ECE 182 Lab #3 Band Pass Filter
Day of Submission: 09/19/2025
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Circuit Design and Schematic

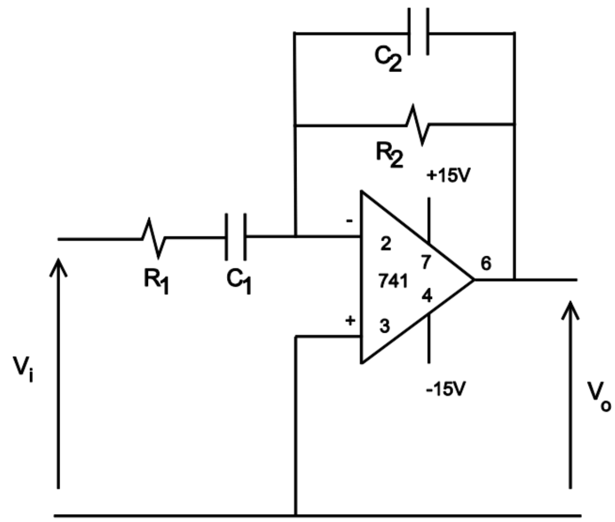


Fig. 1 Active band pass filter

Figure 1

- Theoretical vs Experimental
- R1: 10kohm vs 9.922kohm
- R2: 10kohm vs 9.943kohm
- C1: 0.1microfarard vs 0.09911microfarad
- C2: 0.01microfarad vs 0.01016microfarad

Equations for Theoretical Basis

Figure 1 Transfer Function

$$\boxed{H(s) = \frac{V_{out}}{V_{in}} = -\frac{sC_1R_2}{(1+sC_1R_1)(1+sC_2R_2)}}$$

Results and Calculations

Figure 1 on Breadboard

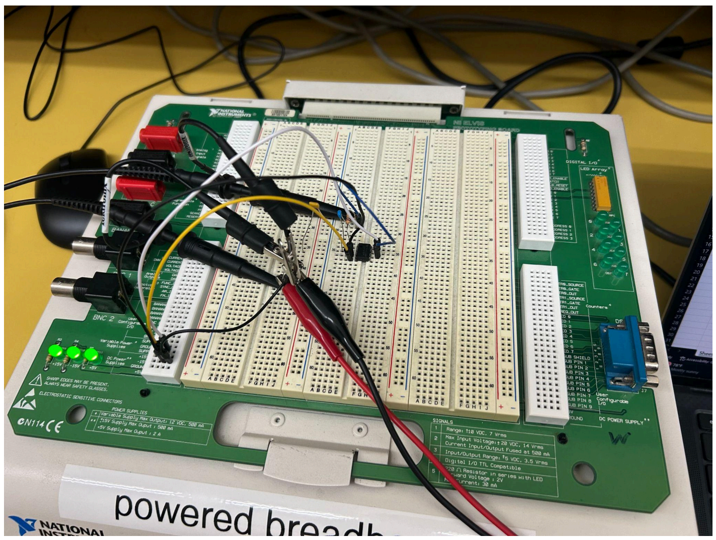


Figure 1 Measurements (Yellow Input vs Blue Output)

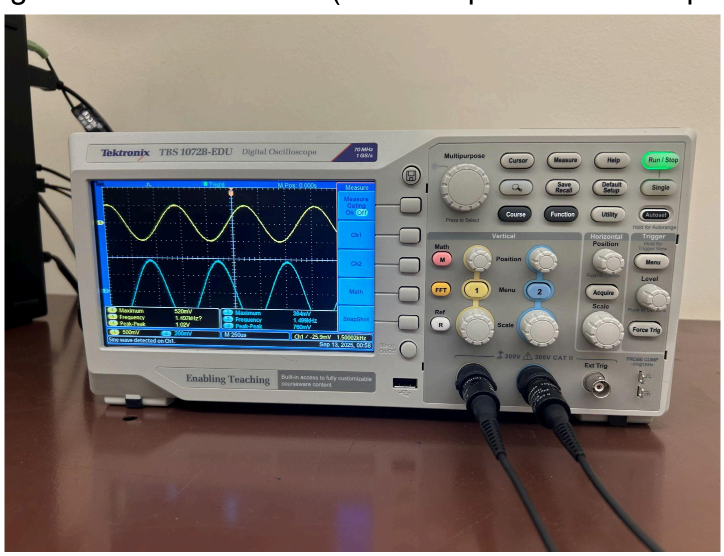
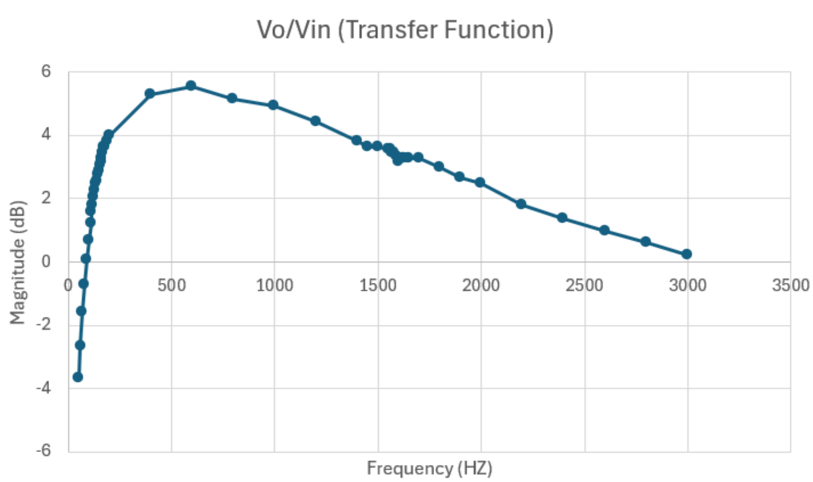


Figure 1 Data

Figure 1				
Vin (V)	Vout (V)	Frequency(HZ)	|H|= Vout/Vin	Mag(dB)
0.5	0.328	50	0.656	-3.661923
0.5	0.368	60	0.736	-2.662444
0.5	0.416	70	0.832	-1.597533
0.5	0.46	80	0.92	-0.724243
0.5	0.504	90	1.008	0.0692106
0.5	0.54	100	1.08	0.6684751
0.5	0.576	110	1.152	1.2290496
0.5	0.6	115	1.2	1.5836249
0.5	0.616	120	1.232	1.8122142
0.5	0.632	125	1.264	2.0349415
0.5	0.648	130	1.296	2.2521
0.5	0.664	135	1.328	2.4639615
0.5	0.672	140	1.344	2.5679854
0.5	0.688	145	1.376	2.7723687
0.5	0.696	150	1.392	2.8727847
0.5	0.712	155	1.424	3.0701998
0.5	0.72	160	1.44	3.1672498
0.5	0.728	165	1.456	3.2632275
0.5	0.744	170	1.488	3.4520586
0.5	0.76	175	1.52	3.6368718
0.5	0.76	180	1.52	3.6368718
0.5	0.776	190	1.552	3.8178343
0.5	0.792	200	1.584	3.9951035
0.5	0.92	400	1.84	5.2963565
0.5	0.944	600	1.888	5.5200398
0.5	0.904	800	1.808	5.1439685
0.5	0.88	1000	1.76	4.9102534
0.5	0.832	1200	1.664	4.4230664
0.5	0.776	1400	1.552	3.8178343
0.5	0.76	1450	1.52	3.6368718
0.5	0.76	1500	1.52	3.6368718
0.5	0.752	1550	1.504	3.5449567
0.5	0.752	1560	1.504	3.5449567
0.5	0.744	1570	1.488	3.4520586
0.5	0.744	1580	1.488	3.4520586
0.5	0.736	1590	1.472	3.3581562
0.5	0.72	1600	1.44	3.1672498
0.5	0.728	1610	1.456	3.2632275
0.5	0.728	1620	1.456	3.2632275
0.5	0.728	1630	1.456	3.2632275
0.5	0.728	1650	1.456	3.2632275
0.5	0.728	1700	1.456	3.2632275
0.5	0.704	1800	1.408	2.9720531
0.5	0.68	1900	1.36	2.6707782
0.5	0.664	2000	1.328	2.4639615
0.5	0.616	2200	1.232	1.8122142
0.5	0.584	2400	1.168	1.3488569
0.5	0.56	2600	1.12	0.9843605
0.5	0.536	2800	1.072	0.6038957
0.5	0.512	3000	1.024	0.2059991

Figure 1 Transfer Function Graph



Calculations

$f_L = 159\text{Hz} = \frac{1}{2\pi C_1 R_1}$

$159 = \frac{1}{2\pi C_1 10k\Omega}$

$\left(159 = \frac{1}{2\pi 10k\Omega C_1}\right)(2\pi 10k\Omega)$

$(9990264.638)^{-1} = \left(\frac{1}{C_1}\right)^{-1}$

$\boxed{C_1 = 0.1\mu F}$

$f_H = 1591\text{Hz} = \frac{1}{2\pi C_2 R_2}$

$\left(1591\text{Hz} = \frac{1}{2\pi 10k\Omega \cdot C_2}\right) 2\pi \cdot 10k\Omega$

$\left(99965478.24 = \frac{1}{C_2}\right)^{-1}$

$\boxed{C_2 = 0.01\mu F}$

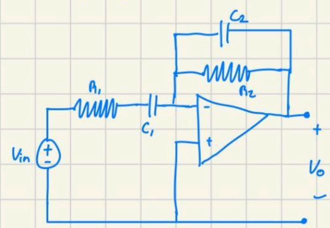
Theoretical vs experimental

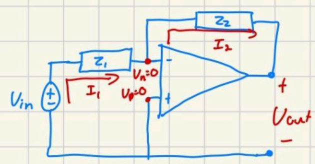
$R_1 = 10k\Omega$ vs $9.922k\Omega$

$R_2 = 10k\Omega$ vs $9.943k\Omega$

$C_1 = 0.1\mu F$ vs $0.09911\mu F$

$C_2 = 0.01\mu F$ vs $0.01016\mu F$





Z_1: $R_1 + C_1$

$\left(R_1 + \frac{1}{sC_1}\right) sC_1$

$1 + sC_1R_1$

Z_2: $R_2 // C_2$

$\frac{R_2 \cdot C_2}{R_2 + C_2}$

$\frac{R_2 \cdot \frac{1}{sC}}{R_2 + \frac{1}{sC}}$

$\left(\frac{\frac{R_2}{sC}}{R_2 + \frac{1}{sC}}\right) sC$

$\frac{R_2}{1 + sC_2R_2}$

$I_1 = I_2$

$\left(\frac{sC_1 V_{in}}{1 + sC_1R_1} = \frac{-V_{out}}{\frac{R_2}{1 + sC_2R_2}}\right) \frac{-R_2}{1 + sC_2R_2}$

$\frac{1}{V_{in}} \cdot \left(\frac{-V_{in} sC_1R_2}{(1 + sC_1R_1)(1 + sC_2R_2)} = V_{out}\right)$

$-\frac{sC_1R_2}{(1 + sC_1R_1)(1 + sC_2R_2)} = \frac{V_{out}}{V_{in}}$

$$\boxed{H(s) = \frac{V_{out}}{V_{in}} = -\frac{sC_1R_2}{(1 + sC_1R_1)(1 + sC_2R_2)}}$$

$$H(s) = \frac{-s(0.09911\mu F)(9.943k\Omega)}{(1 + s(0.09911\mu F)(9.922k\Omega))(1 + s(0.01016\mu F)(9.943k\Omega))}$$

$$\boxed{H(s) = -\frac{s(9.855 \times 10^{-4})}{(1 + s(9.834 \times 10^{-4}))(1 + s(1.01 \times 10^{-4}))}}$$

Summary

The measured frequency response showed that the circuit behaved as a band pass filter with a center frequency of about 550Hz. The overall shape of the response matched theory, with signal loss at low and high frequencies and a clear mid band peak. The experimental low cutoff frequency was about 140 Hz compared to the calculated 159 Hz, while the experimental high cutoff frequency was about 1900 Hz compared to the calculated 1591 Hz. These differences between the calculated and experimental results are most likely due to differences in component tolerances and experimental error. Overall, the lab was a success because the data closely followed the expected band pass filter behavior.