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Canada

SYSC3203 Bioelectronic Systems

Laboratory 0: Linear circuit analysis and measurement

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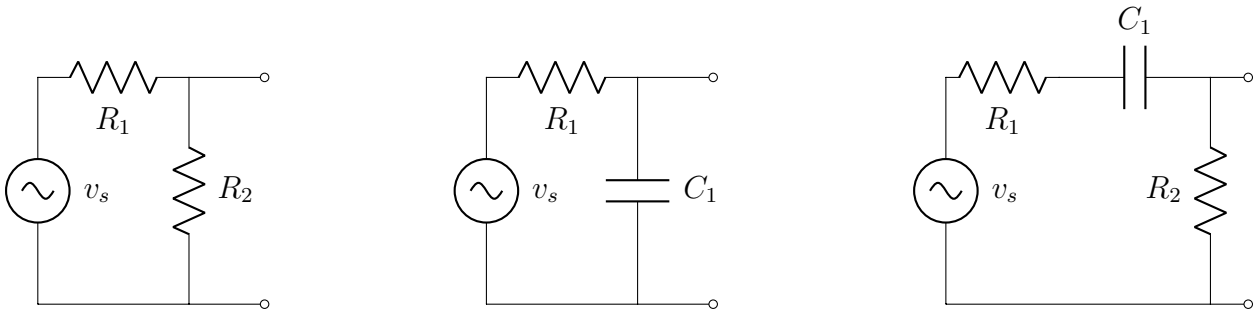
1. Linear circuit analysis

For each of the circuits shown in Figure 1



(a) Circuit (A) (b) Circuit (B) (c) Circuit (C)

Figure 1: Circuits for analysis

Circuit	R_1	R_2	C_1
(A)	20 kΩ	39 kΩ	-
(B)	39 kΩ	-	2.2 nF
(C)	20 kΩ	39 kΩ	2.2 nF

Table 1: Component values for the circuits

A 1. Circuit A

A 1 (a). **Copy the circuit into your laboratory notebook, and annotate the components with the values shown in Table 1**

For **each** of the input signals shown in Figure 2

A 1 (b). **Sketch what you expect the output waveform of the circuit to look like**

A 1 (c). **Calculate the peak-to-peak voltage at the output of the circuit, for each of the input waveforms**

A 1 (d). **Indicate whether you expect the output to *lead*, *lag*, or be *in phase* with the input signal in each case**

B 1. Circuit B

B 1 (a). **Copy the circuit into your laboratory notebook, and annotate the components with the values shown in Table 1**

For **each** of the input signals shown in Figure 2

B 1 (b). **Sketch what you expect the output waveform of the circuit to look like**

B 1 (c). **Calculate the peak-to-peak voltage at the output of the circuit, for each of the input waveforms**

B 1 (d). **Indicate whether you expect the output to *lead*, *lag*, or be *in phase* with the input signal in each case**

C 1. Circuit C

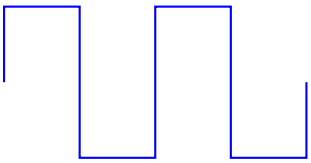
C 1 (a). **Copy the circuit into your laboratory notebook, and annotate the components with the values shown in Table 1**

For **each** of the input signals shown in Figure 2

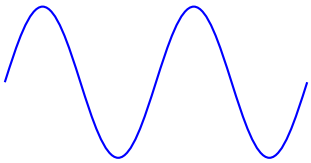
C 1 (b). **Sketch what you expect the output waveform of the circuit to look like**

C 1 (c). **Calculate the peak-to-peak voltage at the output of the circuit, for each of the input waveforms**

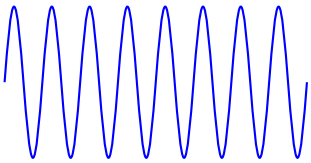
C 1 (d). **Indicate whether you expect the output to *lead*, *lag*, or be *in phase* with the input signal in each case**



(a) Square 1 kHz 2 Vp-p



(b) Sine 1 kHz 2 Vp-p



(c) Sine 10 kHz 2 Vp-p

Figure 2: Stimulus waveforms

2. Circuit measurements

Construct each of the circuits using one of the solderless breadboards provided. Using the Picoscope at your workstation, apply each of the specified input signals in turn and carefully measure the circuit's output.

A 2. Circuit A

A 2 (a). **Demonstrate the operation of the circuit to your instructor, and get them to sign this item in your lab notebook.**

For **each** of the input signals shown in Figure 2

A 2 (b). **Sketch and label the measured signals, showing the axes and values. Compare the measured results with those from your analysis above.**

A 2 (c). **Briefly (1-2 sentences) explain any differences.**

B 2. Circuit B

B 2 (a). **Demonstrate the operation of the circuit to your instructor, and get them to sign this item in your lab notebook.**

For **each** of the input signals shown in Figure 2

B 2 (b). **Sketch and label the measured signals, showing the axes and values. Compare the measured results with those from your analysis above.**

B 2 (c). **Briefly (1-2 sentences) explain any differences.**

C 2. Circuit C

C 2 (a). **Demonstrate the operation of the circuit to your instructor, and get them to sign this item in your lab notebook.**

For **each** of the input signals shown in Figure 2

C 2 (b). **Sketch and label the measured signals, showing the axes and values. Compare the measured results with those from your analysis above.**

C 2 (c). **Briefly (1-2 sentences) explain any differences.**

3. Rise and fall times

Return to circuit (B) with the square-wave input. If you did not already do so, calculate the circuit's *time constant*. Use this result to calculate the expected 20-80 % rise and fall times for this circuit. **Tabulate these values in your lab-book**.

Time constant τ (ms)	
20-80 % risetime t_r	
80-20 % falltime t_f	

3 (a). **Calculate the 20 % and 80 % voltage levels, given a 2 V p-p input signal**

20 % level (mV)	
80 % level (mV)	

3 (b). **Use the Picoscope's moveable vertical and horizontal markers to estimate the rise time (20-80%) and fall time (80-20%) of the output signal (Figure 3)**

3 (c). **Repeat your measurement using the Picoscope's automated measurement feature. Does the result agree with your manual measurement?**

	Calculated	Measured	Measured (auto)
20-80 % risetime t_r			
80-20 % falltime t_f			

Figure 3: Rise and fall time measurement