

LAB 3 Tank circuit procedure and other information

1. Verify that the statement “the natural response will be an oscillation at $\omega_0 = \frac{1}{\sqrt{LC}}$ with no damping” is true for the circuit above.

What is expected:

Proof that damping constant is “zero”

How to do it:

You have formula

$$\omega_o = \frac{1}{\sqrt{LC}} \quad \text{and} \quad \alpha = \frac{1}{2RC}$$

where α = Damping constant

2. Calculate the resonant frequency of the LC tank in Figure 1 (a) with $L = 300 \mu\text{H}$ and $C = 100 \text{ pF}$. Verify your calculation with LTSpice simulations. You should do an ac sweep around f_0 , and also a transient run to observe the natural response. Suggestion: use the fft to verify the frequency of the oscillations. Calculate the Q of the circuit from the ac simulation. Note that the resonant frequency and the bandwidth can both be in Hz or both be in rad/s, as long as they are in the same units.

What is expected:

- i) Resonant frequency “fr” (calculations)
- ii) Verification of resonant frequency value from LTSpice simulation with specified components value by running an AC simulation (screen shot)
- iii) Also run Transient analysis by giving current source a pulse to verify oscillations (screen shot)
- iv) Run FFT on transient output to confirm the frequency of oscillations (screen shot)
- v) Calculate the value of “Q”

How to do it:

- i) Resonant frequency formula =

$$\omega_o = \frac{1}{\sqrt{LC}}$$

and where

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

- ii) Run AC simulations for given using a current source with the following settings

In the source : **AC amplitude = 1**

In the Edit simulation command set like : **ac dec 1000 0.5MEG 1.5MEG**

iii) Run transient analysis with following settings

In the source : **PULSE(0 1 0 10f 10f 3u 3u)**

In the Edit simulation command set like : **tran 10u**

iv) Run FFT on transient you got from previous step output in simulations window

Right click in simulation window : choose **“VIEW”** : choose **“FFT”**

3. Build the tank circuit in the lab using the variable capacitor. Use a large resistor in series with the function generator to mimic a current source. Observe the resonant frequency and the Q of the circuit. There is more detail on testing the LC tank in the appendix to this lab. Note that it is the *total current* you need to observe, using the voltage across the resistor as the output.

One issue to be aware of is the capacitance of the scope probe. The 10x probe will have a smaller capacitance than the 1x probe.

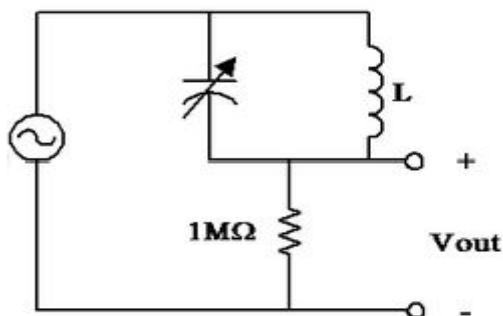
What is expected:

- i) Build circuit and observe its “resonant frequency” (screen shot from scope)
- ii) Find “Q” of circuit that you built

How to do it:

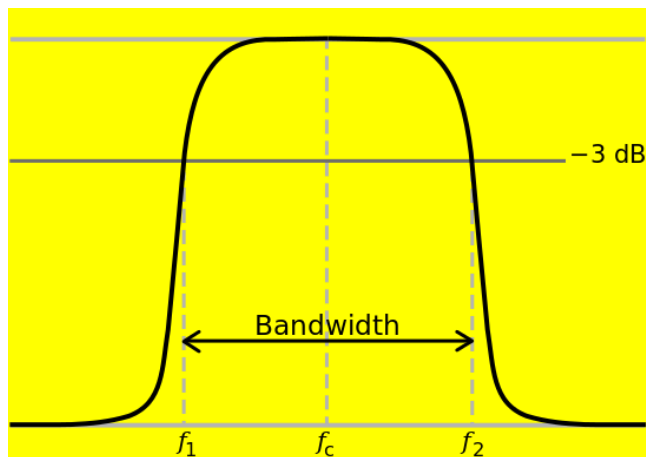
- i) Build and test the following circuit

Tank Test Circuit



(keep the probe in 10x)

- ii) Calculate the value of “Q” = Resonant frequency / Bandwidth ;
Reference

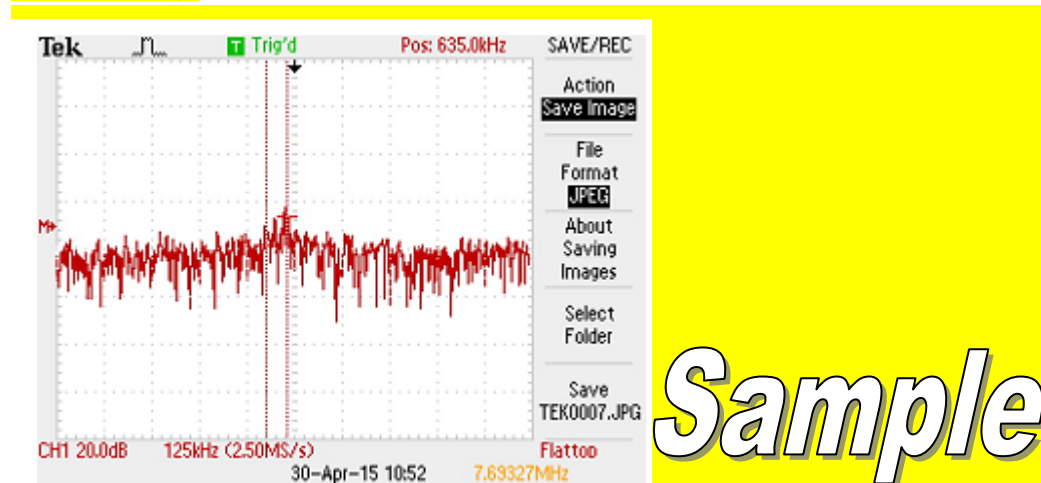


4. Find the maximum and minimum resonant frequencies achievable with this LC tank. The AM radio band is 530 – 1700 kHz. Can you tune your circuit over this entire range? Note that when you attempt to make measurements around 1 MHz or higher, it becomes important to keep the wires in the circuit as short as possible to avoid picking up noise.

What is expected: Tuning of resonant frequency by varying capacitor.

How to do it: Varying the capacitor knob and finding the response in scope through FFT

Reference image



Additionally, In your report, include calculations, simulations, test results and discussion as in the previous labs. In particular, discuss the issues and limitations in building and measuring the tank circuit such as the effect of the probe capacitance, the resistance in the circuit, and any other problems you encountered.