Teaching LabVIEW Across the Curriculum

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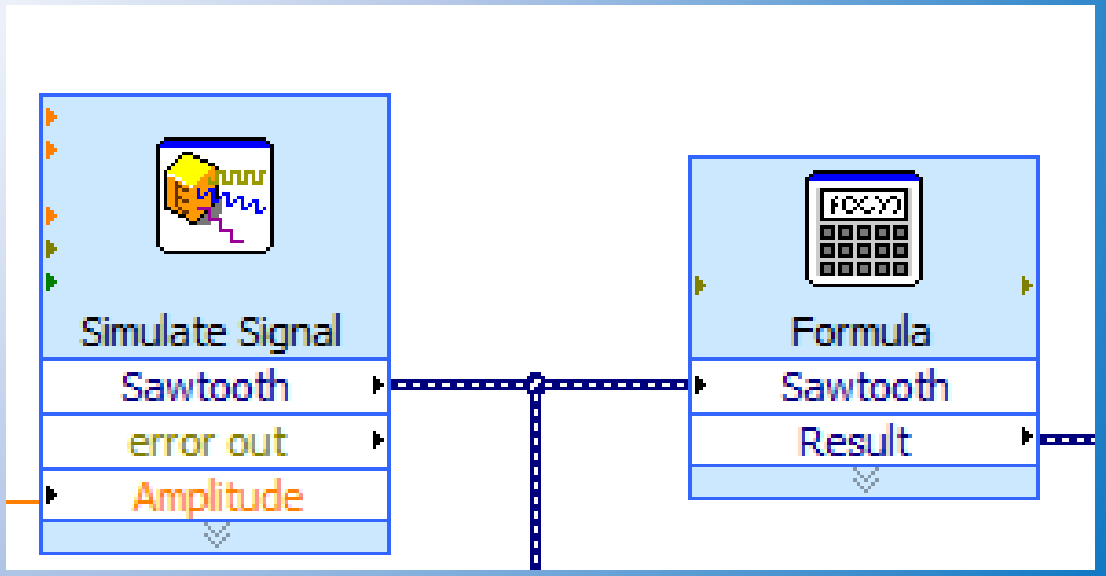
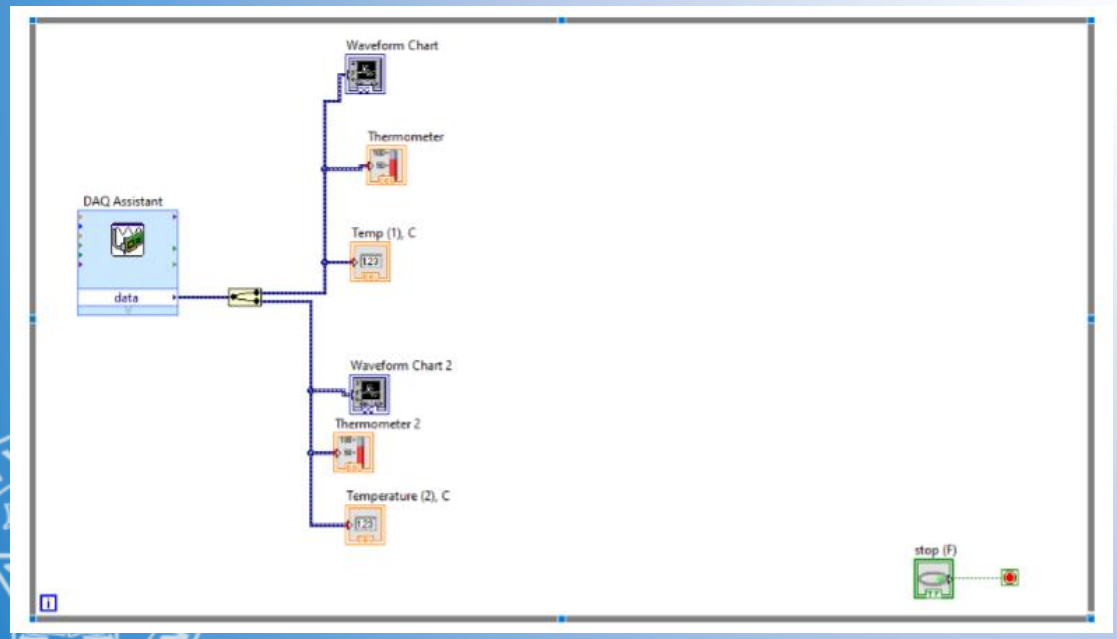
Data Acquisition Software: LabVIEW

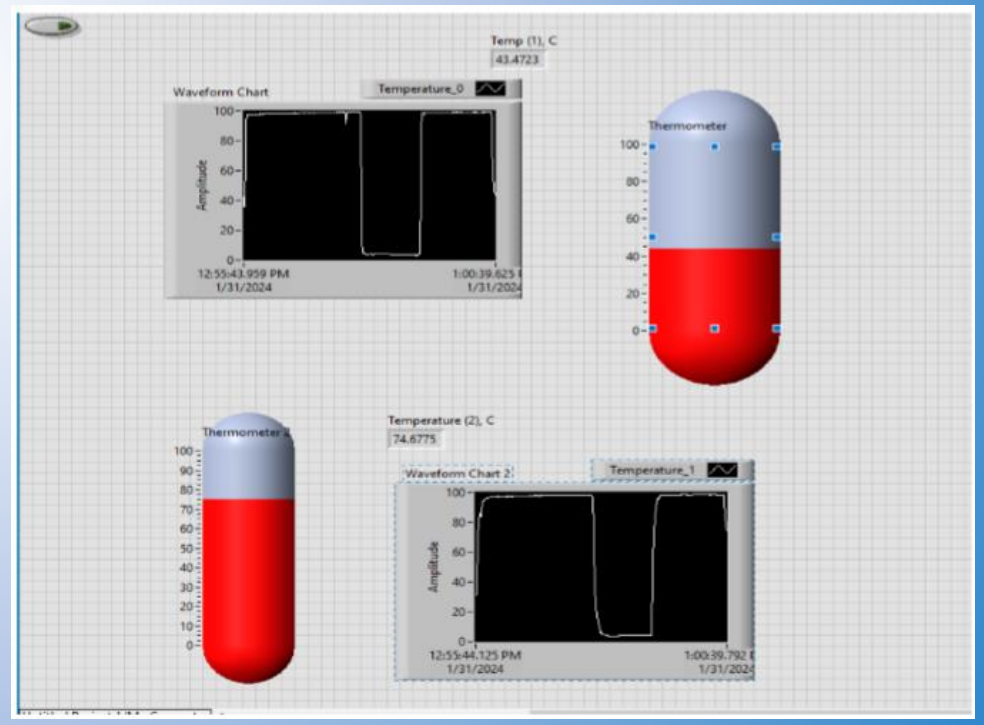
- **Lab**oratory **V**irtual **I**nstrument **E**ngineering **W**orkbench
  - A powerful and flexible tool for data acquisition and instrument control
- Uses the ‘G’ dataflow programing language
  - Icons are used to represent applications
  - Each application is connected to the other applications with wires to indicate the flow of data.



Data Acquisition Software: LabVIEW

- LabVIEW programs are called virtual instruments with:
  - A block diagram - shows the parts of the actual program
  - A front panel - resembles the actual lab equipment like knobs, buttons, and controls.





Spreading LabVIEW Across the Years

First Year

- Introduction to software & hardware
- Familiarity with how to code
- Some open-ended control problem solving

Third Year

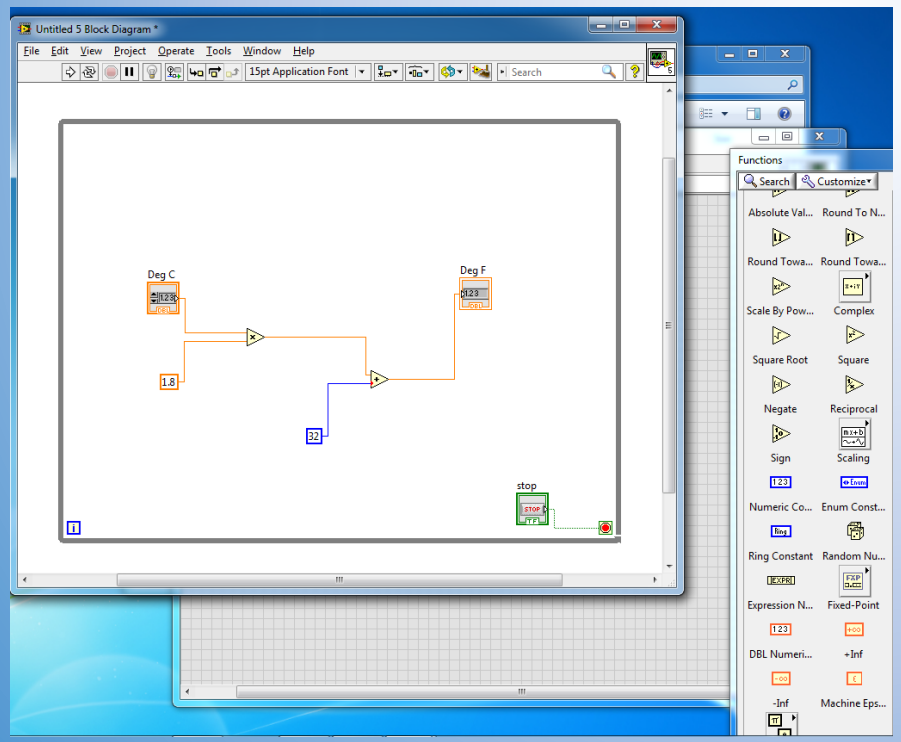
- Reintroduction to coding
- More formal control instruction

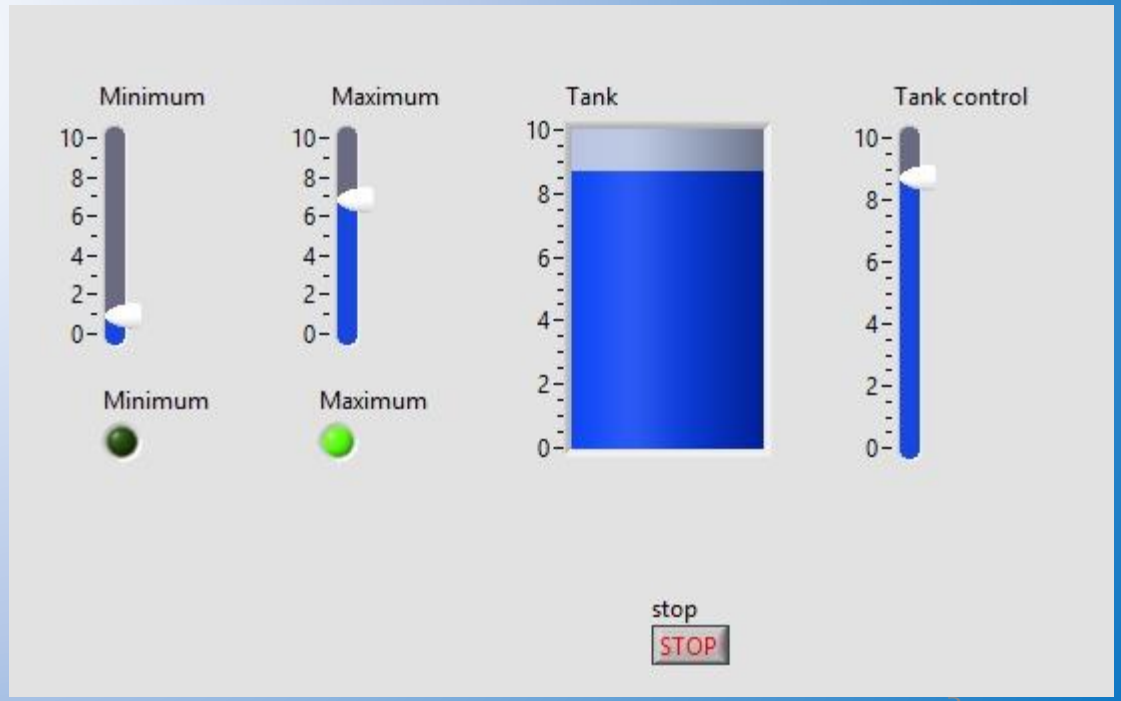
Fourth Year

- More challenging calibration inputs
- Design your own code

Chemical Engineering Technology (Spring First Year)

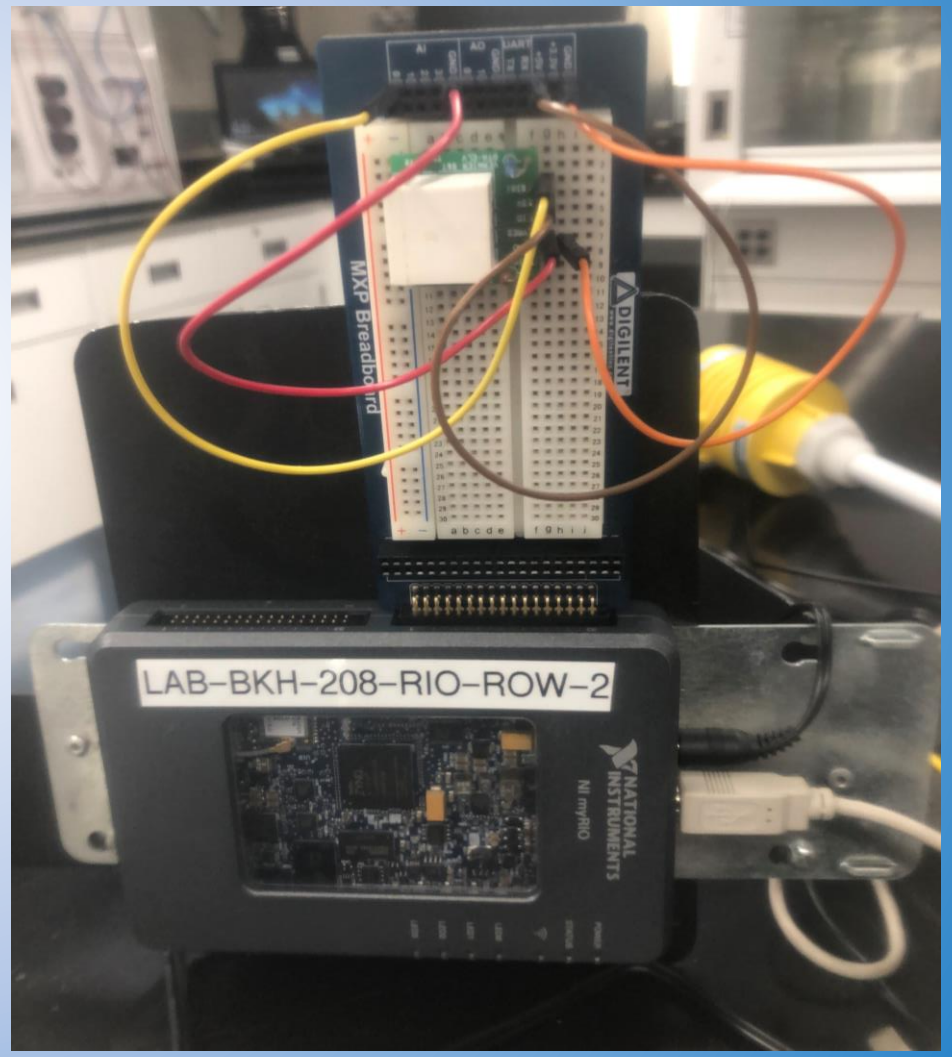
- LabVIEW is introduced in the last two months of the semester
- Begin with no hardware and only software:
  - Start with an interactive demonstration to make a program to convert temperature units
  - Then have students follow a set of instructions to build a water level indicator.





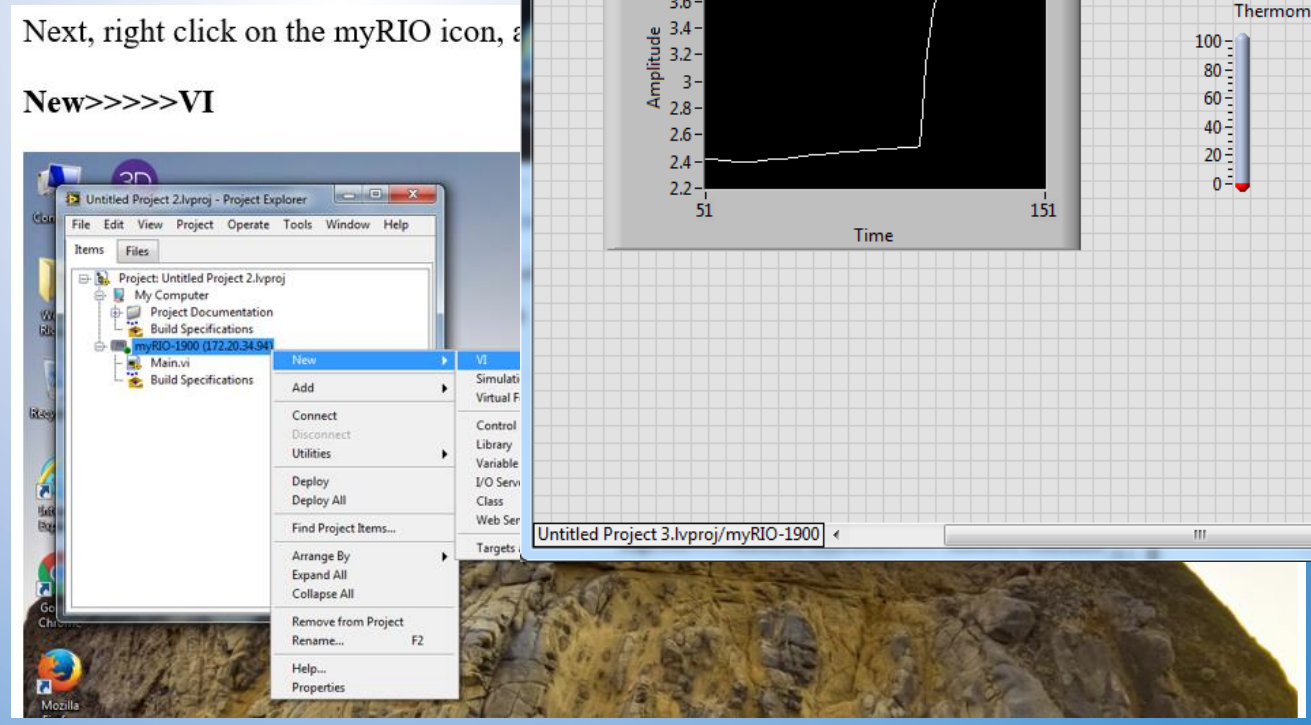
Introducing Hardware: Thermistor Calibration

- Create a temperature calibration curve, using an alcohol thermometer for a reference temperature
  - Students must determine how to collect data with access to ice and a hot plate
- Create a LV program with a formula to display a true temperature



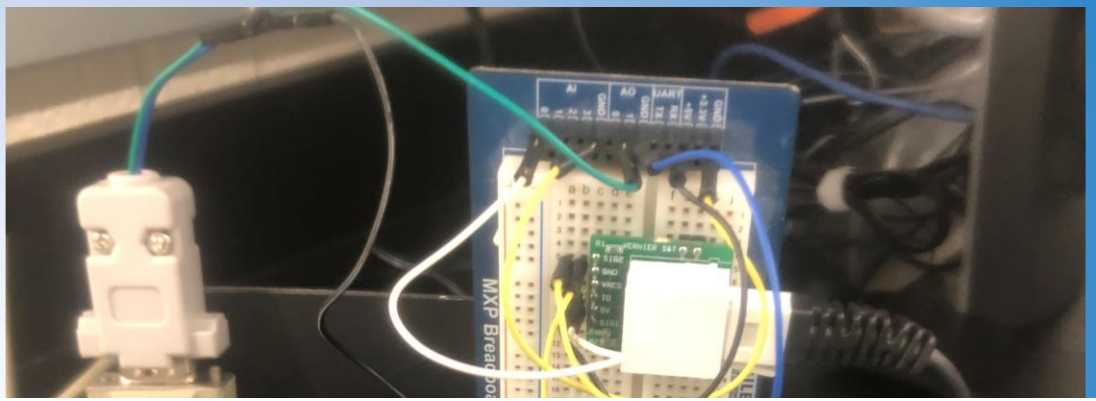
Introducing Hardware: Thermistor Calibration

- Highly structured assignment with step-by-step guide and screenshots
- Deliverables: ~2 pg individual technical memo explaining their:
  - Calibration curve
  - Physical circuit
  - Digital program

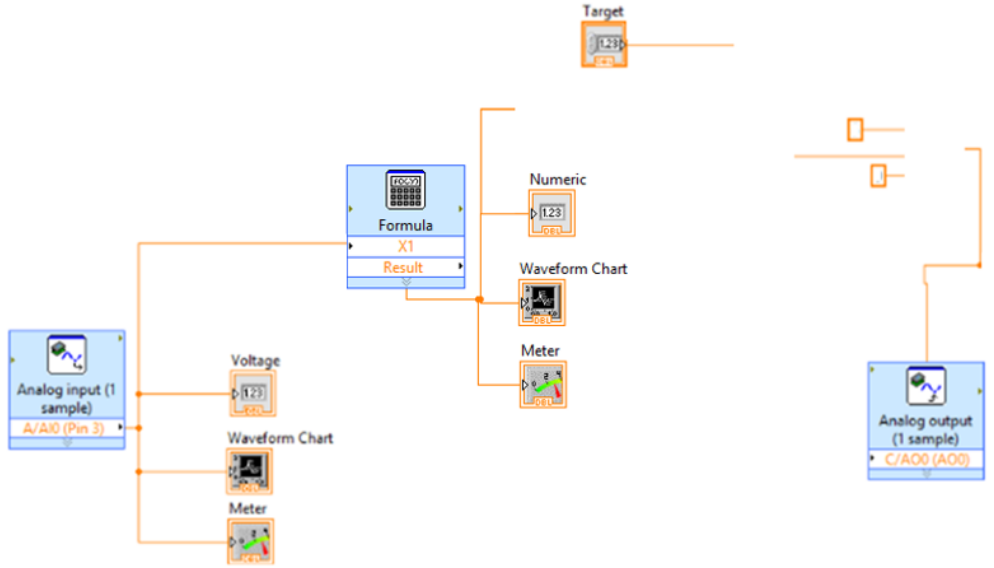


LabVIEW Salinity Control Project

- Student Challenge: **Design a control system to the control concentration of salt for fish in an aquarium to a level of 0.2 M**
- Create a salinity calibration curve using the available reference salt solutions
- Create a LV program with a formula to display a true salinity
- Create a Feedback Control so that you can tell LV what salinity you want to achieve in your system



A sample program might look something like this, though parts of the program are missing for you to determine what to do.

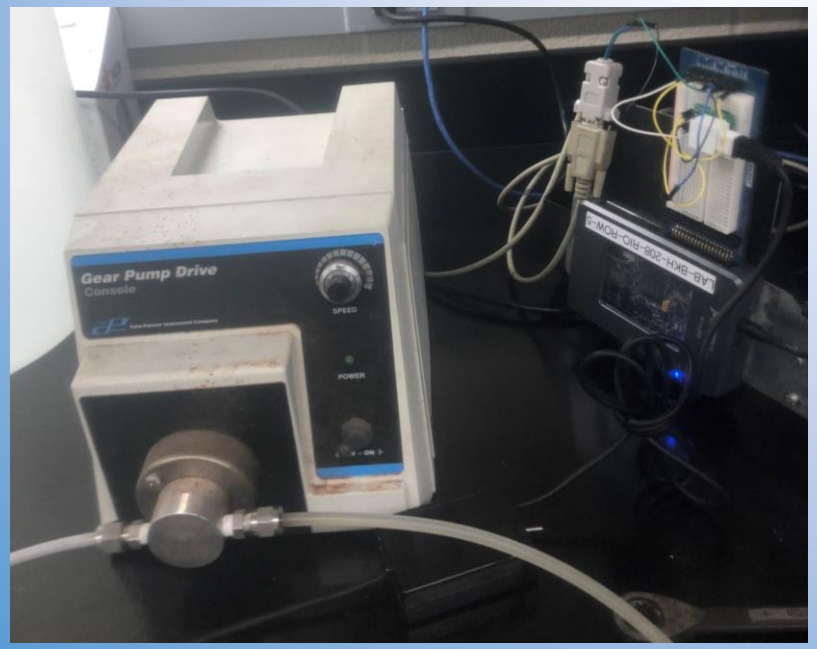


More open-ended:

- Some advice for program building provided, but not exact steps

Experimental Setup

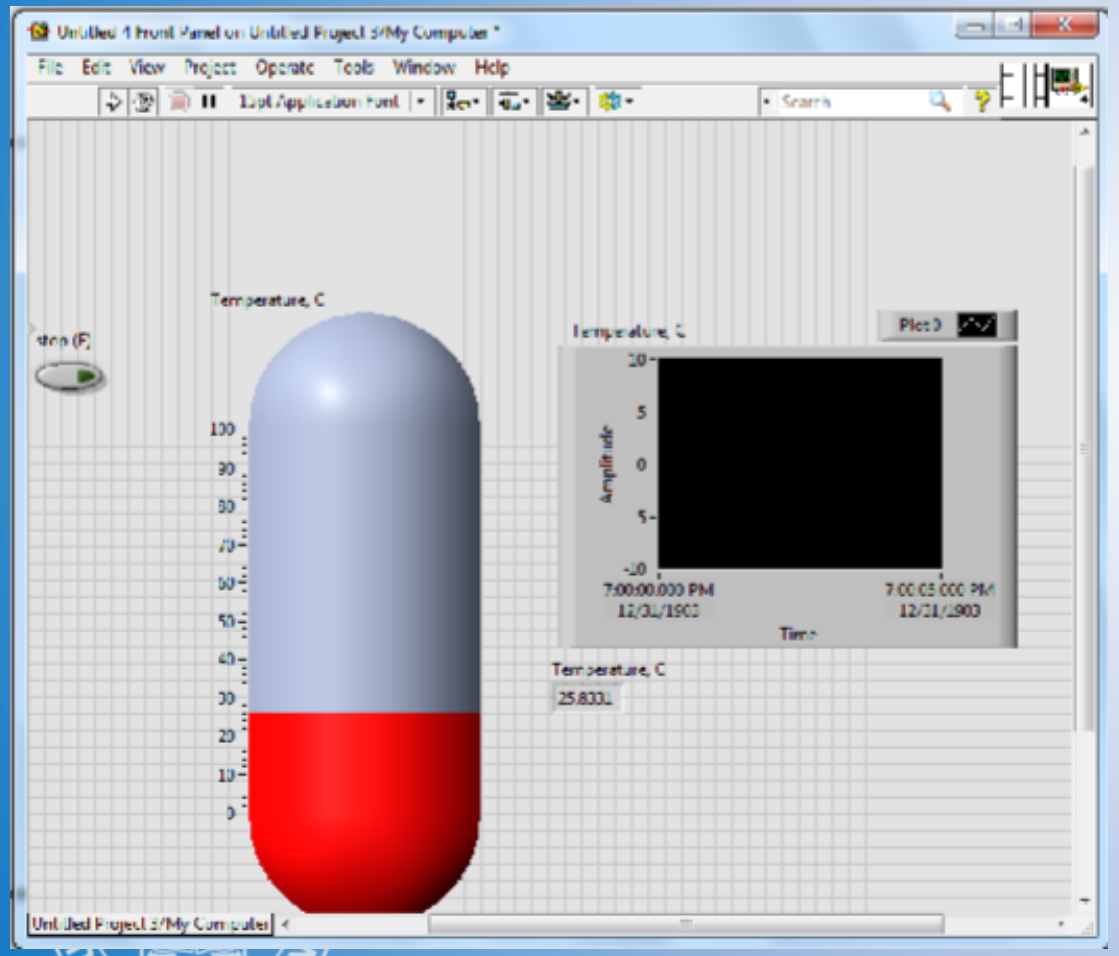
- Students have:
  - A MyRIO LabVIEW setup
  - A pump capable of external control
  - A larger beaker of 0.4 M salt solution
  - Various samples of 0-0.4 M salt solution
  - A plastic cylinder with a valve at the bottom
  - Tubing connected to a sink to add pure water
  - A salinity or conductivity probe



Deliverables

- System demonstration
- ~ 5 pg individual technical report
  - Includes abstract, introduction, results & discussion, and conclusions
    - Must explain their circuit and coding

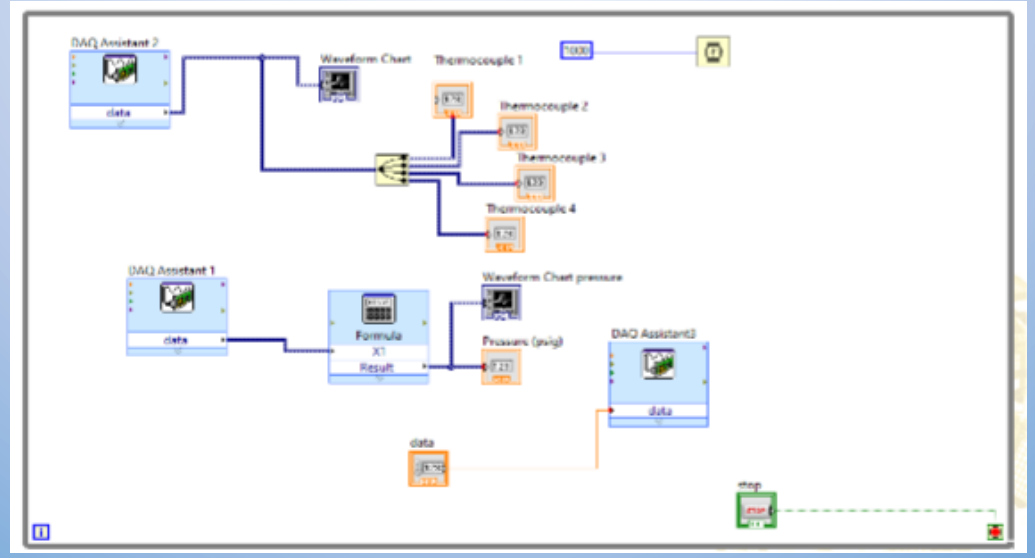
Chemical Engineering Lab I (Spring Third Year)



- LabVIEW is reviewed
- Students work with LV on teams
- First Lab: Studying the response time of different temperature sensors
  - Students utilize:
    - Analog thermometer (manual data collection)
    - Thermistor (Vernier software)
    - Thermocouples (LabVIEW software)
- Students need to do all physical wiring
- Detailed LabVIEW guide provided, but students need to plan how to collect useful data
- Deliverables: Individual lab report that includes an explanation of their data acquisition programs

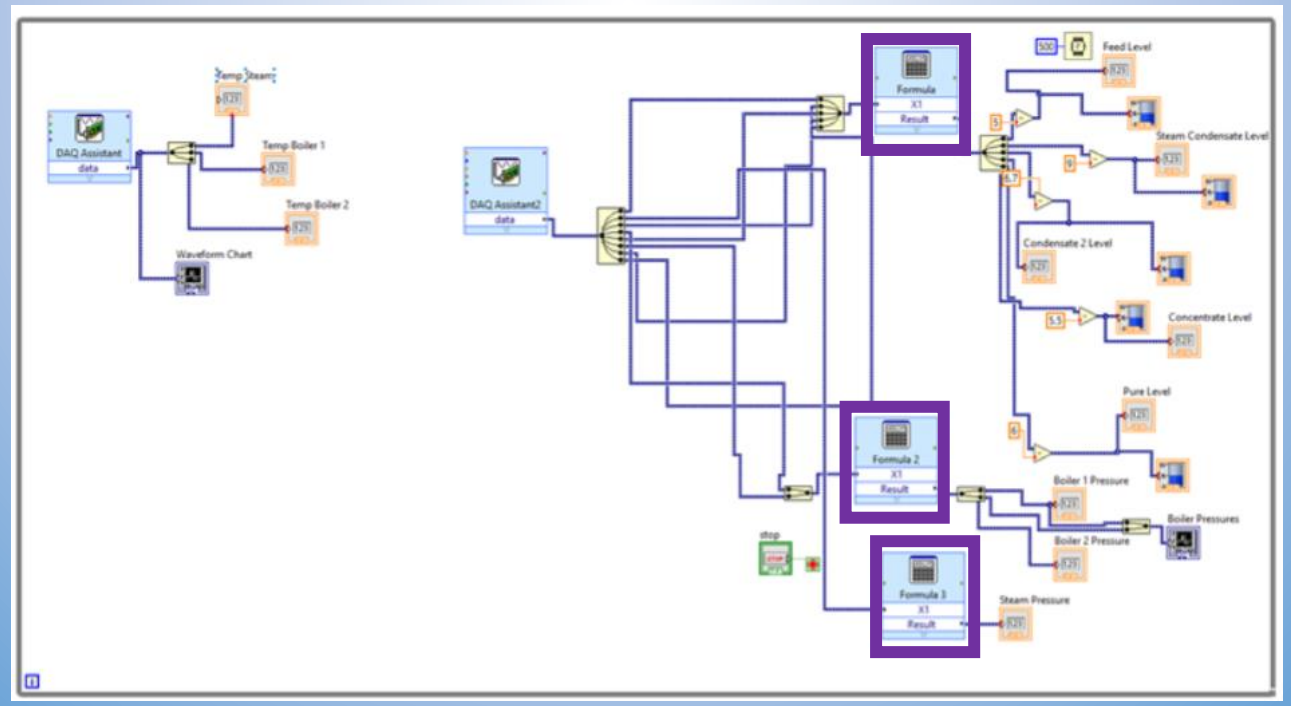
Chemical Engineering Lab I (Spring Third Year)

- Double Pipe Heat Exchanger Lab:
  - Basic instructions provided for building a LV program with 8 thermocouples
    - Ex: Use a loop, add a DAQ Assistant, provide temperature indicators and a chart
- Shell & Tube Heat Exchanger Lab:
  - Detailed instructions provided for how to build a control loop to adjust the opening of a control valve
  - Basic instructions provided for adding 4 thermocouples and adding a calibration curve for a pressure transducer



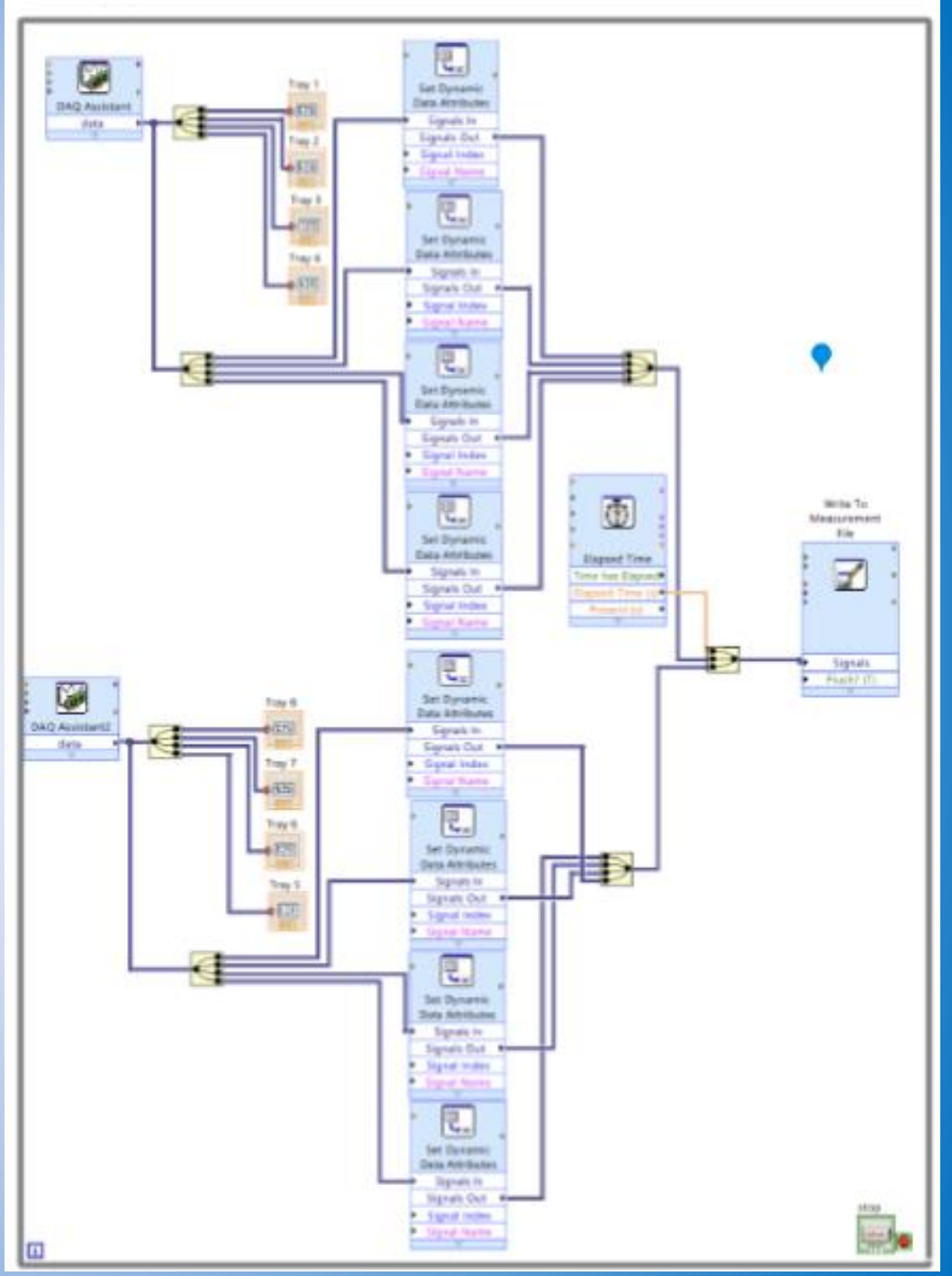
Chemical Engineering Lab II (Fall Fourth Year)

- Students work with LV on teams
- Double Effect Evaporator Lab:
  - Students given a large, nearly completed LV program
    - Need to determine calibration equations for two pressure transducers and create equations to convert differential pressure from five differential pressure transducers into level



Chemical Engineering Lab II (Fall Fourth Year)

- Students work with LV on teams
- Distillation Lab:
  - Students must build a program to display and record temperature readings automatically to an Excel file without any instructions



Spreading LabVIEW Outcomes Across the Years

First Year

- Describe the uses for LV software & hardware
- Build simple LV programs
- Determine how to control a pump using LV

Third Year

- Build LV programs for data acquisition
- Build a program to control a valve

Fourth Year

- Formulate multi-step calibration equations
- Construct your own code

Instructor-Observed Results & Student Feedback

Students were:

- ‘scared’ of programming initially
- excited to work on real-life applications
- thought outside the box and did their own research
- very actively involved in class

Student Feedback

- “I enjoyed … the freedom given to make mistakes and figure out solutions.”

Student Outcomes

- Only 1 cohort has completed this sequence
- Data analysis is ongoing, but anecdotally:
  - Students are more confident with LabVIEW
  - Students are better with troubleshooting
  - Students still missing some basics (selecting the thermocouple type in the DAQ)
- More individual LabVIEW assessment needed

Questions?