.6 \times (1.0207 - (-0.48))$

$= 111.90$

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

$= \frac{111.90}{2 \times 3.142 \times 50 \times 239.6^2}$

$= 0.0000062 \simeq 6.2 \times 10^{-6} F.$

It is a Three-phase Induction motor

17/EHG04/031
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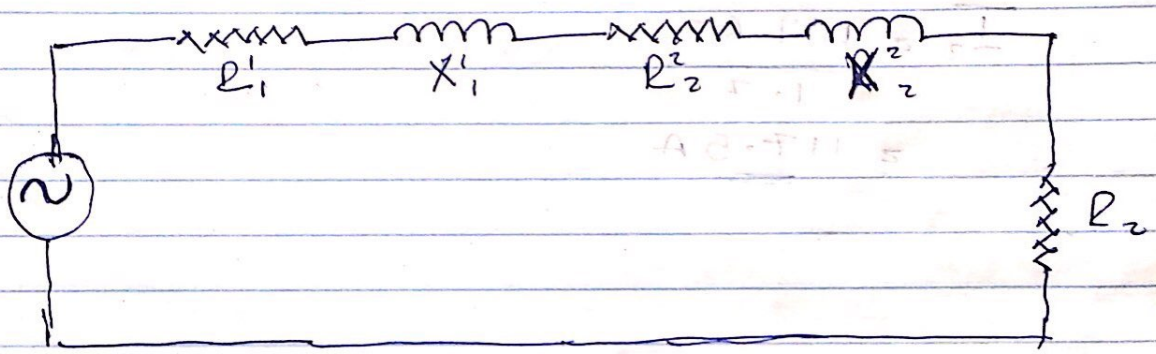
QUESTION 2

$V = 415V$

Poles = 6V

1 = $Z_1 = 0.25 + j0.75$ — stator

$Z_2 = 1.173 + j0.52$ — rotor



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

To rotor;

$R_{o_2} = (R_2 + K^2 R_1)$

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

$= 1.347\Omega$.

$X_{o_2} = (X_2 + K^2 X_1)$

$= j(0.52 + (5/6)^2 \times 0.25)$

$= 1.041\Omega$.

$Z_{o_2} = \sqrt{R_{o_2}^2 + X_{o_2}^2}$

$= \sqrt{1.347^2 + j1.041^2}$

$= \sqrt{1.347^2 + j1.041^2}$

$= 1.7\Omega$.

17/ENG04/031
ELECT/ELECT

300LVL

To Find rotor current:

$$\underline{I}_2 = \frac{\underline{E}_2}{\underline{Z}_{02}}$$

Recall that $E_2 = kV_1$

~~$= 2.39$~~

$= 239.6 \times 0.85$.

$= 199.67$.

$$\underline{I}_2 = \frac{199.67}{1.7}$$

$= 117.5\,A$

17/EHG04/031
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Question 3

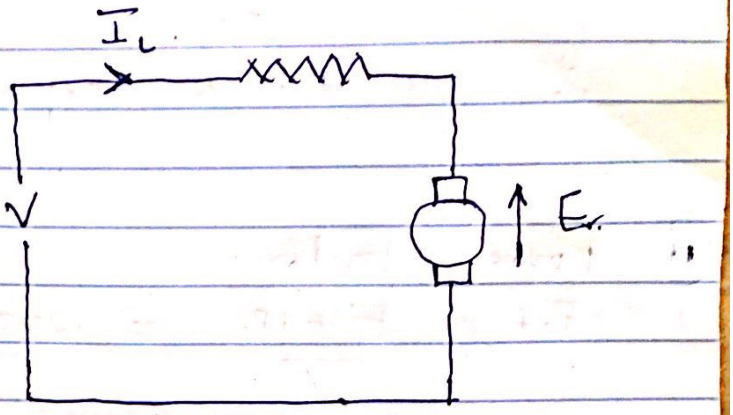
$F = 50Hz$

$N_s = 1000rpm$

$R = 15\Omega$

$I = 0.7A$

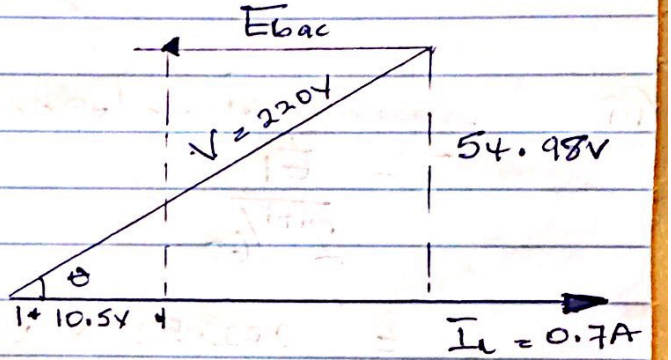
$V = 220V$.



(i) $E_{dc} = V - IR$

$= 220 - (0.7 \times 15)$

$= 209.5V$.



$E_{ac} = \sqrt{V^2 - (IX_L)^2} - IR$.

$IX_L = 0.7 \times 2\pi fl$.

$= 0.7 \times 2 \times 3.142 \times 50 \times 0.25$

$= 54.98V$.

$IR = 0.7 \times 15$

$= 10.5V$

$\therefore E_{ac} = \sqrt{220^2 - 54.98^2} - 10.5$.

$= 213.02 - 10.5$

$= 202.52V$.

(ii) Speed of Motor

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

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

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

$\therefore N_{ac} = 1933.4 \text{ rpm}$.

(ii) Power factor.

$$P.F = \frac{E + IR}{V} = \frac{202.52 + 10.5}{220}$$

$$= 0.97$$

(iii) Torque developed

$$T = \frac{EI}{2\pi N/60}$$

$$= \frac{202.52 \times 0.7}{\frac{2 \times 3.142 \times 1933.37}{60}}$$

$$= 0.7 \text{ Nm}.$$

(iv) Universal Motor.