UNIVERSITY OF MALAYA

Department of Electrical Engineering

Virtual Instrumentation using LabVIEW

Name: ____

Matric number: ____

LIST OF EXPERIMENTS

No.	Title
1	Build a Virtual instrument that simulates a heating and cooling system. The system must be able to be controlled manually or automatically.
2	Build a Virtual instrument that simulates a basic calculator.
3	Build a virtual instrument that simulates a water level indicator.
4	Demonstrate how to create basic VI which calculates area and perimeter of a circle.
5	Simulated AI and AO for Temperature Control System
6	Tank Level Control using PID
7	Simulated DI and DO for two-tank control system using Fuzzy Controller

EXPERIMENT 1

BUILD A VI THAT SIMULATES A HEATING AND COOLING SYSTEM.THE SYSTEM MUST BE ABLE TO BE CONTROLLED MANUALLY OR AUTOMATICALLY.

AIM:

To build a VI that simulates a heating and cooling system. The system must be able to be controlled manually or automatically.

The VI’s specifications are listed below.

- Must be able to be controlled automatically or manually
- In manual mode, the heater and air conditioning (AC) can be switched on/off by the user
- In automatic mode, the heater and AC turn on/off based on the following conditions:
  - The air conditioner is turned on when the temperature is above 80°F
  - The heater is turned on when the temperature is below 60°F
  - The heater and the air conditioner are turned off when the temperature is between 60°F and 80°F.

THEORY:

Structures are process control elements, such as while loops and for loops. The structure to be used in this experiment is the **case structure** which is essentially multiple if-statements. A case structure contains multiple subdiagrams (or cases), and a case will be executed depending on the input to the case structure

PROCEDURE:

1. In the front panel, drag and drop three Round LEDs and three Slide Switches by going to the Controls palette > Modern tab > Boolean. Each round LED and each slide switch will represent the AC, heater, and manual mode. The round LEDs will indicate if the item is on, and the slide switches will toggle the items on/off.

2. Rename the LEDs and their corresponding switches "Manual," "AC," and "Heater" to make building the system clearer. This can be done by using the editing text tool in the Tools palette.

3. Drag and drop a thermometer into the front panel (Controls palette > Modern tab > Numeric > Thermometer).

4. In the back panel, right click the thermometer terminal and select Change to Control, and observe how the arrow switches from the left side to the right side. This makes the

thermometer a control that will give an input to the program, which in this case is temperature.

5. In the back panel, insert a case structure to control the manual and automatic operation of the heating and cooling system (Functions palette > Structures > Case Structure). To place the case structure, click once to place one corner of the case structure, and once more to place the other corner of the case structure.

6. Wire the slide switch designated as Manual to the case selector on the case structure. This should automatically change the selector label values to True and False, if they were not already, because the slide switch is a Boolean data type. The true value corresponds to manual mode being on (where the user can directly toggle the heater and AC), while the false value corresponds to manual mode being off (where the heater and AC are automatically toggled by the system).

7. Because the temperature of the room is input into the system only when the system is not in manual mode (the false case), the thermometer terminal should be moved into the false sub-diagram.

8. In the true sub-diagram, wire the AC and heater switches directly to their corresponding LEDs. This allows the switches to directly toggle their corresponding LEDs.

9. Staying in the true sub diagram, insert a True Constant (Functions palette > Programming tab > Boolean > True Constant). Wire the true constant to the manual LED to turn the manual LED on and indicate that the system is in manual mode.

10. In the false sub diagram, insert two Numeric Constants (Functions palette > Programming > Numeric > Numeric Constant), one Greater? function and one Less? function (Functions palette > Programming > Comparison). These will be used to build the program for the heating and cooling system in automatic mode.

11. The less and greater functions compare what is wired to the upper input terminal to what is wired to the lower input terminal. Wire the thermometer to the upper input terminals of the less and greater functions. Set a numeric constant to 60 and the other to 80. Wire the 60 numeric constant to the lower input terminal of the less function and the 80 numeric constant to the lower input terminal of the greater function. Wire the output terminal of the greater function to the AC LED and wire the output of the less function to the heater LED.

12. In the false sub diagram, Insert a False Constant (Functions palette > Programming > Boolean > False Constant) and wire it to the manual LED. This is to turn off the manual LED and indicate that the system is in automatic mode.

13. The system is now complete. Click the continuously run button to control and test the VI. If the continuously run button is faded out, that means the system is wired completely. When successfully running the system, the gridlines in the background of the front panel should disappear. Click the switches and thermometer on the front panel to test the system.

BLOCK DIAGRAM:

Fig 1.1 and 1.2 shows the block diagram for true case and false case respectively.

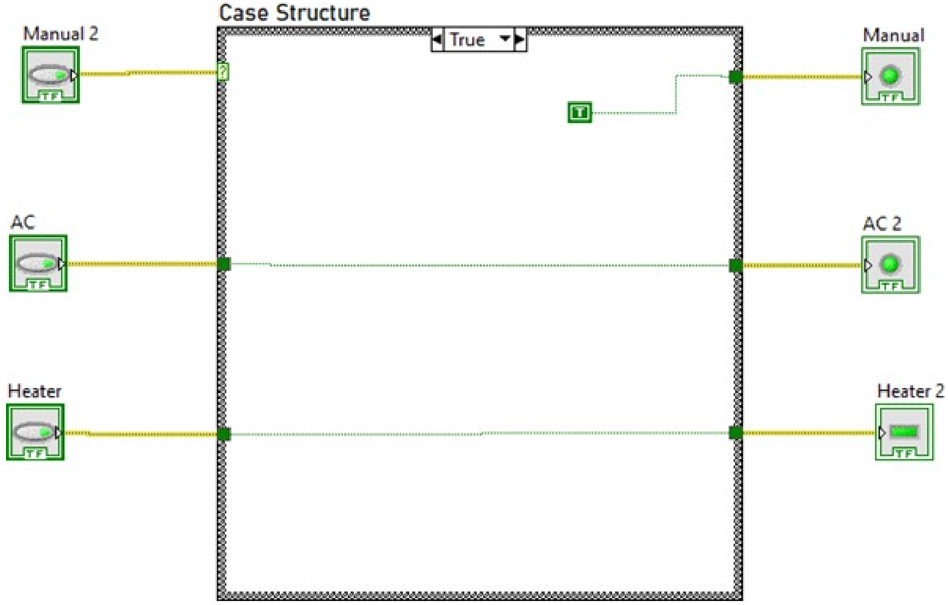


Fig 1.1 Block Diagram – For True Case

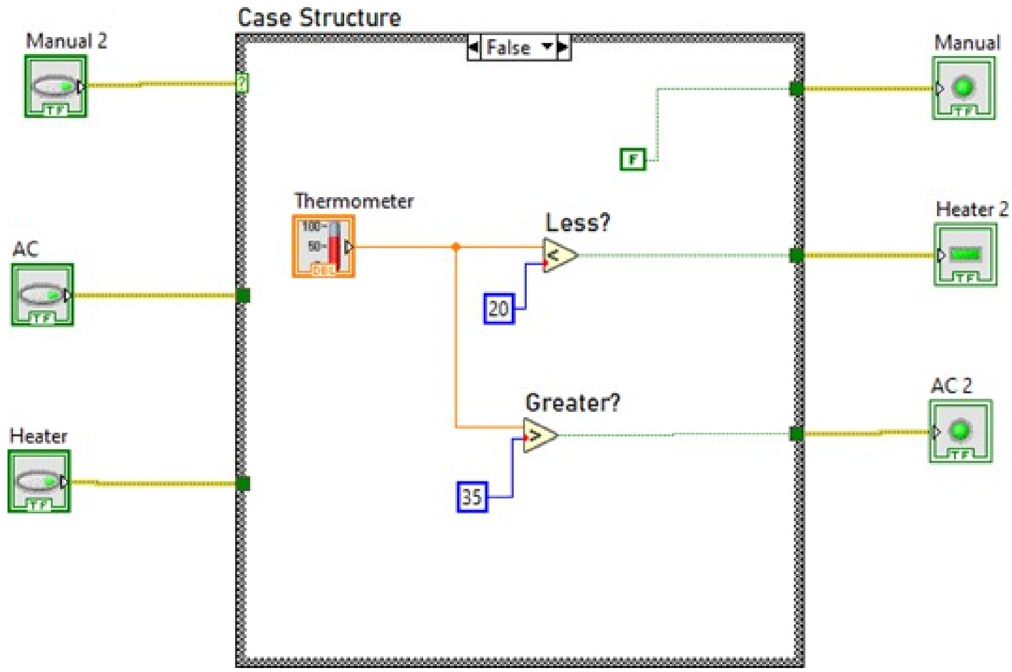


Fig 1.2. Block Diagram – For False Case

OUTPUT/FRONT PANEL:

The output for VI simulating a heating and cooling system is shown in Fig 1.3.

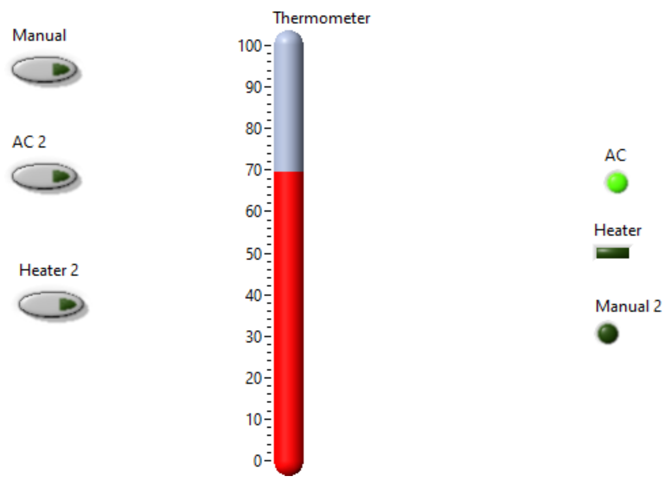


Fig 1.3.output

RESULT:

A virtual instrument that simulates a heating and cooling system is built.

EXPERIMENT 2

BUILD A VIRTUAL INSTRUMENT THAT SIMULATES BASIC CALCULATOR USING FORMULA MODE

AIM :

To build a Virtual Instrument that simulates basic Calculator Using Formula Mode.

THEORY:

The Formula Node in LabVIEW software is a convenient, text-based node you can use to perform complicated mathematical operations on a block diagram using the C- syntax structure. It is most useful for equations that have many variables or are otherwise complicated. The text-based code simplifies the block diagram and increases its readability. Furthermore, you can copy and paste existing code directly into the Formula Node rather than recreating it graphically. The Formula Node is available in all development versions of LabVIEW and does not require an additional toolkit or add-on.

PROCEDURE:

1. Selecting **File»New VI** to open a blank VI.
2. Place a Formula Node on the block diagram.
    1. Right-click on the diagram and navigate to **Programming»Structures»Formula Node**.
    2. Left-click to select the **Formula Node.**
    3. Place the Formula Node on the block diagram by left-clicking, dragging, and releasing the mouse.
3. Right-click the border of the Formula Node and select **Add Input** from the shortcut menu.
4. Label the input variable x.
5. Repeat steps 3 and 4 to add another input and label it y as in fig 2.1.

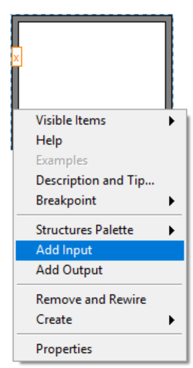


Fig.2.1 add input

5. Right-click the border of the Formula Node and select **Add Output** from the shortcut menu as in fig 2.2.

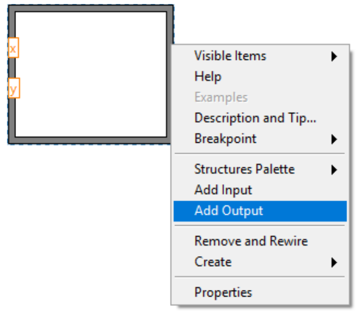


Fig.2.2. add output

6. Label the output S1.
7. Repeat step 5 to create another output, and label this output D1

8. Enter the expressions below in the Formula Node.
   - Make sure that you complete each command with a semicolon. Notice, however, that the if-statement does not require a semicolon on the first line.

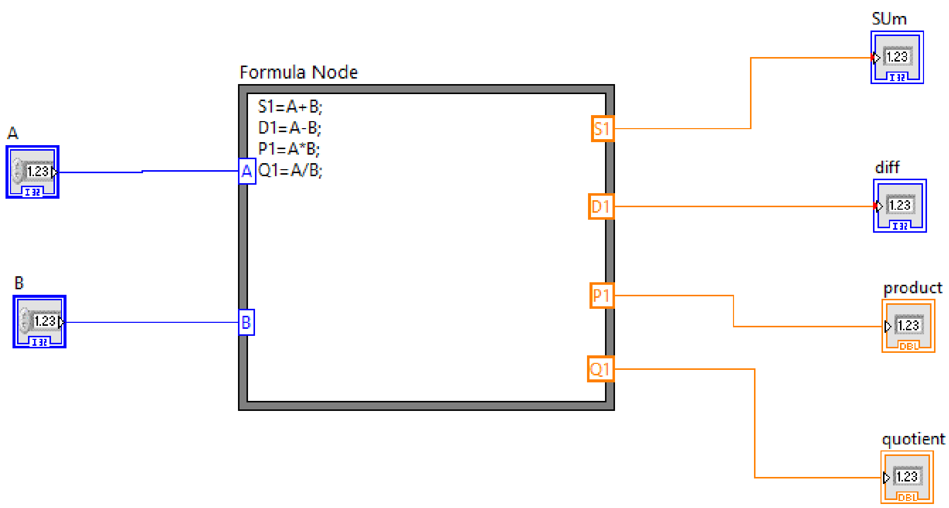
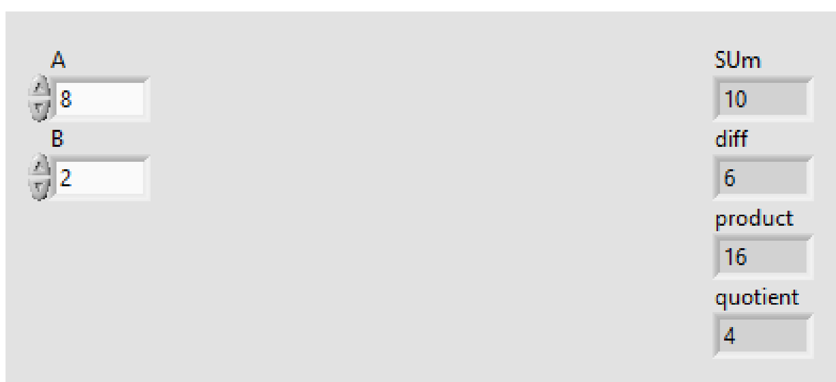


Fig 2.3 Block diagram

OUTPUT/FRONT PANEL:

The front panel view is shown in following Fig. 2.4



RESULT:

A virtual instrument that simulates a basic calculator is built.

QUESTIONS:

1. What is the formula node?
2. Use formula node for finding area of circle, circumference of circle and arc of a circle
3. What is the advantage of using formula node?
4. Is formula node text based or block (graphical) based?

EXPERIMENT 3

WATER LEVEL INDICATOR

AIM:

To create and demonstrate water level indicator.

Description:

If No water is in tank then motor must be ON.

If water level crosses 8 then Motor must be OFF.

THEORY:

The water level indicator circuits are used in factories, chemical plants, and electrical substations and in other liquid storage systems. There are many possible uses for this simple system, examples include monitoring a sump pit (to control pump activation), rainfall detection, and leakage detection. Electronic water level circuits have the capability of alerting if there is a water leak somewhere in the factory. When the water level is too high or too low or exceeds the higher limit, it can detect the water level easily by hearing an alarm sound or from different colors of a light bulb. We can also measure the fuel level in motor vehicles and the liquid level containers which are huge in the companies.

The circuit is designed to indicate three levels of water stored in the tank: empty, half and full but not overflowing. When there is no water in the tank, all the LEDs are off as an indication that the tank is completely empty. Then, manually control the knob to turn ON LED. When water level increases and touches the maximum limit, the OFF LED will glow indicating that there is water within the tank. As the water level continues to rise and reaches half the tank, ON LED will still glow indicating tank is filling.

The important LabVIEW components or tools, required to design a water level detector, list of these components below:

- Tank
- Round Knob
- Upper Level Indicator
- Lower Level Indicator
- Numerical Indicator
- Graph to observe the results

Vertical pointer is used to control the level of the water in the tank. Upper level indicator shows when the tank is about to completely fill. Lower level indicator shows indication by turning "ON" the LED when the level of the water in the tank is too low and we need to fill it. Graphs shows the graphical visualization as the vertical pointer moves up ow down.

PROCEDURE:

Step 1: Create blank VI.

Step 2: Right click on the front panel →numeric→ knob.

Step 3: Right click on the knob →Properties→ scale→ Set maximum 10 and minimum 0

Step 4: Right click on the front panel →Boolean→ Round LED (Name it ON).

Step 5: Right click on the front panel →Boolean→ Round LED (Name it OFF).

Step 6: Right click on the front panel →numeric→ Numeric control

Step 7: Right click on the front panel →numeric→ Tank

Step 8: Right click on the Block diagram panel →comparison→ greater or equal?

Step 9: Right click on the Block diagram panel →comparison→ less?

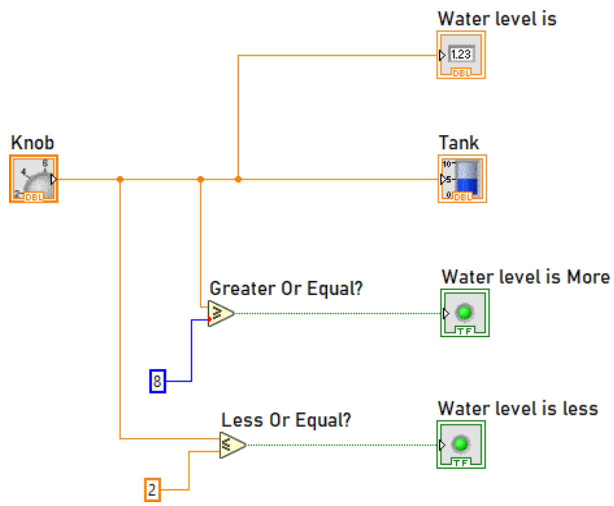
Step 10: Right click on the Block diagram panel → numeric→ Numeric constant (set 8) [twice]

Step 11: Using wiring operations required connections are made as given in the block diagram.

Step 5: Execute- give inputs in the front panel by rotating knob and observe tank filling and switches ON & OFF.

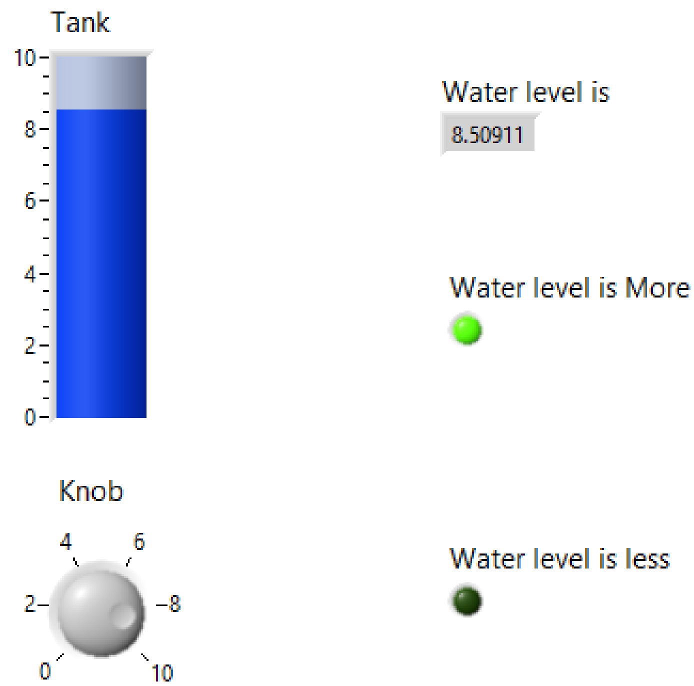
BLOCK DIAGRAM:

Fig below shows the block diagram water level indicator in LabVIEW. A round control knob is used to switch on the motor and off. Numeric indicator display water level in tank.



Block diagram

OUTPUT /FRONT PANEL :



RESULT:

Fig shows motor on with no water and filling and reached upper limit and off. A VI that indicates water level is built.

QUESTIONS:

1. How to create vertical indicators?
2. Is it possible to change the settings of LED?
3. Is it possible to implement this using While loop?
4. Comparator functions are present in which palette?

EXPERIMENT 4

CALCULATION OF AREA AND PERIMETER OF CIRCLE

AIM:

To calculate area and perimeter of a circle.

Description: Area of circle = πr^2

Perimeter/circumference of circle = $2\pi r$

r- radius of circle

if r>10 then indicate to reduce radius.

THEORY:

The area shows the space inside an object having two dimensions. Where as, circumference is the parameter which shows the boundary of the object. Area is usually measured in **m²** and circumference is measured in **m** according to their System International (SI) units. In this area and area and circumference calculation of circle is achieved. In this LabVIEW program, which will take **radius** as an input and calculates the area and circumference of circle, You can also select the maximum limit of the radius. When the radius approaches its maximum limit an LED will glow showing the notification **reduce the radius.**

PROCEDURE:

Step 1: Create blank VI.

Step 2: Right click on the front panel → numeric→ Numeric control

Step 3: Right click on the front panel → numeric→ Numeric indicator [Name Area]

Step 4: Right click on the front panel → numeric→ Numeric indicator [Name Circumference]

Step 5: Right click on the front panel → Boolean→ Square LED

Step 6: Right click on the Block diagram panel →Numeric→ multiply (thrice)

Step 7: Right click on the Block diagram panel →structures→ while loop

Step 8: Right click on the Block diagram panel →numeric→ numeric constant [set value 10]

Step 9: Right click on the Block diagram panel →numeric→ numeric constant [set value 2]

Step 10: Right click on the Block diagram panel →numeric→ math constants→pi

Step 11: Using wiring operations required connections are made as given in the block diagram

BLOCK DIAGRAM:

Fig 4.1 shows the block diagram of area and circumference of circle in LabVIEW. Area and circumference is calculated using formulas. An upper limit to radius is also kept here.

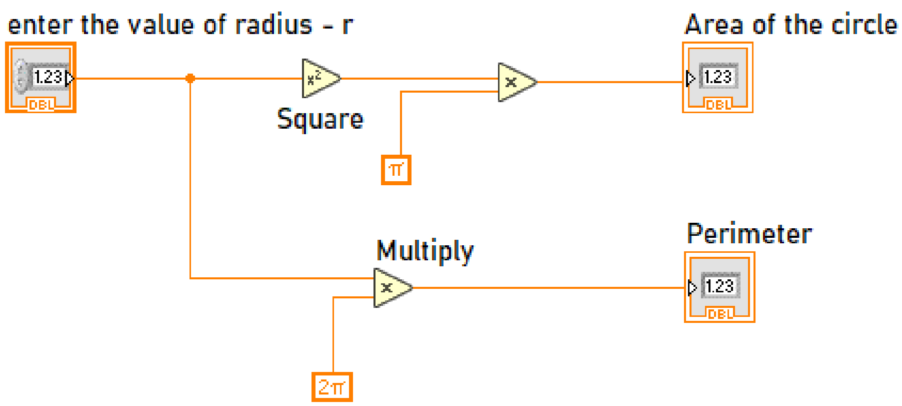
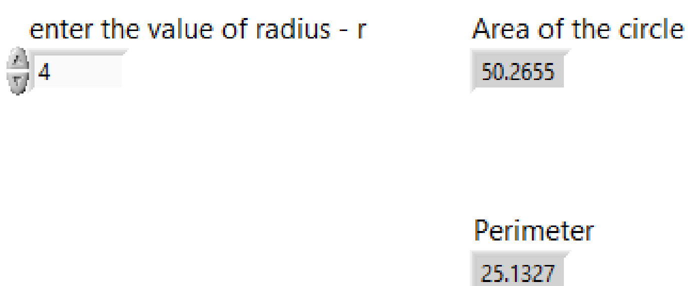


Fig.4.1 block diargram

OUTPUT /FRONT PANEL :



RESULT:

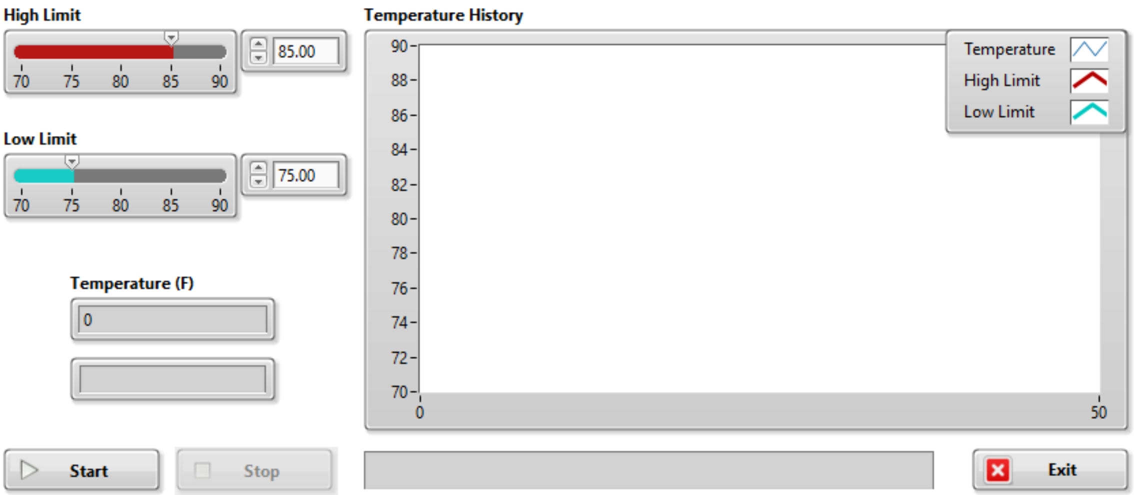
Questions:

1. What are the units of area and perimeter?
2. Where to select pi function?
3. What is the difference between continuous run and run?
4. How to indicate broken wire in LabVIEW?

EXPERIMENT 5

SIMULATED AI AND AO FOR TEMPERATURE CONTROL SYSTEM

Temperature Monitoring demonstrates a temperature monitoring application. The main VI reads a simulated temperature and alarms if it is outside a given range.



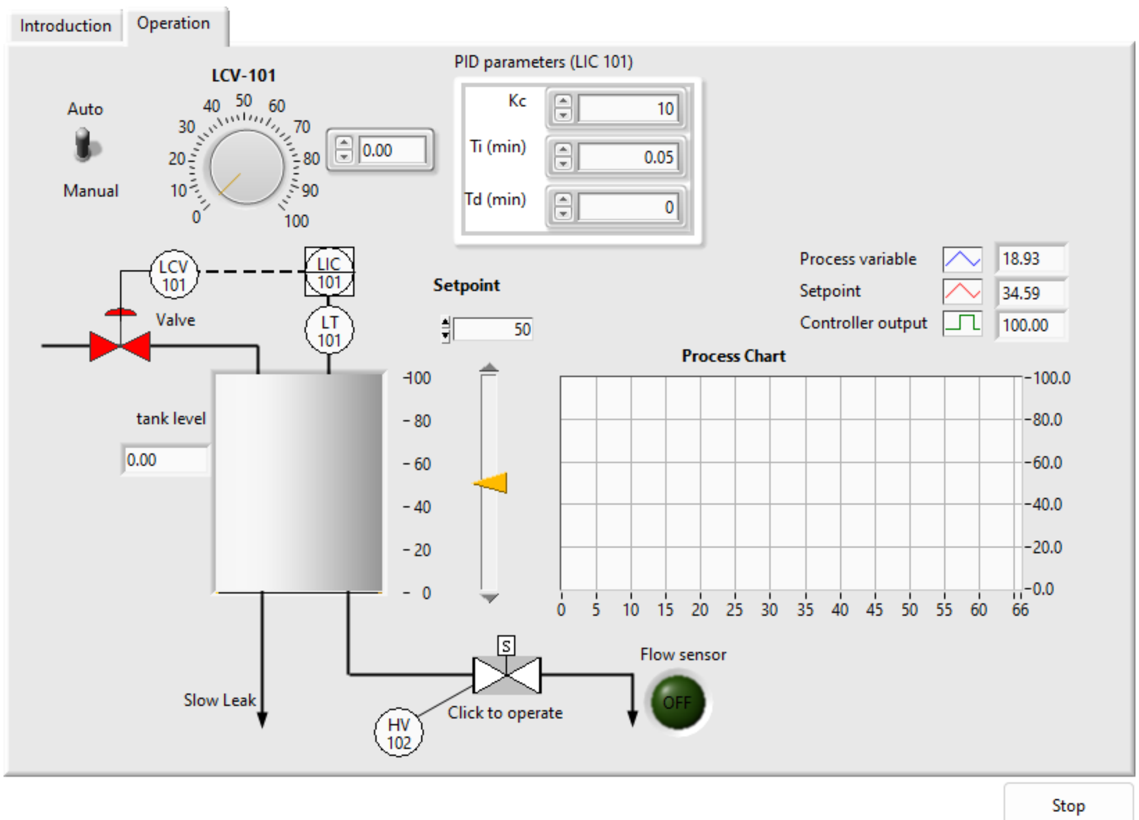
Instructions:

1. Run the VI. (Industry Applications > Temperature Monitoring.lvproj)
2. Click the Start button to start monitoring temperature data.
3. Click the Stop button to stop monitoring temperature data.
4. Change the temperature so the alarm is activated when the temperature is greater than 90 F?
5. Click Exit to stop the VI.
6. Give comment on the simulated input and output of the experiment.

EXPERIMENT 6

TANK LEVEL CONTROL USING PID

This example demonstrates a process simulation for a tank level. The process has added noise, valve deadband, lag, and deadtime. A level controller adjusts the inflow to a tank. An on/off valve serves as a drain that you can click on to operate. This s-valve represents a change in the process loading. You also can switch this VI from automatic control to manual control.



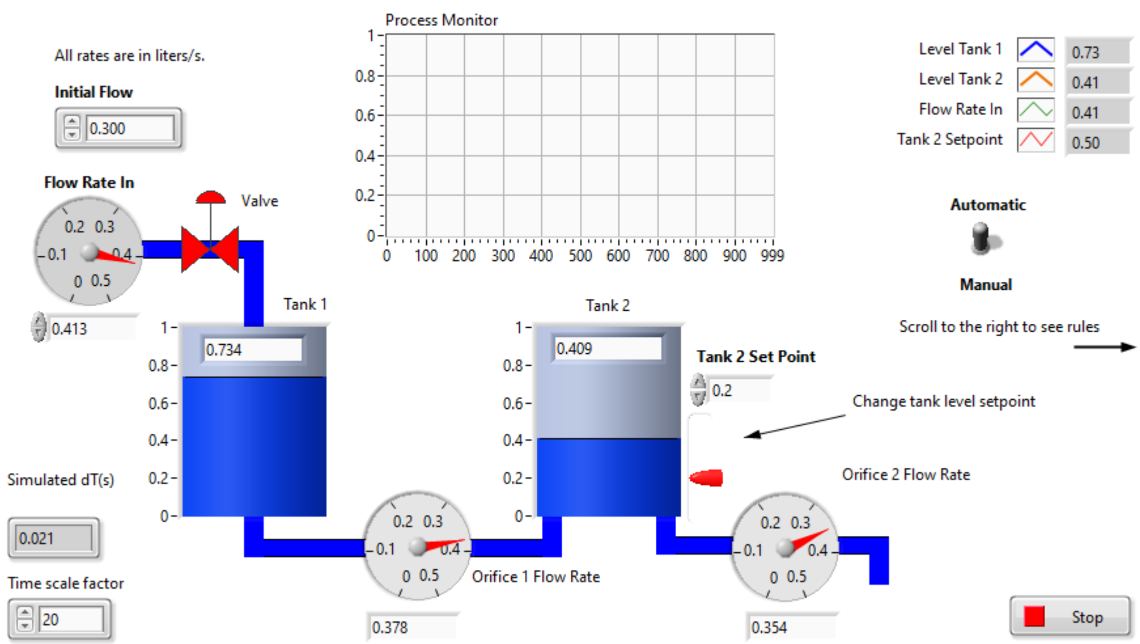
Instructions:

1. Run the VI. (Control and Simulation > PID > Simulation – Tank Level.vi)
2. Verify the PID controller in closed-loop to track the setpoint.
3. Change the setpoint to another value and verify the controller tracking the new setpoint.
4. Apply a disturbance to the system by switching the valve HV 102 (click on the valve symbol). You will see the controller recovering from the change.
5. Change PID gains and see if you can improve its performance without going unstable.
6. Switch to manual mode and see if you can control the level by changing the Valve LVC 101.
7. Click Stop to stop the VI.
8. Give comment on the stability of the system.

EXPERIMENT 7

SIMULATED DI AND DO FOR TWO-TANK CONTROL SYSTEM USING FUZZY CONTROLLER

This example simulates a two-tank system with a fuzzy controller. The system is two tanks of water with a small orifice between the tanks at the bottom of both (height = 0 m). The second tank has another small orifice at the tank bottom that empties into a reservoir at a lower height than the two tanks. The initial properties of the tanks and orifices are shown on the front panel controls below each tank. The goal of the simulation is to control the height of tank 2 to the user-specified height setpoint. The control value is the flow rate into tank 1. Therefore, this system is a second-order control system.



Instructions:

1. Run the VI. (Control and Simulation > Fuzzy Logic > FuzzyEx Tanks with PI control.vi)

2. Change the Tank 2 Set Point and see the Fuzzy Logic System Controlling input valve to set the Flow Rate In.

3. Click Stop to stop the VI.

4. Give comment on the stability of the system.