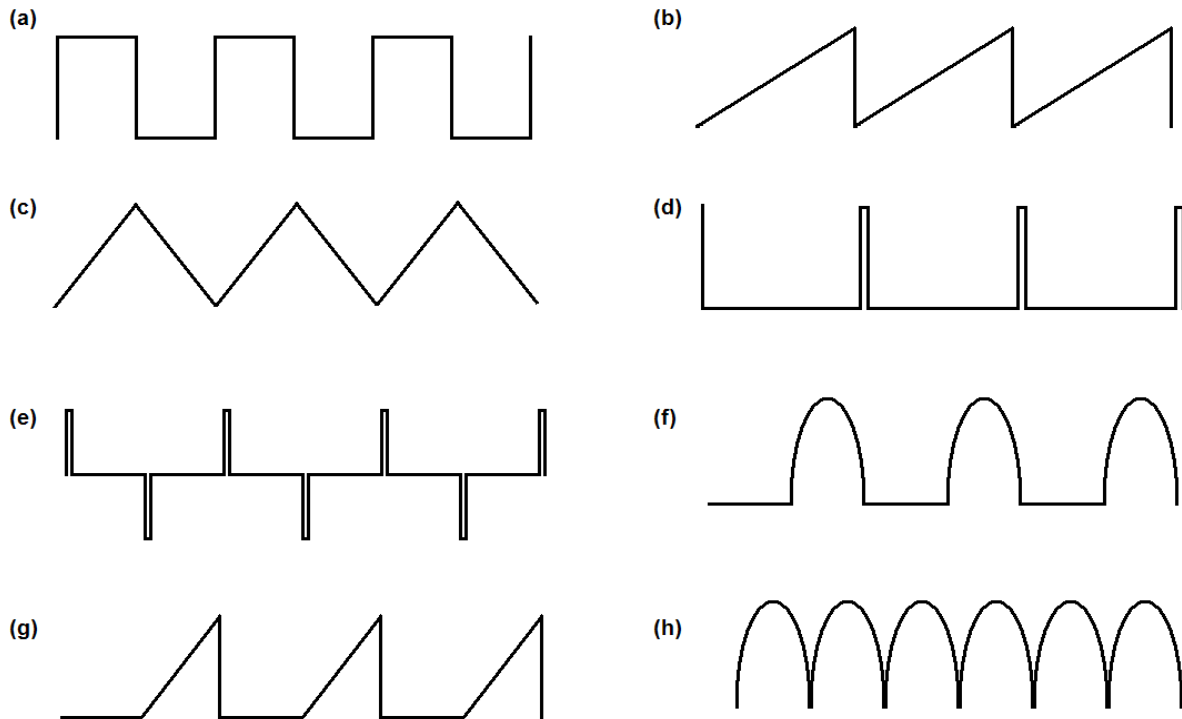


UNIVERSITY OF WATERLOO
Department of Physics and Astronomy

Physics 360/460 – Experiment 16

ANALYSIS OF WAVES

Periodic functions can be analyzed into their Fourier components (harmonics) either mathematically or electronically. The waveforms given below will be analyzed in this experiment, and the measured amplitudes of the harmonics can be compared with calculated values.



Waveforms (a), (b), (c), and (g) are ideally made up of straight-line segments. (d) and (e) are ideally infinitely high and narrow spikes and should be assumed to be Dirac-Delta functions for purposes of calculation. Waveform (f) is a half-wave and (h) is a full-wave rectified sine waveform. Calculate[†] the Fourier series for all these functions and list the amplitudes of the coefficients for the first several terms. Note that (e) and (d) are essentially the derivatives of (a) and (b), and (c) is the integral of (a). These relationships can be used to simplify your calculations. You will be provided with a 100 Hz generator, which will give all the waveforms (a) to (h) as well as a pure sine wave. (a), (b), (c) and (d) are given directly; (e) by differentiating (a); (f) and (h) by half or full wave rectification of the sine wave; and (g) by half wave rectification of (b).

[†] it is sufficient to just go through a detailed calculation for one of above waveforms and simply quote the results from a textbook for the others.

Experiment:

A personal computer (PC) fitted with an oscilloscope card is used in the analysis of the waveforms. An additional (standalone) oscilloscope is provided to check the input waveforms and DC levels. Connect the output from the 100 Hz waveform generator to channel 1 of the scope and to the channel 1 input of the oscilloscope card (at the back of the PC). The external trigger output from the signal generator should be wired to the EXT trigger connection of the standalone oscilloscope, and to the external trigger connection on the scope card in the PC. A LabVIEW program is used to acquire the signal from the oscilloscope card, analyze the signal, and provide a peak analysis on the Fourier spectrum. Run the program and follow the instructions. You will first want to check that the sine wave has only one component and that it is close to 100 Hz (If not, ask the demonstrator for assistance). Run the analysis portion of the program on all of the other 8 waveforms listed above. You should note any subtle discrepancies between the waveforms observed on the oscilloscope display and the “ideal” waveforms used in the Fourier series calculations. For each waveform you should use the program to obtain two data files: the .lvm file contains all the data points from the Fourier analysis (Frequency and amplitude) and the .txt file contains only the peak location and amplitude data. The .lvm file is just an ordinary text file, which can easily be plotted using a spreadsheet program such as Excel. The amplitudes of the Fourier components in the .txt files should be normalized for each of the 8 waveforms and your results should be compared with theoretical predictions. Discuss the origins of any discrepancies. Verify the periodicity in the frequency of the harmonics for the various waveforms and comment on those as well.

Equipment List:

Waveform Generator (UW Phys. Dept. A784)
Tektronix Oscilloscope Model 503
Personal Computer fitted with a National Instruments NI-5102 oscilloscope card
Connecting Cables.

REVISED
May 2007
JG