ELTR 115 (AC 2), section 3 Exam

NAME: ____

Question 1: Parallel LR circuit (*worth 30 points*)

Question 2: Passive RC filter circuit design (*worth 30 points*)

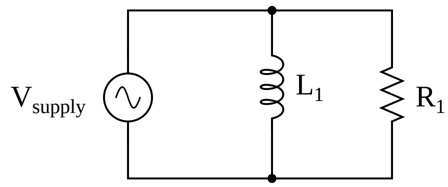
Question 3: Passive integrator/differentiator circuit (*worth 30 points*)

Question 4: Phase shift circuit (*worth 10 points*)

Each of the first three performance assessments is worth 30 points if successfully demonstrated on the first try. The last is worth 10 points if successfully demonstrated on the first try. For each failed attempt, 5 points will be deducted.

Competency: **Parallel LR circuit** Version:

Schematic



Given conditions

V_{supply} = L_1 = R_1 =

f_{supply} =

Parameters

	Predicted	Measured
I_{L1}		
I_{R1}		
I_{total}		

file 01816

Answer 1

Use circuit simulation software to verify your predicted and measured parameter values.

Notes 1

Use a sine-wave function generator for the AC voltage source. I recommend against using line-power AC because of strong harmonic frequencies which may be present (due to nonlinear loads operating on the same power circuit). Specify standard resistor and inductor values, and select a frequency that results in the inductor having a high Q value, so that its parasitic resistance does not become a significant factor in the calculations.

If students are to use a multimeter to make their current and voltage measurements, be sure it is capable of accurate measurement at the circuit frequency! Inexpensive digital multimeters often experience difficulty measuring AC voltage and current toward the high end of the audio-frequency range.

An extension of this exercise is to incorporate troubleshooting questions. Whether using this exercise as a performance assessment or simply as a concept-building lab, you might want to follow up your students' results by asking them to predict the consequences of certain circuit faults.

Question 2

Competency: **Passive RC filter circuit design** Version:

Description

Design and build an RC filter circuit, either high pass or low pass, with the specified cutoff frequency.

Given conditions

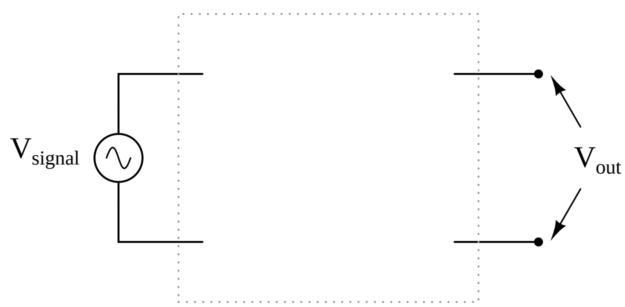
(instructor checks one)

f_{-3dB} = High-pass ☐ Low-pass ☐

Parameters

	Predicted	Measured
f_{-3dB}		
θ_{-3dB}		

Schematic



file 02095

Answer 2

Use circuit simulation software to verify your predicted and measured parameter values.

Notes 2

Use a sine-wave function generator for the AC voltage source. Specify a cutoff frequency within the audio range.

I recommend setting the function generator output for 1 volt, to make it easier for students to measure the point of "cutoff". You may set it at some other value, though, if you so choose (or let students set the value themselves when they test the circuit!).

I also recommend having students use an oscilloscope to measure AC voltage in a circuit such as this, because some digital multimeters have difficulty accurately measuring AC voltage much beyond line frequency range. I find it particularly helpful to set the oscilloscope to the "X-Y" mode so that it draws a thin line on the screen rather than sweeps across the screen to show an actual waveform. This makes it easier to measure peak-to-peak voltage.

Competency: **Passive integrator/differentiator circuit** Version:

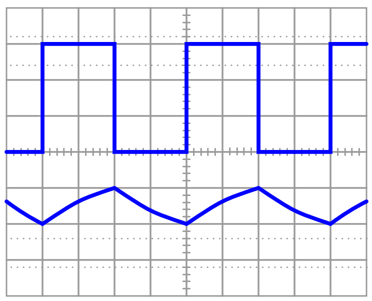
Description

Build either a passive integrator or a passive differentiator circuit to produce the desired waveforms given a square-wave input.

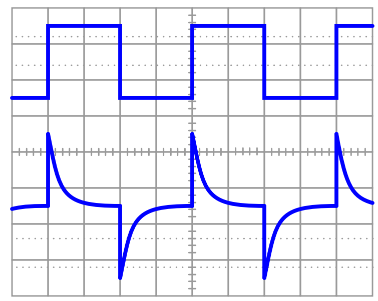
Given conditions

$f_{signal} =$

Integrator ☐ *(instructor checks one)* Differentiator ☐

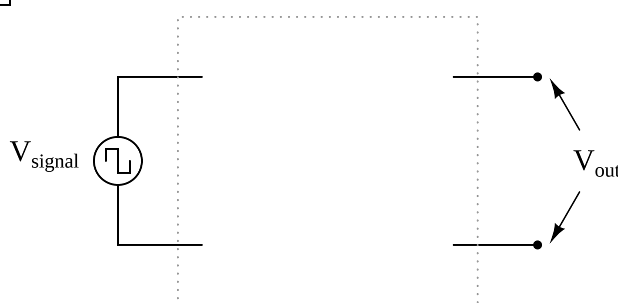


$V_{out} = {}^{1}/_{3} V_{in}$



5τ in each pulse width

Schematic



Parameters

	Predicted
C_1	
R_1	

file 02169

Answer 3

Use circuit simulation software to verify your predicted and measured parameter values.

Notes 3

Here, students must calculate values for C_1 and R_1 that will produce the V_{out} waveshape specified in the "Given conditions" oscilloscope plot. The input signal, of course, is a square wave.

If the chosen circuit is a differentiator, students must calculate the time constant of the circuit (τ) such that the pulse fully decays within the pulse width (half-period) of the square wave. With 5τ being the accepted standard for full charge/discharge of a time-constant circuit, this is an easy calculation.

If the chosen circuit is an integrator, students should be able to show mathematically why the time constant of the integrator (τ) must be 69.3% of the waveform's half-period. Instructors, note: the calculations for this circuit, with $V_{out} = \frac{1}{3}V_{in}$, are exactly the same as for a 555 timer circuit, because 555 timers also cycle their capacitors' voltages at peak-to-peak values equal to one-third of the supply voltage.

There are many different combinations of values for C_1 and R_1 possible for any given square-wave signal frequencies. The purpose of this exercise is for students to be able to predict and select practical component values from their parts kits.

An extension of this exercise is to incorporate troubleshooting questions. Whether using this exercise as a performance assessment or simply as a concept-building lab, you might want to follow up your students' results by asking them to predict the consequences of certain circuit faults.

Competency: **Phase shift circuit** Version:

Description

Build an RC circuit to produce the specified phase shift from input to output, and measure this shift with an oscilloscope.

Given conditions

$\theta =$

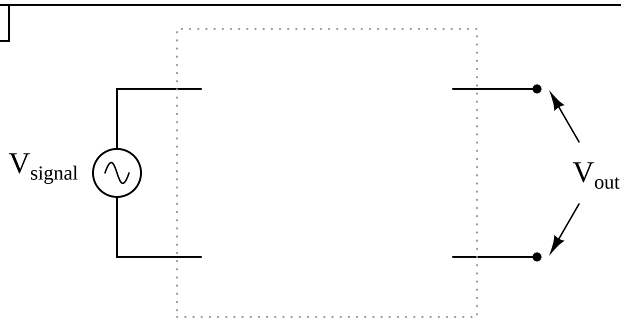
$f_{supply} =$

Leading ☐

(instructor checks one)

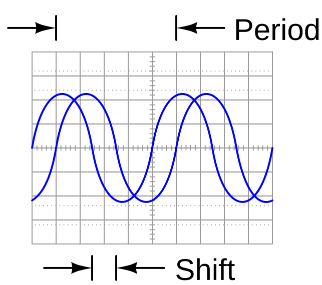
Lagging ☐

Schematic



Parameters

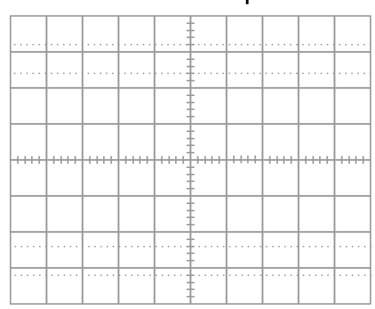
	Measured
Shift (divisions)	
Period (divisions)	
θ	



Predicted

C_1	
R_1	

Dual oscilloscope trace



file 02170

Answer 4

Use circuit simulation software to verify your predicted and measured parameter values.

Notes 4

Here, students must choose the right type of series RC circuit configuration to provide the requested phase shift. This, of course, also involves choosing proper values for C_1 and R_1, and being able to successfully measure phase shift with an oscilloscope.

I recommend selecting a phase shift angle (Θ) somewhere between 15^o and 75^o. Angles too close to 90^o will result in small output voltages that are difficult to measure through the noise.

An extension of this exercise is to incorporate troubleshooting questions. Whether using this exercise as a performance assessment or simply as a concept-building lab, you might want to follow up your students' results by asking them to predict the consequences of certain circuit faults.