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17/ENG06/023 MECHANICAL
EEE 326 TEST.
17/06/20.

ANSWER TO QUESTION 1

V = 415V P = 74.6 kW
f = 50Hz % Efficiency = 85%
Power Factor = 0.7.

(i) Unity = 1 ; $C = \frac{KVAR}{2\pi f V^2}$

$KVAR = P(Tan(p.f_{actual}) - Tan(p.f_{target}))$.

$P.F_{(actual)} \Rightarrow Cos\ \theta = 0.7$

$\theta = Cos^{-1}(0.7) = 45.57°$

$Tan(45.57°) = 1.0201$

$P.F_{(target)} \Rightarrow Cos\ \theta = 1$

$\theta = Cos^{-1}(1) = 0$

$Tan(0°) = 0$

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

$74.6 \times 1.0201 = 76.10$

$C = \frac{76.10}{2 \times \pi \times 50 \times (415^2)} = 0.0000014$

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

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(ii) 0.9 Lagging

P.F(actual) = 1.0201

P.F(target) = $\cos\theta$ = 0.9

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

= 154.16

$\tan\theta$ = -0.48

KVAR = 74.6 x (1.0201 - (-0.48)

= 111.90

≃ 112.

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

= 0.000000207

≃ 2.07×10^{-6} C

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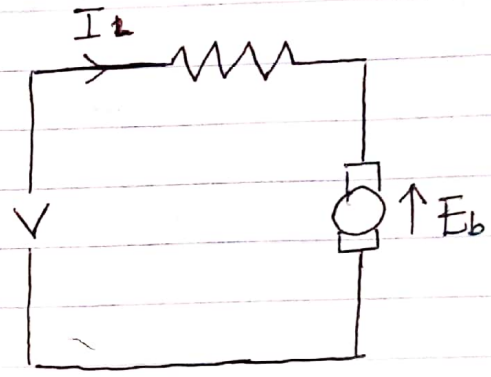
Answer To Question 3

F = 50Hz , 0.25hp , N = 2000rpm
V = 220 , R = 15Ω , H = 0.25.

On DC Supply...

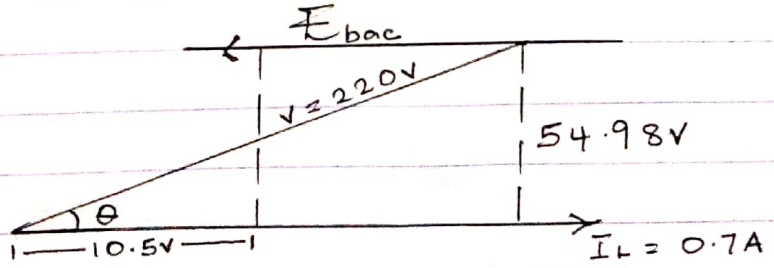
Voltage supplied = 220V
Current (I) = 0.7A



$V - E_b = I_L \times R$
$V - (I_L \times R) = E_b$
$E_b = 220 - (0.7 \times 15)$
$= 220 - 10.5$
$= 209.5V$
DC speed, (N) = 2000rpm

On AC Supply...

Voltage Supplied = 220V
Current, (I_L) = 0.7A
Drop in Reactance = $I_L \times R = 0.7 \times 15 = 10.5V$
Drop in Reactance Voltage = $I_L \times X_L$
$= 0.7 \times 2\pi fL$
$= 0.7 \times 2 \times \pi \times 50 \times 0.25$
$= 54.98V$



$E_{bac} = \sqrt{V^2 - (X_L)^2} - IR$
$= \sqrt{(220)^2 - (54.98)^2} - 10.5 = 202.52V$

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(i) Equation for speed constant

$$\Rightarrow \frac{N_2}{N_1} = \frac{E_{b_2}}{E_{b_1}}$$

Therefore;

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

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

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

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

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

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

$$= 0.968 \text{ lagging}$$

(iii) Torque Developed by the motor

$$T_H = E_{bac} \times I$$

Re-arranging;

$$T_{ac} = \frac{E_{bac} \times I}{W}$$

(W is speed in rad/s).

$W = 2\pi n$ (n is speed in rpm)

$$T_{ac} = \frac{E_{bac} \times I}{2\pi \times (N_{ac} \div 60)}$$

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

$$= 0.700 \text{ Nm}$$

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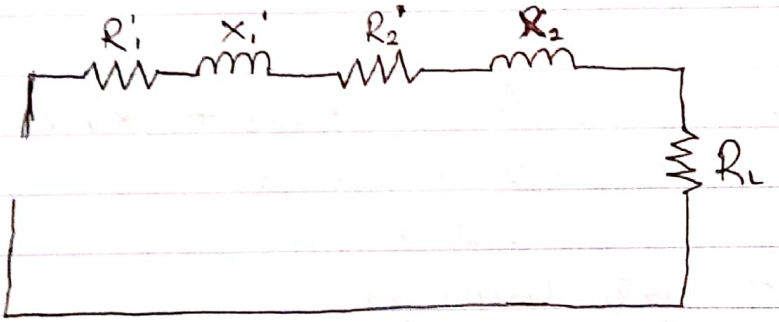
No3 (iv) The Universal Motor

ANSWER TO QUESTION 2.

V = 415
No of Poles = 6
f = 50Hz
k = 5/6 = 0.23
R ⇒ Z_1 = 0.25 + 0.75j (Stator)
Z_2 = 1.173 + 0.52j (Rotor).



Voltage supply per phase, V = 415 ÷ (√3)
= 239.60 V

With respect to Rotor;
$R_{o_2} = (R_2 + k^2 R_1)$
$= (1.173 + (5/6)^2 \times 0.25)$
$= 1.347\ \Omega$

$X_{o_2} = (X_2 + k^2 X_1)$
$= j(0.52 + (5/6)^2 \times 0.75)$
$= 1.041\ \Omega$

$Z_{o_2} = R_{o_2} + X_{o_2}$
$= 1.347 + j\,1.041 = \sqrt{(1.347)^2 + (1.041)^2} = 1.7\ \Omega$

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Current in Rotor;

$I_2 = E_2 \div Z_{o_2}$

$= KV_2 \div Z_{o_2}$

$I_2 = \frac{(239.6 \times 0.25)}{1.7}$

$= 117.45\,A$