# Resfiltwthoutinducto -- Overview

## Resonant Filter (without inductor)

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## OBJECTIVES:

At the end of performing this experiment, learners would be able to:
• Describe the concept of Resonant filter
• Obtain the Quality factor,Bandwidth and cutoff frequency of the filter designed
• Compare the designed cut-off frequency with the desired cut-off frequency
• Understand the working of µA741 IC (Op Amp)

## EQUIPMENT:

• IC µA741
• Signal generator
• Resistors
• Capacitor
• +/- 15V DC Power Supply
• Digital Storage Oscilloscope & probes
• Connecting wires  & Bread Board

## DESIGN:

• Given second order active Bandpass filter with a centre frequency 5KHz, quality factor 10, and voltage gain 25

Given the following parameters:

voltage gain $A_0 = (V_0/V_i)$,

the center frequency $\omega_0$, with $f_0 = \sqrt{f_L f_H}$,

and the quality factor, $Q = f_0/Bw$, where $Bw = f_H - f_L$

• Compute Rs , the internal resistance of the signal source

• Choose R1, higher than Rs

• Obtain C1from the following equation

$$-R_1 C_1 = Q/(\omega_0 A_0)$$

- Assume C1 = C2

- Computer R3 from,

$$R_3 \frac{C_1 C_2}{C_1 + C_2} = \frac{Q}{\omega_0}$$

- Compute R2 from

$$(R_1 \parallel R_2) R_3 C_1 C_2 = \frac{1}{\omega_0^2}$$

# THEORY:

- The µA741 device is a general-purpose operational amplifier featuring offset-voltage null capability

- Band pass filters have a frequency response as shown in figure 1. The difference between the two cut-off frequencies fl (the lower cut-off ) and fh(the upper cut-off) is known as the bandwidth Bw.
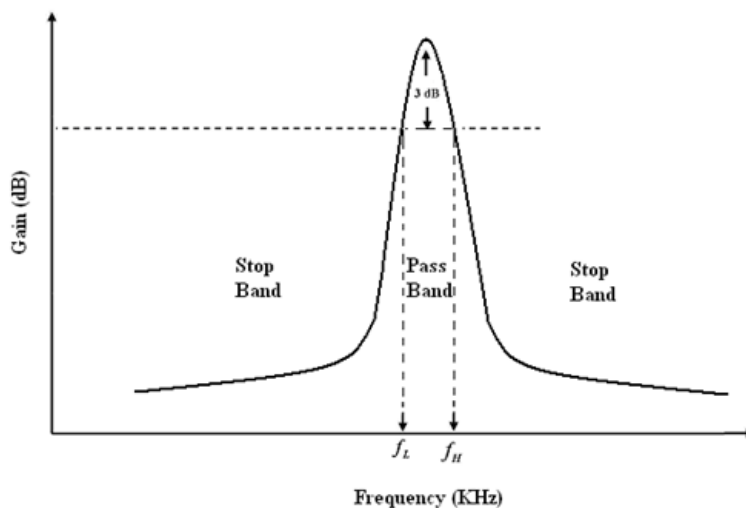


**Figure 1**: Frequency response of a narrow band-pass filter

- When the bandwidth Bw is small compared to either fl or fh the circuit is known as a resonant circuit with frequency response shown in figure 1.

Reference reading:

1) Theory and application of Digital SIgnal Processing, by Lawrence R Rabine and Bernard Gold, Prentice Hall, Easter Economy Edition
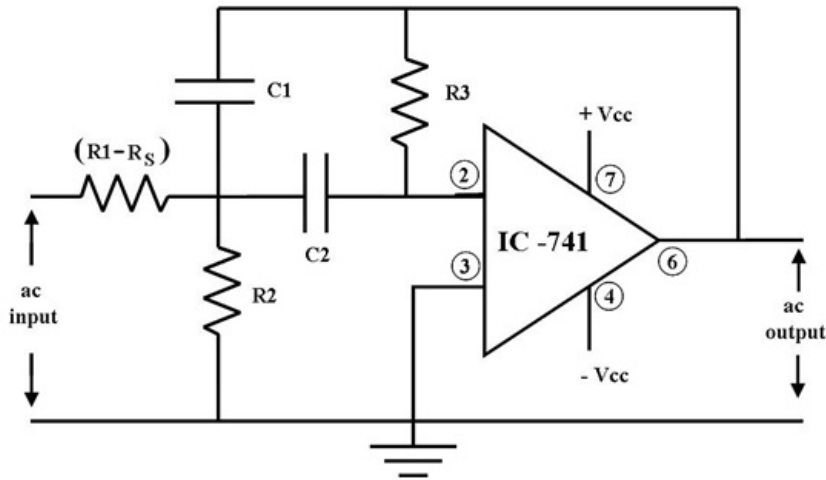2) Integrated Electronics, by Millman and Halkias, Tata McGraw-Hill

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# Resfiltwthoutinducto -- Procedures

## Step 1

### Circuit setup:

Build the following circuit with designed values



Active second order band-pass filter without inductor

## Step 2

• Use a signal generator to generate analog input . The analog input will be set to 1 Vpp Sine wave
• Turn on the supply of the circuit and enable signal generator that is feeding signal to the circuit.

## Step 3

• Connect the DSO probe – CH1 at analog input (Sine wave), CH2 at output (pin # 6 of  µA741 IC)
• Perform Autoset on DSO and capture the output signal.

## Step 4

• Configure PEAK-to-PEAK measurement on the input and output signal
• Observe and record the signal – input and output.

## Step 5

 Record the input and output peak-to-peak voltage for various input frequencies, and complete the table below.

| Frequency | Vin(v) | Vout(v) | Gain = 20 log |
|---|---|---|---|

| (Hz) | Vin(v) | Vout(v) | ( Vout / Vin) dB |
|---|---|---|---|
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## Step 6

Plot the frequency response of the designed filter (Plot of Frequency Vs. Gain on a semi-log sheet)



## Step 7

### Observations:

From the frequency response obtain

i)      The lower cut-off frequency $f_L$ and the higher cut-off frequency $f_H$

ii)     The bandwidth $Bw = f_H - f_L$

iii)    The quality factor, $Q = f_0 / Bw$

iv)     The voltage gain $A_0 = (V_0 / V_i)$, in the pass band of the filter

### Open-ended Question / Can you answer this?

   If the designed parameters are not equal to the desired ones, give reasons.