(1)

V = 415V, 3-θ, 4-wire f = 50 Hz P = 74.6

pf = 0.7 , % eff = 85%

i) unity = 1

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

→ KVAR = P x (tan p.f

actual p.f ⇒ cos θ = 0.7

θ = cos⁻¹ 0.7

= 45.57

tan (45.57) = 1.0201

target p.f = cos θ = 1

θ = cos⁻¹ 1 = 0

tan 0 = 0

KVAR = 74.6 x (1.0201 - 0)

= 76.0995

≃ 76.10

$C = \frac{76.10}{2 \times \pi \times 50 \times 45^2}$

= 0.000014

≃ 1.4×10^{-6} c

ii) 0.9 lagging

actual p.f = 1.0201

target pf = cos θ = -0.9

θ = cos⁻¹ (-0.9)

= 154.16

tan θ = -0.48

Scanned by TapScanner

1 Continuation

$KVAR = 74.6 \times (1.0201 - (-0.48))$

$= 111.90$

$= 112$

$C = \frac{KVAR}{2\pi f V} = \frac{112}{2 \times \pi \times 50 \times (4.15)^2}$

$= 2.07 \times 10^{-6}\ C$

2) $V = 415V$

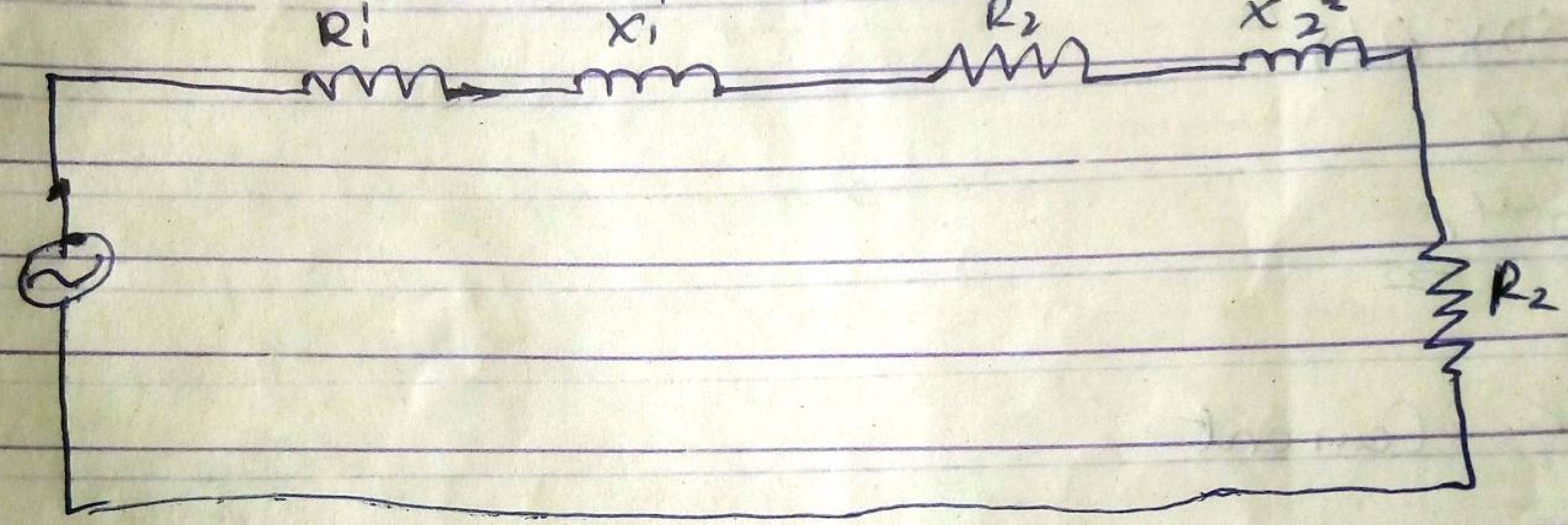
no of poles = 6

$f = 50Hz$

$K = 5/6 = 0.83$

$Z_1 = 0.25 + j0.75$ ... stator

$Z_2 = 1.73 + j0.52$ --- rotor



Supply voltage per phase, $V = \frac{415}{\sqrt{3}} = 239.60V$

refering to rotor

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

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

$R_{O2} = 1.3477 \Omega$

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

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

$= 1.041$

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

$= 1.547 + j1.041$

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

$= \underline{1.7 \Omega}$

Scanned by TapScanner

$KVAR = 74.6 \times (1.0201 - (-0.48))$

$= 111.90$

$\simeq 112$

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

$= \frac{112}{2 \times \pi \times 50 \times 415^{2}}$

$= 0.00056$

$= 5.6 \times 10^{-4} C$

To find rotor Current

$I_2 = \frac{E_2}{Z_{02}}$

Recall that $E_2 = KV_1$

$= 239.6 \times 0.85$

$= 199.67V$

$\therefore I_2 = \frac{199.67}{1.7}$

$= 117.45A$

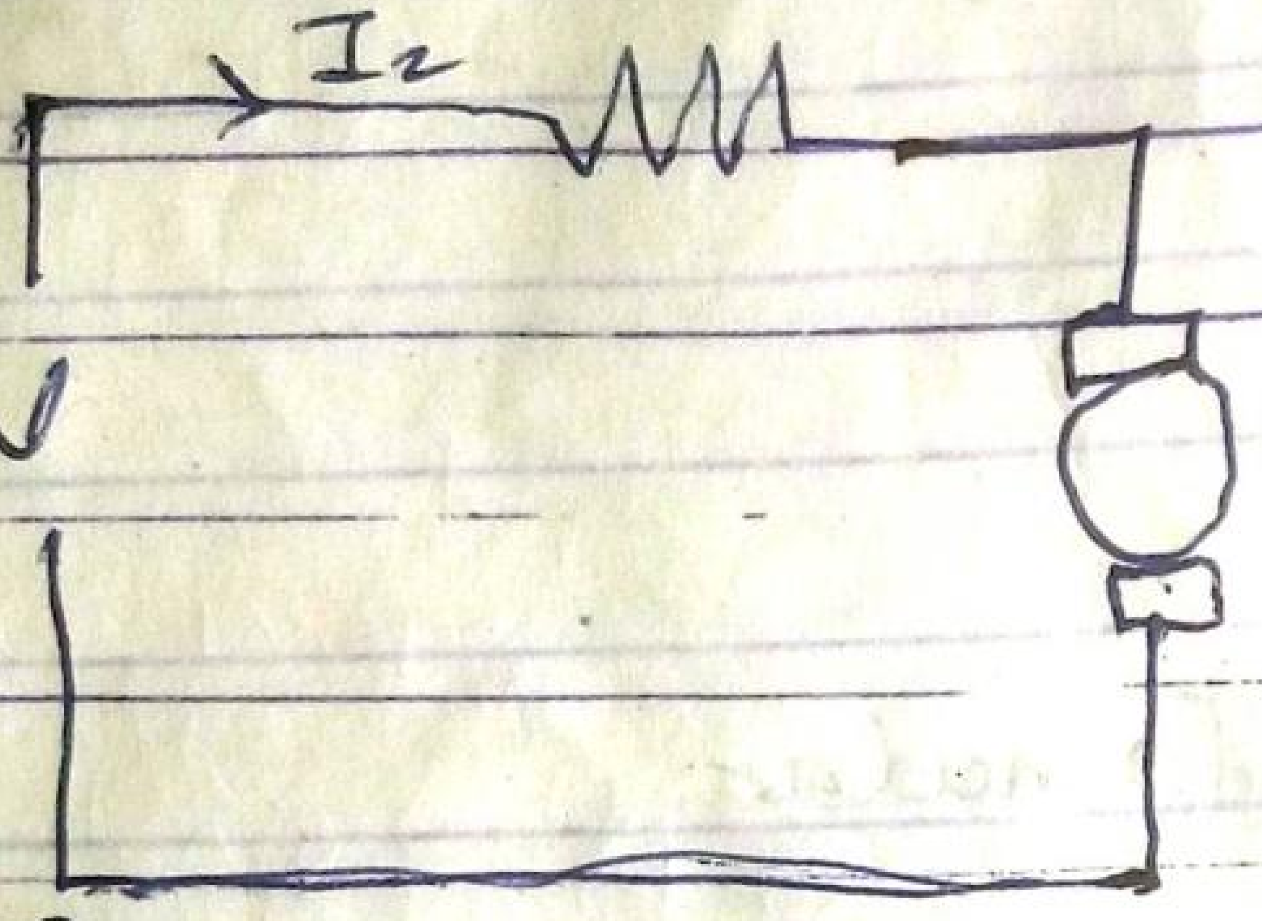
Question 3

f = 50 Hz, 1/4 hp, N = 2000 rpm, 15Ω and 0.25 H

On DC Supply

Supply voltage = 220V

Current draws I = 0.7A



$V - E_b = I_L * R$

$V - [I_L * R] = E_b$

$E_b = 220 - [0.7 * 15]$

$= 209.5V$

Speed on DC

$N_{dc} = 2000 rpm$

On AC Supply

Supply voltage = 220V

Reactance drop = 0.7 × 15 = 10.5V

Current drawn I = 0.7A

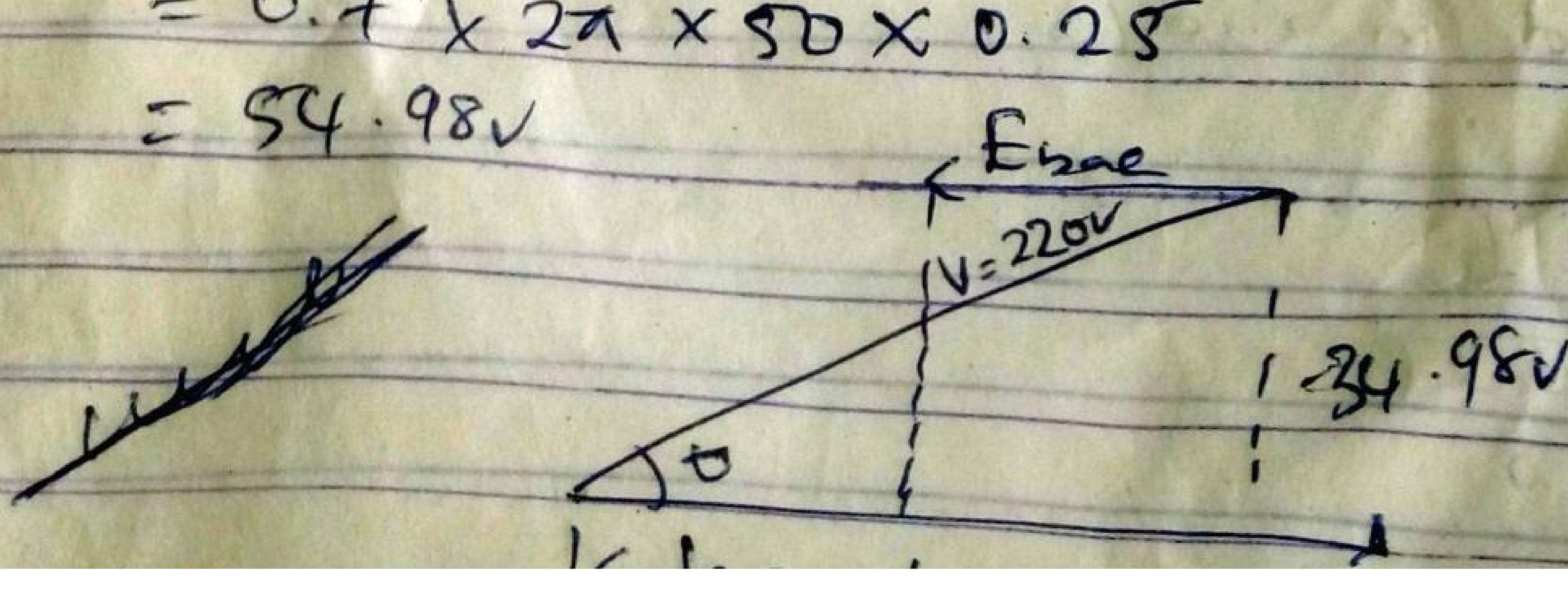
Reactance voltage drop = $I_L \times X_L$

$= 0.7 \times 2\pi f L$

where $X_L = j\omega L = 2\pi f L$

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

$= 54.98V$



$E_{bac} = \sqrt{V^2 - [X_L]^2} - IR$

$= \sqrt{(220)^2 - (54.98)^2}$

$= 202.52V$

Recall speed

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

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

making $N_{a.c}$ subject of the formular

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

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

$= 1933.37rpm$

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

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

$= 0.968$

Torque developed $T\omega = E_{bdc} \times I$

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

ω is speed in rad/s.

$\omega = 2\pi n$

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

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

$= 0.700Nm$

James Evidence

17/Eng06/049 300l

Mechanical Engineering

Question 3

A $f = 50 Hz$