17/ENG041057

ELECTRICAL ELETRONICS ENGINEERING

300LEVEL

Question (1).

$V = 415\ V$

4 wire Supply — Star Connection.

frequency = 50.

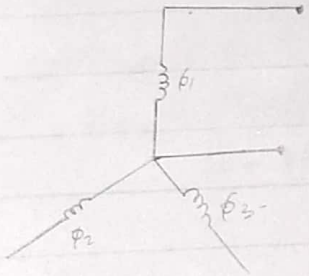
Power factor = 0.7.

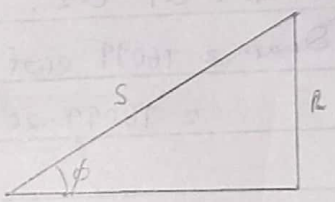
$\eta = 85\%$

$P = 74.6\ kW$.

Capacitance per phase.

Diagramatic Representation;

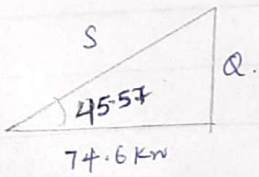




P2 74.6 KW.

at Power Factor of 0.7.

Diagram.



$\cos\phi = 0.7$

$\phi = \cos^{-1}(0.7)$

$\phi = 45.57$

i. Where; $Q_1 = P\tan\phi_1$

$Q_1 = 74.6 \times 10^3 (\tan 45.57)$

$Q_1 = 76099.2625$.

Recall; When raise in power factor;

$\phi_1 < \phi_2$, $P_1 = P_2$, $Q_1 < Q_2$, $S_1 < S_2$.

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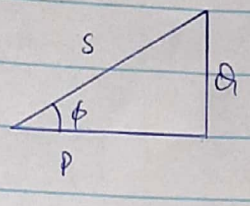
∴ at unity Power factor.

Diagram;



$\cos\phi = 1$

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

$\phi = 0$.

$\phi = 0$.

∴ $Q_2 = P \tan\phi_2$

∴ $Q_2 = 74.6K * \tan\phi$ $= 74.6K * \tan(0)$

$Q_2 = 0$.

∴ Recall ; $Q_{cap} = Q_1 - Q_2$.

$Q_{cap} = 76099.2625 - 0$.

$= 76099.26$.

∴ Capacitance per phase $\Rightarrow \frac{Q_{cap}}{\omega * V_{rms}^2}$.

$\Rightarrow$ at $F = 50Hz$. Standard frequency Nigeria.

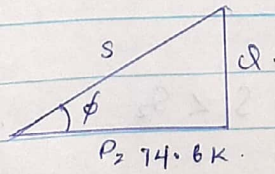
∴ $\frac{76099.26}{2\pi * 50 * 415^2}$.

$C = 0.0014106$

$C = 1.41mF$.

∴ at Lagging pf (0.9).

Diagramatic Representation.



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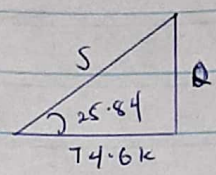


$\cos\phi = 0.9$

$\phi = 25.84$

∴ Where $Q_1 = P\tan\phi$

$Q_2 = 74.6K * \tan(25.84)$

$Q_2 = 36127.322$

Recall Rise in power factor to 0.9

Where $Q_1 = 76099.26$

∴ $Q_2 = 36127.322$

∴ $Q_{cap} = -Q_1 + (-Q_2)$

$Q_{cap} = -76099.26 - 36127$

$= -112226.58$

∴ Capacitive Eff $\Rightarrow \frac{Q_{cap}}{2\pi * V_{rms}^2}$

$= \frac{-112226.58}{2\pi * 415^2}$

$= 0.137\ F$

Current Value;

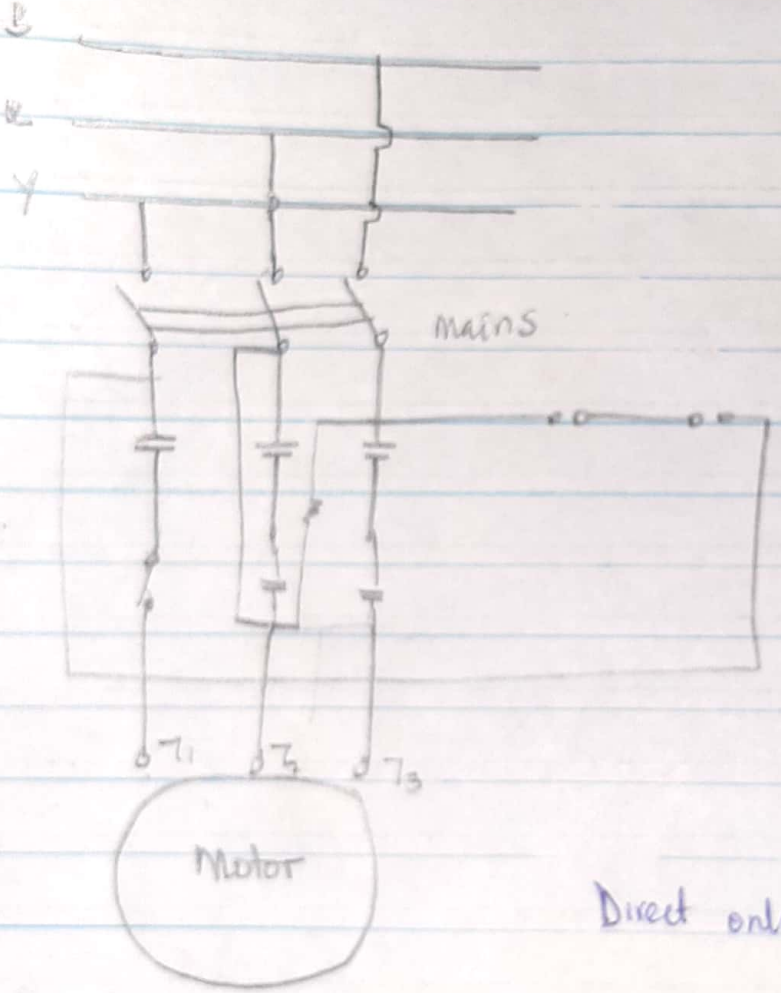
Current value =

$P = V * I * \cos\phi$

$I = \frac{24.6 \times 10^3}{239.5 * 0.7}$

$I = 146.73\ A$

Type of Motor = 3ϕ Induction motor Drive. Q.1.



Direct online Starter Diagram.

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Question (2).

Parameters.

$V_{line} = 415\ V_{L-L}$.

No of poles = 6.

frequency = 50Hz.

Star-Connected.

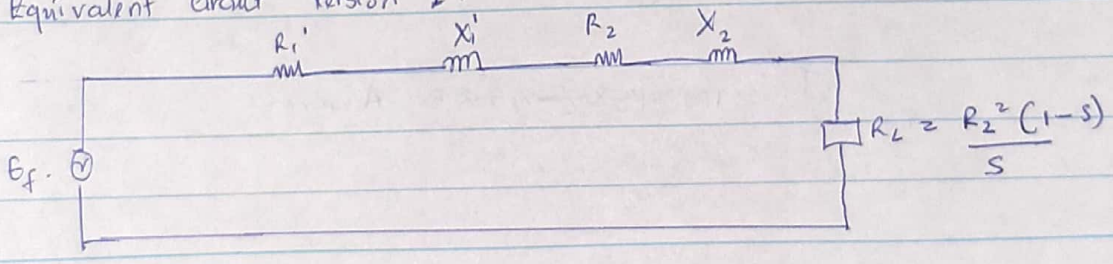
Voltage ratio = 6/5 = 1.2.

$Z_s = 0.25 + j0.75$

$Z_R = 1.173 + j0.52$.

Diagramatic Representation.

Equivalent Circuit Version 2.



Given that

$R_2 = 1.173$ ~~Ω~~ 1.173Ω.

$R_L = 0$.

$X_2 = j0.52$.

$R_1' = K^2 \cdot R_1$

$= (1.2)^2 * 0.25 = 0.38$

$X_1' = K^2 * X_1$

$= (1.2)^2 * (0.75)$

$\Rightarrow 1.08$

∴ Series Connection;

$\therefore Z_T = Z_s + Z_T + R_L$

$Z_T = 1.173 + j0.52 + 0.38 + j1.08$

$= 1.553 + 1.6i$

$= 2.2297 \angle 45.85°$

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∴ Refers (Secondary Current) I_2

Given that; $V_{line} = 415$

$\Rightarrow \frac{415}{\sqrt{3}}$

$\Rightarrow 239.60\ V$

Note; Star = ~~$V_{phase} \times \sqrt{3}$~~

$V_{line} = \sqrt{3}\ V_{phase}$

$V_{phase} = \frac{V_{line}}{\sqrt{3}}$

∴ Secondary Current $I_2 = I_1$

$\therefore I_2 = \frac{V_{phase}}{Z_Y}$

$I_2 = \frac{239.60}{2.2297 \angle 45.85}$

$I_2 = 107.458 \angle -45.85$ Amperes.

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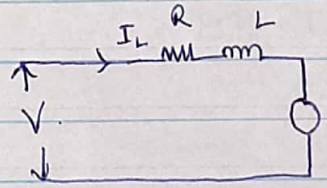
Q3

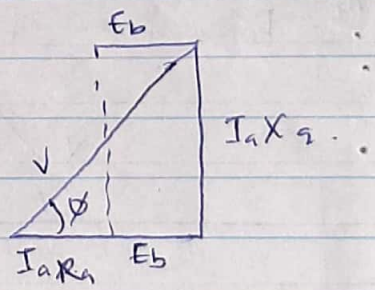
Given preamble;

Freq = 50Hz.
No of poles = 6?
N = 2000 rpm.
Current = 0.7A.
V_{DC} = 220
Resistance = 15Ω.
~~Rea~~. Inductance = 0.25.

Diagram;



DC.



Using the formula;

$V - E_b = I_L R$.
$220 - E_b = 0.7 * 15\Omega$.
$220 - E_b = 10.5$
$E_b = 209.5$ V.

∴ at AC

∴ Using the formula

$\sqrt{V^2 - I_a^2 X_2^2} - I_L \cdot R = E_b$.

∴ $E_b = \sqrt{(220)^2 - (0.7)^2 * (X_L)^2} - (0.7)(15) = E_b$.

Where $X_L = 2\pi f L$

$X_L = 2 \times \pi \times 50 \times 0.25$
$= 78.539$

Put into equation.

∴ $E_b = 201.45$ V.

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Where,

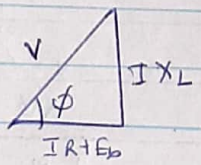
$$\frac{E_b AC}{E_b DC} = \frac{N_{AC}}{N_{DC}}$$

$$\frac{201.45}{209.5} = \frac{N_{AC}}{2000}$$

$$N_{AC} = 1923.15$$

∴ Speed of motor = 1923.15.

(b) Power factor of motor.



∴ at V = 220.

$IX_L = 54.977$

$\sin \phi = \frac{54.977}{220}$

$\phi = \sin^{-1} 0.25$

$\phi = 14.47°$

∴ Power factor = $\cos \phi$

$= \cos(14.47)$

$= 0.968$

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(3) Torque developed

Using the formula;

$$T_{AC} = \frac{E_{bAC} * I_L}{2\pi \times \frac{N_{AC}}{60}}$$

$$T_{AC} = \frac{201.45 * 0.7}{2 * \pi * \frac{1923.15}{60}}$$

$$T_{AC} = 0.70 \text{ Nm}.$$

(4) A Universal motor Could be used for the Application because it can operate on both Neither AC or Dc.