



# Power Factor and Harmonic Analysis Worksheets

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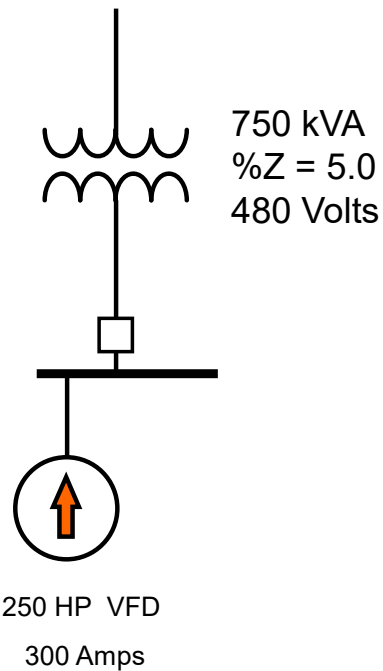
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## Problem 7

### Harmonic Distortion

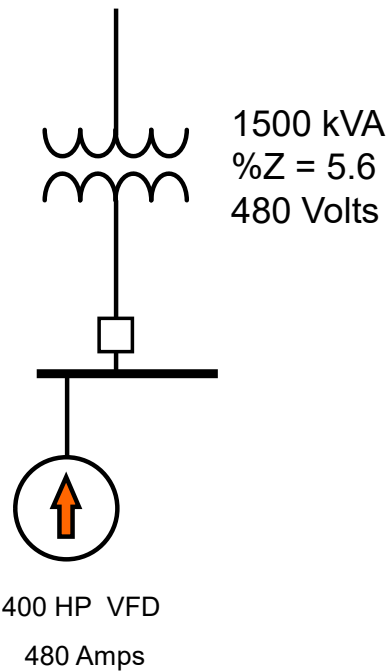


Given the harmonic spectrum of the 250 HP motor,  
Calculate the total harmonic voltage distortion.  
Assume  $Z_{\text{source}} = 0$  and  $Z = X$

Harmonic Order	Harmonic Current (Amps) $I_h$	System Impedance (Ohms) $Z_h$	Harmonic Voltage (Volts) $V_h$
5	60		
7	45		
11	15		
13	10		

## Problem 8

### Harmonic Distortion



Given the harmonic spectrum of the 400 HP motor,  
Calculate the total harmonic voltage distortion.  
Assume  $Z_{\text{source}} = 0$  and  $Z = X$

Harmonic Order	Harmonic Current (Amps) $I_h$	System Impedance (Ohms) $Z_h$	Harmonic Voltage (Volts) $V_h$
5	96		
7	72		
11	24		
13	15		

## Worksheet K-Factor

h	I <sub>h</sub>	h <sup>2</sup>	I <sub>h</sub> <sup>2</sup>	I <sub>h</sub> <sup>2</sup> h <sup>2</sup>
		<b>Total</b>		

$$K = \frac{I_h^2 h^2 \text{ (Total)}}{I_h^2 \text{ (Total)}} = \frac{(\quad)}{(\quad)} =$$

## Filter Design Worksheet - Part 1

**CAPACITOR DATA:** Mvar = \_\_\_\_\_ kV<sub>system(L-L)</sub> = \_\_\_\_\_ kV<sub>L-N</sub> = \_\_\_\_\_ /  $\sqrt{3}$  = \_\_\_\_\_ h = \_\_

$X_{\text{eff}} = kV_{L-L}^2 / \text{Mvar}$	( _____ ) <sup>2</sup> / ( _____ ) = ( _____ ) / ( _____ )	
$X_C = [h^2 / (h^2 - 1)] \times (X_{\text{eff}})$	( _____ ) <sup>2</sup> / [( _____ ) <sup>2</sup> - 1] x ( _____ ) = ( _____ ) x ( _____ )	
$X_L = X_C / h^2$  $X_C - X_{\text{eff}}$	Or ( _____ ) / ( _____ ) <sup>2</sup> or ( _____ ) - ( _____ )	
$I_{f1} = kV_{L-N} / (X_C - X_L)$  $I_{f1} = kV_{L-N} / (X_{\text{eff}})$	Or [( _____ ) x 1000] / [( _____ ) - ( _____ )] or [( _____ ) x 1000] / ( _____ )	
$I_{\text{rms}} = (I_{f1}^2 + I_{f2}^2 + I_{f3}^2 + \dots)^{1/2}$	[( _____ ) <sup>2</sup> + ( _____ ) <sup>2</sup> + ( _____ ) <sup>2</sup> + ...] <sup>1/2</sup> [( _____ ) + ( _____ ) + ( _____ ) + ...] <sup>1/2</sup>	
$V_{C1} = I_{f1} \times X_C$	( _____ ) x ( _____ )	
$V_C(h) = (I_{f1} \times X_C / f_{1-}) + (I_{f2} \times X_C / f_{2-}) \dots$	[( _____ ) x ( _____ / _____ )] + [( _____ ) x ( _____ / _____ ) + ...] [( _____ ) x ( _____ )] + [( _____ ) x ( _____ ) + ...] ( _____ ) + ( _____ ) + ...	
$V_{\text{rated (L-N)}} = [V_{C1} + V_C(h)]$	( _____ ) + ( _____ )	

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## Filter Design Worksheet - Part 2

<b>CAPACITOR DATA:</b> $kV_{\text{rated(L-N)}} =$ _____ $kV_{\text{rated(L-L)}} =$ _____ $Mvar =$ _____		
$Mvar_{\text{rated}} = (\sqrt{3} \times kV_{\text{rated(LL)}})^2 / X_C$	$( \text{_____} )^2 / ( \text{_____} ) = ( \text{_____} )^2 / ( \text{_____} )$	
$I_{\text{nominal}} = kvar_{\text{rated}} / (\sqrt{3} \times V_{\text{rated(LL)}})$	$( \text{_____} ) / [\sqrt{3} \times ( \text{_____} )]$	
<b>ADEQUACY</b>		
$I_{\text{rms duty}} / I_{\text{nominal}} \leq 135\%$	$( \text{_____} ) / [ ( \text{_____} ) ]$	
$[ \sum I(h)^2 \times (X_c / h) ] / 1000$ $I(h) =$ from harmonic data	$h = ( \text{___} ): [ ( \text{_____} )^2 \times ( \text{_____} ) ] / 1000$ $h = ( \text{___} ): [ ( \text{_____} )^2 \times ( \text{_____} ) ] / 1000$ $h = ( \text{___} ): [ ( \text{_____} )^2 \times ( \text{_____} ) ] / 1000$	_____
$\text{Total Mvar} \leq 1.35 \times Mvar_{\text{rated}}$	$3 \times ( \text{_____} ) / 1000$	
$1.35 \times Mvar_{\text{rated}}$	$1.35 \times ( \text{_____} )$	
$\text{Total Mvar} < 1.35 Mvar_{\text{rated}}$	$( \text{_____} ) \leq ( \text{_____} )$ Yes/No?	

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