AC Circuits Laboratory **Lab # 1**

Introduction to the Oscilloscope and Function Generator

Lab Objectives

1. To become familiar with the basic measurement capabilities of the oscilloscope.
2. To become familiar with the basic signal generating capabilities of the function generator.

Pre-Laboratory Prep. :

Prior to your scheduled laboratory meeting time the following items need to be completed:

Research

1. Carefully read the textbook sections on **Function Generators, The Oscilloscope** and **Average Value** found in the "Sinusoidal Alternating Waveforms chapter." (Starting on page 574 in the text.)
2. Locate and read the pertinent sections of the operator's manual for the WaveStation 2022 arbitrary waveform generator and the Keysight EDUX1002A Oscilloscope.

AC Circuits Lab Procedure: Work with your lab partners and make sure you know your assigned roles

Pre-Lab Quiz Preparation

1. The online prelab quiz questions will be based on the sections of your textbook mentioned above.

PART 1 – Basic Oscilloscope Functions Tutorial

1. Turn the oscilloscope on by pressing the power button at the lower left corner of the scope. Wait for the scope to initialize.

2. If the yellow trace is not present, press CH1 (Yellow button) in the Vertical Section.
   a. Connect the CH1 probe to the "Probe Comp" post and the ground clip (alligator lead) to the ground post. These connections are located below the display.
   b. On the right side of the display are the CH1 settings. (the top starts with Coupling)
      Press the button next to Coupling to see that the selections are DC and AC. Set this to DC (direct coupling). The oscilloscope will now show any DC offset in addition to the AC waveform.
      Press the "Auto Scale" button – located at the top to the left side of the "Horizontal" controls. A perfect square wave should be displayed.
   c. Explore the CH1 menu to become familiar with the contents. (use the top Back button to move back through the Menu layers)
3. Adjust the Vertical scale:
   a. Turn the CH1 large dial, in the Vertical section, back and forth. Observe the indicator at the top left corner of the display. The signal will look larger and smaller; you are changing the Vertical Gain. If it gets too tall the top will go off the screen. **Set the CH1 Vertical gain to 1v/Div.**
   b. On some scope probes, there is a slide switch that changes the probes from a 1X to a 10X probe. Slide this switch and adjust the Vertical Gain such that the waveform is viewable. **Leave the probe switch in the 1X position with 1V/Div. Adjust/verify that the channel 1 probe is set for 1:00:1 in the CH1 menu.**
4. Adjust the vertical position:
   a. Turn the Vertical Position knob CW. You are changing the location of ground, indicated by the "1" on the left side of the display.
   b. Adjust the Vertical position until the bottom of the square wave is on any major grid line

and both the top and bottom of the square wave are displayed on the screen. (Note: pressing "in" on this button will place the ground to the middle of the display).

5. Measure the signal amplitude:
   a. Count the number of divisions (grids or blocks) from the bottom to the top of the waveform (peak to peak).
   b. Multiply the number of divisions by 1V; the vertical gain is in volts per division (1V/div).
   c. Verify that the signal amplitude is approximately 2.5V peak to peak.
   d. Insert a thumb drive in the USB port next to the power switch. Press the "Save/Recall" button on the left-hand side of the oscilloscope controls. Select the "Save" menu choice, then set the Format to "PNG". Enter the "Settings" menu and verify that "Invert Grat" is selected, then back out and select the "File Name" menu. For now, use the default name scope_0. Make sure the "Increment" selection is highlighted. Select the "Press to Save" button. Use the "Back" button to exit the "Save" menu.
   e. Turn the Vertical Scale knob until CH1 is 2V/Div.
   f. Count the number of divisions and multiply by 2 volts/div.
   g. Repeat the Save/Recall sequence. The filename should now be scope_1. If it is not, modify it as described below.

      Note: the file name can be modified in the "File Name" menu. By using the "Spell" & "Enter" keys and Entry knob, the file name can be changed.

   h. Transfer the scope screenshots to page 1 of a WORD Document and label them as follows with 2 screen captures per page:

      Scope_0: "**Print #1, Vertical 1V/div"**.
      Scope_1: "**Print #2, Vertical 2V/div"**.

6. Automated Measurements:
   a. Press the "MEAS" key – located within MEASURE section.
   b. The screen changes to show you measurement options.
   c. The buttons on the side of the screen are called the Side Menu.
   d. Press the "Type" key then "Pk - Pk" from the side menu key to display the peak to peak measurement.
   e. Repeat the Save/Recall sequence. The filename should now be scope_2. Copy it to page 2 of your WORD document and label it:

      "**Print #3, Pk-Pk Measurements with 2V/div**".
   f. Observe the Pk-Pk value. Press "AUTOSCALE." The scope thinks it is optimizing the display. Does the peak to peak measurement change? Is this better or worse?
   g. Explain what happened when you pressed AUTOSCALE and answer the questions posed in 6.f directly under Print #3 in WORD.
7. Adjust the horizontal scale:
   a. Turn the Horizontal Scale knob CW and CCW. Notice that it makes the signal look "fatter" or "thinner"; you are changing the horizontal gain.
   b. Adjust the Horizontal Scale knob until "500us" is displayed on the top of the screen.
8. Adjust the horizontal position:
   a. Turn the Horizontal Position knob back and forth to move the waveform left and right.
   b. Adjust the Horizontal Position until the delay indicates -500uS.
9. Measure the signal period:
   a. Count the number of horizontal divisions in one cycle (period); the time it takes the square wave to repeat.

b. Multiply the number of divisions by 500usec, the horizontal gain (500us/div).
c. Verify the signal period is 1 ms.

10. Automated Measurements:
    a. Press the "MEAS" key and then the "Clear Meas" Key and then "Clear all".
    b. Press "Type" key and using the "Entry" knob, Select "Max" and press the knob in.
    c. Repeat this process for "Period"
    d. Press "Back"
    e. Adjust the vertical position of the waveform so the ground reference is aligned with a major grid-line and the waveform falls completely within the screen of the oscilloscope.
    f. Repeat the screenshot Save/Recall steps and label this print "**Print #4, Period and Maximum Measurements with 500mV/div**" on page 2 of your WORD document.

11. Show your instructor/TA your prints (captures 1 through 4) and get a sign-off (NO MORE THAN 2 PRINTS PER PAGE IN WORD).

PART 2 – Basic Function Generator Operation

In the previous section you explored the oscilloscope operation using detailed step by step instructions. For this section you will use the function generator (the arbitrary waveform generator referenced in the pre-lab research section) operator's manual and experiment to create several waveforms.

1. Create a 1V peak-peak sinusoidal waveform at 1kHz with no DC offset.
2. View the output signal of the function generator using channel one of your oscilloscope. (once the waveform parameters are set, be sure to press "Output" button.)
    a. Use a BNC to alligator clip set of test leads on the function generator.
    b. Set your ground reference to the center of the screen.
    c. Adjust the vertical gain so that the entire waveform takes up as much of the screen as possible without going off-screen.
    d. Adjust the horizontal gain so that at least two but less than four cycles of the waveform is displayed.
    e. You may need to use the BW limit function and adjust your trigger level (ask your instructor how if your waveform keeps running across the screen).
    f. Using the automated measurements function of the oscilloscope, display the period, frequency and peak to peak amplitude of the waveform.
    g. Store a screenshot, label this print "**Print #5, 1V p-p, 1kHz Sinusoid**" on page 3 of your WORD document.
3. Using the function generator controls and leaving the oscilloscope connected, create a sinusoidal waveform with a frequency of 10 kHz, a peak to peak amplitude of 2 volts and no DC offset.
    a. Set your ground reference to be in the center of the screen.
    b. Adjust the vertical gain so that the entire waveform takes up as much of the screen as possible without going off-screen.
    c. Adjust the horizontal gain so that at least two but less than four cycles of the waveform is displayed.
    d. Using the automated measurements function of the oscilloscope, display the period, frequency and peak to peak amplitude of the waveform.
    e. Store a screen capture, label this print "**Print #6, 2V p-p, 10kHz Sinusoid**" on page 3 of your WORD document.
4. Using the function generator controls and leaving the oscilloscope connected, create a

sinusoidal waveform with a frequency of 100 kHz, a peak to peak amplitude of 1 volts and 500mV of DC offset. (You may need to adjust the trigger level as indicated by the "T" to the left of the display.)

a. Set your ground reference to the center of the screen.
b. Adjust the vertical gain so that the entire waveform takes up as much of the screen as possible without going off-screen.
c. Adjust the horizontal gain so that at least two but less than four cycles of the waveform is displayed.
d. Using the automated measurements function of the oscilloscope, display the period, frequency, average –FS (mean) value and peak to peak amplitude of the waveform.
e. Store a screenshot, label this print "**Print #7, 1V p-p, 100Khz Sinusoid with 0.5V Offset**" on page 4 of your WORD document.

5. Using the function generator controls and leaving the oscilloscope connected, create a **square-wave** with a frequency of 40 kHz, a peak to peak amplitude of 5 volts and 2.5V of DC offset.

a. Set your ground reference to the center of the screen.
b. Adjust the vertical gain so that the entire waveform takes up as much of the screen as possible without going off-screen.
c. Adjust the horizontal gain so that at least two but less than four cycles of the waveform is displayed.
d. Using the automated measurements function of the oscilloscope, display the period, frequency, average value – FS (mean) and peak to peak amplitude of the waveform.
e. Store a screenshot, label this print "**Print #8, 5V p-p, 40kHz Square-Wave with 2.5V Offset**" On page 4 of your WORD document.

6. Show your instructor/TA your WORD document with prints 5 through 8 on pages 3 and 4 and get a sign-off (NO MORE THAN 2 PRINTS/PAGE in WORD).

Make sure your lab work has been signed off on the attached cover page. Work not bearing a signoff from an instructor or TA will not be accepted for grade.

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Post Lab Requirements:

After lab, **during a time specified by your instructor**, take the Post Lab Quiz on myCourses. You may use your prelab work, lab data and answers to the lab questions as reference material.

Turn in your completed documentation at the beginning of next week's lab before you take that week's prelab quiz, (remember, it's late 10 minutes after lab starts). Your submission package will be graded and returned with comments. Submit the following in order at the start of lab NEXT week:

1. The following cover sheet (completely filled in by all of your team members, one per team).
2. The work your team accomplished (printouts and included annotations/questions for PRINT#3 answered) – One set PER TEAM
    a. Staple your work together with the completely filled out grade sheet as your cover page followed by your printouts in order (1 through 8) and turn in this package at the beginning of lab next week.

Submit NO ADDITIONAL PAPER or INFORMATION other than that requested. Extraneous Information such as the lab handout, equipment quick-start guides, etc will result in reduced credit for this assignment.

If you have any questions about the lab submission, please ask your instructor for clarification.

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Team Name and Lab Section: .....

Team Members Present (printed)

First Name, Last Name	Role This Lab	RIT Program

TEAM LABORATORY RESULTS GRADE

(all work done neatly, legible and organized, completed on time, all signoffs in place, no missing information and no extraneous information)

Instructor Signature, Part 1 _____	/10
Prints 1 through 4	/16
Print 3 Q&A	/4
Instructor Signature, Part 2 _____	/10
Prints 5 through 8	/20
Final Team Grade	**/60**

Instructor comments: