X310994

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE
Department of Electrical Engineering

Experiment No.________Fourier Analysis of Periodic Waveforms

INTRODUCTION

Periodic waveforms that are nonsinusoidal can be synthesized by summing together sinusoidal waveforms of different magnitudes and frequencies. The sinusoidal waveforms would consist of a fundamental waveform (same frequency as the nonsinusoidal waveform being synthesized) and/or waveforms that are multiple frequencies (harmonics) of the fundamental waveform, i.e.,

$$f(t) = ao/2 + a1 \text{ Cos } \omega t + a2 \text{ Cos } 2\omega t + ... + b1 \text{ Sin } \omega t + ...$$

or,

$$f(t) = \frac{ao}{2} + \sum_{n=1}^{\infty} Cn \cos(n\omega t - \Theta)$$

where,

$$Cn = \sqrt{an^2 + bn^2}$$

$$\Theta = \operatorname{atan}\left(\frac{bn}{an}\right)$$

$$ao = \text{DC value of the function}$$

or,

$$f(t) = \frac{ao}{2} + \sum_{n=1}^{\infty} Cn \sin(n\omega t + \phi)$$

where,

$$\phi = \operatorname{atan}\left(\frac{an}{bn}\right)$$

and,

$$\omega = 2\pi f = 2\frac{\pi}{T}$$

$$T = \text{time period of the fundamental frequency}$$

$$an = \left(\frac{2}{T}\right)\int_{0} f(t)\cos\left(\frac{2n\pi t}{T}\right)dt$$

$$bn = \left(\frac{2}{T}\right)\int_{0}^{T} f(t)\sin\left(\frac{2n\pi t}{T}\right)dt$$

PRELIMINARY REPORT

P-1. Find the Fourier series for a square-wave, triangular-wave, ramp-wave, and a sine-wave.

P-2. Using the digital computer, determine the magnitude (Cn) and phase (Θ) of sinusoidal waveforms that would form a periodic square-wave, triangular-wave, ramp-wave and a sine-wave. Assume a magnitude of $\pm$1 unit and a frequency of 1 Hertz. Do not go beyond the ninth harmonic.

Waveform	C1	Θ1	C2	Θ2	C3	Θ3
Square						
Triangular						
Ramp						
Sine						

Waveform	C4	Θ4	C5	Θ5	C6	Θ6
Square						
Triangular						
Ramp						
Sine						

Waveform	C7	Θ7	C8	Θ8	C9	Θ9
Square						
Triangular						
Ramp						
Sine						

(INSTRUCTOR'S SIGNATURE______________________________DATE___________)

PROCEDURE

F-1. Connect the circuit in Figure 1 and adjust L to approximately 3 mH and C to 0.1 uF. Set the function generator for a square-wave output of maximum output and 10 K-Hertz with zero DC offset. Connect the oscilloscope to the output of the function generator and adjust the sweep so that exactly one cycle is displayed (NOTE: The sweep does not have to be calibrated). DO NOT RE-ADJUST! Next, connect the oscilloscope so as to measure the output voltage of the circuit, Vo. Adjust L to give a one-cycle signal of PEAK magnitude. This would be the fundamental waveform. Record the frequency (f1), L1, C1, and VO1.

F-2. Try adjusting L and C to give two cycles displayed on the oscilloscope (it may or may not be possible). This would be the second harmonic signal. Again record f2, L2, C2, and VO2.

F-3. Repeat F-2 above up to the ninth harmonic.

F-4. Repeat F-1 through F-3 above for a triangular, ramp, and a sine wave.

REPORT

R-1. Calculate the measured magnitude of each harmonic for each waveform using the following equation;

$$V_{Hn} = \left(1 + \frac{RsRL}{(2\pi fnLn)^2}\right)V_{On}$$

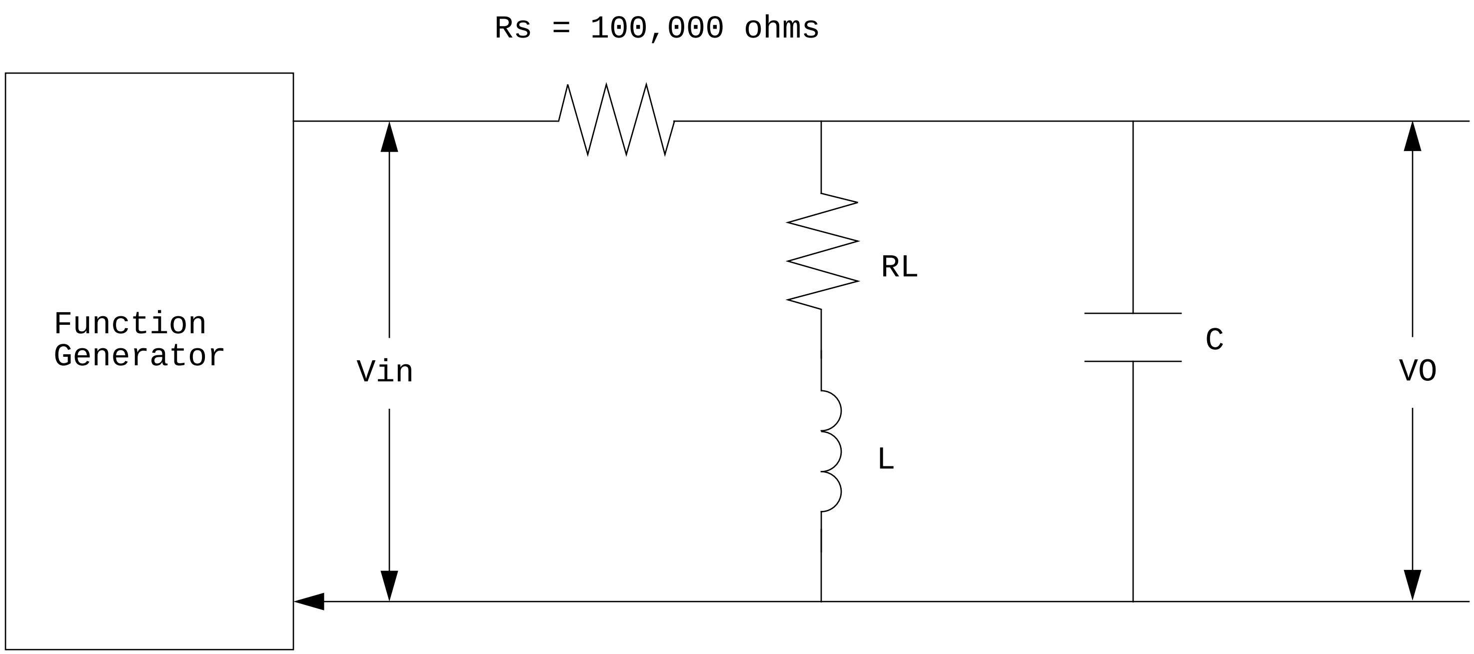
where,

RL - resistance of the coil

R-2 Plot the "normalized" MEASURED values, VHn/Vin, for each frequency on a piece of graph paper. Do this for each waveform.

R-3. Compare in a table the "normalized" MEASURED values with the calculated values for each waveform.

R-4. Discuss the results.


Rs = 100,000 ohms
Function
Generator
Vin
RL
L
C
VO