

Lab 2 Procedure, Report Format Fourier Series and Low Pass Filtering

1 Report Format

1. Briefly explain the procedure (what you did in the lab)
2. Show the Results/plots, you can use excel or a snap shot (picture).
5. (k), (L), (m)
3. In this lab, first, we will examine the different frequencies present in the time domain signal (Fourier series decomposition, similar to Lab 1). Later, we will reconstruct the signal by adding one harmonic at a time. Then, compare the reconstructed and the actual signals using the oscilloscope. The reconstructed signal looks more and more similar to the actual signal as we add additional harmonics (notice the Gibbs Phenomenon).
4. To accomplish this task, we will use the function generator to generate the signals, and the TIMS (Telecommunication Instructional Modeling System) 301 modeling system to manipulate the signals. Oscilloscope is used to examine the time domain signal, while the corresponding spectrum is analyzed using SR770 FFT Network analyzer. Later, these results will be verified in Matlab.
5. Use the following procedure:
 - (a) Use the function generator to create a 5V (peak to peak) square wave of 500 Hz.
 - (b) Connect a “BNC to Banana adapter” (figure 1(a)) to the “OUTPUT” (BNC adapter of the function generator). This allows to draw the square wave signal using a banana plug patch cord (figure 1(b)) for the rest of the circuit.

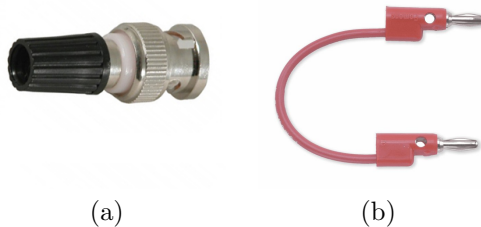


Figure 1: BNC to Banana adapter, banana plug patch cord

- (c) Using a banana plug patch cord, connect this BNC to Banana adapter output to “IN” of the TUNABLE LPF module (of the TIMS 301 modeling system). Thus providing the square wave as the input to the tunable low pass filter (LPF).
- (d) Set the Tunable LPF to “WIDE” setting and also set the “TUNE” to the lowest end by turning it completely counter-clockwise. Make sure the “GAIN” is maximum, turn it all the way in the clock wise direction.
- (e) In the TIMS 301 modeling system, patch a cord between “IN” of the TUNABLE LPF module and CH1 A (located under “Scope Selector” or “PC-based instruments inputs (in newer TIMS systems)” (figure 2(a)). Make sure it is connected to the banana jack. Now, use a BNC cable (figure 2(b)) to connect the corresponding BNC adapter to “CH1” of the oscilloscope.



Figure 2: “Scope Selector” (TIMS 301 modeling system),
BNC cable and BNC Female T-Adapter

- (f) Connect “OUT” of the TUNABLE LPF module to “CH2 A” (located under “Scope Selector”) with a banana plug patch cord.
- (g) Place a “BNC Female T-Adapter” (figure 2(c)) on “CH2” of the oscilloscope. Using a BNC cable, connect one end to the FFT Network analyzer and the other to CH2 A’s (TIMS system) BNC plug.
- (h) Patch a cord between Tunable LPF “CLK” to the “TTL” of the “Frequency Counter” (of the TIMS system). A reading should appear, this corresponds to the tunable low pass filter (LPF) cut-off frequency, after diving by 360.
- (i) Connect a BNC cable between the “SYNC” (of the function generator) and “TRIG” (of the TIMS 301 modeling system under “SCOPE SELECTOR”).
- (j) Now slowly vary the “TUNE” of the TUNABLE LPF module. On the oscilloscope, you should be able to see the reconstructed square wave, and keep an eye on the corresponding spectrum to see which frequencies are being added.
- (k) Document the reconstructed time domain waveforms and the corresponding spectrum for at-least two cases.
- (l) Do you also see the Gibbs Phenomenon?
- (m) Repeat the process with a saw-tooth wave.

6. Answer the following questions

- (a) What is Gibbs Phenomenon?
- (b) If a signal is real, what can you say about its spectrum?
- (c) If a signal is real and even, what can you say about its spectrum?
- (d) If a signal is real and odd, what can you say about its spectrum?

7. Additional Matlab:

- (a) Using the Fourier series expansion, generate a square wave of frequency 500 Hz with 10, 20, 50 Fourier series.
- (b) Show the output, and on the same plot show the actual square wave of frequency 500 Hz.
- (c) Finally, design the filters specified on the webpage.

