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17/Eng04/014 ELECT/ELEC

①

1. (b)

(a) unity = 1

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

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

actual P.F = $\cos\theta = 0.7$

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

$\theta = 45.57°$ $\tan[45.57] = 1.0201$

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1 (b) KVAR = P x [tan (Powerfactor] x tan (P.factor]

1 = Cos θ = 1

θ = cos⁻¹

θ = 0

tan θ = 0

KVAR = 74.6 [1.0201 - 0]

KVAR = 76.10

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

C = 0.00000422

C = 42.2 x 10⁻⁶ C

For 0.9 lagging = -0.9 negative because its lagging

target P.F = Cos θ = -0.9

θ = cos⁻¹ (-0.9)

θ = 154.16

tan θ = -0.48

KVAR = 74.6 x [1.0201 - (-0.48)]

KVAR = 111.90

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

$$C = \frac{112}{2 \pi \times 50 \times 239.6^2}$$

C = 0.00000621

C = 6.2 x 10⁻⁶ C //

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ELECTRICAL (2)

(2) (i) Given 415V (Line-Line)

$N_s : N_r = 6:5$

$Z_s = (0.25 + j0.75)\Omega$

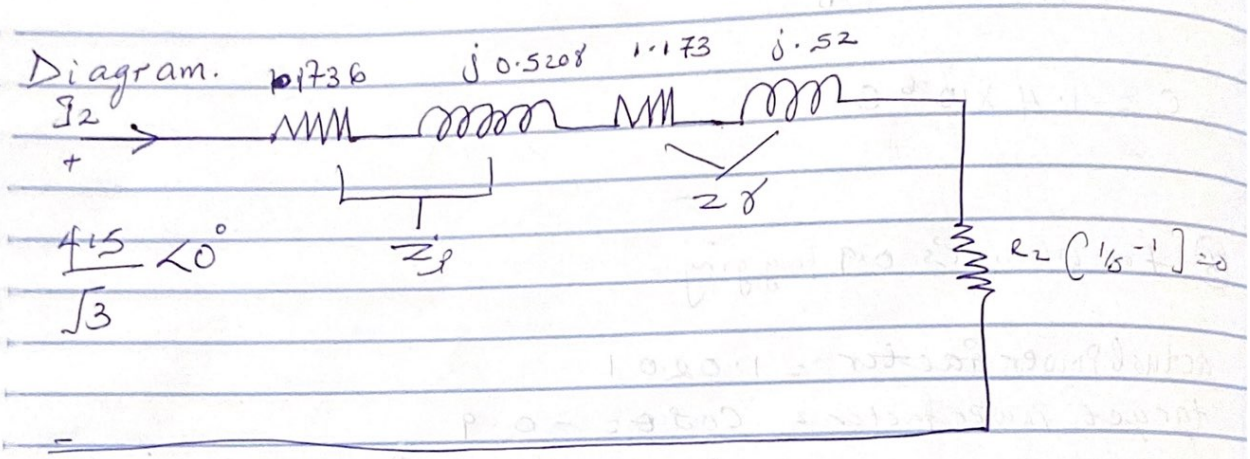
$Z_r = (1.173 + j0.52)\Omega$

$Z'_s$ = Stator impedance refers to rotor side

$Z'_s = (0.25 + j0.75) \times \left(\frac{5}{6}\right)^2$

$Z'_s = (0.1736 + j0.5208)\Omega$

Diagram.




$\therefore R_2\left(\frac{1}{s} - 1\right) = 0$

↳ mechanical load

as at $s = 1$, $R_2\left(\frac{1}{s} - 1\right) = 0$

(b) (ii) from the approximate circuit of (i)

$$\bar{I}_2 = \frac{415/\sqrt{3}}{(0.1736 + 1.173) + j(0.5208 + 0.52)}$$

$\bar{I}_2 = 140.780 \angle -37.70^\circ$ A.

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(3) For the DC supply
Supply voltage = 220V
current draws, I = 0.7A.

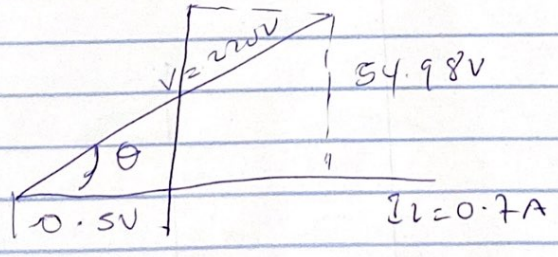
$V - E_b = I_L * R$
$V - [I_2 * R] = E_b$
$E_b = 220 - [0.7 * 15]$
$E_b$ = 209.5 V

Speed on DC
$N_{dc}$ = 2000rpm

For the AC supply.
Supply voltage = 220V
Current = $I_L$ = 0.7A
Reactance drop = $I_L * R = 0.7 \times 15$
= 10.5V

Reactance voltage = $I_L * X_L$
= $0.7 \times 2\pi fL$.

where $X_L = j\omega L = 2\pi fL$
$= 0.7 \times 2\pi \times 50 \times 0.25$
= 54.98




$E_{b\,ac} = \sqrt{V^2 - (X_L)^2} - IR$
$= \sqrt{(220)^2 - (54.98)^2} - 10.5V$
$E_b$ = 202.52V

(i) Recall Speed Constant Equation

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$

$$\text{So } \frac{E_{bac}}{E_{bdc}} = \frac{N_{ac}}{N_{dc}}$$

$$\text{Making } N_{ac} = N_{dc} \times \frac{E_{bac}}{E_{bdc}}$$

$$= 2000 \times \frac{202.52\text{V}}{209.5\text{V}}$$

$$N_{ac} = 1933.37 \text{ rpm}$$

(ii) Power factor, $\cos\phi = \frac{E_{bac} + IR}{V}$

$$= \frac{202.52 + 10}{220}$$

$$= 0.968 \text{ lagging}$$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$

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

$$N_{ac} = N_{dc} \times \frac{E_{bac}}{E_{bdc}}$$

$$= 2000 \times \frac{202.52\text{V}}{209.5\text{V}} = 1933.37 \text{ rpm.}$$

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3(ii)

$\omega = 2\pi n$, where $n$ = speed

$$T_{ac} = \frac{E_{bac} \times I_c}{2\pi \times \frac{N_{ac}}{60}}$$

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

$$= 0.700 \text{ Nm}$$

Torque developed = 0.700 Nm.

3(iv) It is a universal motor because it has both direct current or single phase AC supply.