17/ENG06/044
MECHANICAL ENGINEERING
EEE 326
17th June 2020

1 a) Unity = 1.

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

→ KVAR = P x (tan actual p.f − tan target 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 × (1.0201 − 0)

= 76.0995

= 76.10

$$C = \frac{76.10}{2 \times \pi \times 50 \times 415}$$

= 0.0000014

≈ $1.4 \times 10^{-6} C_1$

17/ENG06/044 (1)

(2) 0.9 Lagging

actual p.f = 1.0201

∴target pf = $\cos\theta = -0.9$

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

$= 154.16$

$\tan\theta = -0.48$

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

$= 111.90$

≈ 112

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

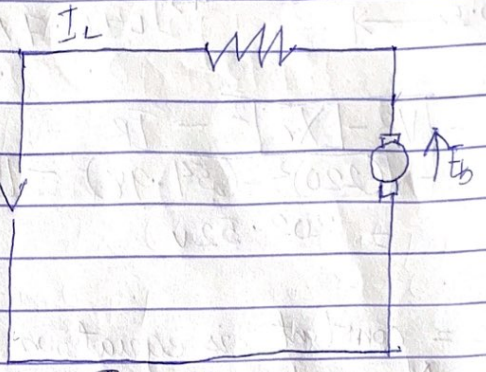
$= \frac{112}{2 \times \pi \times 50 \times 415^2}$

$= 0.00086$

$\approx 8.6 \times 10^{-4} C_1$

17/EN/C06/044 (3)

3) On DC supply
supply voltage = 220v
current drawn, $I = 0.7A$



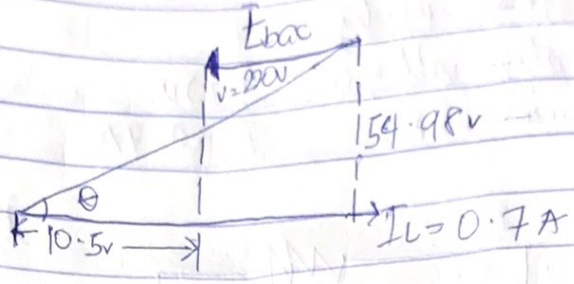
$V - E_b = I_L * R$
$V - [I_L * R] = E_b$
$E_b = 220 - [0.7 * 15]$
$= 209.5v$

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

On AC supply
supply voltage = 220v
current drawn, $I_L = 0.7A$

Reactance drop = $I_L * R = 0.7 \times 15 = 10.5v$
Reactance voltage drop = $I_L \times X_L$
$= 0.7 \times 2\pi fL$
where $X_L = j\omega L = 2\pi fL$
$= 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98v$

17/ENG06/044 (3)



$$E_{bac} = \sqrt{V^2 - [X_r]^2} - IR$$
$$= \sqrt{(220)^2 - (54.98)^2} - 10.5v$$
$$= 202.52v$$

(2) Recall speed = constant. is equation

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

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

making Nac subject of the formula

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

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

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

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

$$= \frac{202.52 + 10}{220} = 0.968 \text{ lagging}$$

17/ENG06/044 (3)

Torque developed $T_w = E_{bac} \times I$

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

where w is speed in rad/s

$w = 2\pi n$

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

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

$$= 0.700 \text{ Nm}$$

17/ENG06/044 (2)

V = 415

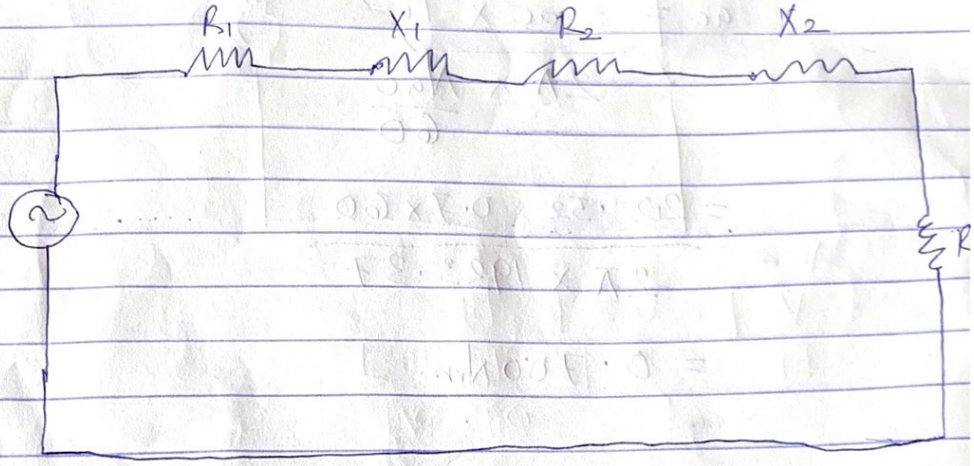
V of pole = 6

f = 50Hz

K = 5/6 = 0.83

$Z_1 = 0.25 + j0.75$

$Z_2 = 1.173 + j0.52$



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

$= 239.60V$

Referring to rotor

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

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

$R_{O2} = 1.347\Omega$

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

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

$= 1.041$

17/ENG06/044 (2)

$Z_{02} = R_{02} + X_{02}$

$= 1.547 + j1.041$

$Z_{02} = \sqrt{1.547^2 + 1.041^2}$

$= 1.7\Omega$

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

Recall that $E_2 = KV_1$

$= 239.6 \times 0.85$

$= 199.67V$

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