

Electrical exam

by Matt Haycock

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1. $L_1 = 250 \text{ mH}$ $Z_1 = 120 \text{ mH} + 20$
 a $L_2 = 230 \text{ mH}$ $Z_2 = 100 \text{ mH}$
 $L_3 = 230 \text{ mH}$ $Z_3 = 120 \text{ mH}$
 $f = 50 \text{ Hz}$

$Z_1 = 20 \Omega + jX_L = 20 \Omega + j2\pi f L = 20 \Omega + j2\pi \times 50 \times 250 \times 10^{-3}$
 $= 20 \Omega + j37.699 \Omega$

$Z_2 = X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} = 31.415 \Omega$

$Z_3 = X_L = 2\pi f L = 2\pi \times 50 \times 120 \times 10^{-3} = 37.699 \Omega$
 $X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} = 31.83 \Omega$

$Z = R + j(X_L - X_C)$
 $= 15 + j(37.699 - 31.83)$
 $= 15 + j5.869$

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$$b) I_1 = \frac{V}{Z_1} = \frac{V_{L1}}{Z_1} = \frac{250 \angle 0^\circ}{20 + j37.699} \times \frac{20 - j37.699}{20 - j37.699}$$

$$\frac{250 + j0}{20 + j37.699} \times \frac{20 - j37.699}{20 - j37.699}$$

$$= \frac{4600 - j8670.77}{400 - j753.98 + j753.98 - j^2 1421.21}$$

$$\frac{4600 - j8670.77}{400 + 1421.21}$$

$$= \frac{4600 - j8670.77}{1821.21}$$

$$2.526 - j4.76 \text{ / } \angle$$

$$5.388 \angle -62^\circ \text{ A}$$

$$10 \text{ IS} = \frac{VL3}{23}$$

$$\begin{array}{r} 230 \text{ L } 740 \\ 15 + j24.71 \end{array} \xrightarrow{\text{see}} -115 - j149.8$$

$$\frac{-115 - j199.18}{15 + j24.71} \times \frac{15 - j24.71}{15 - j24.71}$$

~~- 1725 + j 3850 - 2487.7~~

$$\begin{array}{r} -1725 + j2841.05 - j2487.7 + j^2 4921.73 \\ 225 - j2487.7 + j370.65 + j370.65 - j^2 610.5811 \\ 225 + 610.58 = 835.58 \end{array}$$

$$-1725 - \$4921.73 = -\$6646.73 - j14608$$

1d) $P_{\text{max}}(LP)$

$$\begin{aligned} Z1 \ P &= I^2 R \\ &= 5.388^2 \times 20 \\ &= 576.88 \text{ W} \end{aligned}$$

~~Z2~~

$$\begin{aligned} Z3 &= P = I^2 R \\ &= 7.951^2 \times 15 \\ &= 948.77 \text{ W.} \end{aligned}$$

e) Z1

$$\begin{aligned} &= Q = I^2 X \\ &= 5.388^2 \times 37.69 \\ &= 1094.161 \text{ VAR.} \end{aligned}$$

Z3

$$\begin{aligned} &= Q = I^2 X \\ &= 7.95 \times 24.71 \\ &= 196.44 \text{ VAR.} \end{aligned}$$

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$$Z_1 = |S| = \sqrt{P^2 + Q^2}$$

$$= \sqrt{578.88^2 + 1094.61^2}$$

$$= \underline{\underline{1237.85}}$$

$$Z_3 = \sqrt{948.77^2 + 196.44^2}$$

$$= \underline{\underline{968.44}}$$

9) Z_1

$$PF = \frac{P}{S}$$

$$S = IV = 5.588 \times 230$$

$$= 1239.74$$

$$= \frac{578.88}{1239.74}$$

$$= \underline{\underline{0.467}}$$

Z_3

$$PF = \frac{P}{S}$$

$$S = IV = 7.951 \times 230$$

$$= 1828.73$$

$$= \frac{948.77}{1828.73}$$

$$= \underline{\underline{0.519}}$$

2 . Advantage of local verses central power factor correction would be that in a central power a low power factor will result in penalties for the power company.

It will reduce the power that is wasted in the impedance components.

If a power factor correction is applied to low voltage, it will maximise the available power to the secondary transformer.

For the active power, a smaller amount of current is used by applying the power factor correction.

Voltage drops will be minimised where the power factor correction is applied. So over working of the circuit will be achieved.

The system will also help to increase the capabilities of having more loads in the circuit.

Voltage of the related equipment will also have a benefit due to the correction



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34) $\frac{V_{LP}}{V_{IS}} = \sqrt{3} = \sqrt{3}$

STAR
DELTA

$\frac{NP}{NS}$

$V_{IS} = \frac{V_{LP}}{NP\sqrt{3}} = \frac{132000}{15\sqrt{3}}$

$= 5080.7 \sqrt{}$

$\frac{I_{LP}}{I_{IS}} = \frac{I_{PP}}{\sqrt{3}}$

$= \frac{1}{\sqrt{3}} \times \frac{NS}{NP}$

$I_{IS} = \sqrt{3} \times I_{IS} \times 170$

$= 4416.72 \text{ A}$

3b) $\frac{V_{PP}}{V_{PS}} = \frac{NP}{NS}$ PAGE (7) DELTA STAR

$$\frac{V_{LP}}{V_{LS}} = V_{PS} \times \frac{V_{PP}}{V_S}$$

$$= \frac{1}{\sqrt{3}} \times \frac{NS}{NP}$$

$$V_{LS} = \sqrt{3} \times \frac{132000}{15}$$

$$= \underline{\underline{15242.04 \text{ V}}}$$

4. $B_{\text{core}} = \frac{\Phi}{A} = \frac{500 \times 10^{-6}}{40 \times 10^{-3} \times 100 \times 10^{-3}} = 0.125 \text{ T}$

BH CURVE $H = 500 \text{ A/m}$

MMF CORE $= H \times L = 500 \times 650 \times 10^{-3} \text{ At}$
 $= 195$

$B_{\text{AIR GAP}} = B_{\text{CORE}}$

MMF CORE $= H \times L = 0.14 \times 90 \times 10^{-3}$
 $= 5.88 \times 10^{-6} \text{ At}$

MMF TOTAL $= \text{MMF CORE} + \text{MMF GAP} =$

$5.88 \times 10^{-6} + 195.$

$= 195 \text{ At}$

$I = \frac{\text{MMF TOTAL}}{N} = \frac{195}{1200} = 0.1625 \text{ A}$

Electrical exam

GRADEMARK REPORT

FINAL GRADE

46/100

GENERAL COMMENTS

Instructor

Q1 a) $2+0+2=4$

Q1 b) $3+0+3=6$

Q1 c) 0 Marks

Q1d) 2 Marks

Q1e) 1.5 Marks

Q1f) 2 Marks

Q1g) 2 Marks

Q1h) 0 Marks

Q2 3 Marks

Q3a) 8

Q3b) 4

Q4)9 Marks

Total 41.5

$41.5/90=46.1\%$

PAGE 1



Comment 1

Q1 a) $2+0+2=4$

Q1 b) $3+0+3=6$

Q1 c) 0 Marks

Q1d) 2 Marks

Q1e) 1.5 Marks

Q1f) 2 Marks

Q1g) 2 Marks

Q1h) 0 Marks

Q2 3 Marks

Q3a) 8

Q3b) 4

Q4)9 Marks

Total 41.5

$41.5/90=46.1\%$



Comment 2

Q1a) 4 Marks

Z1 and Z3 correct

PAGE 2



Comment 3

Q1b - I1 Correct

PAGE 3



Comment 4

Q1b) Phase 3 Correct

Ph1 - 3 Marks

Ph2 - 0 Marks

Ph3 - 3 Marks

Q3 Total 6 Marks

PAGE 4



Comment 5

Q1d)

Ph 1 - 1 Mark

Ph 2 - 0 Mark

Ph3 - 1 Mark

Total 2 Marks



Comment 6

Lost the square on current.



Comment 7

Q1e)

Ph 1 - Correct - 1 Mark

Ph2 - 0 Marks

Ph3 - 0.5 Marks

Total 1.5

PAGE 5



Comment 8

Q1f)

Ph1 - 1 Mark

Ph2 - 0 Mark

Ph3 - 1 Mark (Error Carried Forward)

Total 2 Marks



Comment 9

Q1g)

Ph1 1 Mark

Ph2 0 Mark

Ph3 1 Mark

Total 2

PAGE 6



Comment 10

Q2 3 Marks

You were meant to compare local and central PFC systems and give examples of where they'd be used

PAGE 7



Comment 11

Q3a) 8 Marks

incomplete answer.

No power calculation.

PAGE 8



Comment 12

Q3b)

4 Marks

Incomplete answer. No Current, No Power

PAGE 9



Comment 13

Should be $(0.14T/\mu_0)*90 \times 10^{-3}$

Missing μ_0



Comment 14

Method correct. One slip up in not including μ_0 for mmf in the air gap.

9 Marks