18/ENG04/082

300LVL

ELECTRICAL ENGINEERING

EEE 326

QUESTION (1)

V = 415V, 3phase,

f = 50Hz, P = 74.6,

Pf = 0.7

Efficiency = 85%

The motor given is a 3-phase induction Motor

Wire → Y connected

∴ $V_c = 415$

$V_p = 415/\sqrt{3}$

$= 239.6$

→ Actual pf ∴ $\cos\theta = 0.7$

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

$= 45.57$

$\tan(45.57) = 1.201$

i) For UNITY

Pf = 1

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

$= P \times [\tan(P_{f\,act}) - \tan(P_{f\,target})]$

target P.f = 1

$\cos\theta = 1$

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

$= 0$

$kVAR = 74.6[1.0201 - 0]$

$= 76.10$

$\therefore C = \frac{76.10}{2\times\pi\times50\times239.6^2}$

$= 0.00000422$

$= 42.2\times10^{-6}$ F

(2) 0.9 lagging

target $P_f = \cos\theta = -0.9$

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

$\theta = 154.16$

$\tan\theta = -0.48$

$kVAR = 74.6[1.0201 - (-0.48)]$

$= 112$

$C = \frac{kVAR}{2\pi f V^2} = \frac{112}{2\pi\times50\times239.6}$

$= 0.0000062$

$= 6.2\times10^{-6}$ F

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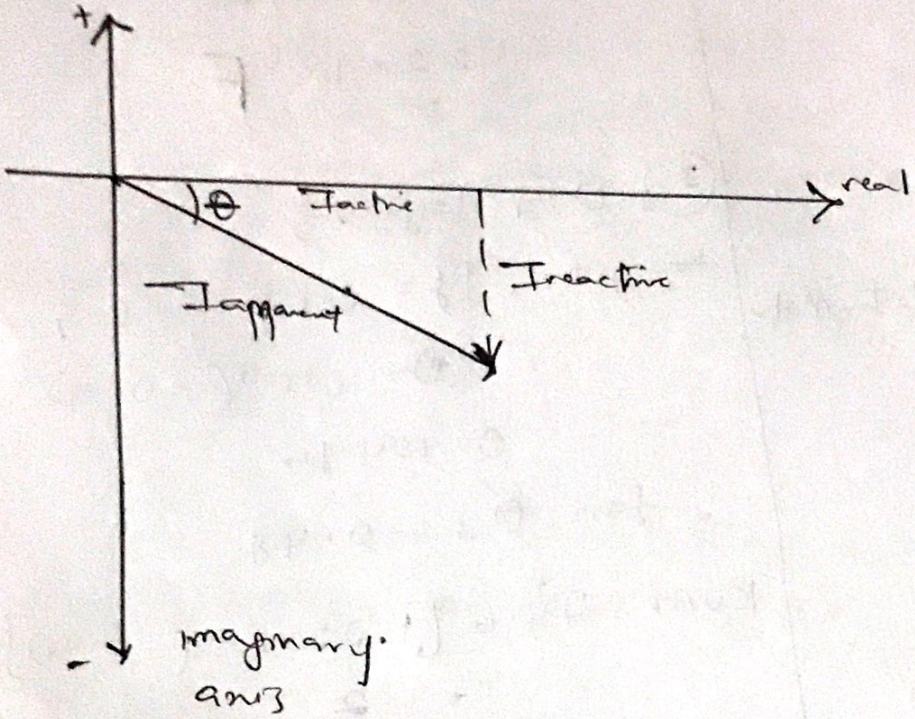
QUESTION (1) continued

Phasor diagram



Question (1) (a)

The drive motor type is a 3phase induction motor

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300LEVEL

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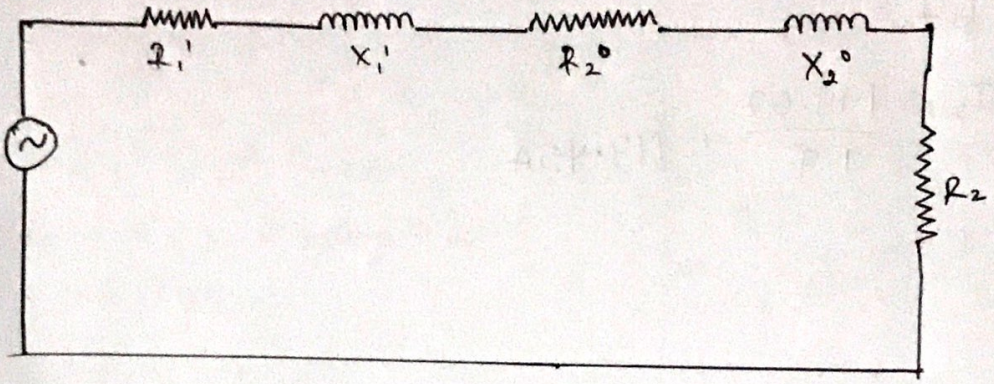
(2)

$R = Z_1 = 0.25 + j0.75$ → Stator

$Z_2 = 1.173 + j0.52$ → rotor



Supply voltage per phase, $V = 415/\sqrt{3} = 239.50V$

For the rotor,

$R_{o2} = (R_2 + k^2 R_1)$

$= (1.173 + (5/6)^2 \times 0.25)$

$R_{o2} = 1.347\Omega$

$X_o = (X_2 + k^2 X_1)$

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

$= 1.041$

$Z_{o2} = R_{o2} + X_{o2}$

$= 1.547 + j1.041$

$Z_{o2} = \sqrt{(1.847)^2 + (1.041)^2}$

$= 1.7\Omega$

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QUESTION 2 Continued

To find rotor current

$I_2 = E_2 / Z_{o2}$

$E_2 = kV_1$

$= 239.6 \times 0.85$

$= 199.67v$

Therefore $I_2 = \frac{199.67}{1.7} = 117.45A$

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QUESTION (3)

$f = 50Hz$ $R = 5\Omega$

$N = 2000rpm$ $L = 0.25H$

$I = 0.7A$

$V = 220V$

$E_{dc} = V - IR$

$= 220 - (0.7 \times 15)$

$= 209.5V$

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

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

$= 54.98V$

$IR = 0.7 \times 15$

$= 10.5V$

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

$= 202.52V$

Speed of motor

Recall $\frac{N_{ac}}{N_{ac}} = \frac{E_{ac}}{E_{dc}}$

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

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

$N_{ac} = 1933.37rpm$

(b) POWER FACTOR

$PF = \cos\theta = \frac{E_{bac} + IR}{V}$

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

$= 0.968$

$= 0.97$ <laggng>

(c) Torque developed

$T = \frac{E_1}{2\pi N/60} = \frac{202.52 \times 0.7}{2\pi \times 1933.37/60}$

$= 0.7 Nm$

(d) Universal motor