# EEEN 202 ELECTRICAL AND ELECTRONIC CIRCUITS II

# EXPERIMENT 4: EXAMINATION OF PASSIVE FILTERS

## INTRODUCTION

Filter circuit passes frequencies within a certain range and rejects frequencies outside that range, or vice versa. There are four types of filter circuits:

**1-** Low pass filters
**2-** High pass filters
**3-** Band pass filters
**4-** Band stop filters

Basic components of these filter circuits are capacitors and inductors. As we know, reactances of inductor and capacitor depend on the frequency. As the frequency increases, reactance of inductor also increases but reactance of capacitor decreases. Various types of filter circuits are designed using these properties. Most used types are "**T**" type and "**Π**" type. These are shown in Figure 4.1.

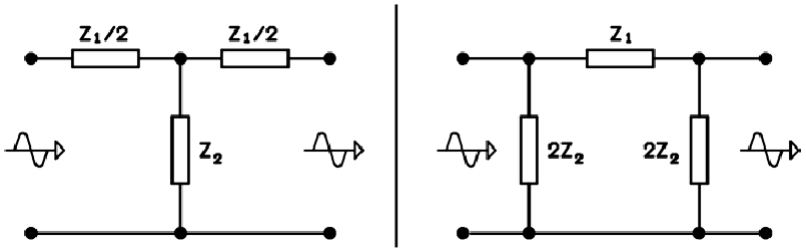


Figure 4.1

Two impedances (Z1 and Z2) are used in designing filter circuits. One of these is inductive reactance of inductor and the other one is the capacitive reactance of the capacitor. Best result will be gained if the filter circuit designs are made like in Figure 4.1. Output of the circuit must be closed with a resistor. This resistance is called "**Rout**" or shortly "**Ro**";

$$Ro = \sqrt{\frac{L}{2C}}$$

The frequency on which the filter is expected to stop passing is called "**cut-off frequency**". It is the frequency value at which the output signal amplitude equals "**0,707**" multiple of the input signal amplitude. For example, if the input signal amplitude is 10Volt, cut-off frequency is the frequency at which the output signal amplitude is 10x0,707=7,07Volt.

Cut-off frequency at "**T**" type filter circuits is calculated by

$$Fc = \frac{1}{4\pi\sqrt{LC}}$$

The following formula is used in"**Π**" type filters;

$$Fc = \frac{1}{2\pi\sqrt{LC}}$$

where

**Fc =** Cut-off frequency (**Hz**)
**L =** inductance of the coil(**Henry**)
**C =** capacitance of the capacitor (**Farad**)

"**Π**" type filters are used in our experiment set. Serial component in "**Π**" type low pass and high pass filters is inductor and the parallel components are capacitors.

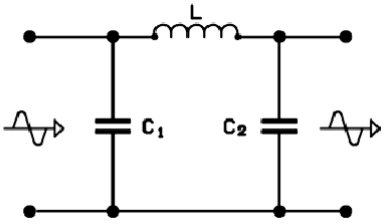


Figure 4.2

Low pass "**Π**" type filter is shown in Figure 4.2 A practical filter has C1=C2 and the effective capacitor value is C1+C2.

In low pass filters, Ohmic resistance of inductor decreases the output signal amplitude.

In high pass filters, the serial component is capacitor and the parallel components are inductors.

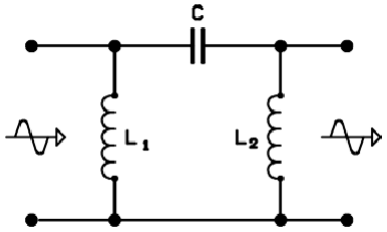


Figure 4.3

High pass "**Π**" type filters are shown in Figure 4.3. A practical filter has L1=L2, and the effective inductor value is L1/2 or L2/2.

**EXPERIMENT 4.1 EXAMINATION OF Π TYPE LOW PASS FILTER**

**EXPERIMENTAL PROCEDURE:**

Adjust the output of function generator to sine peak to peak Epp=10V and the frequency to 1KHz. Plug the Y-0016/03AC module. Make the circuit connections as in Figure 4.4.

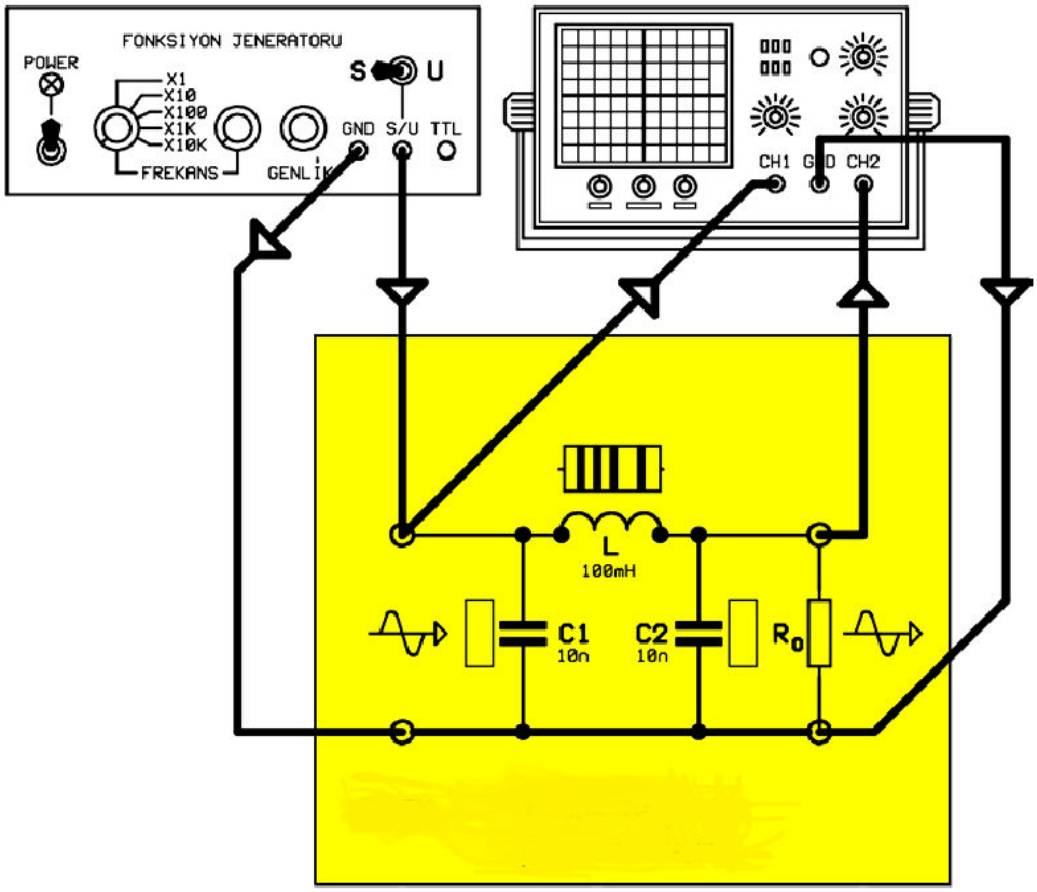


Figure 4.4

1. In the experiment L=100mH, C=10nf. Calculate the "**Ro**" resistance.

2. Calculate the cut-off frequency of the circuit.

3. What does the cut-off frequency denote? Explain it.

**4.** Apply energy to the circuit. Increase the input signal frequency 1KHz for each step until achieving 10KHz. Note the output signal amplitude to a scale in each step. Especially, measure the output signal amplitude at cut-off frequency.

Table 4.1

| Frequency (kHz) | Vo (Vpp) |
|---|---|
| 1,0 | |
| 2,0 | |
| 3,0 | |
| 3,5 | |
| 4,0 | |
| 4,5 | |
| 6,0 | |
| 7,0 | |
| 8,0 | |
| 9,0 | |
| 10,0 | |

**5.** Compare the calculated cut-off frequency and the value you measured. If there is a difference, explain why?

**6.** What can be said about the change in scale?

## EXPERIMENT 4.2 EXAMINATION OF Π TYPE HIGH PASS FILTER

The preliminary information has been given above.

## EXPERIMENTAL PROCEDURE:

Adjust the output of function generator to sine peak to peak Epp=10V and the frequency to 1KHz. Plug the Y-0016/03AC module. Make the circuit connections as in Figure 4.5.

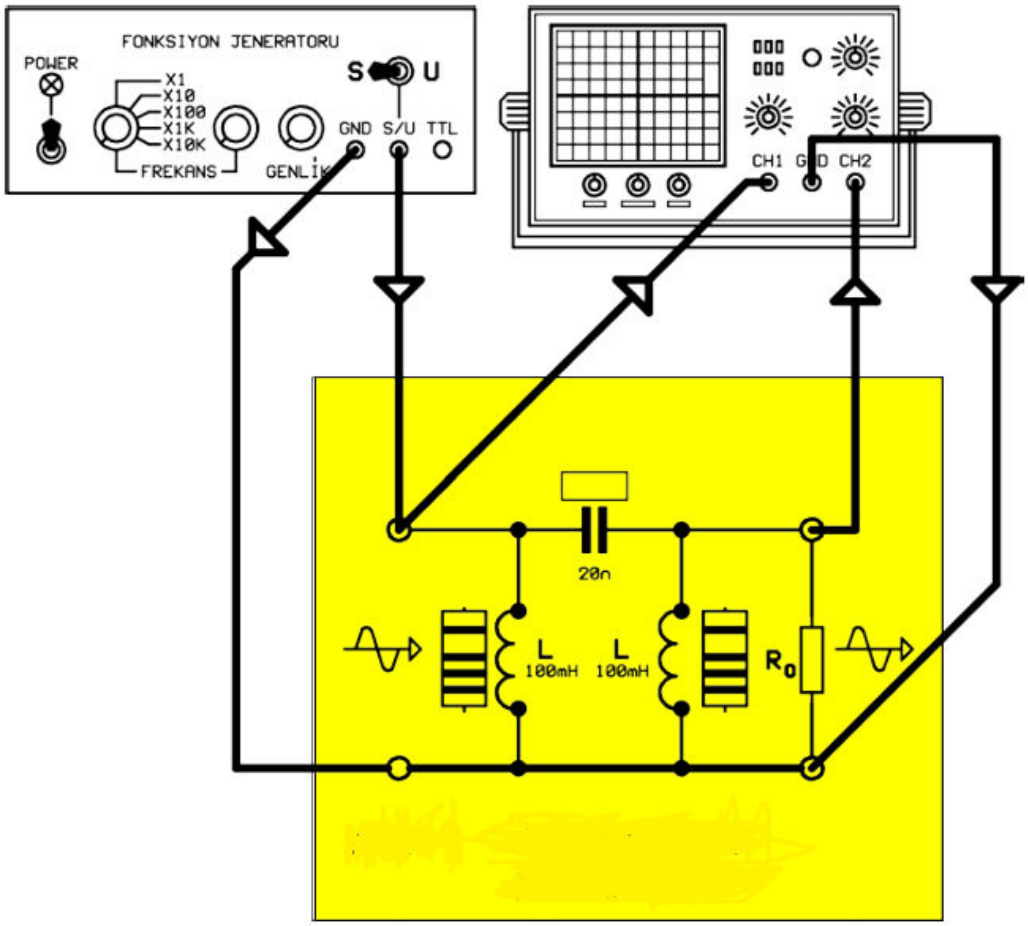


Figure 4.5

1. In the experiment L=100mH, C=10nf. Calculate the "**Ro**" resistance.

2. Calculate the cut-off frequency of the circuit.

3. What does cut-off frequency denote?

**4.** Apply energy to the circuit. Increase the input signal frequency 1KHz each step until 10KHz. Note the output signal amplitude to a scale in each step.

Table 4.2

| Frequency (kHz) | Vo (Vpp) |
|---|---|
| 1,0 | |
| 2,0 | |
| 3,0 | |
| 4,0 | |
| 5,0 | |
| 6,0 | |
| 7,0 | |
| 8,0 | |
| 9,0 | |
| 10,0 | |

**5.** Compare the calculated cut-off frequency and the value you measured. If there is a difference, explain why?

**6.** What can be said about the change in scale?