17/ENG061022 3DOL/L

Mechanical Engineering

Question 1

V = 415V P.f = 0.7

f = 50Hz Power output = 74.6kw

Unity 1

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

KVAR = P x (tan actual p.f − tan target p.f)

actual p.f = $\cos\theta = 0.7$

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

$\theta = 45.57$

$\tan(45.57) = 1.0201$

target p.f = $\cos\theta = 1$

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

$\theta = 0$

$\tan(0) = 0$

KVAR = 74.6 (1.0201 − 0)

= 76

$C = \frac{76}{2\times\pi\times50\times415^2}$

$= 1.4 \times 10^{-6}$ C4

Mechanical Engineering

Question 1

Lagging 0.9

Actual p.f = 1.0201

Target p.f = $\cos\theta = 0.9$

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

$\theta = 154.16$

$\tan(154.16) = -0.48$

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

$= 111.9$

$\simeq 112$

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

$= 9.92 \times 10^{-7}$ C/V

17/ENG/06/022

Mechanical Engineering

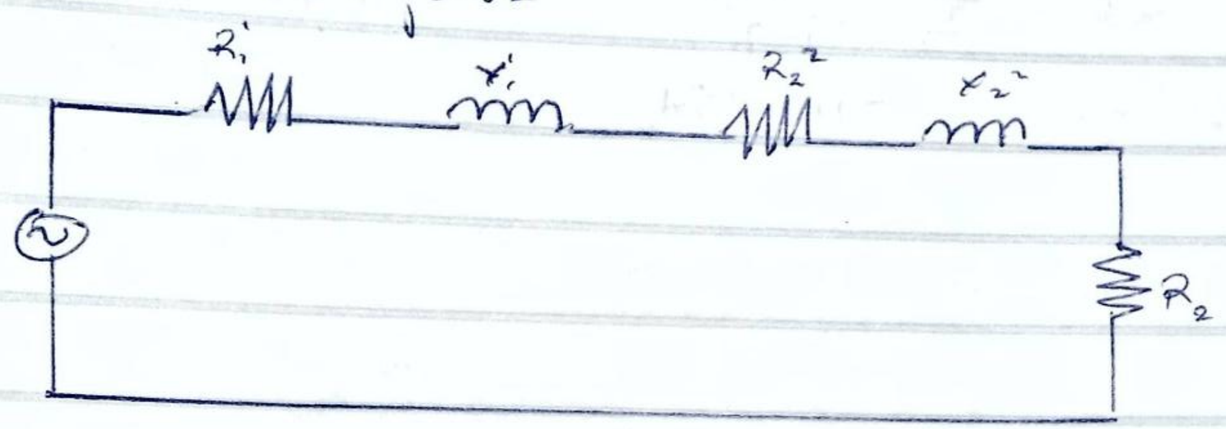
Question 2

$V = 415V$ $\quad f = 50Hz$

$p = 6$ poles $\quad s = 5/6 = 0.833$

$R = Z_1 = 0.25 + j0.75$

$Z_2 = 1.173 + j0.52$



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

Rotor

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

$= (1.173 + (0.83^2) \times 0.25)$

$R_{O2} = 1.347\Omega$

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

$= (0.52 + (0.83^2) \times 0.75)$

$= 1.041$

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

$= 1.347 + j1.041$

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

$Z_{O2} = 1.7\Omega$

17/eng06/022 3008L4L

Mechanical Engineering

Question 2

Roto current

$\Rightarrow \bar{I}_2 = \frac{\bar{E}_2}{Z_{0_2}}$ Recall $E_2 = kV_1$

$= 239.6 \times 0.8$

$= 199.67\ V$

$\bar{I}_2 = \frac{199.67}{1.7}$

$= 117.45A$

Mechanical Engineering

Question 3

$f = 50Hz$ $I = 0.7A$ $R = 15\Omega$

$V = 220V$ $N_s = 2000 rpm$ $L = 0.25H$

① $\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$

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

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

$V - \bar{E}_b = \bar{I}_L * R$

$V - [\bar{I}_L * R] = \bar{E}_b$

$\bar{E}_b = 220 - [0.7 * 15]$

$= 209.5V$

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

$N_{ac} = 1933.37 rpm$

Power factor, $\cos\phi = \frac{E_{bac} + \bar{I}R}{V}$

$= \frac{202.52 + 10*5}{220}$

$= 0.968$ lagging

developed; $T_w = E_{bac} \times \bar{I}$

$T_{ac} = \frac{E_{bac} \times \bar{I}}{w}$ where w = speed in rad/s

$w = 2\pi n$ where n = speed in rad/s

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

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

$= 0.700 Nm$

17/eng 06/022 BOOLAL

Mechanical Engineering

Question 3

AC Supply

Supply Voltage = 220V

Current = $\bar{I}_L = 0.7A$

Reactance drop = $\bar{I}_L * R = 0.7 \times 15 = 10.5V$

Reactance voltage drop = $\bar{I}_L * X_L = 0.7 \times 2\pi fl$

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

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

$= 54.98V$

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

$= \sqrt{220^2 - 54.98^2} - 10.5$

$E_{bac} = 202.52V$