Matric no: 17/ENG04/024
Department: Electrical/Electronics Eng.
Level: 300 LvL

Question 1

ABUAD Mango Juice factory is serviced by a 415 V, 3-phase, 4-wire 50Hz. This supply powers the main drive motor having an output of 74.6kw and running on full load at a power factor of 0.7 lagging with an efficiency of 85%. identify the drive motor type and stretch the motor supply circuit with a dived online scale. i) determine the capacitance per phase of the mesh connected capacitor necessary to raise the power factor to (i) unity (ii) 0.9 lagging

ii) Stretch the phasor diagram using an appropriate scale showing the computed values of current.

Answer:

(A).

V = 415V, 3-ϕ, 4-wire, F = 50Hz, P = 74.6

P.f = 0.7, % eff = 85% ∴ V = 415V to star = $415/\sqrt{3}$

$= 239.6$

(B)

i) unity = 1

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

$\rightarrow kVAR = P * [\text{Tan actual P.f} - \text{Tan target P.f}$

actual P.f $\Rightarrow \cos\theta = 0.7$

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

$= 45.57$

$\tan(45.57) = 1.020$

Target P.f $\Rightarrow \cos\theta = 1$

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

$\text{Tan } 0 = 0$

Matric no: 17/ENG04/024
Level: 300 level
Department: Electrical/Electronic Engg
Continuation of No 1

$kVAR = 74.6 \times (1.0201 - 0)$
$= 76.6995$
≈ 76.10

$C = \frac{76.16}{2\pi \times 50 \times 239.6^2} = 0.00000422$
$\approx 42.2 \times 10^{-6} C_1$

B) 0.9 lagging
actual P.f = 1.0201

Target Pf = $\cos\theta = -0.9$
$\theta = \cos^{-1}(-0.9)$
$= 154.16$
$\tan\theta = -0.48$

$kVAR = 74.6 \times (1.0201 - (-0.48))$
$= 111.90$
$\approx 112_1$

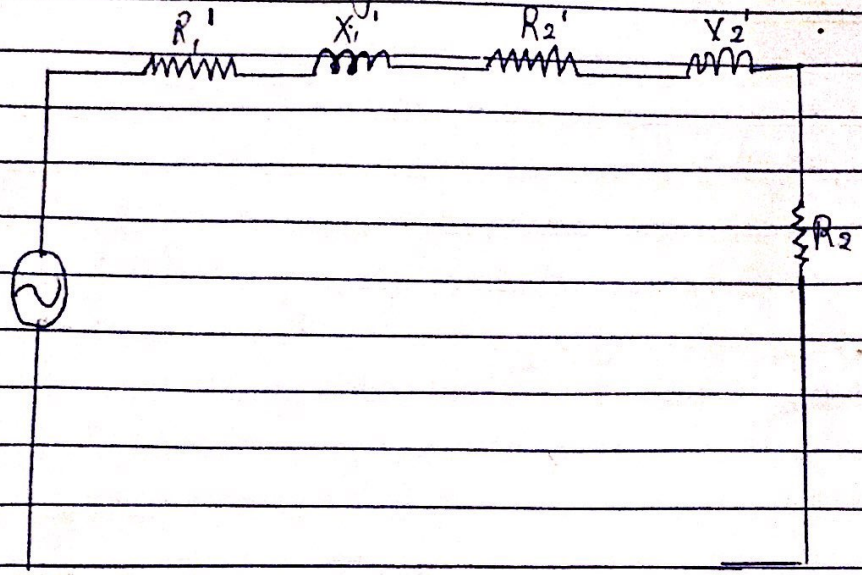
$C = \frac{kVAR}{2\pi f V}$

$= \frac{112}{2\pi \times 50 \times 239.6^2}$
$= 0.00086$
$= 8.6 \times 10^{-4} C_1$
$= 0.00000062$
$= 62 \times 10^{-6} C_1$

Question 3.
M = 415 V
No

Matric no: 17/ENG04/024
Level: 300 level
Department: Electrical/Electronic Eng.

Question 2.
~~Vline~~ 415 V
No of pole = 6
F = 50 Hz
K = 5/6 = 0.83
R $I_1 = 0.25 + j0.75$ – stator
$I_2 = 1.173 + j0.52$ – rotor



Supply voltage Per phase $V = \frac{415}{\sqrt{3}} = 239.50\ V$

referring to rotor

$R_{02} = (R_2 + k^2 R_1)$

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

$R_{02} = 1.347\ \Omega$

$X_{02} = (X_2 + k^2 X_1)$

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

$= 1.041$

Matric no: 17/ENG04/024
Level: 300 LvL
Dept: Electrical / Electronic Eng

Continuation of No. 2

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

$= |1.347 + j1.041|$

$I_{02} = \sqrt{1.347^2 + 1.041^2}$

$= 1.7\,\Omega$,

To find rotor current-

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

Recall that $E_2 = KV$,

$= 239.6 \times 0.85$

$= 199.67\,N$

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

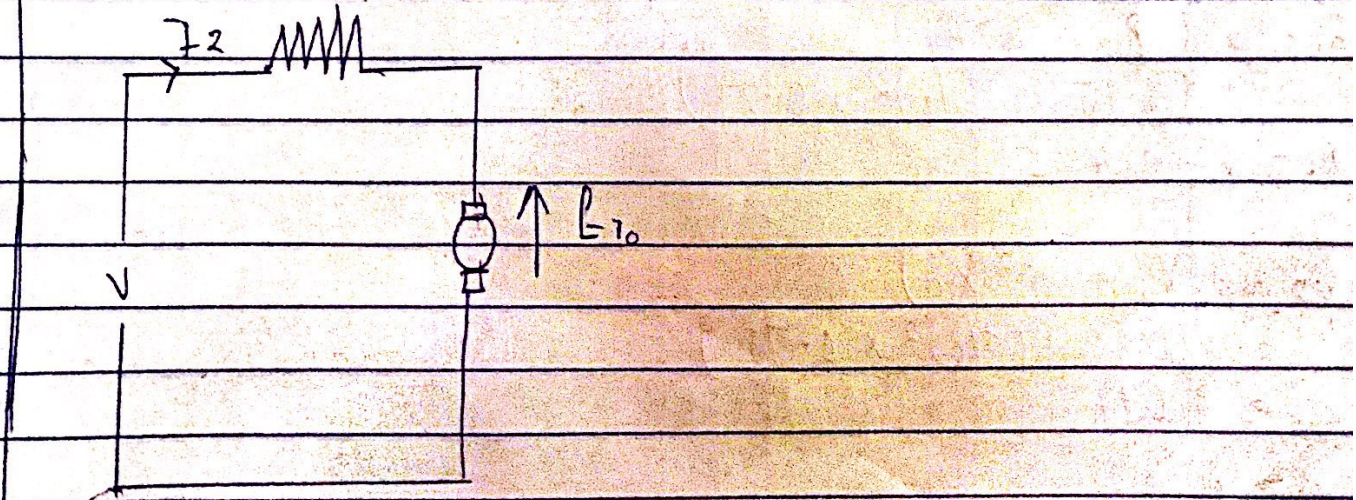
Question 3

$F = 50Hz$, $1/4\,hp$, $N_2 = 2000\,rpm$, $15\,\Omega$ and $0.25\,H$

On DC supply

Supply voltage = 220V

current draws, $I = 0.7A$.



Matric no: 17/eng04/024
Level: 300 Lvl
Dept: Electrical / Electronics Engg.

Continuation of No. 3

On DC supply
Supply voltage = 220 V
Current draws I = 0.7A
$V - E_b = I_2 * R$
$V - [I_2 * R] = E_b$
$E_b = 220 - [0.7 \times 15]$
$= 209.5\ V$
Speed on DC
$N_{dc} = 2000\ rpm.$

On AC supply
Supply voltage = 220 V
Current draws, $I = 0.7A$
Reactance drop $= I_2 \times R = 0.7 * 15 = 10.5\ V$
Reactance voltage drop $= I_2 \times X_2$
$= 0.7 \times 2\pi f L$

where $X_L = j\omega L = 2\pi f L$
$= 0.7 \times 2\pi \times 50 \times 0.25$
$= 54.98\ V$

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

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

Matric no: 17/ENG04/024
Department: Elect/Elect Eng
Level: 300 Lvl

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

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

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

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

ii) Power factor, $\cos\theta = \frac{E_{bac} + IR}{V}$

$$= \frac{202.52 + 10.3}{220}$$

$$\Rightarrow 0.968 \text{ lagging}$$

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

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

ω is speed in rad/s

$\omega = 2\pi n$, where n is speed

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

$$= \frac{207.52 \times 0.7 \times 60}{2\pi \times 1933.37}$$

$$= 0.700\,Nm$$

iv) Universal Motors