17/EN/04/046

Elect/Elect

Machines test : Test answered in this order : Q2, Q3, and Q1

No 2) Question 2

Solution

b) Supply voltage phase $V = \frac{415}{\sqrt{3}} = 239.600$

the rotor to stator phase voltage ratio $k = 5/6$

Equivalent resistance of motor as refered to rotor

$R_{o2} = R_2' + k^2 R_1 = 1.173 + \left(\frac{5}{6}\right)^2 \times 0.25$

$= 0.3466\ \Omega$

Equivalent reactance of motor as refered to the motor

$x_{o2} = x_2 + k^2 x_1 = 0.52 + \left(\frac{5}{6}\right)^2 \times 0.75$

$= 1.0408\ \Omega$

Equivalent rotor impedance

$Z_{o1} = \sqrt{(R_1)^2 + X_o^2} = \sqrt{1.3466}$

$Z_{o1} = \sqrt{(R)^2 + (x_o)^2}$

$= \sqrt{(1.3466)^2 + (1.0408)^2}$

$= 1.7019\ \Omega$

To find rotor current

$I_2 = \frac{E_2}{Z_2}$

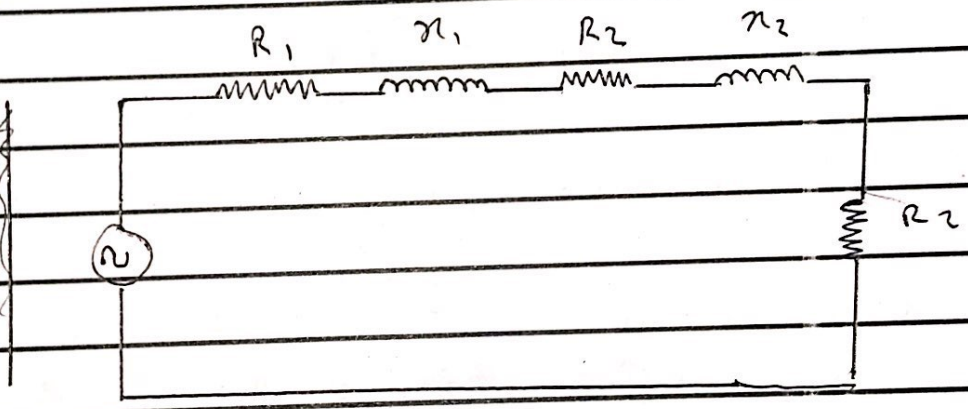
recall that $E_2 = kV_1$

$= 239.6 \times 0.85$

$= 199.67V$

$\therefore I_2 = \frac{199.69}{1.7} = 117.45A$

a)



Equivalent circuit diagram reffered to the rotor side

Supply voltage per phase.

No 3 Question 3

$F = 50Hz$ $R = 15\Omega$

$N_s = 2000rpm$ $L = 0.25H$

$I = 0.7A$

$V = 220V$

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$E_{dc} = V - IR$

$= 220 - (0.7 \times 15)$

$= 209.5\,V$

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

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

$= 54.98\,V$

$IR = 0.7 \times 15$

$= 10.5\,V$

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

$= 215.02 - 10.5$

$= 202.52\,V$

i) Speed of motor

We remember: $\frac{N_{ac}}{N_{dc}} = \frac{E_{ac}}{E_{dc}}$

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

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

$N_{ac} = 1933.37\,RPM$

ii) power factor

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

iii) Torque developed

$T = \frac{EI}{2\pi N/60} = \frac{202.52 \times 0.7}{2\pi \times 1933.37/60} = 0.7\,Nm$

(5)

iiii) universal synchronous motor (both AC and DC)

No 1 Question 1

Parameters

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

$pf = 0.7$, fo eff $= 85\%$

b)

1) unity $= 1$

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

=> $KVAR = P \times (\tan \text{actuated pf} - \tan \text{targeted p.f})$

actuated p.f => $\cos\theta = 0.7$

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

$= 45.57$

$\tan(45.59) = 1.0201$

Target pf => $\cos\theta = 1$

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

$\tan 0 = 0$

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

$= 76.0995$

$= 76.10$ //

$$C = \frac{76.10}{2 \times \pi \times 50 \times 239.60^2}$$

$= \sim\sim 0.0000014 \sim\sim = \sim\sim 1.4 \times 10^{-6} \sim\sim$ F //

(a) => $0.00000422 = 4.22 \times 10^{-6}$ //

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b) 0.9 (lagging)

calculated p.f = 1.0201

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

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

= 154.16

$\tan\theta$ = -0.48

KVAR = 74.6 × (1.0261 − (−048))

= 111.90

≈ 112

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

$= \frac{112}{2 \times \pi \times 50 \times 239.60^2}$

= ~~0.00086~~ = 0.00000621

~~= 8.6 × 10^-4 C~~ = 6.21×10^{-6}

Sketch phasor diagram

(i) lagging

$I_a(\text{line}) = \frac{P}{\sqrt{3}\, V_L \cos\theta}$

$I_a = \frac{74500}{\sqrt{3} \times 415 \times 0.7}$ = 148.06A

$V_t = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}}$ = 239.60

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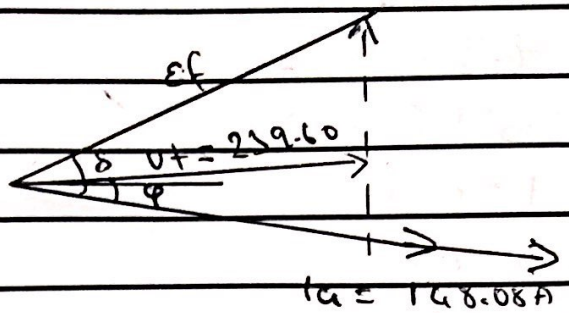
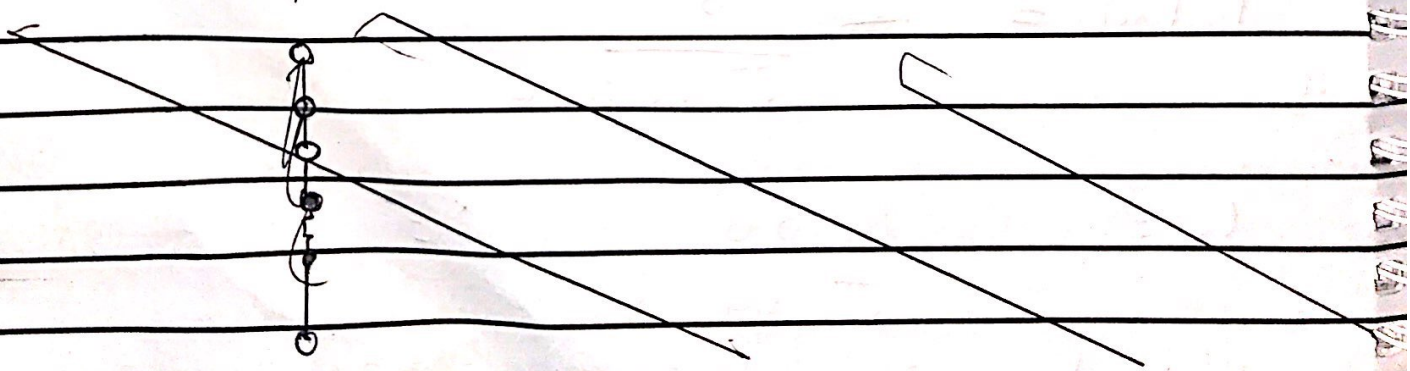
$E_{fph} = \vec{V}_{tph} + jX_s I_a$



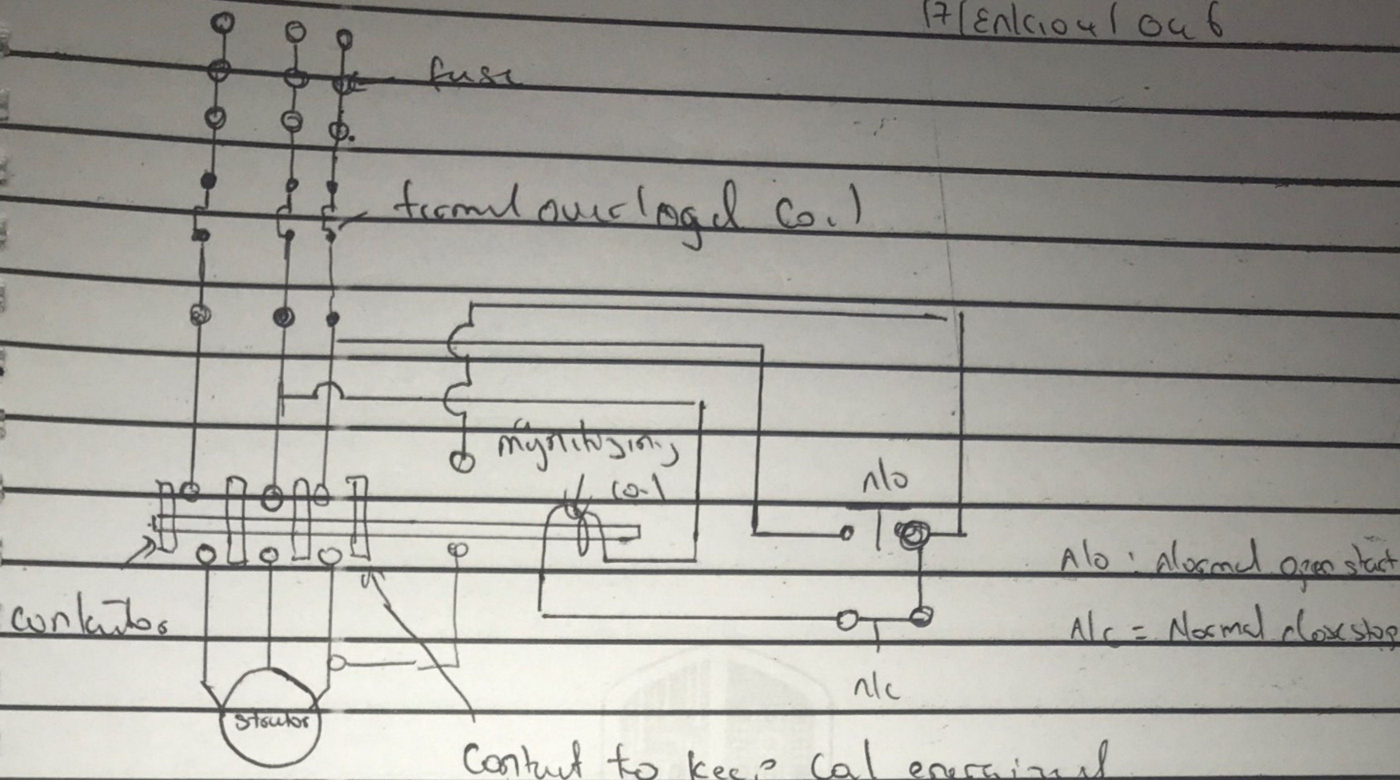
Phasor diagram for lagging Ef > Vt & δ positive.

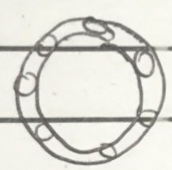
1a) Identify the device motor type:

Ans: three phase induction motor



(6)





Sketch of three phase induction motor with direct online starter