17/ENG04/071

ELECT/ELECT

300L

QUESTION 1.

$V = 415V$ $\quad V_L = 415$ and $V_L = \sqrt{3} V_P$

$P.F = 0.7$ $\quad V_P = \frac{V_L}{\sqrt{3}}$

Efficiency = 85%

$f = 50Hz$ $\quad V_P = 415/\sqrt{3} = 239.6$

$P = 74.6$ $\quad$ Actual PF $= \cos\theta = 0.7$

$\theta = \cos^{-1} 0.7 = 45.57$

(i) Unity = 1

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

$\rightarrow KVAR = P \times (\tan \text{actual powerfactor} - \tan \text{target powerfactor})$

Actual powerfactor $= \cos\theta = 0.7$

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

$= 45.57$

$\tan(45.57) = 1.0201$

Target powerfactor $= \cos\theta = 1$

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

$\tan 0 = 0$

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

$= 76.0995 \approx 76.10$

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

$= 0.00000044 \approx 1.4 \times 10^{-6} C$

$= 0.00000422 \approx 42.2 \times 10^{-6} C$

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(i) 0.99 lagging

Actual power factor = 1.0201

Target power factor = cos θ

θ = cos⁻¹(−0.9)

= 154.16

tan θ = −0.48

KVAR = 74.6 × (1.0201 − (−0.48))

= 111.95 ≈ 112.

C = KVAR / 2πfV

= 112 / 2 × π × 50 × 415²

= 0.00080 ≈ 8.0 × 10⁻⁴ C

C = KVAR / 2πfV²

= 112 / 2π × 50 × 239.6²

= 0.00000062 ≈ 6.2 × 10⁻⁶ C

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QUESTION 2

No. of poles = 6

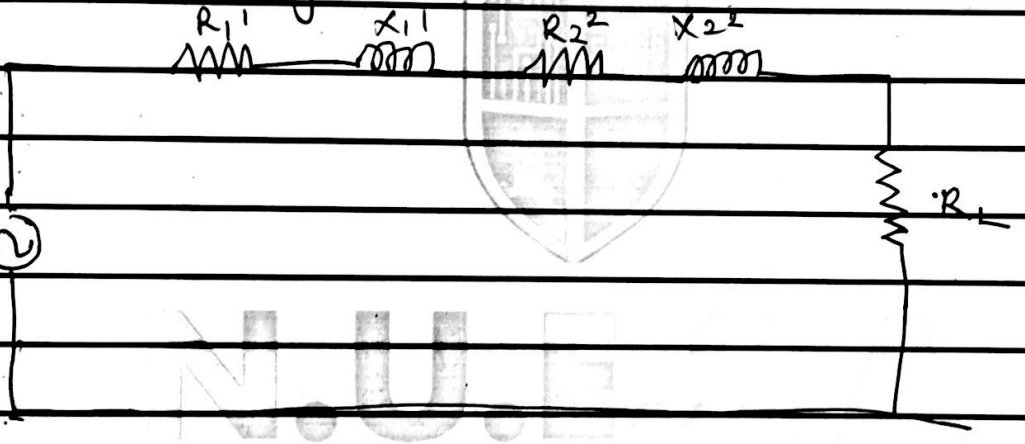
Frequency = 50Hz

Voltage ratio = 5/6

$V_{LN} = 4.5$

$Z_S = 0.25 + 0.75j$

$Z_R = 1.173 + 0.52j$



Given that

$R_2 = 1.173$

$X_2 = 0.52j$

$R_{11} = k^2 \cdot R_1$

$= (1.2)^2 \times 0.75 = 0.36$

$X_1 = k^2 \times X_1$

$= (1.2)^2 \times 0.75$

$= 1.08$

For a series connection

$Z_T = Z_S + Z_T + R_4$

$Z_R = 1.173 + j0.52 + 0.88 + j1.08$

Referring to rotor

$R_{O2} = (R_2 + k^2 R_1)$

$= (1.173 + (5/6)^2 \times 0.28)$

$R_{OL} = 1.347\Omega$

$X_{O2} = (X_2 + k^2 X_1)$

$= j(0.52 + (5/6)^2 \times 0.75)$

$= 1.041$

$Z_{O2} = R_{O2} + X_{O2}$

$= 1.547 + j1.041$

$Z_{O2} = \sqrt{1.547^2 + 1.041^2}$

$= 1.7\Omega$

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To find rotor current

$I_2 = \frac{E_2}{Z_{2L}}$

Recall that $E_2 = kV_1$

$= 234.6 \times 0.83$

$= 199.67\,V$

$\therefore I_2 = \frac{199.67}{1.7} = 117.45\,A$

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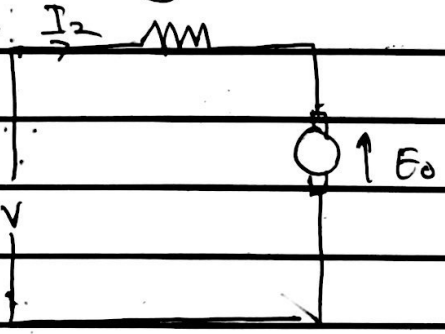
QUESTION 3

On ~~AC~~ Supply F=50Hz, 1/4hp, Nr=2000rpm, V=220V

Su

On DC Supply



$V - E_b = I_2 R$

$V - [I_L \times R] = E_b$

$E_b = 220 - (0.7 \times 15)$

$= 209.5V$

Speed on DC

$N_{dc} = 2000 rpm$

On AC supply

Voltage = 220V

Current drawn $I_L = 0.7A$

Reactance drop = $I_L R = 0.7 \times 15 = 10.5V$

Reactance voltage drop = $I_L \times X_L = 0.7 \times 2\pi f L$

Wher $X_L = \omega L = 2\pi f L$

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

$= 54.98V$

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

$= \sqrt{(220)^2 - (5498)^2} - 10.5V$

$= 202.52V$

(i) Recay speed

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

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

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

$N_{ac} = 1933.37$ rpm

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

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

$= 0.968$

(iii) Torque developed $T_W = E_{bac} \times I$

$I_{ac} = \frac{E_{bac} \times I}{\omega}$

$\omega = 2\pi n$

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

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

$= 0.700 N/m$

(iv) Universal motor