AE251a: Experiments in Aerospace Engineering

Lab – 1 **Date: Mar 05, 2019**

Save your work in your own directory (you may create a directory in D drive)

Exercise 1: Open and Run a VI

Objective: *Open, run, and explore the components of a VI.*

Open "**1a_*Function Generator***" VI from the LAB_1 directory.

Front Panel

This VI generates different types of signal with noise. You can generate Sawtooth, Square, Triangular, and Sine waveform and also add noise to it if you desire. You can also change the frequency, amplitude, and offset of the signal.

1. Run the VI by clicking the **Run** button. The button changes appearance to indicate that the VI is running.
2. Select **View » Show Tools Palette** to display the **Tools** palette.
3. Use the Operating tool to change the value of the slider and knobs in the Front Panel. Notice the signal displayed on the chart changes as you change the value.

You operate LabVIEW controls just as you would similar real controls. Other ways to operate knob controls using the Operating tool include:

- Clicking the slider and dragging it to a new location.
- Clicking the black region of the slider to move the slider to the value at the point you clicked.
- Clicking the digital display and entering a number. If you use this method, the Enter button appears on the toolbar. LabVIEW does not pass the value to the control until you click this button or press <Enter>. Macintosh Press <Return> to enter the value.

Block Diagram

1. View the block diagram for the Function Generator VI by selecting **Window » Show Diagram**. This block diagram contains several basic elements of LabVIEW programming, including structures, functions, and subVIs.
2. Use the Operating tool to double-click the Temperature Status icon to open the front panel of this subVI.
3. Explore the subVIs in the block diagram to understand their functions. When you run the Function Generator VI, it calls the basic function generator subVI to generate the desired waveform and then it executes the uniform white noise subVI.
4. Close the front panel for the Function Generator VI by selecting **Close** from the **File** menu.

Additional Task (Repeat Exercise-1 tasks for the following VI)

1. Explore **1b_Thermometer** VI. This VI measures room temperature and displays in a thermometer and in a chart. Temperature can either be displayed in degree C or F.

Exercise 2: Use of LabVIEW help utilities

Objective: *Become familiar with the **context help** and the **LabVIEW help***

Open the Function Generator VI from the LAB-1 directory if it is not already open from Exercise 1.

Part I

1. View the block diagram window by selecting **Window » Show Diagram** or by pressing
<Ctrl-e>.
2. Display the Context Help window by selecting **Help » Show Context Help** or pressing
<Ctrl-h>.
3. The **Context Help** window displays information about the functions and wires as you move the cursor over each object.
    a. Select the Positioning tool from the **Tools** menu and move the Positioning tool over the basic function generator subVI. Notice the description of the function in the **Context Help** window.
    b. Select the Wiring tool from the **Tools** palette and move the Wiring tool over the terminals of the basic function generator subVI. Notice that the terminals blink in the **Context Help** window as the tool passes over them.
    c. Move the Wiring tool over a wire. Notice the **Context Help** window displays the wire data type.

Part II

1. On the block diagram of the Function generator VI, move the mouse over the Uniform white noise subVI. Notice there is a blue link (detailed help) at the bottom of the **Context Help** window.

    This link opens the LabVIEW Help function reference information for the function. The function reference information in the LabVIEW Help is more complete than the information in the **Context Help** window. Most VIs and functions that ship with LabVIEW have links in the **Context Help** window to detailed VI and function reference in the LabVIEW Help.

    Note: When you perform the next step, you will go to a different topic in the LabVIEW Help and these instructions will disappear. To return to these instructions, click the **Back** button in the LabVIEW Help.

2. Click the blue link at the bottom of the **Context Help** window to view the function reference information in the LabVIEW Help**.**

Exercise 3: Navigation and editing

Objective: *To learn LabVIEW editing techniques.*

Use Open VI to open the *Editing Exercise.vi* from the Lab-1 directory. Now follow the given instructions on the front panel and edit the VI. If you wish to save the exercise please use some other name so that your partner can also do the same operations. Please take your time since navigation and editing must be mastered in order to learn LabVIEW. You also try and familiarize yourself with the Tools, Function and Control Palettes and their operation.

Exercise 4: Create a VI

Objective: Build a simple VI that converts a Celsius temperature reading to Fahrenheit.

Front Panel

1. Open a new front panel by selecting **File » New VI** or press <Ctrl-n>. If you have closed all VIs, select **New VI** from the LabVIEW dialog box.
2. Select **View » Show Controls Palette** to display the Controls palette. You also can access a temporary **Controls** palette by right-clicking an open area of the front panel.
3. Select a Thermometer from the **Controls » Numeric** palette, and place it on the front panel.
4. Type deg C in the label text box and click the **Enter** button on the toolbar or click anywhere on the front panel, to complete the new label.

   Note: If you click outside the text box without entering text, the label defaults to Thermometer. To show the label again, right-click the control and select **Visible Items » Label** from the shortcut menu.

   By default, a thermometer is an indicator because it displays a data value. In this VI, however, use the **deg C** thermometer as a control, because it is the data source.
5. Right-click the **deg C** thermometer and select **Change to Control** from the shortcut menu.
6. To make it easier to precisely enter a value into the deg C thermometer, make the Digital Display visible. To do this, right-click on the thermometer and select **Visible Items » Digital Display** from the shortcut menu.

Now that you have a thermometer control for the Celsius temperature, you need an indicator to display the Fahrenheit value.

7. Select another thermometer from the **Controls » Numeric** palette and place it on the front panel.
8. Label this Thermometer deg F as you did in Step 3, and make the Digital Display visible as you did in Step 5.

Because this thermometer will display temperatures in degrees Fahrenheit, change the scale of the thermometer so it can display readings higher than 100 degrees.

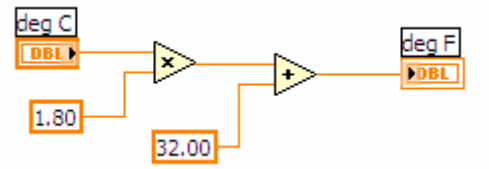
9. To change the scale of the **deg F** thermometer, use the Labeling tool or the Operating tool to highlight the topmost value of the scale and type 212, which is the Fahrenheit equivalent of 100 degrees Celsius, the highest visible value on the **deg C** Thermometer.

Block Diagram

1. Open the block diagram by selecting **Window » Show Diagram**, or by clicking the block diagram window behind the front panel window. You also can press <Ctrl-e> to switch between the front panel and block diagram windows.

   Notice the objects on the block diagram. These objects are terminal that correspond to the thermometer control and indicator you placed on the front panel.

To convert a Celsius temperature value to Fahrenheit, multiply the Celsius value by 1.8 and add 32. Use the functions on the **Functions » Numeric** palette to build a block diagram that does this.



2. Select **View » Show Functions Palette** to show the Functions palette. You also can access a temporary **Functions** palette by right-clicking an open area of the block diagram.
3. Select a Multiply function from the **Functions » Numeric** palette and drag it to the block diagram. Before you click the mouse button to drop the Multiply function on the block diagram, drag the function just to the right of the **deg C** terminal.

   Notice when you hold the function close to the terminal, LabVIEW automatically draws a wire to one of the terminals on the Multiply function. When LabVIEW draws a wire between the function and the **deg C** terminal, click the mouse button to place the function on the block diagram. Notice the **deg C** terminal is wired to the Multiply function.
4. If you placed the Multiply function without a wire connection to the **deg C** terminal, use the Wiring tool to wire them together by completing the following steps.
   a. Select the Wiring tool from the **Tools** palette.
   b. Click the **deg C** terminal to tack a wire to the terminal. You do not need to hold down the mouse button.
   c. Drag the mouse to a terminal on the Multiply function and click to tack down the wire to wire the two terminals together.
5. You need to multiply the **deg C** value by 1.8. Right-click the unwired input terminal on the Multiply function and select **Create » Constant**. LabVIEW creates a numeric constant value and wires it to the input terminal, with the numeric value highlighted for you to enter a value. Type 1.8 and click the **Enter** button, or click anywhere on the block diagram.
6. You need to add 32 to complete the calculation. Select an Add function from the **Functions » Numeric** palette and drag it to the block diagram. Before you click the mouse to place the Add function on the block diagram, drag the function just to the right of the output terminal of the Multiply function.

   When a wire that connects the output terminal of the Multiply function and one of the input terminals of the Add function appears, click the mouse button to place the function on the block diagram. LabVIEW automatically wires the two functions together.

   If the functions are not wired together, use the Wiring tool as described in Step 3.
7. Right-click on the unwired input terminal of the Add function and select **Create » Constant**, as you did in Step 4. Type 32 and click the **Enter** button, or click anywhere on the block diagram.
8. Now that you've multiplied the **deg C** value by 1.8 and added 32, you need to pass the value to the **deg F** terminal by completing the following steps.
   a. Select the Wiring tool from the **Tools** palette.
   b. Click the output terminal of the Add function to tack a wire to the terminal.

c. Drag the mouse to the **deg F** terminal and click the mouse button to wire the two terminals together.

9. You can rearrange the objects on your block diagram. Use the Positioning tool to select objects and move them.

   Your block diagram is now complete.

10. Select **File » Save** and save the VI as Convert C to F.vi in the Lab-1 directory. You may create your own directory in the LAB-1 directory and save your work there.

Running the VI

1. On the front panel, use the Operating tool or Labeling tool to enter 37, which is normal body temperature in Celsius, in the digital display of the **deg C** thermometer.
2. Run the VI by clicking on the **Run** button. Notice that LabVIEW converts the Celsius temperature to 98.6 degrees Fahrenheit and displays it on the **deg F** thermometer and its digital display. Enter other values in the **deg C** thermometer and run the VI.
3. Close the VI by selecting **File » Close** to close the VI.

Exercise 5: Document a VI

Objective: *Document a VI that you have created.*

Front Panel

1. If it is not already open from the previous exercise, open the Convert C to F VI.
2. Select **File » VI Properties** and select **Documentation** from the pull-down menu to display the documentation properties of the VI.
3. Type a description for the VI (*e.g. this VI converts a temperature measured in Centigrade to Fahrenheit*) and click **OK**.
4. Right-click the **deg C** thermometer and select **Description and Tip** from the shortcut menu. Type the description and tip information for the control, as shown in the following illustration, and click **OK**.
5. Right-click the **deg F** thermometer and select **Description and Tip** from the shortcut menu. Type in the description: *Displays the calculated Fahrenheit temperature* for the description, and *Fahrenheit temperature* for the tip. Click **OK**.
6. Idle the cursor over the **deg C** thermometer. Notice the information you entered in the **"deg C" Tip** field of the **Description and Tip** dialog box shows up as a tip strip.
7. Select **Help » Context Help**. Place the cursor on the **deg C** thermometer and then on the **deg F** thermometer. Notice the information you entered in the **Description and Tip** dialog box appears in the help window.
8. Place the cursor over the icon in the upper right corner of the block diagram or front panel window. The description you entered in the Documentation page of the **VI Properties** dialog box appears in the **Context Help** window.
9. Save the VI.

Exercise 6: Debug a VI

Objective: To *use the probe tool and the probe window and to examine data flow in the block diagram using execution highlighting.*

Probes

1. If it is not already open from the previous activity, open the Convert C to F VI.

Block Diagram

2. Select **Window » Show Diagram**.
3. If the **Tools** palette is not open, select **View » Show Tools Palette**.
4. Select the Probe tool from the **Tools** palette and click the wire coming out of the Multiply function. A Probe window appears with the title [1] **Probe** and a yellow glyph with the number of the probe appears on the wire.

Front Panel

5. Return to the front panel. Move the Probe window so you can view the probe value and both of the thermometer values. Run the VI. The value at the probe appears in the [1] Probe window.
6. Close the [1] **Probe** window by clicking the close box at the top of the Probe window title bar.

Execution Highlighting and Single Stepping

Another useful debugging technique is to examine the flow of data in the block diagram using the execution highlighting feature.

Block Diagram

1. On the block diagram, begin execution highlighting by clicking the **Highlight Execution** button, in the toolbar. The **Highlight Execution** button changes to an illuminated light bulb.
2. Click the **Run** button to run the VI. Notice that execution highlighting animates the VI block diagram execution. Moving dots represent the flow of data through the VI. Also notice that data values appear on the wires and display the values contained in the wires at that time just as if you had probed the wire.
3. Begin single-stepping by clicking the **Step In** button in the toolbar.
4. Click the **Step Over** button until the VI finishes executing.
5. Finish executing the block diagram by clicking **the Step Out** button in the toolbar. Clicking this button completes all remaining steps in the block diagram.

7. a) Build a VI (Exercise)

A projectile is projected with a velocity of V (in m/s) and at an angle θ (in degree) to the horizontal. Build a VI to compute (i) Maximum height reached (in meters), (ii) Time of flight (in seconds) and (iii) Range of the projectile (in meters).

b) Create a subVI (Exercise)

Convert the VI created in part a) above to a sub-VI by assigning controls and indicators to the appropriate terminals. Also, modify the default icon to whatever you like using the tools of the icon editor. You have just created your first VI capable of being used as a sub-VI. You will now use this sub-VI in the next exercise to build a VI. Do not forget to document your VI.

c) Use of subVI (Exercise)

Build a VI using the sub-VI created in part b) to compute maximum height, time of flight, and range.