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CARINTHIA UNIVERSITY OF APPLIED SCIENCES

Using Pocket Labs in Engineering Education Programs

12 April 2017

Rio de Janeiro - Brazil

Co-funded by the Erasmus+ Programme of the European Union

AGENDA OF THE MEETING

12. April. 2017

9:00 – 10:30 Introduction

- Platforms to use
- Case Study

10:30 – 11:00 Wrap up/ Discussions

ABOUT US

Carinthia University of Applied Sciences

- Founded in 1995
- School of Engineering & IT with 7 Bachelor degree programs, 8 Master degree programs

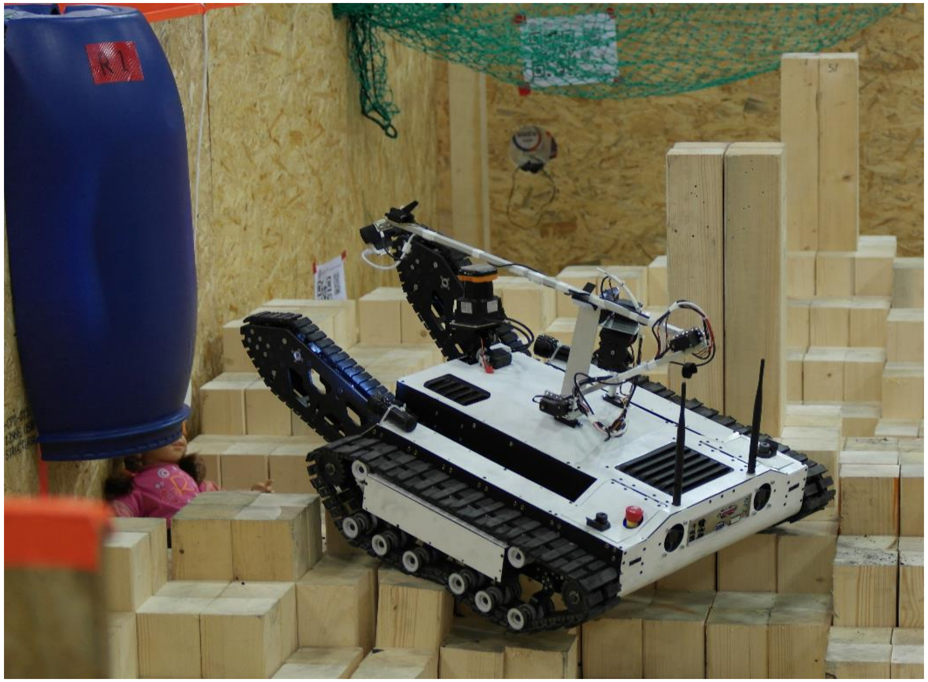
Andreas Pester

- Professor of Mathematics and Mathematical Modeling
- Teaching Experience: different math courses, mathematical modeling (Matlab, Maple and OpenModelica), Machine Learning (R, Python)
- Research Experience:
  - OLA, MARE, PiUELS, ECEL, OLAREX, ePragmatic, iCo-oP, eScence, MIMI, VISIR+, PILAR

MOTIVATION

Trend in Higher Education towards Maker Universities*:

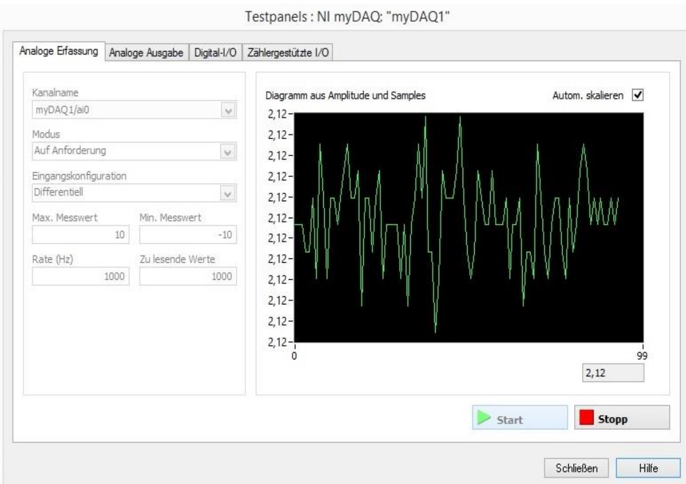
- Challenge: Close connection of the experimental and theoretical part of teaching & increase interactive part in (engineering) education
- Pocket labs are one of the technological answers to that challenge.

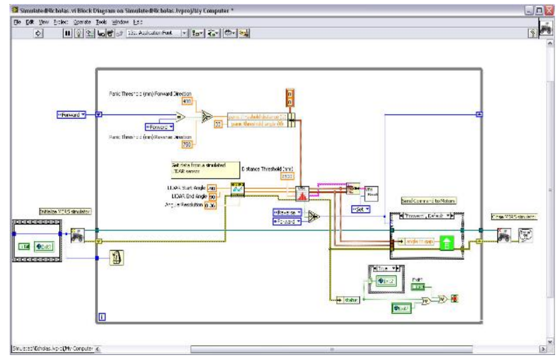


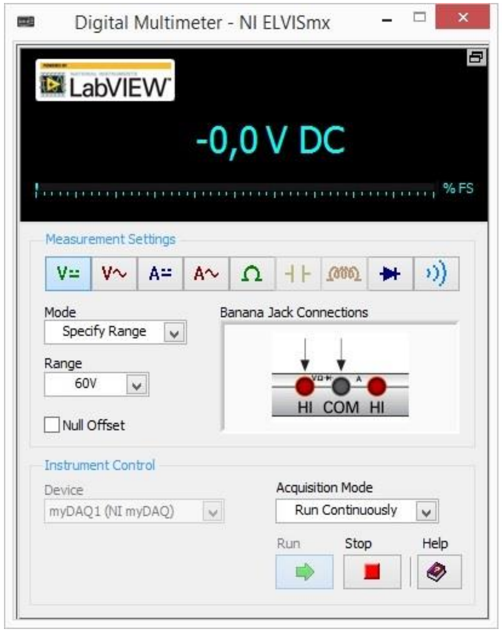
*New Media Consortium 2014

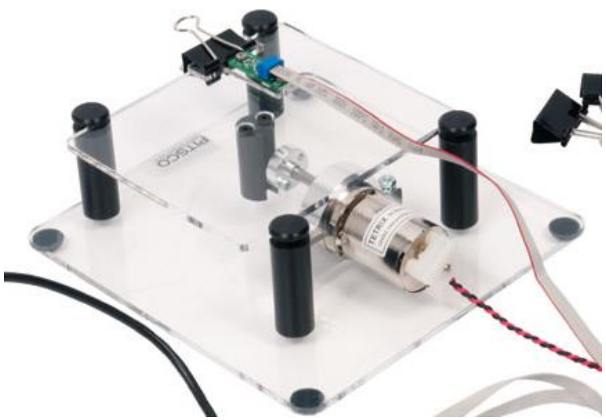
BACHELOR DEGREE PROGRAMS

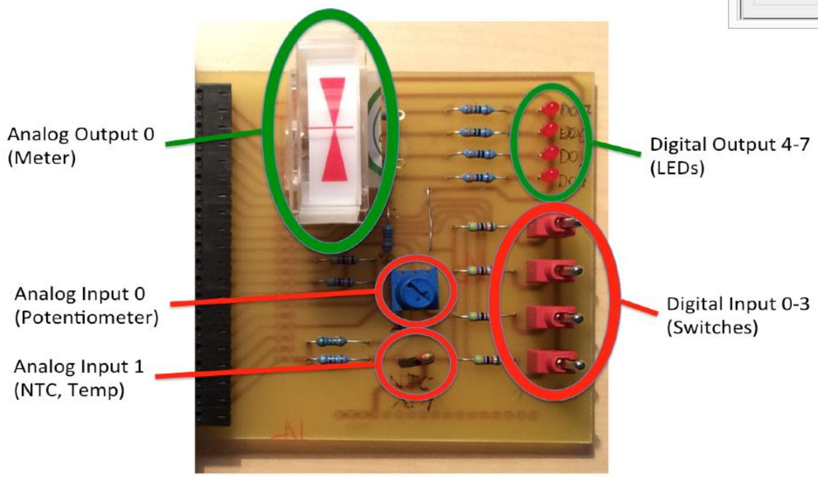
- Emphasis is on the application of theory in predefined circuits, programmes etc., hypothesis generation and practical training of technical skills.
  - “Students focus on basics and theoretical subjects: Pockets labs should support them at their learning process as smoothly as possible.“
  - Bring students together with state-of-the-art technologies
- Learning methods
  - Interactive learning, collaborative learning, inverted classroom
- NI myDAQ + miniSystems, FH miniSystem, breadboards
  - C/C++, LabVIEW
  - Computer Science, Electrical Engineering, Physics

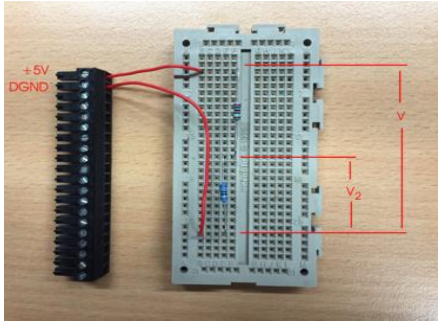

Testpanels : NI myDAQ: "myDAQ1"
Analoge Erfassung
Analoge Ausgabe
Digital-I/O
Zählergestützte I/O
Kanalname
myDAQ1/ai0
Modus
Auf Anforderung
Eingangskonfiguration
Differentiell
Max. Messwert
10
Min. Messwert
-10
Rate (Hz)
1000
Zu lesende Werte
1000
Diagramm aus Amplitude und Samples
Autom. skalieren
2,12
0
99
Start
Stopp
Schließen
Hilfe




Digital Multimeter - NI ELVISmx
LabVIEW
-0,0 V DC
% FS
Measurement Settings
Mode
Specify Range
Range
60V
Null Offset
Banana Jack Connections
HI
COM
HI
Instrument Control
Device
myDAQ1 (NI myDAQ)
Acquisition Mode
Run Continuously
Run
Stop
Help




Analog Output 0
(Meter)
Analog Input 0
(Potentiometer)
Analog Input 1
(NTC, Temp)
Digital Output 4-7
(LEDs)
Digital Input 0-3
(Switches)

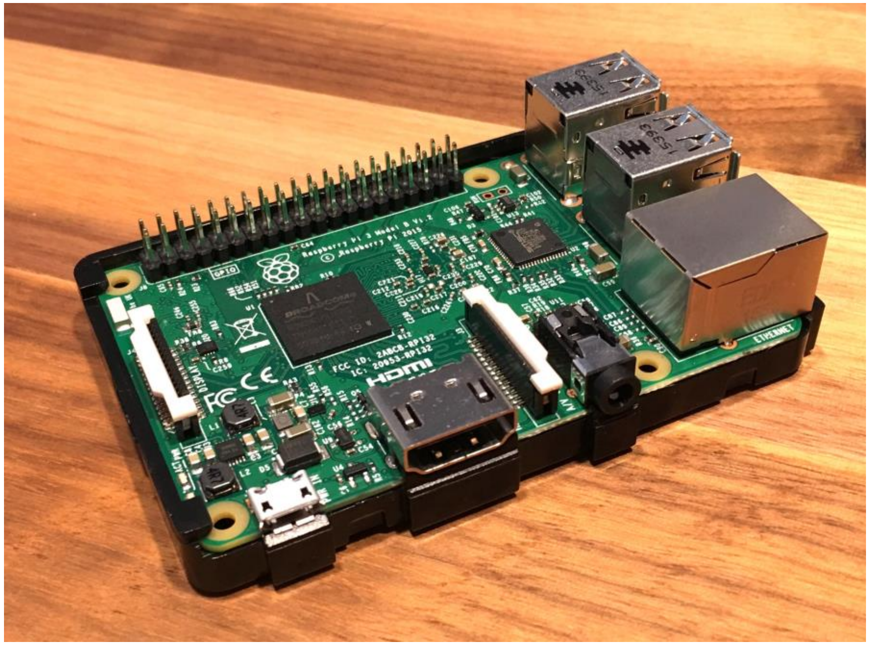

+5V
DGND

MASTER DEGREE PROGRAMS

- Focused on analysis, error- and performance evaluation and improvement of self-designed or given cyber-physical systems, software and/or hardware solutions.
  - complexity and abilities of the Pocket lab platform higher
  - students are focusing on systems and concepts
- Learning methods:
  - Inverted classroom
  - Blended learning
  - PBL

PLATFORMS TO USE

- Raspberry Pi, extension boards, breadboards, cameras, sensor/actor kits
  - C/C++, Python
  - Raspbian, Windows 10 IoT, …



PLATFORMS TO USE

- NI myRIO, stand-alone embedded real-time system, application processor + FPGA

- miniSystems, FH miniSystems, breadboards, …
- LabVIEW, C/C++ (Linux)

PLATFORMS TO USE

- AD ADALM 1000, low-cost analog input/output device connected to a PC, a Raspberry Pi, or Mac.

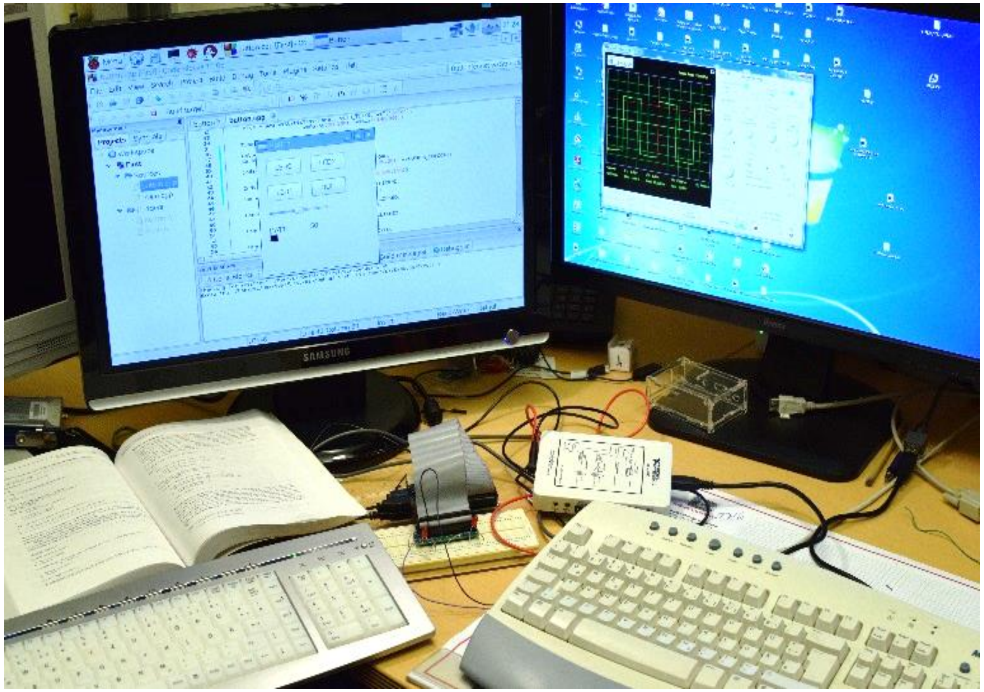
  - Connected to a PC, a Raspberry Pi, or Mac.
  - Capable of measuring and sourcing of currents and voltages.
  - C/C++, Python.

CASE STUDY 1

Microcontrollers Special Topics

- Components:
  - Raspberry Pi, breadboard,
  - power supply
  - Raspbian Linux, Code::Blocks
  - IDE, wxWidgets library

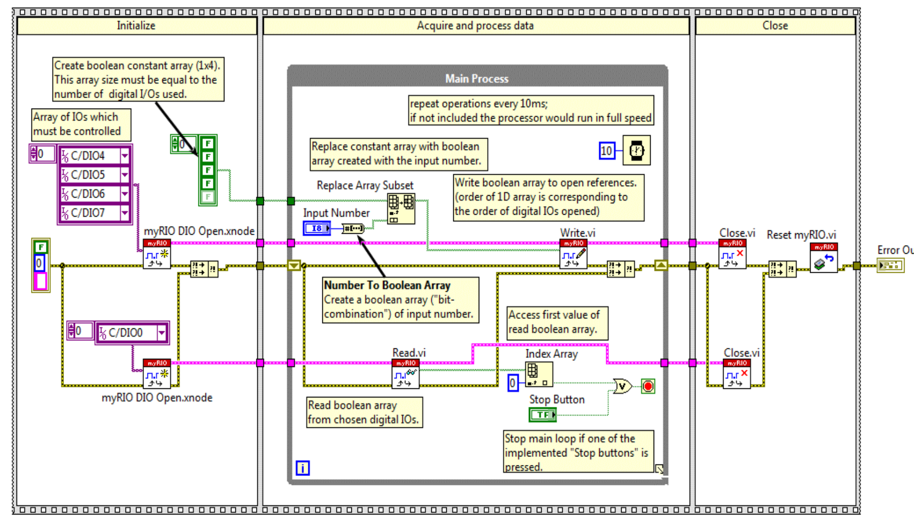
- Tasks:
  - Set-up the system
  - Create and measure PWM
  - signals
  - Use I2C communication
  - Use asynchronous and
  - synchronous serial ports
  - Use interrupt and DMA controller

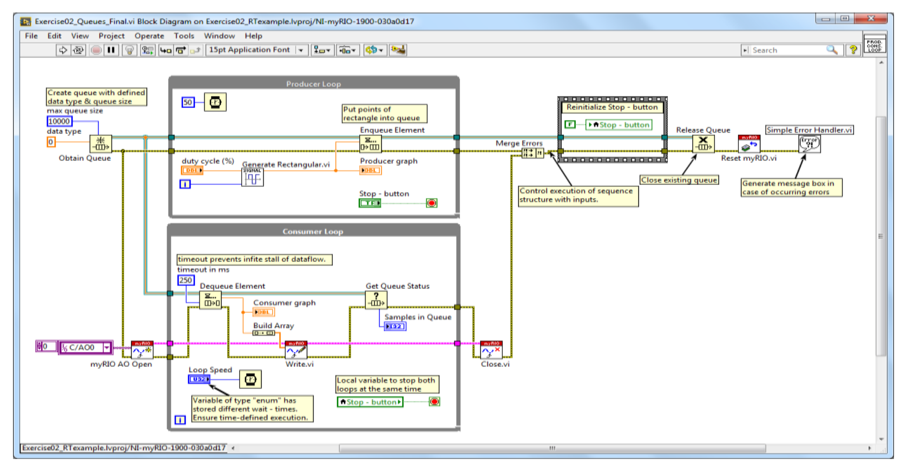


CASE STUDY 2

Real-Time System Special Topics

- Components:
  - NI myRIO, FH miniSystem
  - LabVIEW
- Tasks:
  - Set-up the system
  - Implement the Binary output of a number
  - Apply the Producer/Consumer design pattern to acquire live data and to process it in time.
  - Make use of the FPGA to run time-critical code.

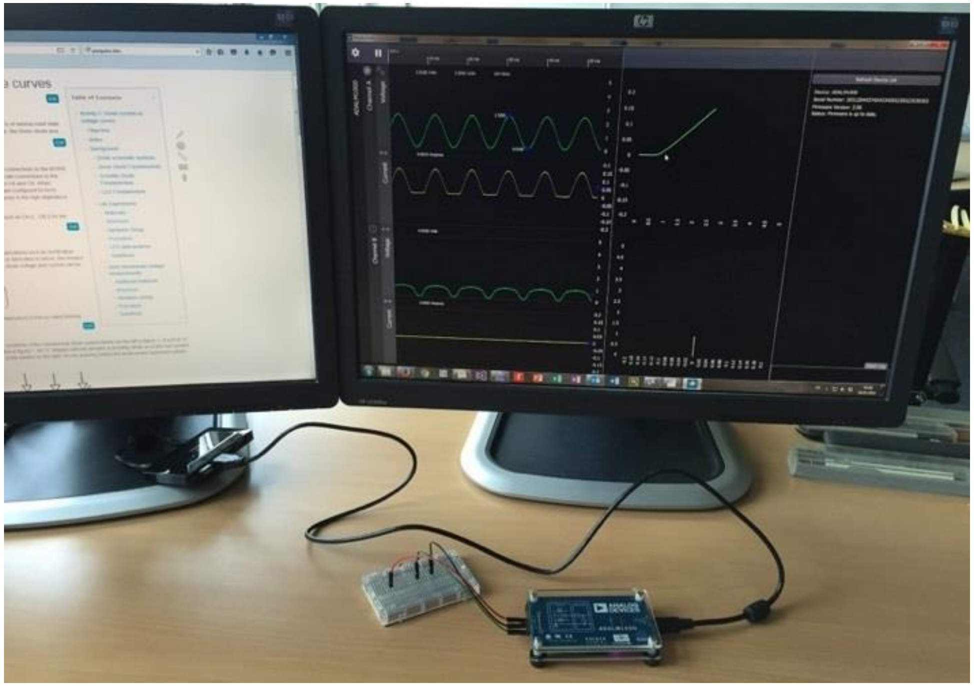




CASE STUDY 3

Electronic Engineering

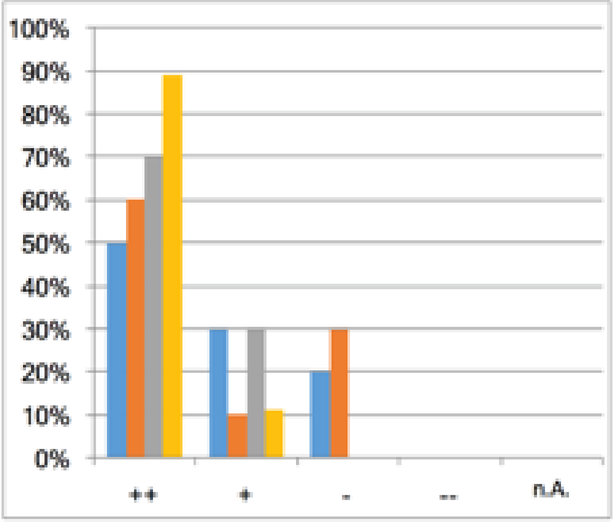
- Components:
  - ADALM 1000, breadboard, PC or mini Computer (Raspberry PI)
  - Waveform Generator and Oscilloscope Application, Python or C/C++



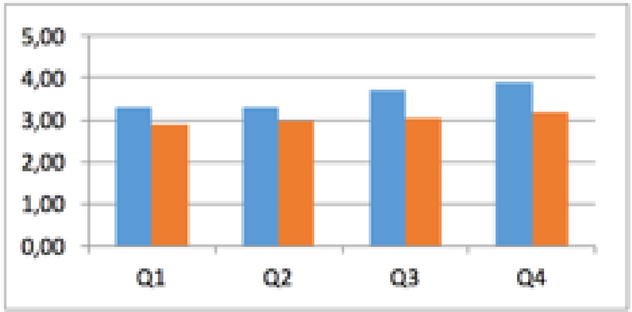
- Tasks:
  - Measurement of a diode characteristics (1N4148)
  - Apply a sine wave voltage on the series combination of resistor and diode
  - Measure the current, …

STUDENT PERCEPTION AND IMPACT 2015/2016

- Students were asked after each lecture about their opinion regarding organization and content; in lectures with pocket labs, the following additional questions were asked:
  - Q1: “Pocket Labs supported my understanding for the content of this lecture.”
  - Q2: “The flexible time management when using Pocket Labs was …”
  - Q3: “The use of Pocket Labs in this course makes the content more descriptive.”
  - Q4: “Overall, the use of Pocket Labs in this course I consider …”



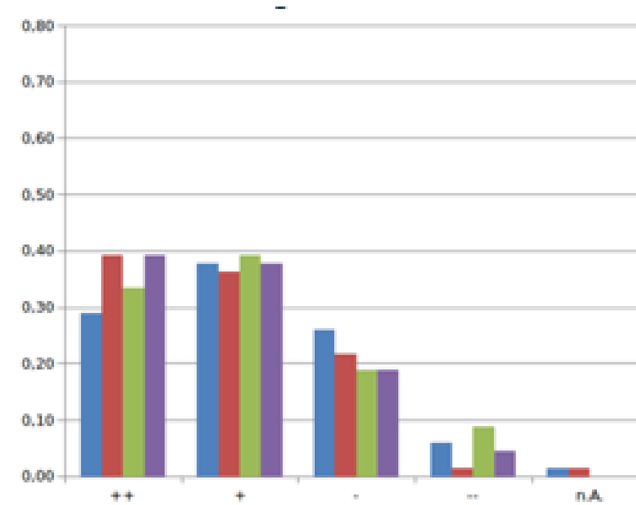
Rating distribution of master students regarding pocket labs



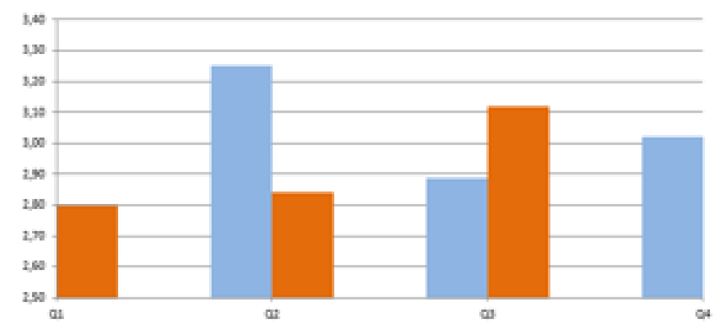
Weighted results. Left – master students, right – bachelor students.

STUDENT PERCEPTION AND IMPACT 2016/2017

- Students were asked the same questions as in the previous academic year
  - Q1: “The Pocket Labs supported my understanding for the contents.”
  - Q2: “The flexible time management when using Pocket Labs was …”
  - Q3: “The use of Pocket Labs in this course makes the content more descriptive.”
  - Q4: “Overall, the use of Pocket Labs in this course I consider …”



Rating distribution of master students regarding pocket labs



Weighted results. Left – evening students, right – full time students.

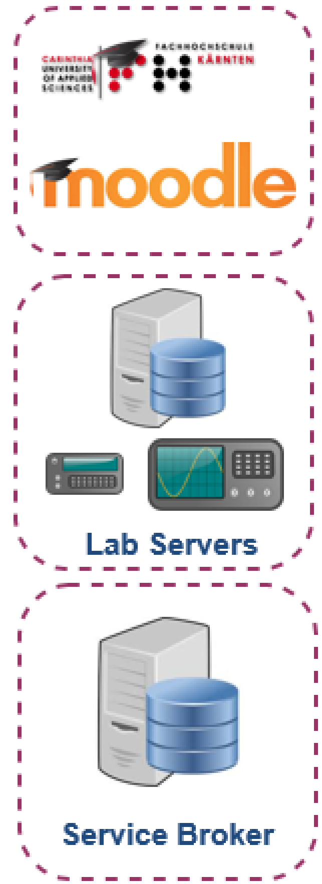
ONLINE LABS@CUAS

Client

- Course content
- Lab assignments
- Lab access

- Experiment delivery
- Lab hardware

- Single sign on
- Lab Management



LESSON LEARNT

Pros

- Pocket Labs are an excellent tool to bring students very **quickly** in a **learning situation**, where they should **apply their knowledge** in challenging **practical engineering** situations;
- Pocket Labs are a lab equipment, which fosters and requires **active students**, **social learning** and the **communication** student- student and student-teacher;
- Pocket Labs **motivate** much more students **to try, test and implement** their own **engineering ideas**.
- **Combination** of pocket and online labs **desirable**

Cons

- **Complexity**
- Only **virtual** instruments
- Dependency from **OS**
- Applicable for **simpler** experiments

NEXT STEPS

Combination of online and pocket labs

- 1. approach:
  - Measuring a black box, elements are analyzed with pocket labs, black box will be located online – planned for courses in electrical engineering basics and advanced courses
- 2. approach:
  - In courses of electrical engineering and mathematics students developed boards for analog computing of mathematical models in differential equations
  - Experimentation with the components on pocket labs, with the complex system on online lab platforms (e.g. VISIR), comparison of simulations based on numerics (e.g. MATLAB/Simulink) and of real component circuits (e.g. ModelSim)

EXAMPLE: PARALLEL USE OF POCKET LABS AND VISIR

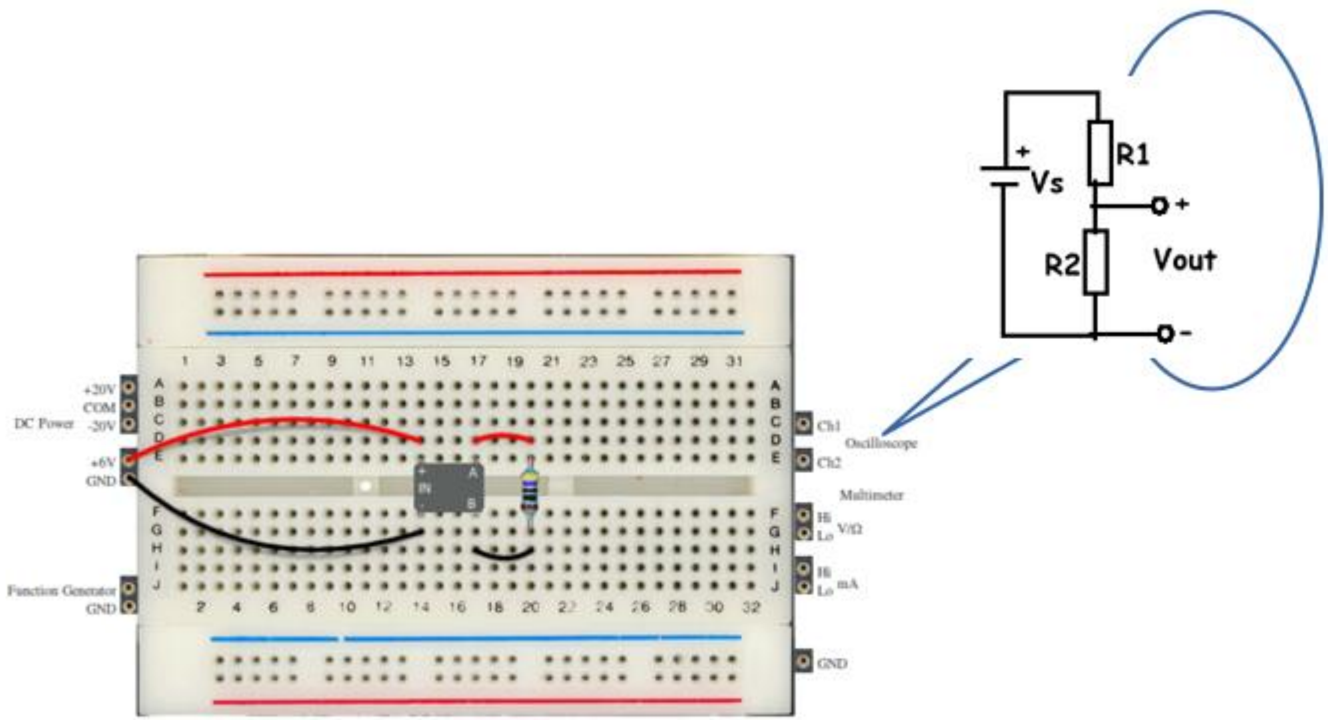
- Finding the Thevenin and Norton equivalents at terminals A and B of an unknown network represented by a black box which contains a voltage divider

- Students do not know the internals of the black box

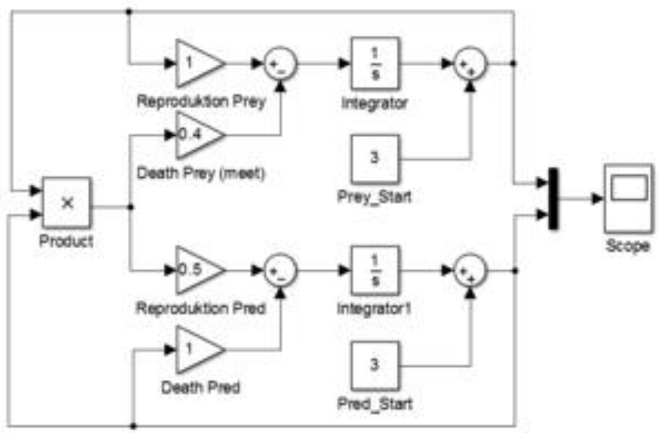
- Thevenin and Norton equivalents can only be obtained experimentally by measuring the open-circuit voltage on terminals A and B and the short-circuit current that shows through A and B

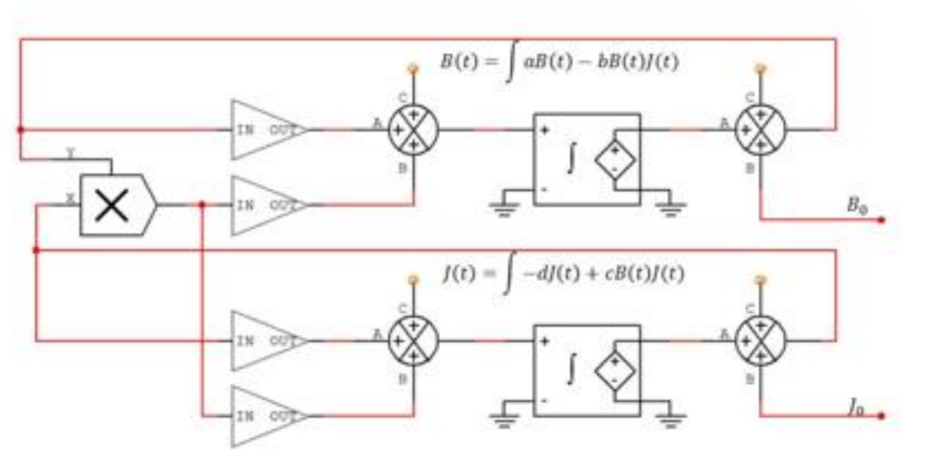
ASSIGNMENT

- Measure the Thévenin equivalent on terminals A B of the Blackbox
- Measure the time constant of a RL Circuit



ANALOG COMPUTING WITH MYDAQ





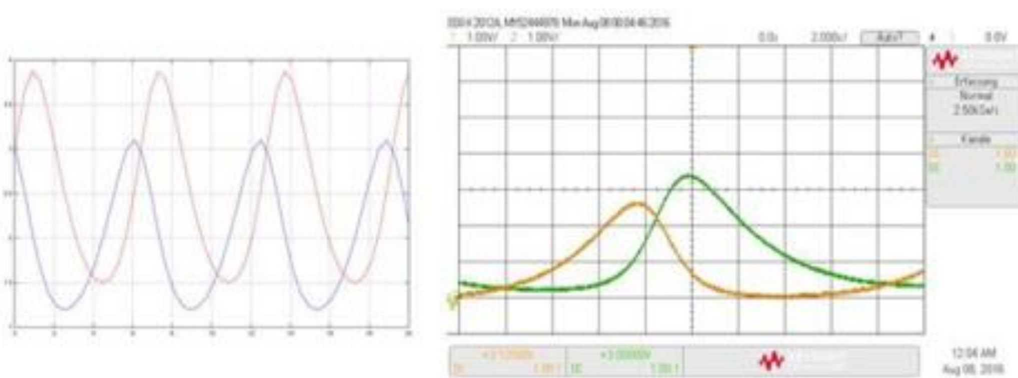
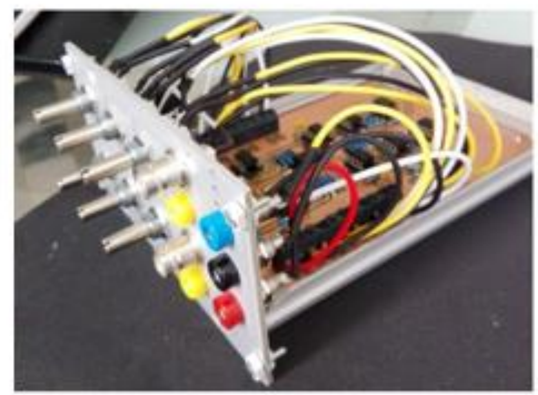
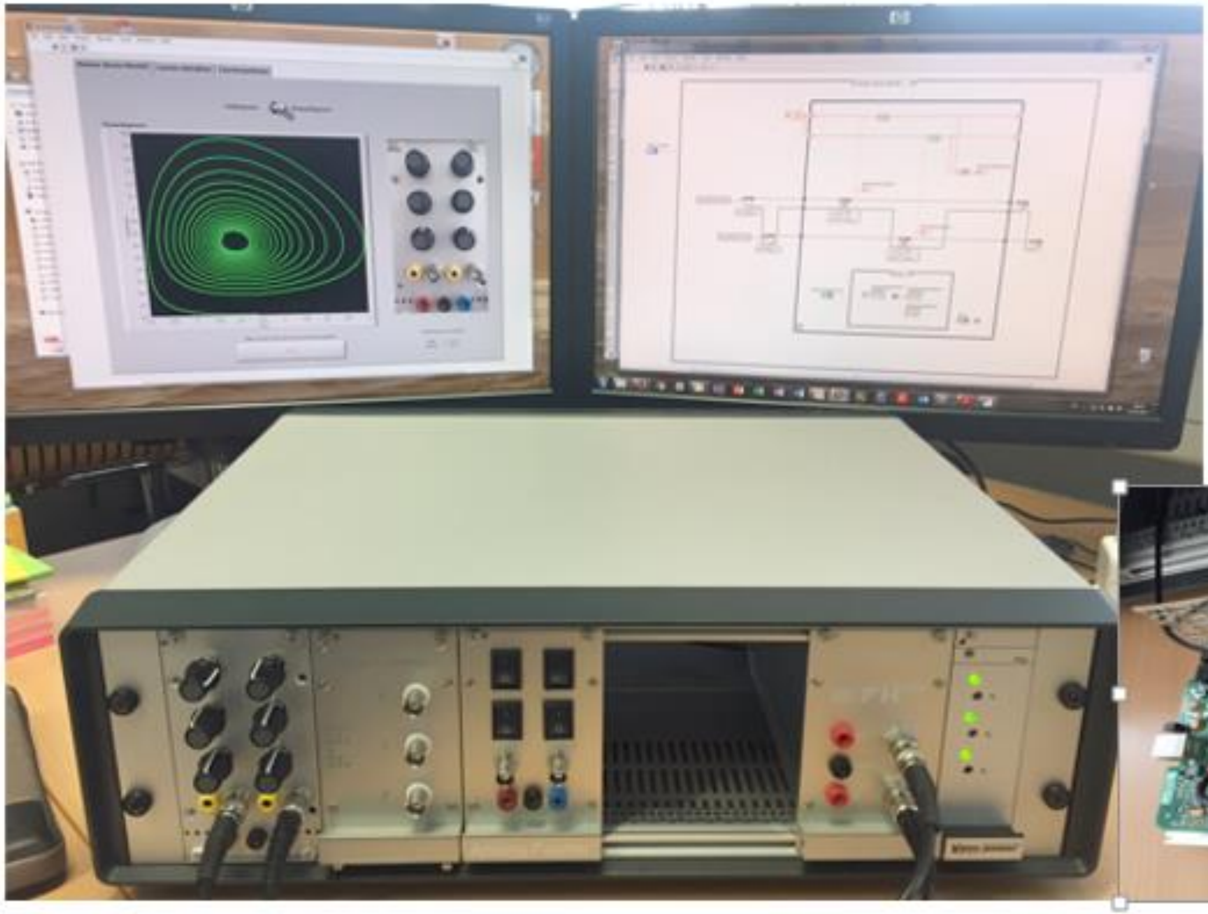


Abbildung 3-38 Vergleich der Simulation mit dem realen Ergebnis



3 Seitenansicht des fertigen 19 Zoll Einschubes mit Analogrechnerplatine

ANALOG COMPUTING RACK AND MYDAQ PCB



OUTLOOK

For the upcoming period we will concentrate on the following:

- **Integrate** this technology in the teaching methodology of **other key courses** of the Master programes;
- **Participate** in the **organization** of an **international community of practice** for Pocket Labs;
- **Combine** pocket with online labs.
- **Combine** the use of **this technology** for education with the **development** of demo projects for **industries** and other areas of practical applications.

Co-funded by the Erasmus+ Programme of the European Union

THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

OPEN DISCUSSIONS