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Report from Pilot Testing Course 10: Cyber-Physical Industrial Systems

Tom SAVU

Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Course Objective

Gaining knowledge about:

- the main characteristics of the Cyber-Physical Systems
- their application areas
- components selection rules
- programming methodology
- specific aspects related to different measured physical parameters
- data storage
- reporting and communications.

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Course Learning Outcomes (CLOs)

The students, on the completion of this course, would be able to

- **CLO 1**: Identify links between industrial engineering knowledge and methods, on one side, and the design, modeling and management activities related to CPIS, on the other side (Analyze)
- **CLO 2**: Implement smart production and co-created product design & development concepts in CPIS related activities (Create)
- **CLO 3**: Identify use cases of big data and real time data analytics applied for CPIS, for supporting smart production, product design & development and advanced manufacturing process (Evaluate)
- **CLO 4**: Exploit the CPIS online connectivity for strengthening business capability (Apply)
- **CLO 5**: Applying CPIS related knowledge and competences for improving sustainability (Apply)

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Course content

Introduction - concept of CPS, basics, model	Lecture
Establishing the projects' subjects and forming the teams	Discussion
Identify the physical quantities to be measured or the datasets to be acquired and computed	Teamwork
Types of transducers, characteristics, application fields, selection criteria	Lecture
Choose or design the sensors and/or the transducers for measuring or for data collection	Teamwork
Signal conditioning basics	Lecture
Data acquisition basics	Lecture

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Course content

Choose or design the needed electronics (power supplies, signal conditioning, analog to digital converters, multiplexers, communication subsystems)	Teamwork
Connect the CPS components	Teamwork
Test the CPS assembly	Teamwork
Data acquisition programming basics	Lecture
Develop the CPS data acquisition software components	Teamwork
Data processing basics	Lecture

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Course content

Develop the CPS data processing software components	Teamwork
Data communication basics	Lecture
IoT communication protocols basics	Lecture
Develop the CPS data communication software components	Teamwork
Cloud computing and artificial intelligence basics	Lecture
Feed artificial intelligence component with experimental data	Teamwork
Final project presentation	Evaluation

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Introduction - concept of CPS, basics, model (lecture)

More general introduction, referring to Industry 4.0.

File

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Establishing the projects' subjects and forming the teams (discussion)

- Studying the variation of temperature, rotational speed and vibration frequency on several points of a lathe
- Measurement of the pressure generated at the compressor air outlet of a turbocharger
- Orthosis pressure measurement
- Bottle manipulator
- Analyzing the accuracy of distance ultrasonic transducers

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Identify the physical quantities to be measured (teamwork)

Physical quantities were enumerated.

Discussion was necessary to be sure that the quantities are correctly chosen.

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General view of the lab

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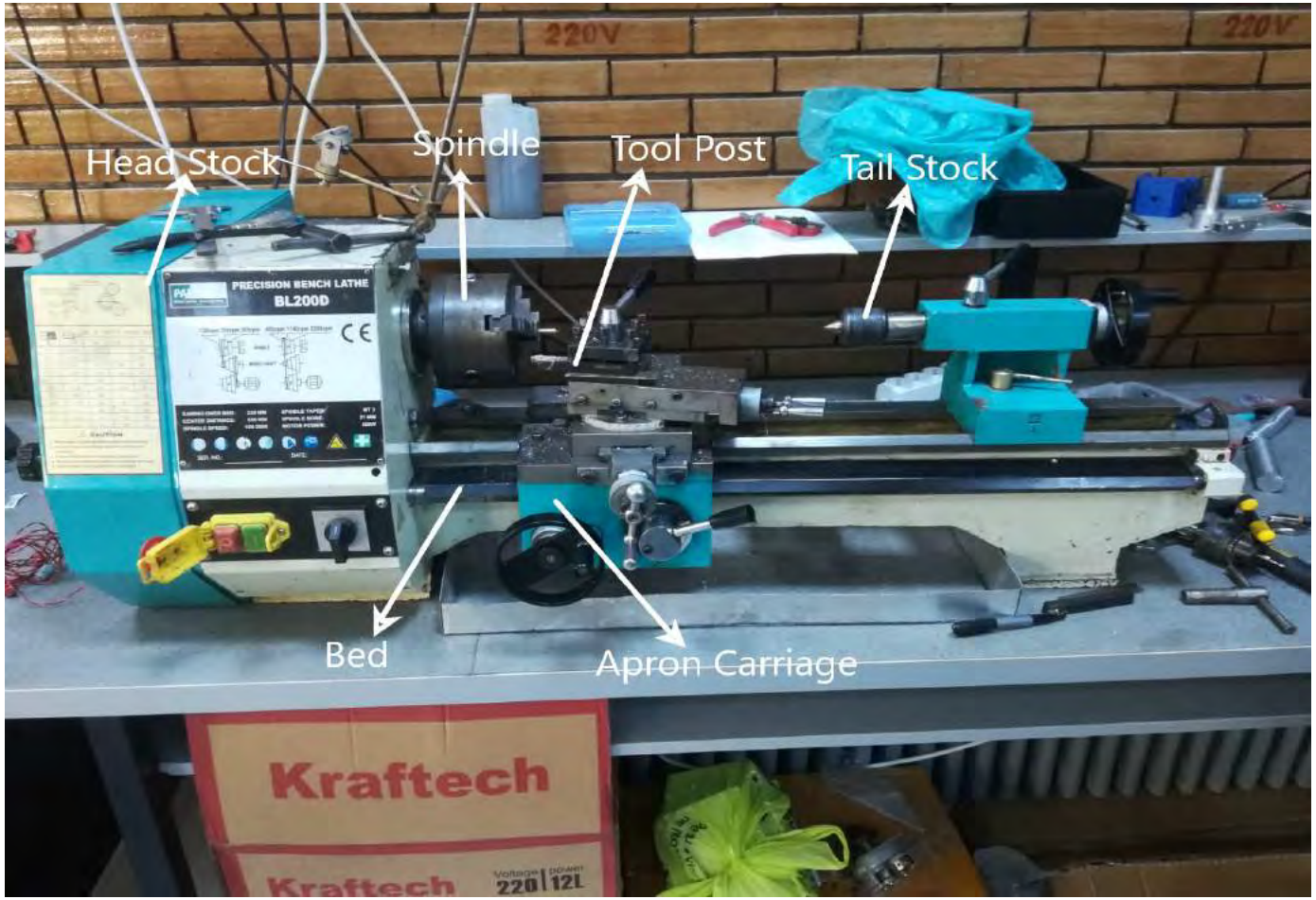
Identify the physical quantities to be measured (teamwork)



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Types of transducers (lecture)

More general introduction, including measurement systems topics.

File

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Choose or design the sensors and/or the transducers (teamwork)

Sensors and transducers were chosen also following a discussion, to try to use those already available in the lab.

This was not always possible, so new components have to be acquired to comply with the subjects.

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Supplementary lab 1

Introduced because students came from different study programmes.

Lab 1: Measuring with a multimeter

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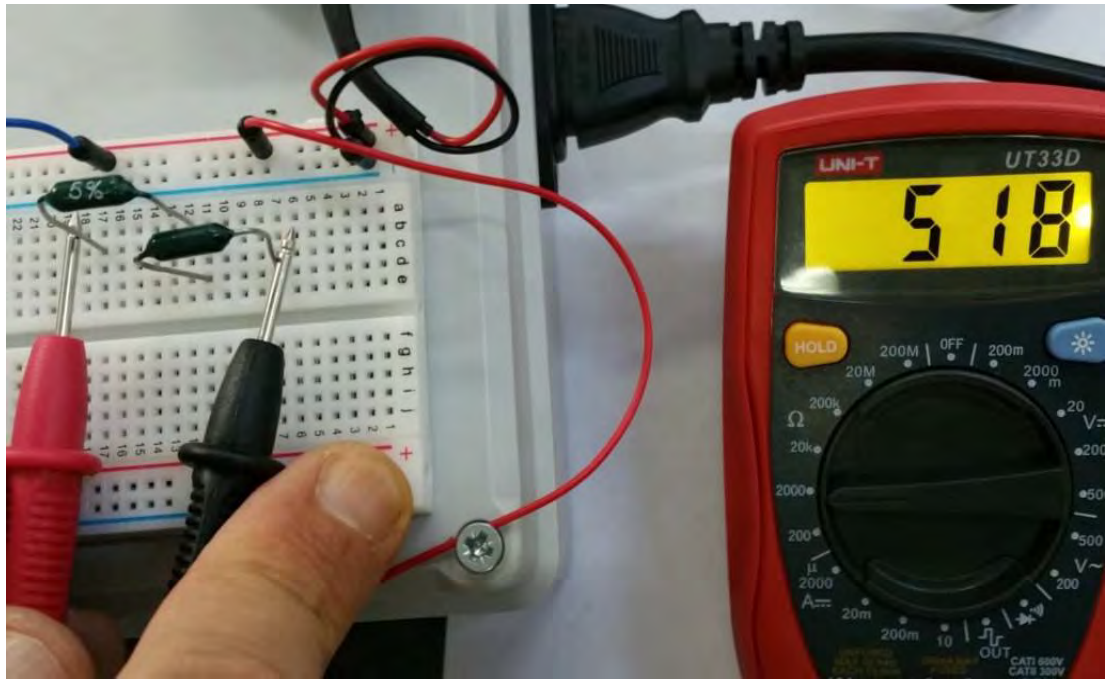
Supplementary lab 1



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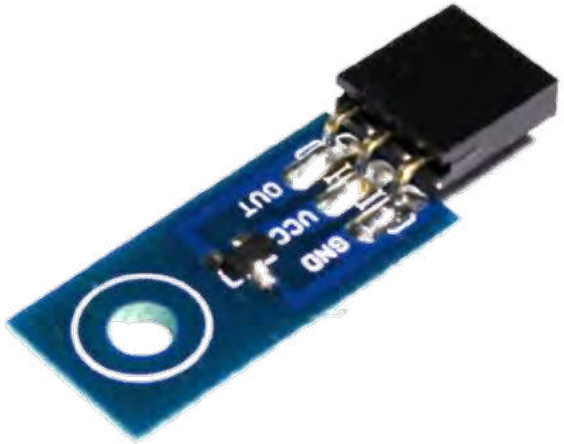
Choose or design the sensors and/or the transducers (teamwork)



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Signal conditioning basics (lecture)

File

There were no need for separate signal conditioning in the projects.

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Data acquisition basics (lecture)

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Supplementary lab 2

Lab 2: Basic functions of a data acquisition board

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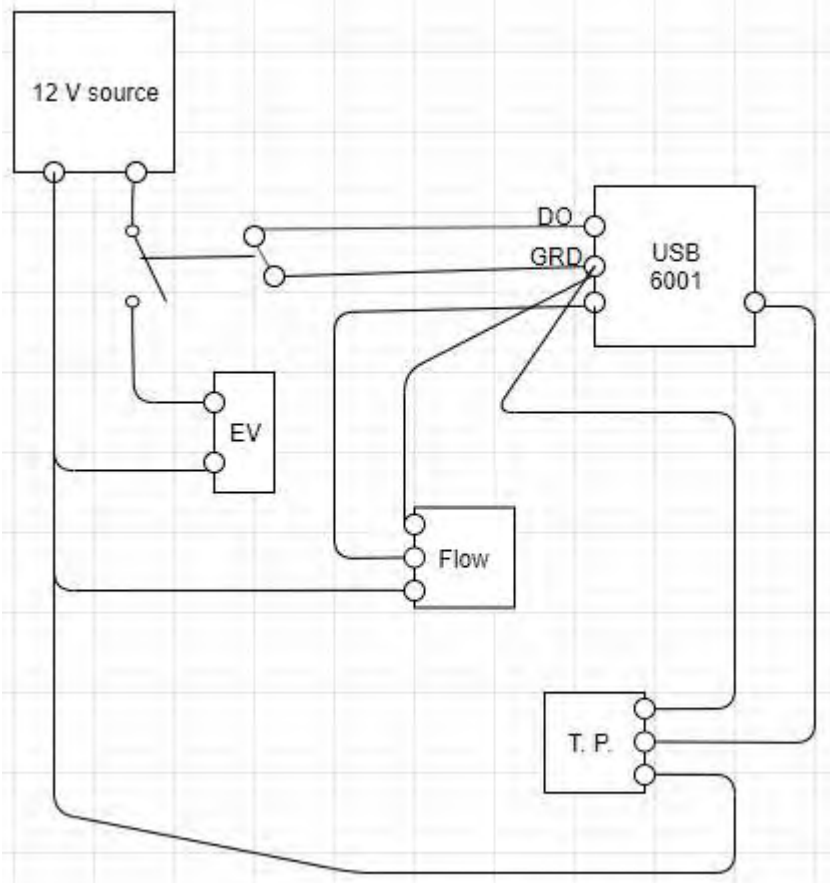
Choose or design the needed electronics (teamwork)

Discussion to comply with the electronics already existing in the lab.

Some components had to be acquired separately.



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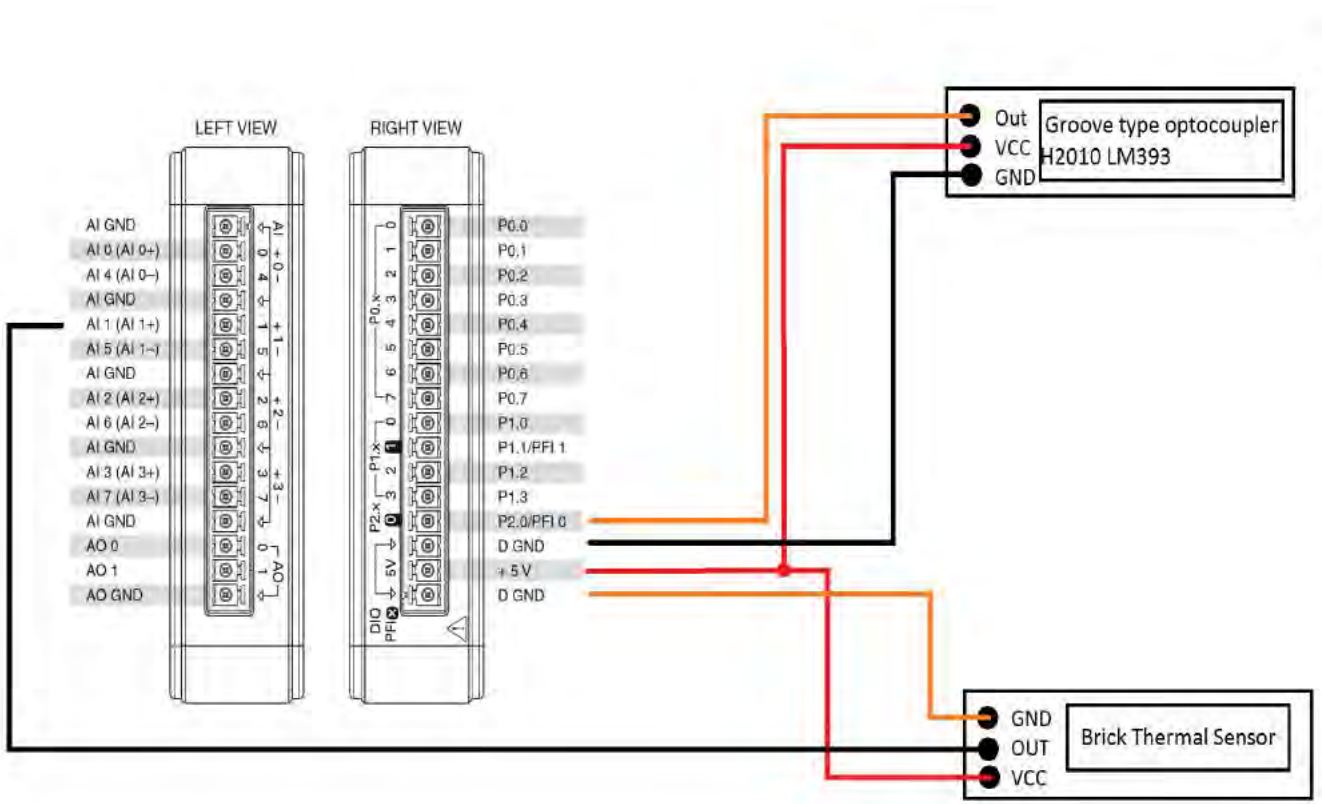
Connect the CPS components (teamwork)



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Students were assisted in acquiring basic electronics skills

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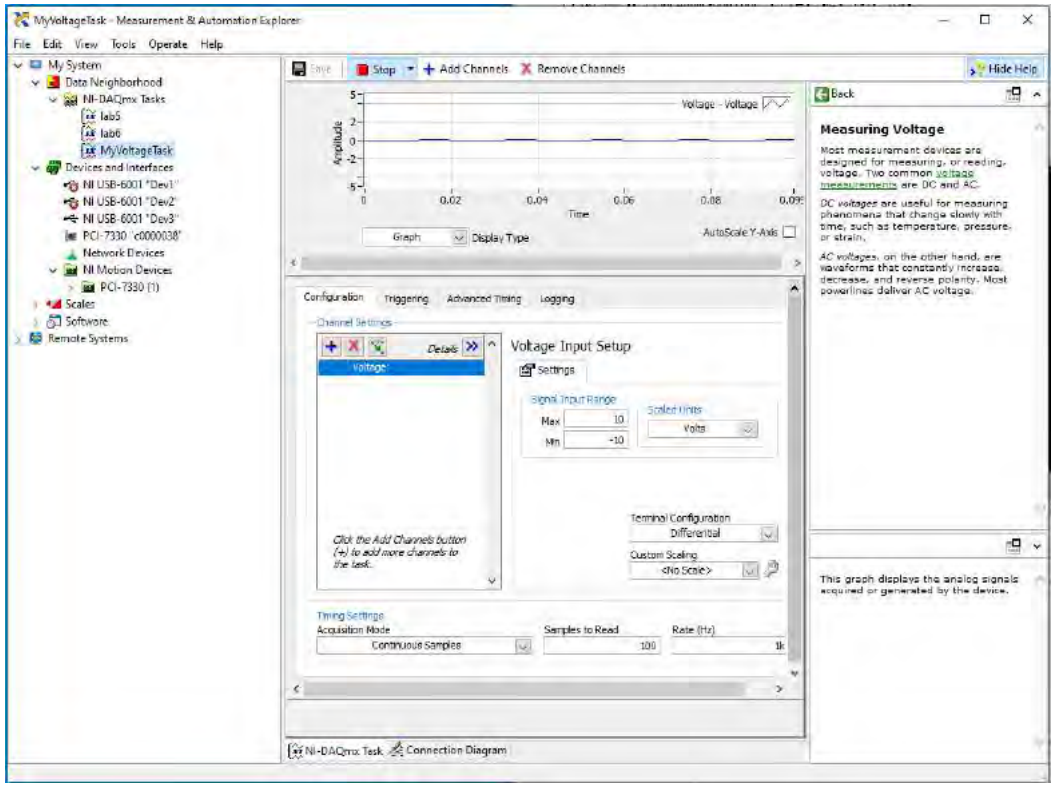
Test the CPS assembly (teamwork)



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Students were assisted in acquiring basic mechanics skills

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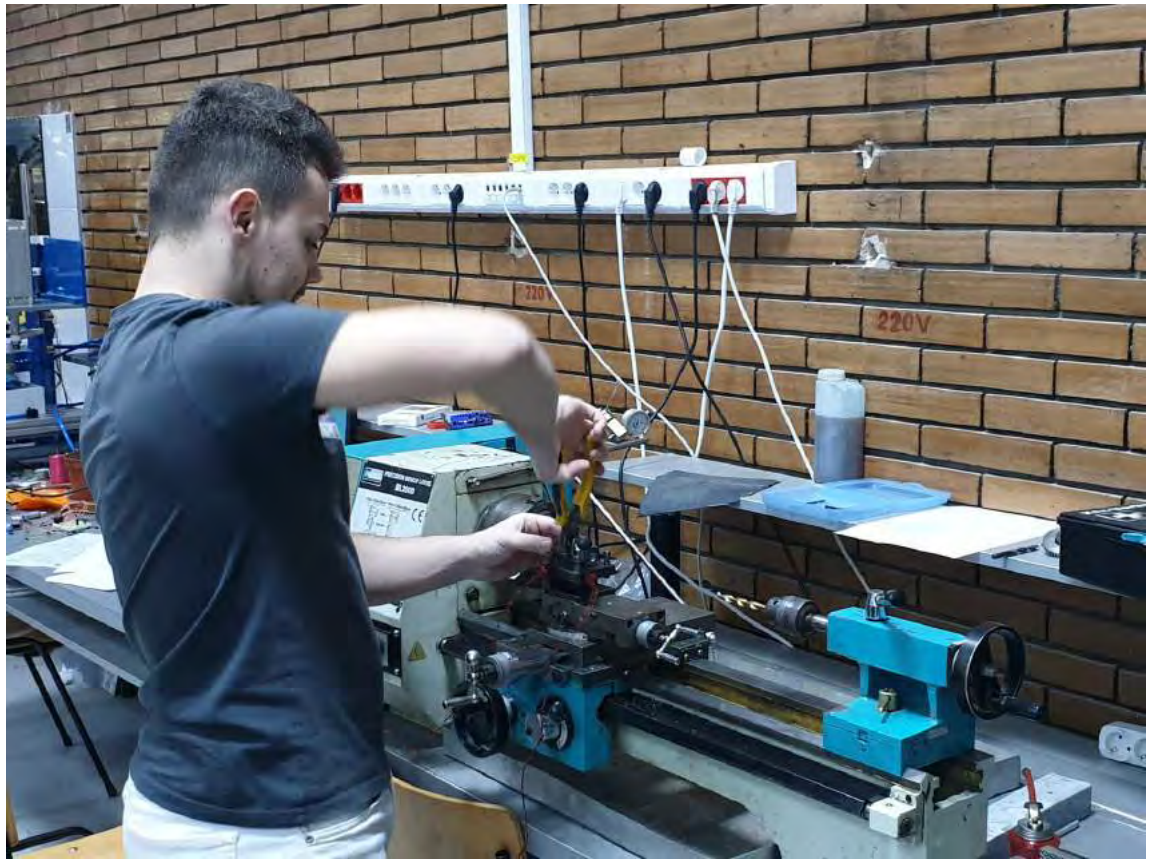
Students were assisted in basics of using tools and machines



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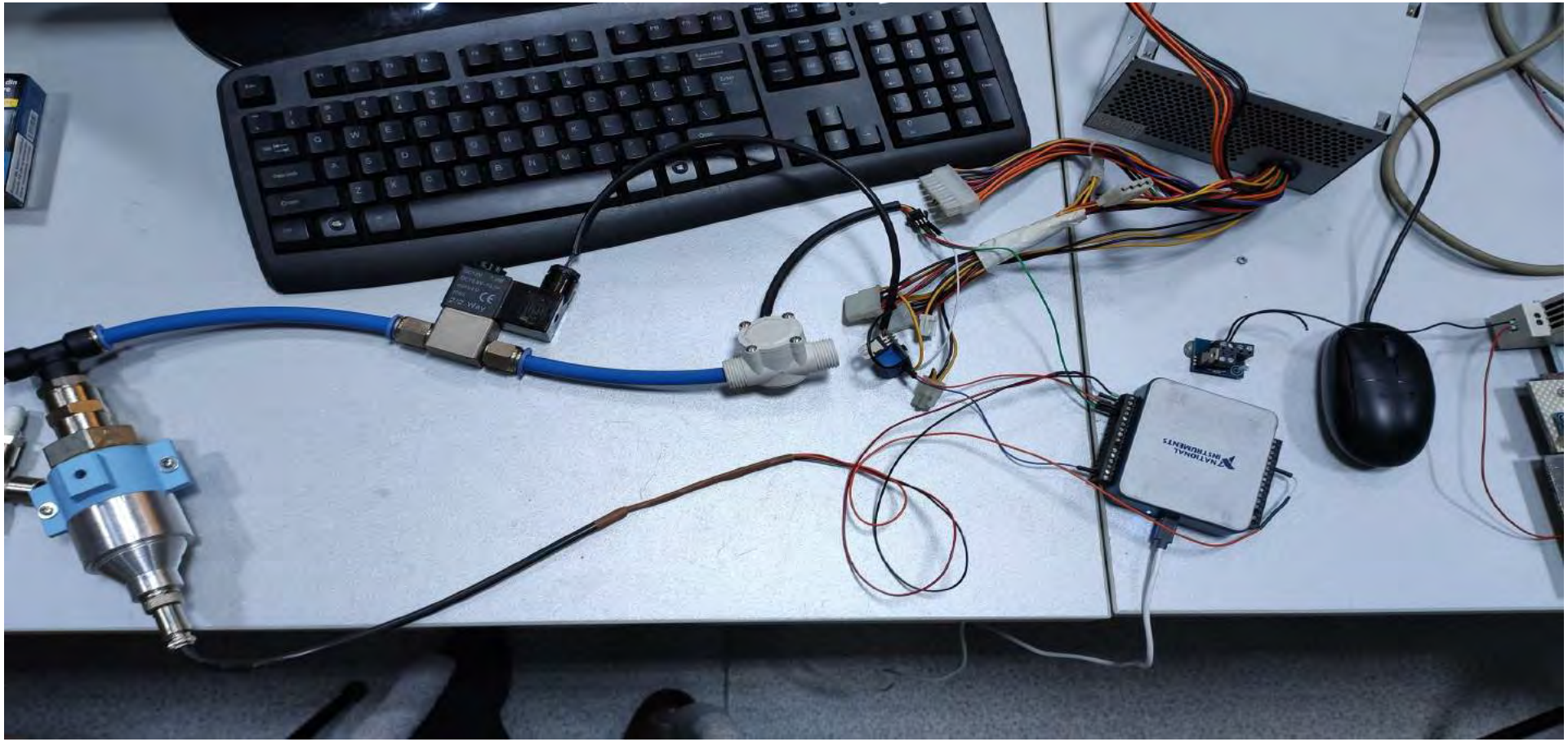
Test the CPS assembly (teamwork)



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Data acquisition programming basics (lecture)

Live programming in LabVIEW

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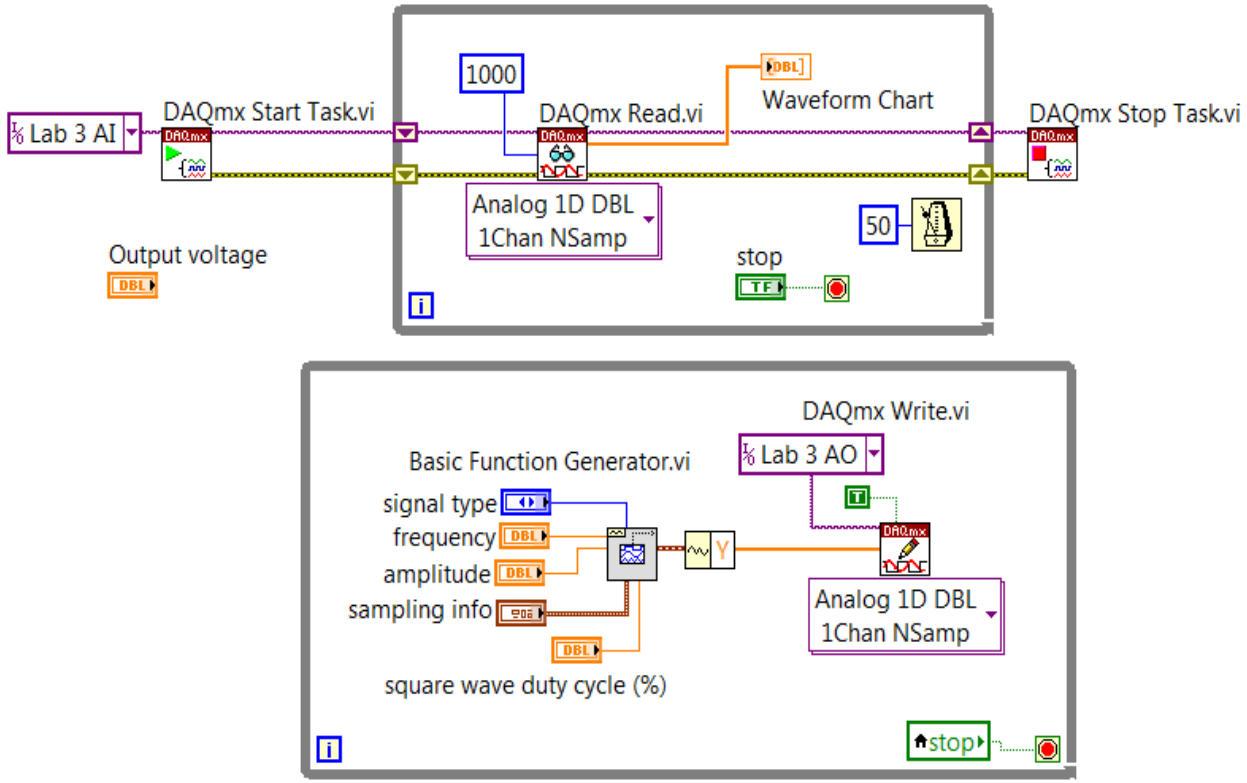
Supplementary lab 3

Lab3: Data acquisition in LabVIEW



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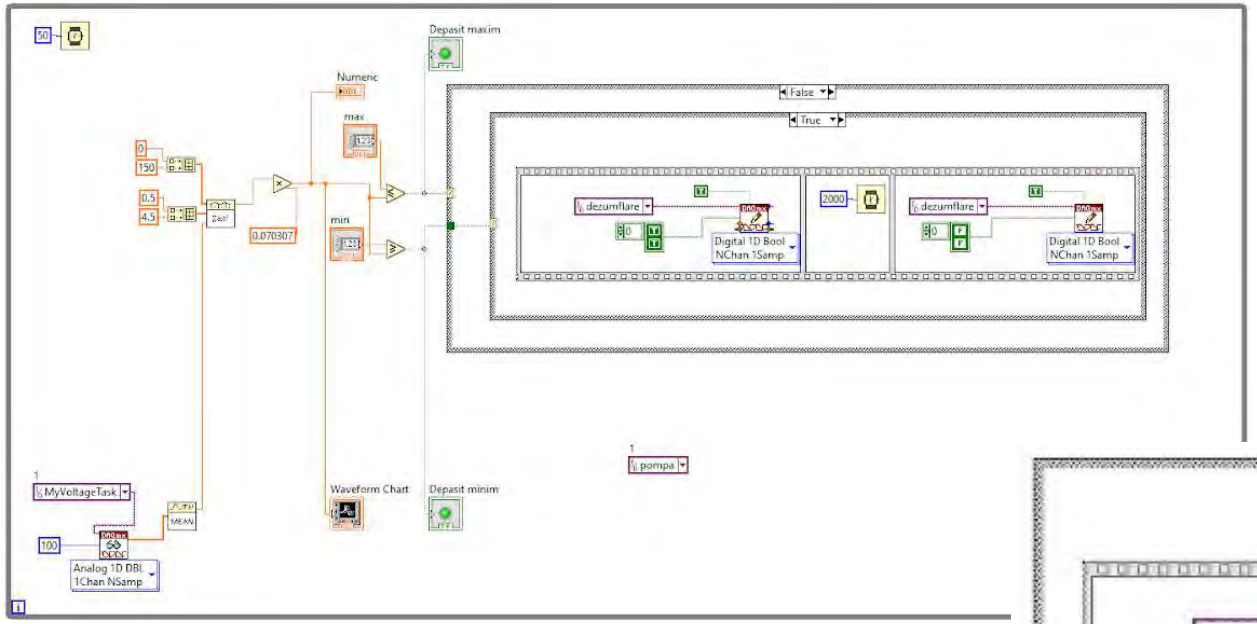
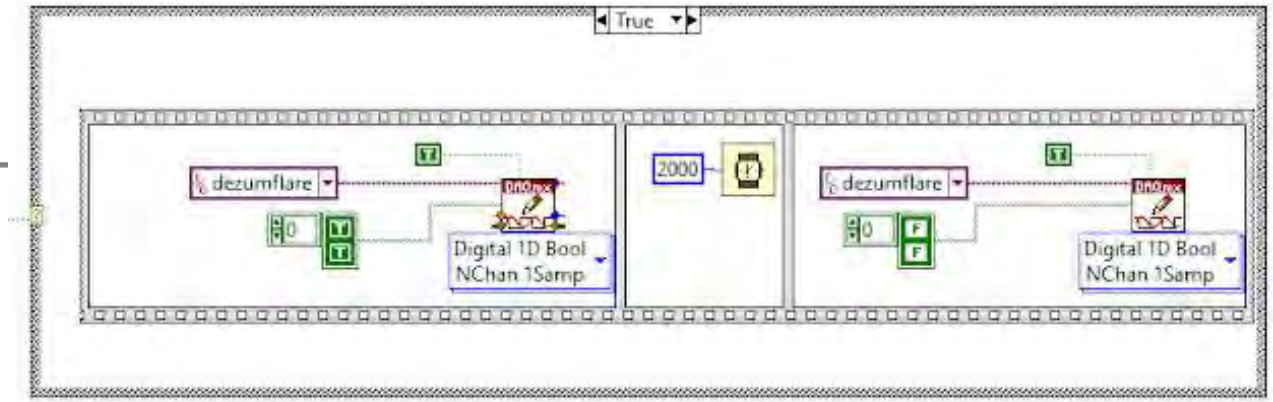
Develop the CPS data acquisition software components (teamwork)





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Data processing basics (lecture)

On the topics needed in the projects:

- statistics
- frequency analysis
- regression

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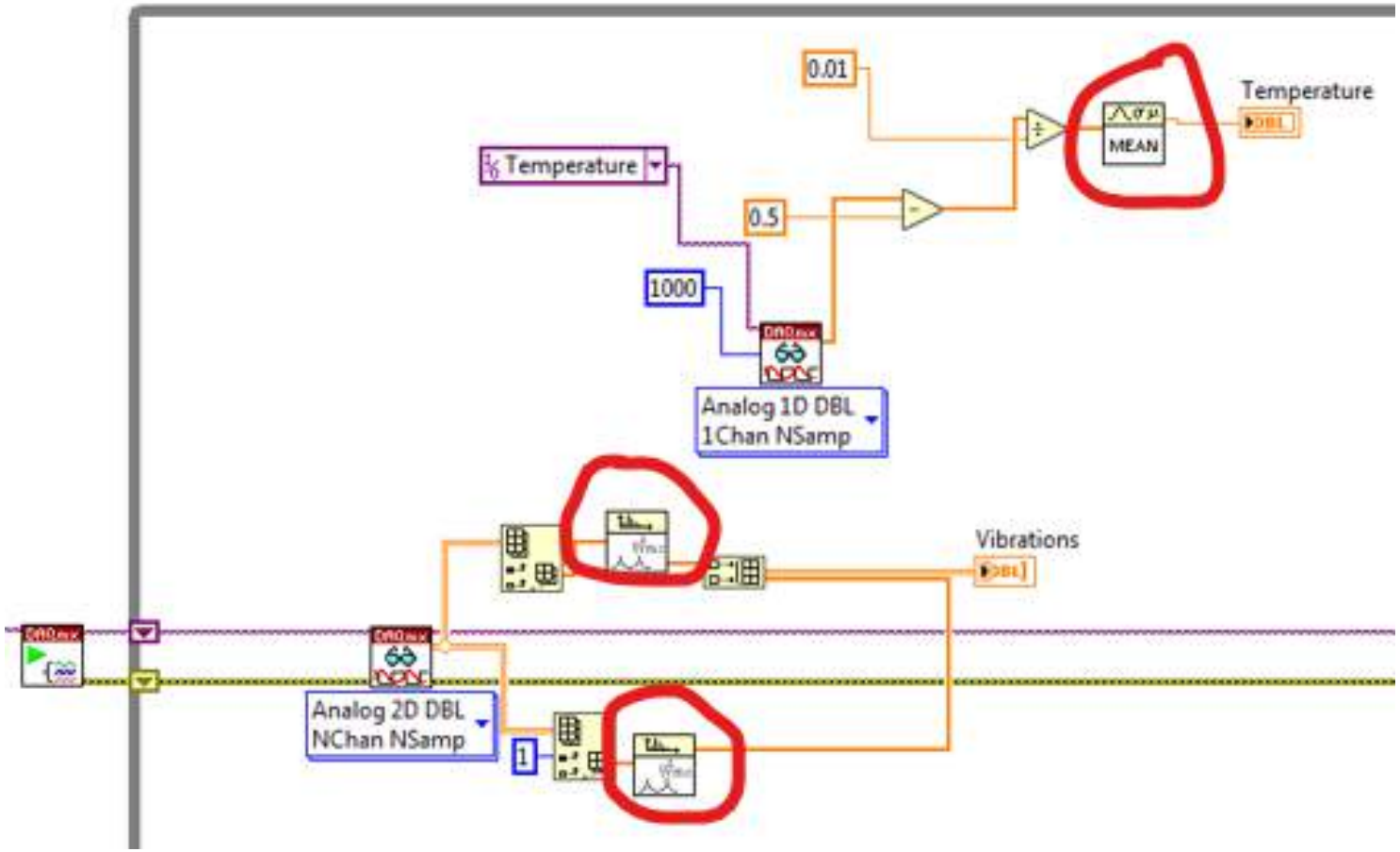
Develop the CPS data processing software components (teamwork)



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Here stopped the designed structure

Remaining chapters to be tested:

- Data communication basics (2nd semester)
- IoT communication protocols basics (2nd semester)
- Develop the CPS data communication software components (2nd semester)
- Cloud computing and artificial intelligence basics (TBD)
- Feed artificial intelligence component with experimental data (TBD)

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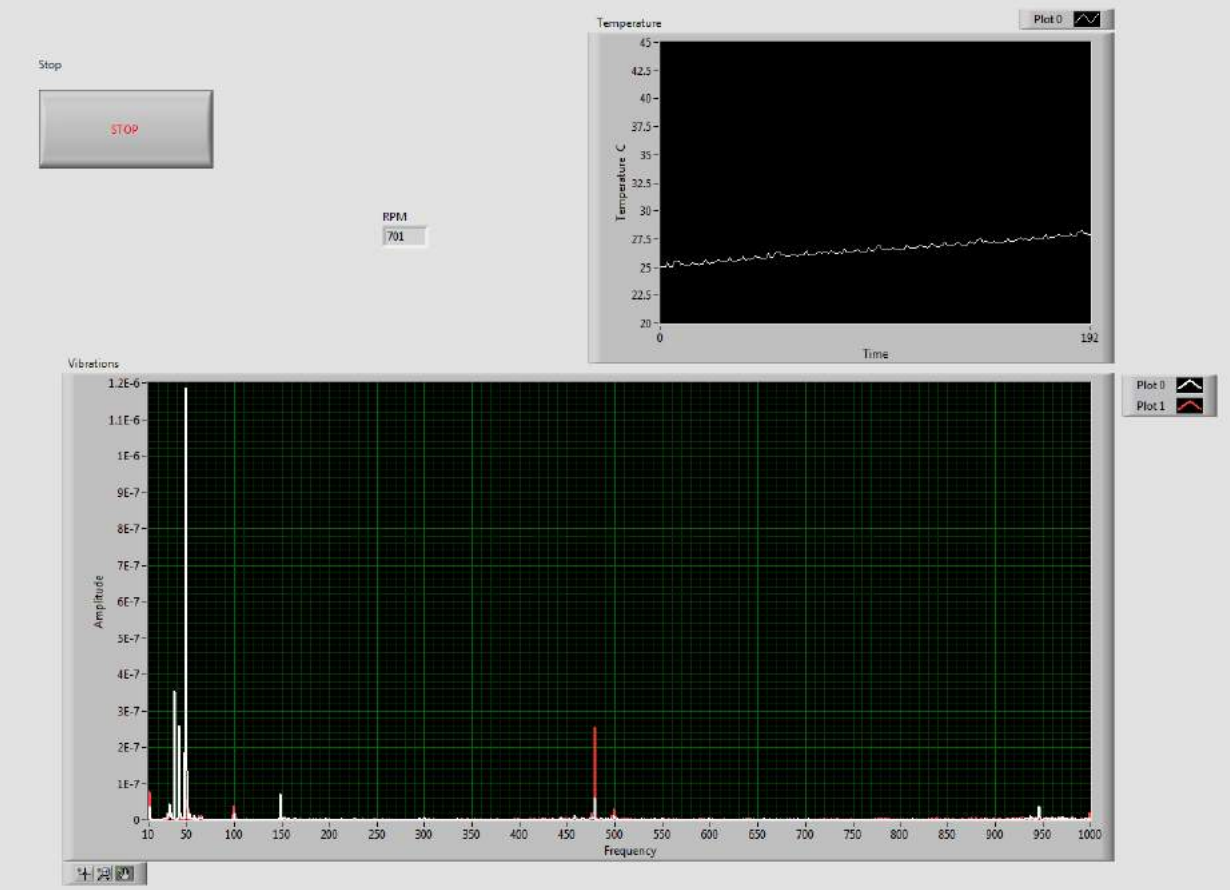
Test H & S setup



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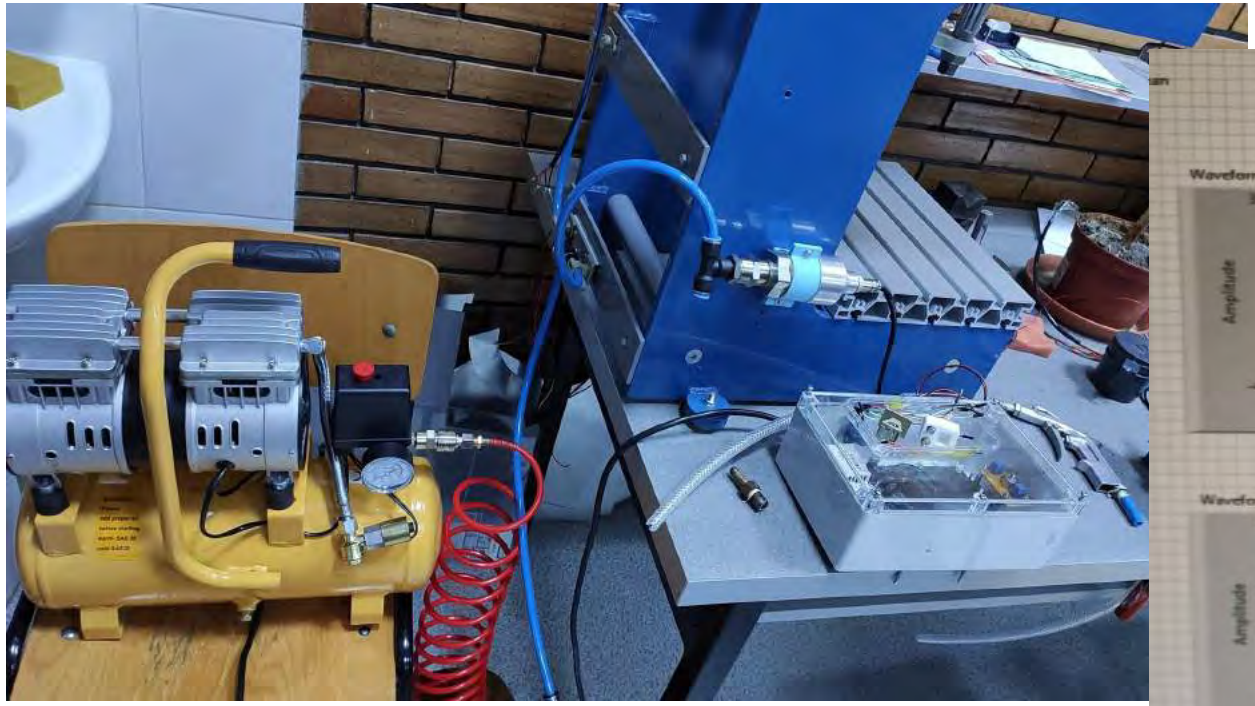
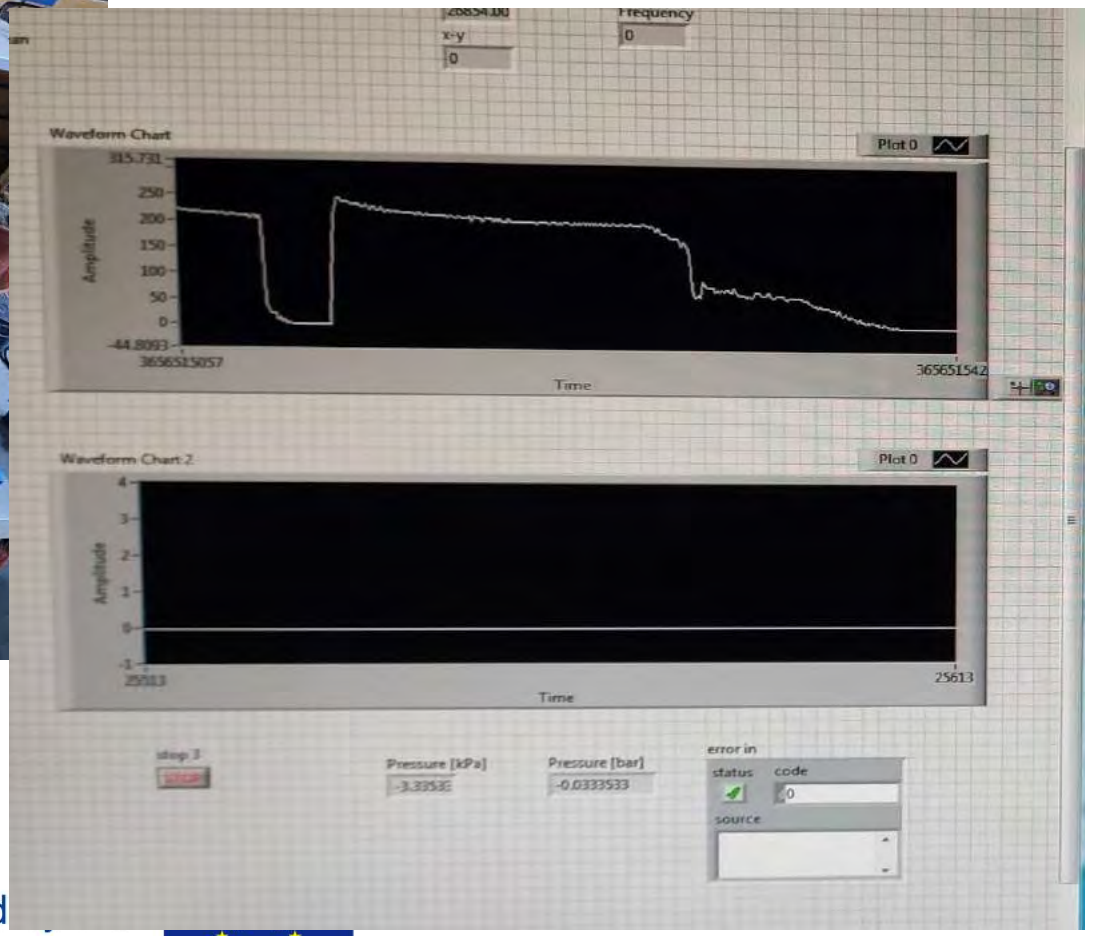
Test H & S setup





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Actual state

- Students finalizing written reports and presentations
  movie
- Final exam scheduled on January 29th

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