Ryerson University
Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Title:	ELE302 Electric Networks
Course Number:	ELE302
Semester/Year (e.g.F2016)	F2024

Instructor:	S. Jassar

Assignment/Lab Number:	Lab 2 In Lab/Post Lab
Assignment/Lab Title:	Second Order Circuits

Submission Date:	Tues Oct 8, 2024
Due Date:	

Student LAST Name	**Student FIRST Name**	**Student Number**	**Section**	**Signature***
Malik	Hamza	501112545	26	Hamza Malik

*By signing above you attest that you have contributed to this written lab report and confirm that all work you have contributed to this lab report is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: http://www.ryerson.ca/senate/current/pol60.pdf

5.0 IN-LAB IMPEMENTATION & MEASUREMENTS (5 marks in total):

Part I: The Step Response of a Second-Order Bandpass Circuit

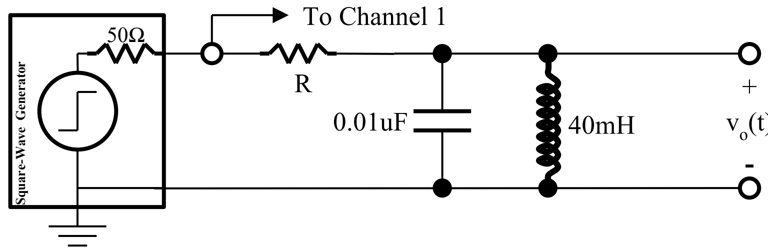


Figure 5.0: Second-Order Bandpass Filter

(a) Step 1: Connect Channel (1) of the oscilloscope to display the open-circuit voltage $v_s(t)$ of the function generator. Set the following:

- Trigger: source→Channel (1), and slope→rising.

Adjust the controls of the function generator to provide a square-wave signal $v_s(t)$ with a peak-to-peak value of 10V and DC offset of 5V at a frequency of 20Hz.
For ENG301, 302, 303 (FG): Waveform → Square, Frequency → 20 Hz, Amplitude → 5 Vpp*, Offset → 2.5 V*

*Due to FG matching impedance (EDU33212A)

For ENG402 (FG): Directly connected it with Oscilloscope, adjust AMPL knob to get 5 Volt peak (Vp) and adjust the OFFSET knob (you may need to pull it out), to get +5V DC off set. *Function Generator GFG8216A

Next, set the following:

- Channel (2): Vertical-position→one division above the bottom of the screen, coupling→dc, and V/div→1V.
- Time: Time/div→50μs when $v_s(t)$ is rising.
- Blank off Channel (1).

(b) Step 2: Construct the circuit shown in **Figure 5.0**. Set R=3.4kΩ. Connect Channel (2) to display the step response $v_o(t)$. Plot $v_o(t)$ on **Graph 1.0.**

(c) Step 3: Use the cursors on the oscilloscope to measure points on the $v_o(t)$ display to calculate the parameters (σ and ω) that characterize the step response as:

$$\mathbf{v_o}(t) = A\boldsymbol{e}^{-\boldsymbol{\sigma t}}\sin(\omega t)$$

(d) Step 4: Record your results in **Table 1.0.**

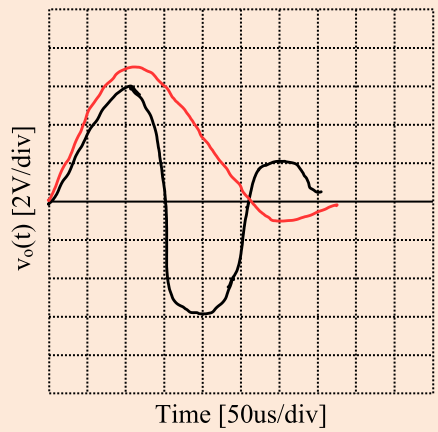
(e) Step 5: Demonstrate the correct operation of your setup to your TA. (1 mark)

(f) Step 6: Set R=1.4kΩ, and repeat as in Step 2 and Step 3. Record your results in **Table 1.0.**

(g) Step 7: Set R=500Ω, and repeat as in Step 2.

D → 1.4K

D → 3.4K



Graph 1.0 (0.5 marks)

Table 1.0 (0.5 marks)

R (KΩ)	**T**	**v_o(T/4)**	**v_o(3T/4)**	**σ**	**ω**
3.4	120	3.97	-1.12	0.0221	0.0520
1.4	88	6.37	150mV	0.0852	0.0714

Part II: The Step Response of a Second-Order Lowpass Circuit

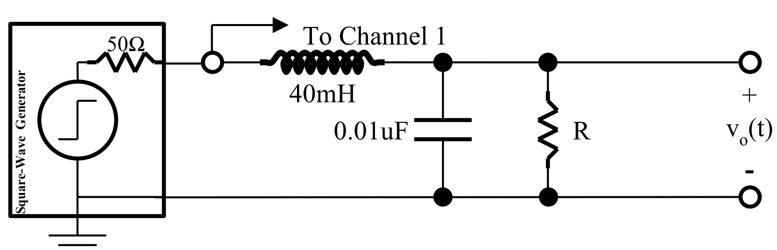


Figure 6.0: Second-Order Lowpass Filter

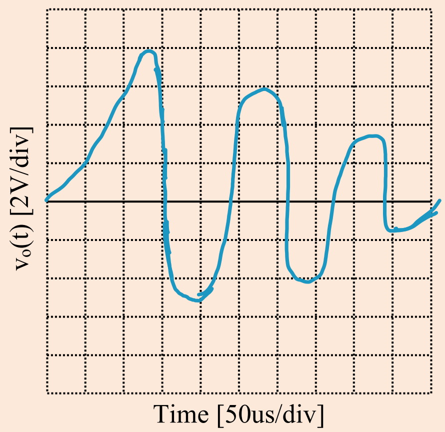
(h) Step 8: Connect the circuit shown in **Figure 6.0.** Set R=10kΩ. Use Channel (2) to display the step response $v_o(t)$. Plot $v_o(t)$ on **Graph 2.0.**

(i) Step 9: Use the cursors on the oscilloscope to measure points on the $v_o(t)$ display to calculate (and record in **Table 2.0**) the parameters (σ and ω) that characterize the step response as:

$$\mathbf{v_o}(t) = B + Ae^{-\sigma t}\cos(\omega t + \theta)$$

(j) Step 10: Set R=1.4kΩ, and repeat as in Step 8.

(k) Step 11: Set R=1kΩ, and repeat as in Step 8.



Graph 2.0 (0.5 marks)

Table 2.0 (0.5 marks)

R (KΩ)	T	$v_o(T/4)$	$v_o(3T/4)$	σ	ω
10	12.8	18.25	1.78	0.3640	0.4909

Part III: The Step Response of a Second-Order Highpass Circuit

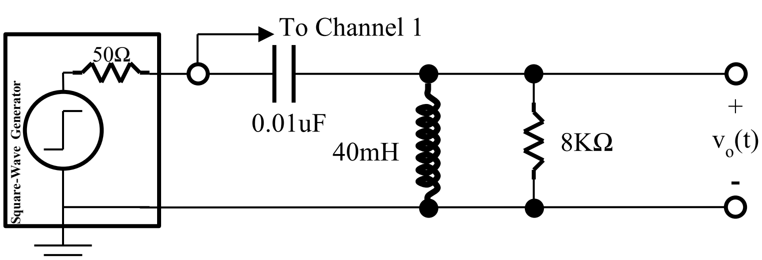


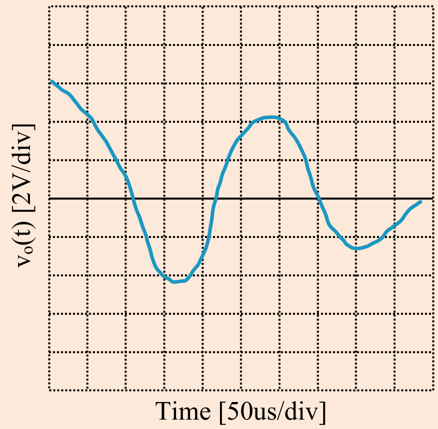
Figure 7.0: Second-Order Highpass Filter

(l) Step 12: Connect the circuit shown in **Figure 7.0.** Connect Channel (2) to display the step response $v_o(t)$. Plot $v_o(t)$ on **Graph 3.0.**

(m) Step 13: Use the cursors on the oscilloscope to measure points on $v_o(t)$ display to calculate (and record in **Table 3.0**) the parameters (σ and ω) that characterize the step response as:

$$\mathbf{v_o}(t) = A\boldsymbol{e}^{-\boldsymbol{\sigma t}}\cos(\omega t + \theta)$$

(n) Step 14: Demonstrate the correct operation of your setup to your TA. (1 mark)



Graph 3.0 (0.5 marks)

Table 3.0 (0.5 marks)

R (KΩ)	T	$v_o(T/4)$	$v_o(3T/4)$	σ	ω
8	123	-9.57	3.6	0.0155	0.05109

6.0 POST-LAB QUESTIONS (2 marks in total, 2/3 marks for each question):

(1) By examining your plots on **Graph 1.0,** answer the following:

a) What are the effects of varying the value of R on the step response of a second-order bandpass circuit?

When Looking at the graph what I noticed was that as the resistance value decreases the Peak voltage increases. Like for instance, when we used the 3.4 kΩ resistor. Our Peak value was 3.97V. However the peak voltage of the 1.4 kΩ resistor was about 6.37V which proves the point that as you decrease resistance the peak increases and vice versa

Also another thing noticed was that higher value of resistance the more sine waves are shown for example when comparing 3.4 and 1.4 kΩ resistors, the 3.4kΩ one has closer sinewaves where as 1.4kΩ waves are more spread apart.

(2) By examining your plots on **Graph 2.0,** answer the following:

a) What are the effects of varying the value of R on the step response of a second-order lowpass circuit?

When looking at the graph I noticed that the 10kΩ resistor has a high peak voltage the ~~the~~ other graphs. Also the 10kΩ resistor has more waves that are closer together.

(3) Suppose that the 8kΩ-resistor is removed from the circuit in Fig (2.6), what effects will this have on the step response?

$$\frac{d^2 i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{1}{LC} = \frac{1}{LC}\frac{dv}{dt}$$

$$6^2 + \frac{0}{40m+1}\frac{di}{dt} + \frac{1}{(40)(0.01)} = 0$$

$$6^2 + 06 + 2.5\times10^9 = 0$$

$$= \frac{0 \pm \sqrt{(0)^2 - 4(1)(2.5\times10^9)}}{2(1)}$$

$$= 0 \pm 5\times10^4\, j$$

If we take the 8kΩ resistor out of the circuit we can see that it'll take some time for the graph to stabilize.