



**COMMUNICATION SYSTEMS (ECE 437)  
LABORATORY MANUAL**

**EXPERIMENT 1**

**School of Engineering and Computer Science  
Oakland University**

## **LABORATORIES PROCEDURES:**

### **LAB REPORTING:**

1. Lab report must be written neatly consists of the followings:
  - Experiment introduction and theory/derivation.
  - Results and Simulation.
  - Result discussion and conclusion.
2. Each group must publish their own lab report.
3. Each lab report is due 1 week after the experiment.
4. Please remember that the students are supposed to bring their own **BREADBOARD** for the experiment.

### **LAB SCHEDULES:**

Group A: Day: Wednesday Time: 12.00 pm – 3.00 pm

Group B: Day: Friday Time: 1.30 pm – 4.30 pm

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## LAB NO.: 1 [Fourier Analysis and LC-Filter Circuit Characteristics.]

### OBJECTIVES:

1. To study the filtering characteristics of an LC tuned circuit.
2. To study the spectra of different waveforms using the LC tuned circuit.

### EXPERIMENTAL PROCEDURES:

1. Using phasor analysis (from EE 222), derive an expression for  $V_{out}/V_{in}$  in terms of frequency ( $\omega$ ) for the LC band-pass filter circuit shown below in **Figure 1**. From this derivation, find an expression for the center frequency  $\omega_c$  of the circuit. (The center frequency is the frequency at which the magnitude is maximum and the phase is zero.)
2. Design an LC band-pass filter such that the center frequency  $f_c = 250$  KHz with a 3 db bandwidth of 10KHz. (Note 3 db bandwidth of 10 KHz means that at  $f_c \pm 5$ KHz, the gain  $V_{out}/V_{in}$  will be -3 db.) This can be done by first obtaining the expression for  $\omega_c$ , which will be in terms of L and C only. Choose L and solve for C, and then substitute L, C and  $\omega = 2\pi(250 \pm 5 \text{ KHz})$  into the formula for the magnitude of  $V_{out}/V_{in}$  and set it equal to 0.707 (which is -3 db.).
3. Design the circuit in PSpice using the R, L, C values obtained from part 2. Simulate the frequency response of the filter using a Sine wave of 100 KHz to 300 KHz frequency with 2Vp-p input voltage.
4. Build the circuit on the bread board and measure the frequency response of the filter, i.e. for a set of frequency values approximately between 100 KHz and 300 KHz, determine the gain  $V_{out}/V_{in}$  for each frequency and plot it as a function of frequency. Take measurements at frequency values closer together when it becomes apparent that the gain is changing rapidly. (Note: Use Sine wave inputs only for the frequency response as it has no harmonics.). Compare the result with PSpice simulation.

5. Connect the output of the band pass filter to the input of the spectrum analyzer. Observe the number of harmonics displayed on the spectrum analyzer screen.
6. Now apply the Triangular and the Square wave to the input of the LC circuit and use it to measure the Fourier series (FS) coefficients of the waves (up to about 5<sup>th</sup> harmonic or so), utilizing the property of the LC band-pass filter that it can pass only one harmonic at a time to its output while suppressing all other harmonics. In other words, set the frequency of the input signal and the center frequency of the filter such that the frequency of the filter is the appropriate harmonic of the input. Also, calculate the theoretical values of the FS coefficients and compare them with the ones obtained experimentally.

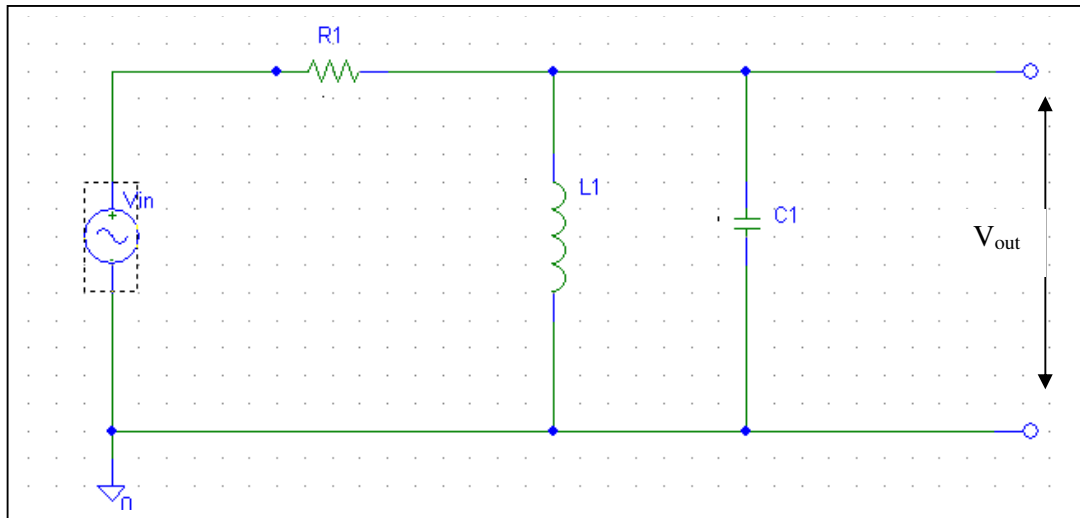


Figure 1: Passive Band Pass filter using L C circuit