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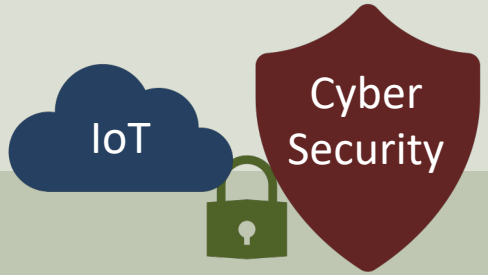
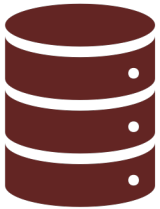
Internet of Things and Cyber Security



Hans-Petter Halvorsen

Internet of Things (IoT) and Cyber Security



Database Systems

Sensor Technology

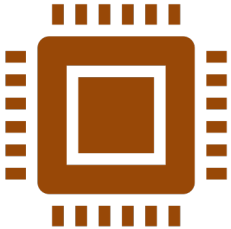
DAQ

Datalogging and Monitoring

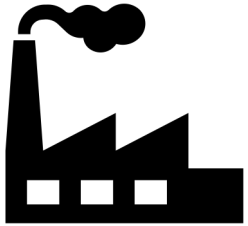
Artificial Intelligence (AI)

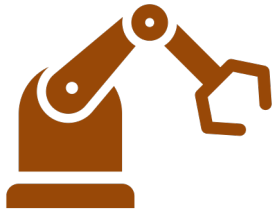
Internet of Things (IoT)

Cloud Computing



Microcontrollers





Industrial Internet of Things (IIoT) and Industry 4.0

Cyber Security

Contents

https://www.halvorsen.blog

Course Introduction

Hans-Petter Halvorsen

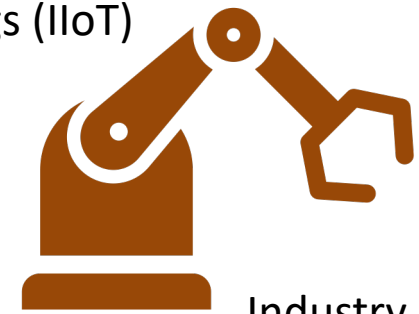
What will you Learn?

- **Internet of Things (IoT)**
- Industrial Internet of Things (IIoT)
- Industry 4.0 and Next Generation Industrial Automation Systems
- The **Cloud** and Cloud Computing
- Data and **Cyber Security**
- Automation and Control Engineering
- **Database Systems**
- **Web Technology**
- Software Engineering
- **Digitalization**
- Various Programming Languages and Industrial Software

Internet of Things and Cyber Security

Cyber Security

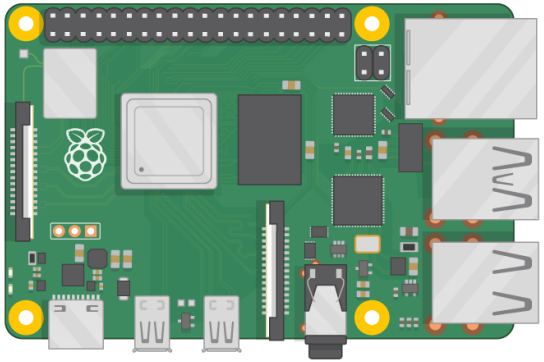
Industrial Internet of Things (IIoT)



Industry 4.0

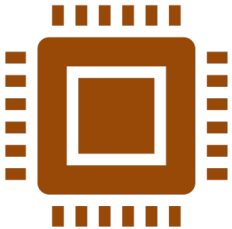
Internet

Cloud Computing

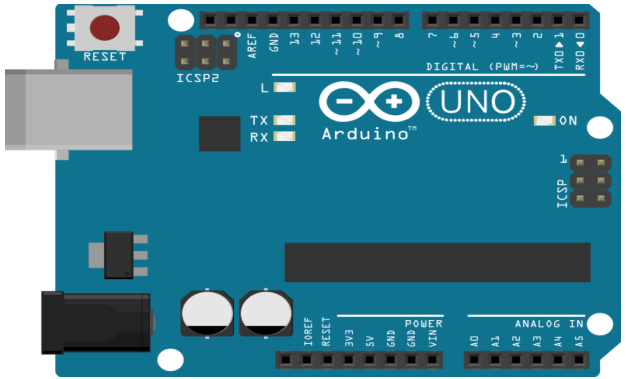


Embedded Systems

Internet of Things (IoT)



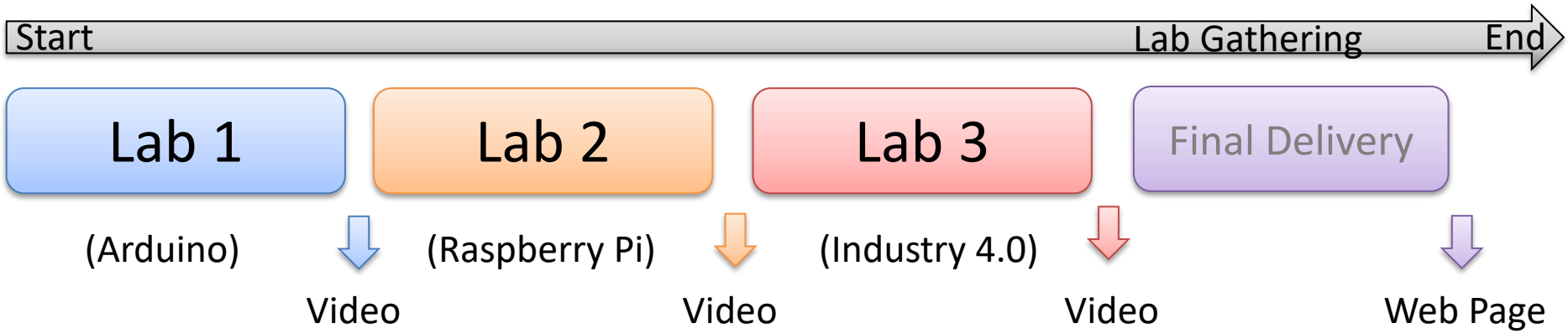
Internet of Things Hardware



Microcontrollers

Lab Assignments

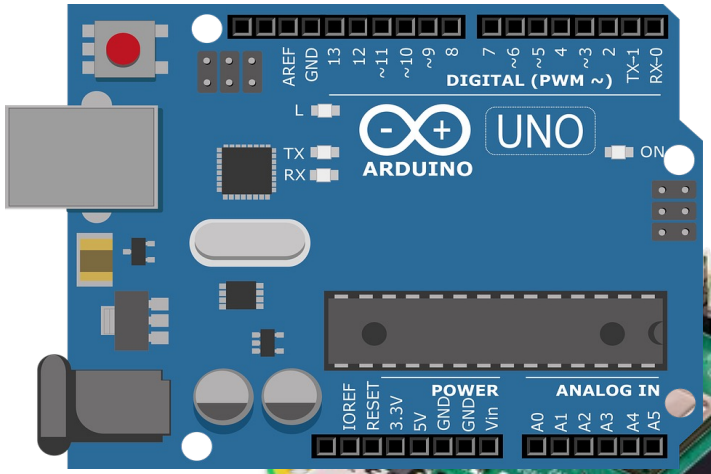
The contents and topics of this course will be learned through practical work and implementation in form of a set of Lab Assignments. There will be no ordinary lectures. It will be focus on practical implementations and less theory.



For each of the Lab Assignments, you shall deliver a **video** (about 10-15 min) where you give an overview of your work. Final delivery ("Exam"): When you have done and delivered a video for each of the assignments, you shall create a final Web Site for one of the Lab Assignments.

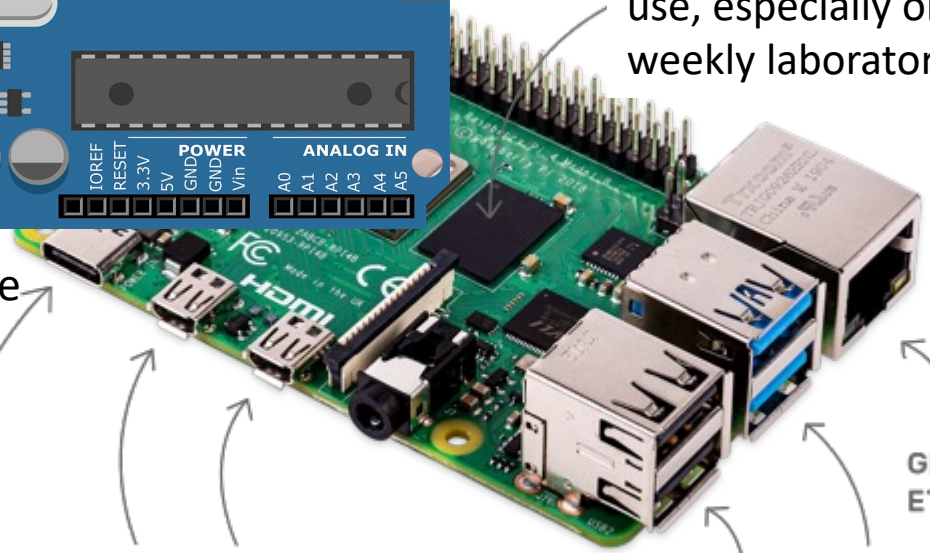
Hardware

Arduino



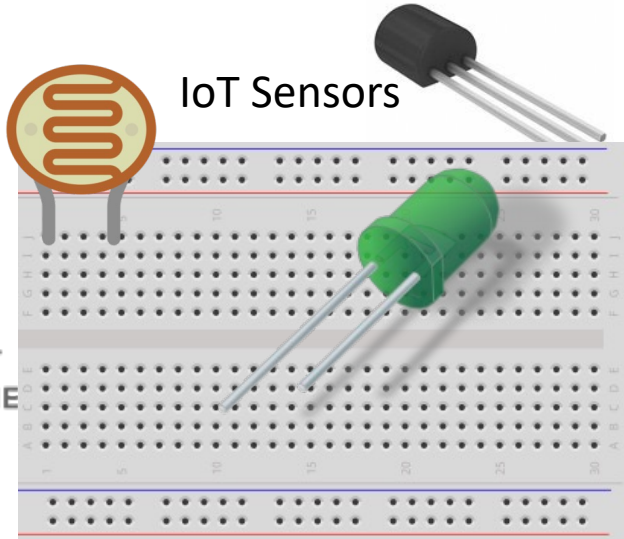
You will need an **Arduino** and a **Raspberry Pi** and some electronic components and small sensors. The equipment will be available in the laboratory, but it is recommended that you buy the hardware for personal use, especially online students that will not join the weekly laboratory sessions.

IoT Hardware



Raspberry Pi

IoT Sensors



Recommended Hardware

- **Arduino UNO R4 WiFi** (or similar)
  - In addition, you need a **USB-C cable** (or USB-B) to connect to a PC
- **Raspberry Pi 4 or 5** (or similar)
  - In addition, you need a **Micro SD card** (+ PC Adapter if needed) and a **Power Supply**.
  - If you want to connect to a Monitor, you also need a **Micro HDMI to HDMI Cable** (+ Keyboard and mouse)
- Additional Electronic Components: Breadboard, wires, resistors and small IoT sensors are also needed.
- Other options are possible if you already have some devices and components, older versions, etc.

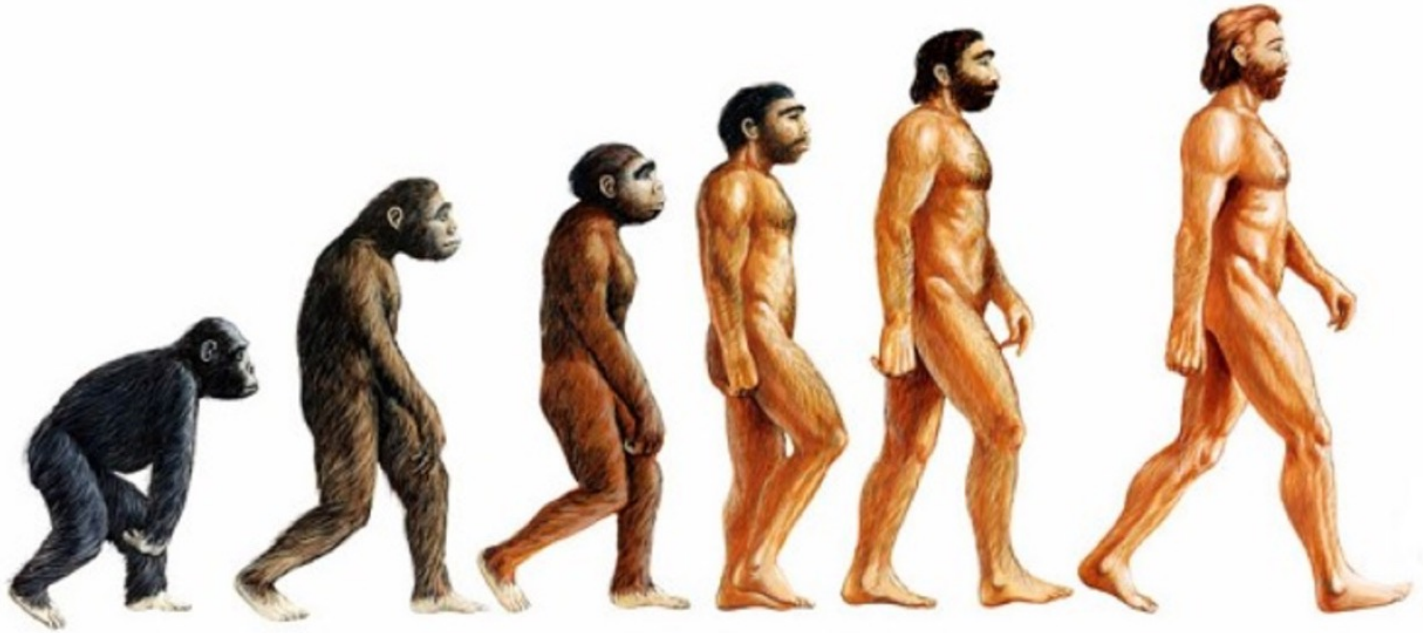
It is recommended that you buy these devices and components as soon as possible, since there are some delivery time. It is strongly recommended that you buy some of the recommended hardware for personal use. The total price will be the same as you pay for an ordinary textbook which you need to buy in other courses.

Internet of Things (IoT)

Hans-Petter Halvorsen

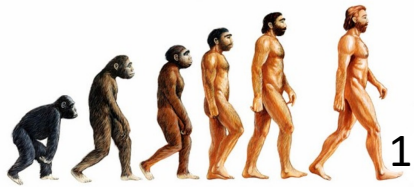
Internet of Things (IoT)

IoT – Consumer oriented, Smart Home Solutions, etc.
IIoT – Industrial use of IoT Technology.
Industrial Internet of Things (IIoT) is another word for Industry 4.0



The Digital Age

Digitalization



1930

The first Computer
The Turing machine, 1936

Internet, 1968-91

The Microprocessor, 1971

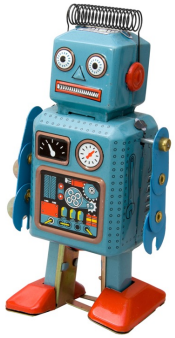
1976: Apple I

1984: Macintosh

PC, 1981 (IBM)

Smartphone, 2007

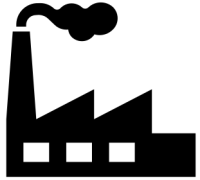
World Wide Web, 1989-93



Internet of Things (IoT), Machine Learning and Industry 4.0

2016

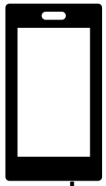
Internet of Things (IoT)



Process Industry

Computers and Devices

Cars and Vehicles



Smartphones

IT

Artificial Intelligence (AI)

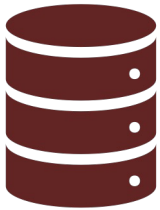
Data Security

People

Home

Soon everything will be connected to the Internet – even your Coffee Maker

Internet of Things (IoT)



Database Systems

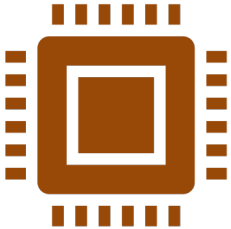
Sensor Technology

Datalogging and Monitoring

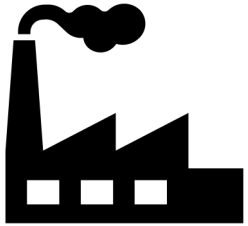
Artificial Intelligence (AI)

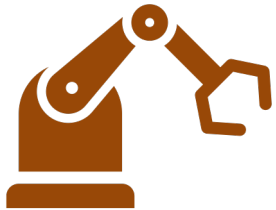
Internet of Things (IoT)

Cloud Computing



Microcontrollers





Industrial Internet of Things (IIoT) and Industry 4.0

Cyber Security

Artificial Intelligence of Things (AIoT)

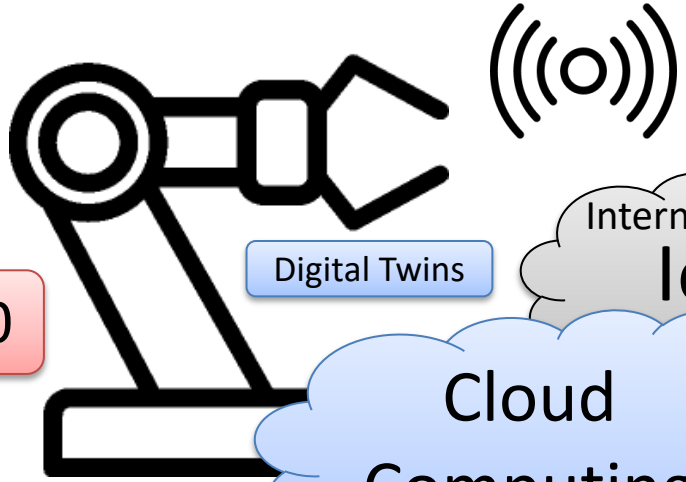
- IoT + AI + ML
- AIoT is Internet of Things (IoT) combined with Artificial Intelligence (AI) and Machine Learning (ML)
- We will see lots of Applications within the AIoT area the next decade

Industry 4.0 (IIoT)

Hans-Petter Halvorsen

Next Generation Industry

We will learn the latest technology and terms used in the industry today and tomorrow



Big Data

Internet of Things
IoT

Digital Twins

Industry 4.0

IIoT
Industrial Internet of Things

Cloud Computing

Artificial Intelligence

Mobile and Web Technology

OPC UA™

Digitalization

MQTT

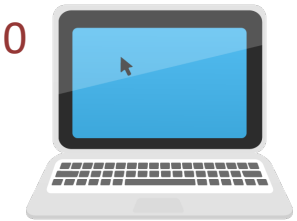
Cyber Security

Software Engineering

Industry 4.0

Internet of Things

Industry 3.0



Industry 4.0

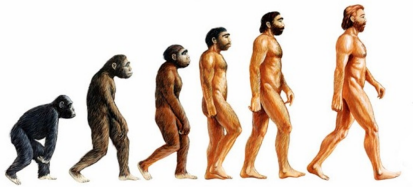
Robotics

Water, Steam and
Mechanical production

Industry 2.0

Electronics, IT and Automation

Industry 1.0



Electricity and mass production

Today

20 mill Years ago

Year Zero

~1784

~1870

~1969

~2011->

Industry 4.0

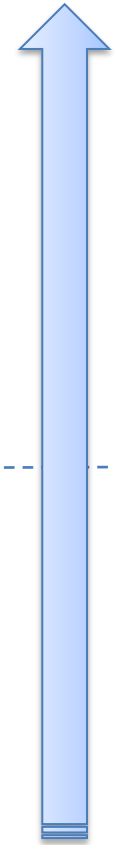
- Industry 4.0 is the buzzword for the combination of industry, automation and the current Internet of Things (IoT) technology.
- IIoT – Industrial use of IoT Technology. Industrial Internet of Things (IIoT) is another word for Industry 4.0.
- You could say that IoT is consumer oriented with applications like Smart Home, Home Automation, etc., while IIoT has more industrial focus and applications.
- The term "Industrie 4.0" was first used in 2011 in Germany.
- Industry 4.0 is also called the fourth industrial revolution.

Industry 4.0

Industry 4.0 is also called the fourth industrial revolution.

- **Industry 1.0**: Mechanization of production using Water and Steam Power.
- **Industry 2.0**: Mass production with the help of Electric Power.
- **Industry 3.0**: The Digital Revolution. From Analog to Digital Devices and Signals. Use of Electronics and IT to further Automate Production
- **Industry 4.0**: The combination of industry, automation, digitalization and the current Internet of Things (IoT) technology.

Industry 4.0



More Intelligent Systems

Industry 4.0

Its all about intelligent algorithms and models implemented in a computer, either locally or in the cloud, so-called Cloud Computing.
Data Analysis: These algorithms work with large amounts of data ("Big Data") in order to make intelligent decisions and Predictions

Big Data

Machine Learning

Mobile Technology

Web Technology

Cloud

IoT

All devices are connected to Internet

"Industry 4.0"

"Industry 3.0"

Industrial IT

Automation

Database Systems

OPC

Control Engineering

...

...

...

Industry 5.0

- We are in the “Industry 4.0” era, the next era is the upcoming “Industry 5.0”.
- The term Industry 4.0 refers to the integration of automation and data exchange in manufacturing.
- The Artificial Intelligence breakthrough has been a game changer, like ChatGPT, etc.
- Industry 5.0 is a new concept that focuses on collaboration between humans and machines

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Data and Cyber Security

Hans-Petter Halvorsen

Cyber Security

Cyber Security

- Data Security: Protect digital data (e.g., data in a database) from destructive forces and from the unwanted actions of unauthorized users (e.g., hackers, etc.)
- Cyber Security is the practice of protecting systems, networks, and programs from digital attacks
- Data Privacy: Issues regarding your personal data stored on Internet
- GDPR - General Data Protection Regulation

Cyber Security

- Basic Overview of Data and Cyber Security
- Data Security in IoT Applications
- Cyber Security in IACS Systems
- How can you secure your Software against threats and vulnerabilities?
- What can you do to protect your Software?

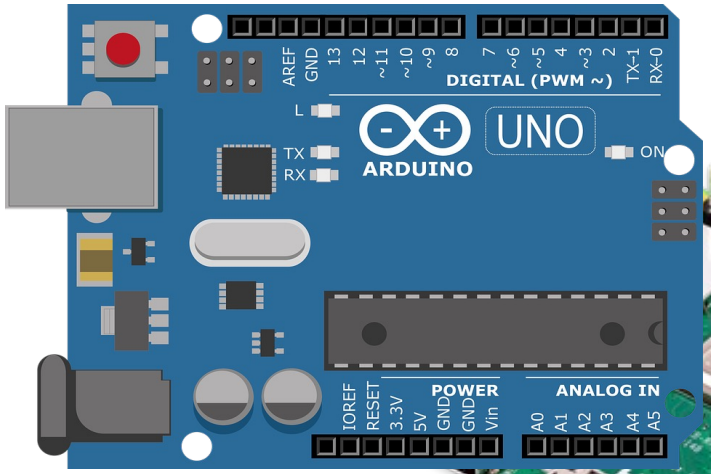
=> Practical Implementation and Reflection regarding these topics

IACS – Industrial Automation and Control Systems

Hardware and Software

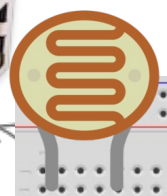
Hans-Petter Halvorsen

Hardware Examples



Arduino

IoT Sensors



Choice of RAM

2GB 4GB 8GB

Raspberry Pi

IoT Hardware

USB-C
Power
supply

MICRO HDMI PORTS
Supporting 2 x 4K displays

USB 2

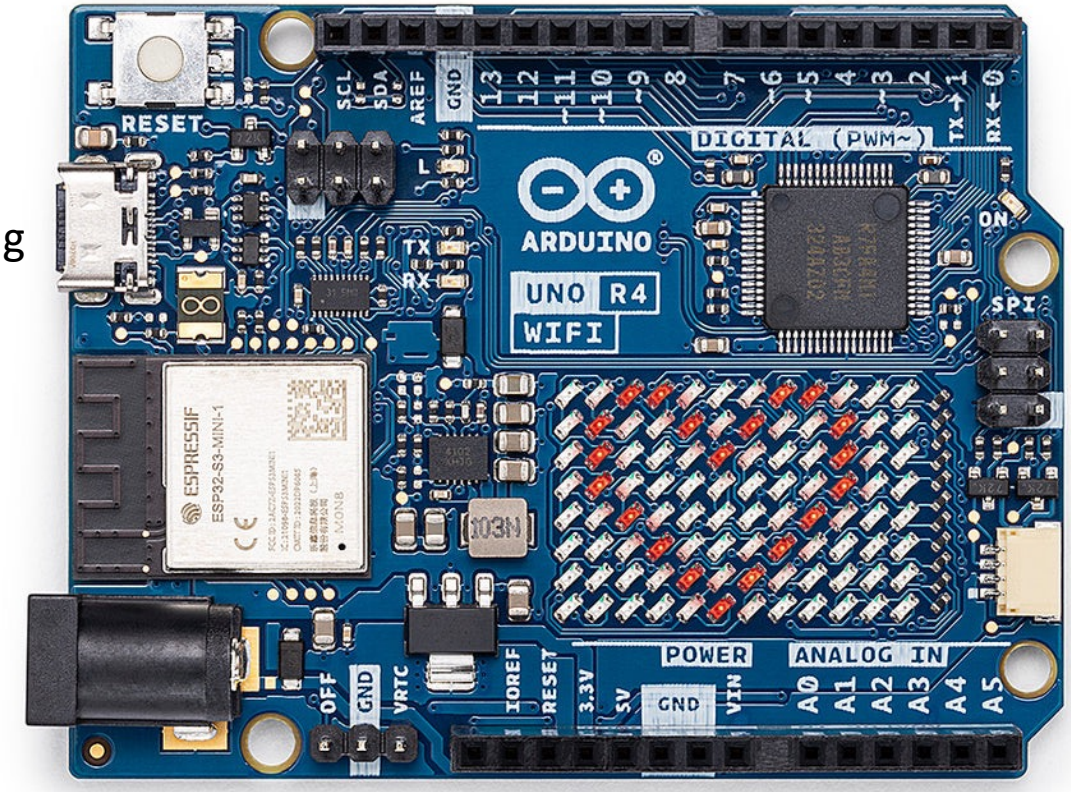
USB 3

Hardware used in the course may vary from year to year

Arduino UNO R4 WiFi

Digital I/O and PWM

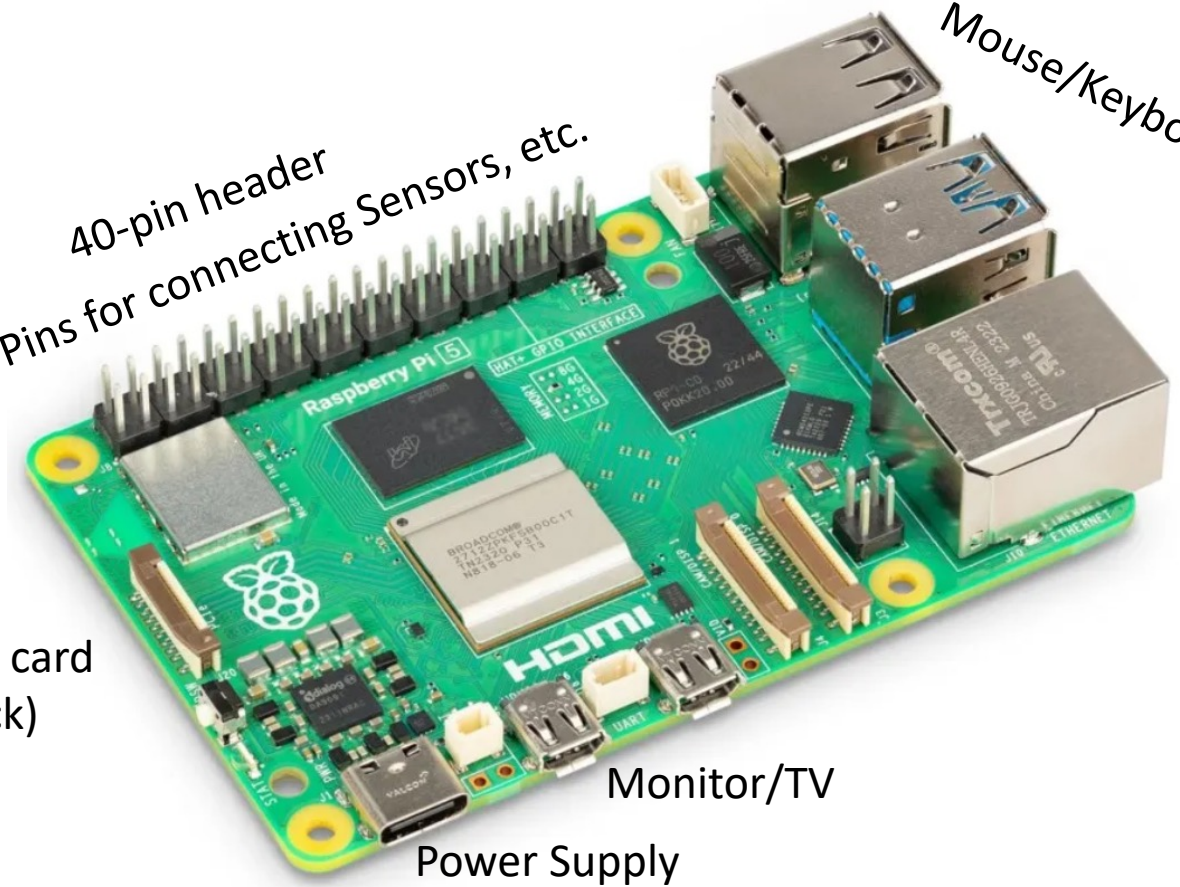
USB-C for connecting to PC



LED Matrix

Analog In/Out

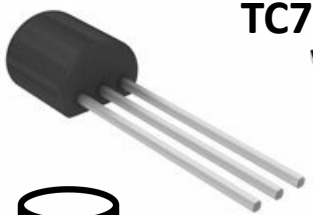
Raspberry Pi 4/5



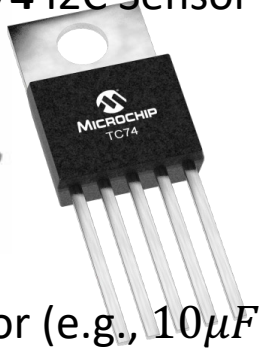
IoT Sensors and components

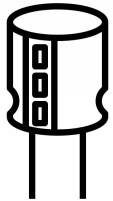
Here are some examples of relevant IoT sensors and other electronic components:

TMP36 Temperature Sensor



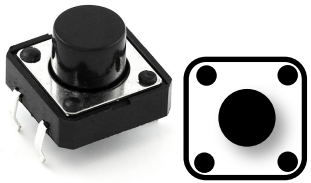
TC74 I2C Sensor



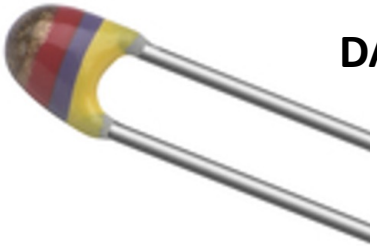


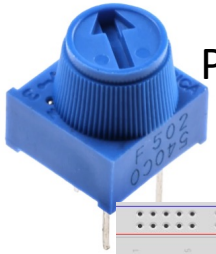
Capacitor (e.g., $10\mu F$)

10K **Thermistor** Temperature Sensor



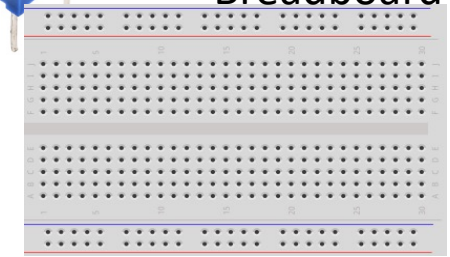
Push Buttons



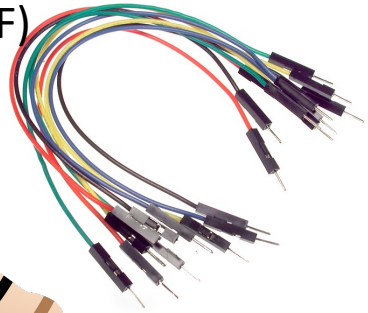


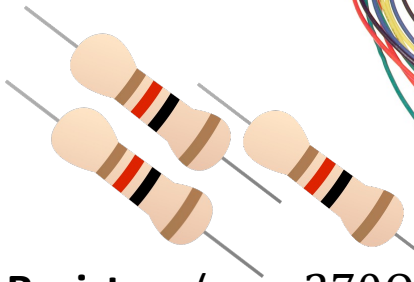
Potentiometer

Breadboard



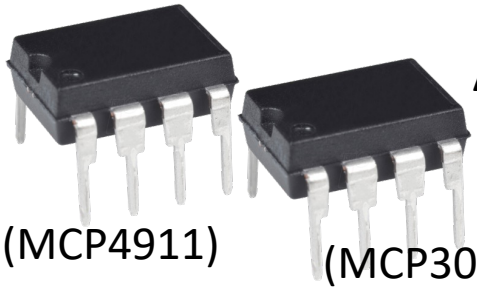
Wires (M-M and M-F)





Resistors (e.g., $270\Omega, 330\Omega, 10k\Omega$)

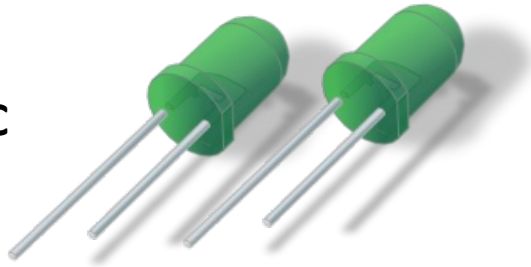
DAC



(MCP4911)

ADC

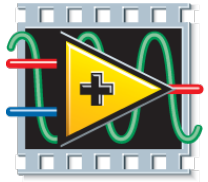
(MCP3002)



LEDs (red/green)

Software Examples

Programming Languages



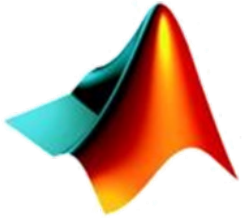
NATIONAL INSTRUMENTS

LabVIEW™

python™

Microsoft®

SQL Server®



MATLAB

Visual Studio

Software and Programming Languages used in the course may vary from year to year

Software Examples

The Industry 4.0 Implementation of OPC

Raspberry Pi OS

Microsoft Azure

mongoDB.

Software and Programming Languages used in the course may vary from year to year

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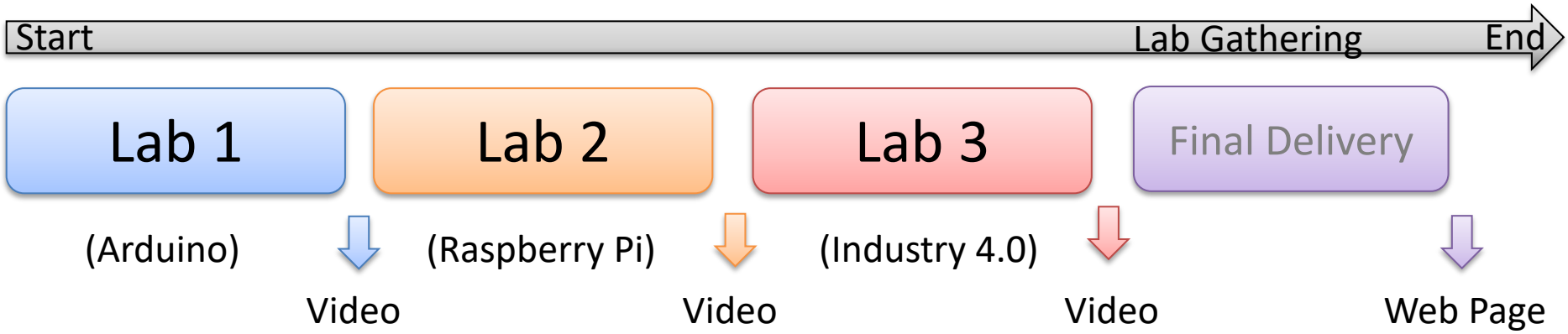
Course Structure and Assessments

Hans-Petter Halvorsen

Lab Assignments

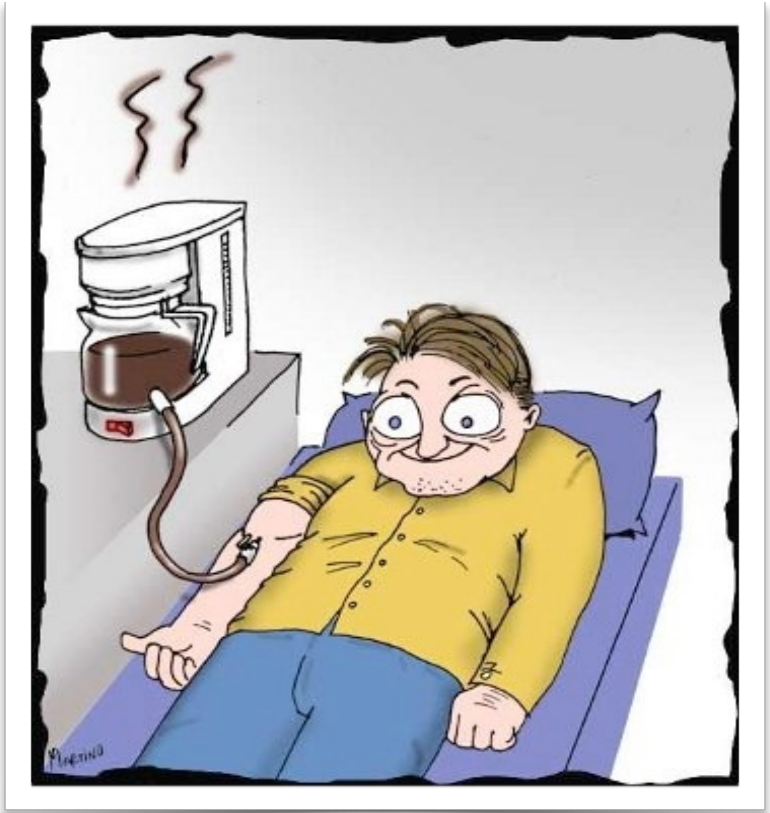
The contents and topics of this course will be learned through practical work and implementation in form of a set of Lab Assignments. There will be no ordinary lectures. It will be focus on practical implementations and less theory.



For each of the 3 Lab Assignments, you shall deliver a **video** (about 10-15 min) where you give an overview of your work. Final delivery ("Exam"): When you have done and delivered a video for each of the assignments, you shall create a final Web Site for one of the Lab Assignments.

Do you learn like this?

Traditional Lectures:



Passive Teaching with little Learning outcome

Theory and Practical Work

The learning activities will be a set of Lab Assignments where we focus on mostly practical aspects, but we see it in combination with relevant theoretical aspects. Just like Yin and Yang from Chinese philosophy.

We learn the topics involved in this course through Problem-based Learning principles

Yin and Yang are a central concepts in Chinese philosophy and religion that express opposites but interconnected that together constitute a whole, and the interaction between them. Yin and yang can be thought of as complementary (rather than opposing) forces that interact to form a dynamic system. https://en.wikipedia.org/wiki/Yin_and_yang

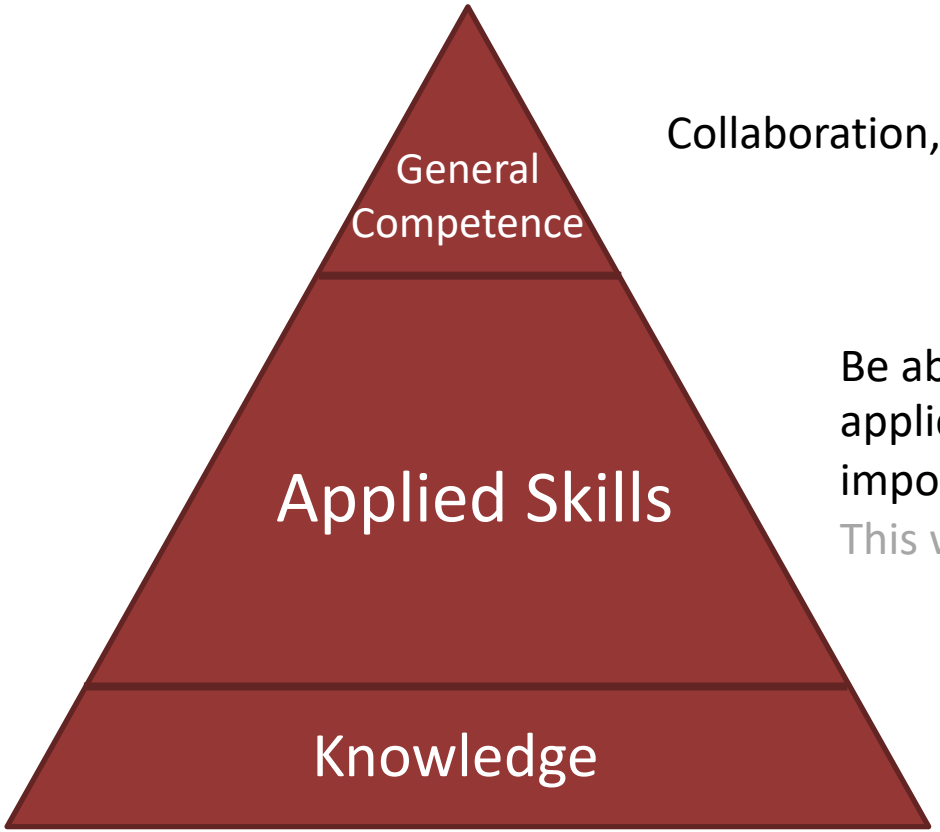
Teaching Principles

Passive Teaching:

- In universities many courses have focus on traditional lectures
- Learning advanced theory with no foundation in real life applications

This Course focuses using Active Teaching Principles such as Problem-based Learning and Practical Application Implementation

Learning Levels



Collaboration, DevOps, Make Technical Documentation

Be able to apply the knowledge to practical applications and implementation on some important and relevant topics.
This will be the main focus in this course.

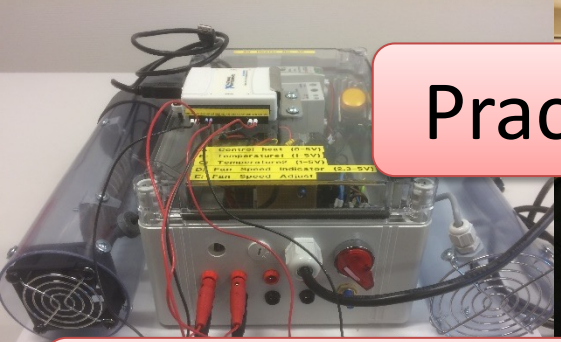
Know concepts and topics on a general level.
So that you can make overall decisions and discuss with others within these topics.

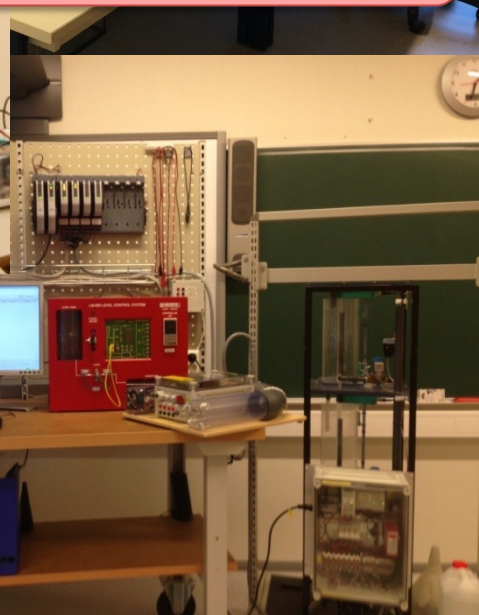
Practical Work

Laboratory Work

We will Create, Build, Implement, Test and Explore – and Collaborate!

In this course we will work with Practical Real-life Challenges





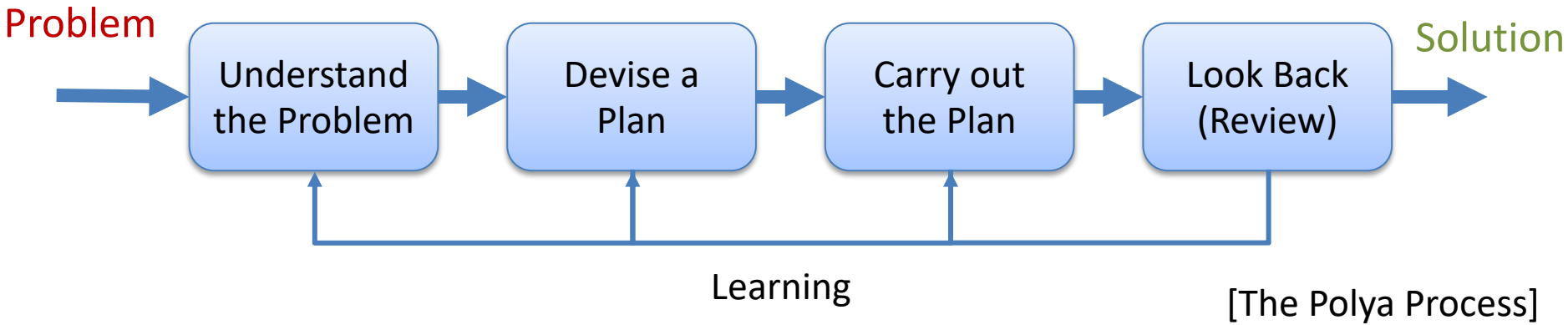
Lab Work and Practical Skills

- Laboratory Work
- Problem-based Learning (PBL)
  - Learning by practical implementations and not focus on theoretical aspects
- Flipped Classroom
  - Prepare at Home. Then do Practical Work at the University
- Authentic Teaching and Learning
  - Real-life Learning. Put the students into a relevant real-life/work scenario
- The Student in center for the Learning Process

Problem-based Learning (PBL)

Learning by Doing

This course will be based on Problem-based Learning principles.
The focus is Practical Implementation.



[The Polya Process]

The PBL students score higher than the students in traditional courses because of their learning competencies, problem solving, self-assessment techniques, data gathering, behavioral science, etc.

Authentic Teaching and Learning

- Learn and practice real-life/work scenarios
- Learning through practical work and less theory
- Put the students into a relevant real-life/work scenario
- The students shall no longer act as they are students but pretend or act that they are actually in a real work situation
- Make the students ready for work from day 1 without the need for months or years of training within the company
- Example: In a Lab Assignment the student shall not be students but act as they are working in a company and executing a real-life project
  - This should also be reflected in the documentation they produce

Authentic Teaching and Learning

- Authentic Learning is Real-life Learning.
- It is a style of learning that encourages students to create a useful products to be shared with their world.
- Not only are we teachers bringing in real world context to our classrooms, but our students are taking real world issues and problems and working to solve them and developing solutions applicable to the world or community around them.
- This means that students are not just sitting at their desks listening to lecture after lecture. They are instead solving real problems and issues.
- Problem solving is a key concept.
- This is the future of learning. Students will become adults in a world more complex than our own and will have to solve real world problems creatively and collaboratively.

https://www.onatlas.com/blog/what-is-authentic-learning-and-how-do-i-use-it

Teaching Outcome

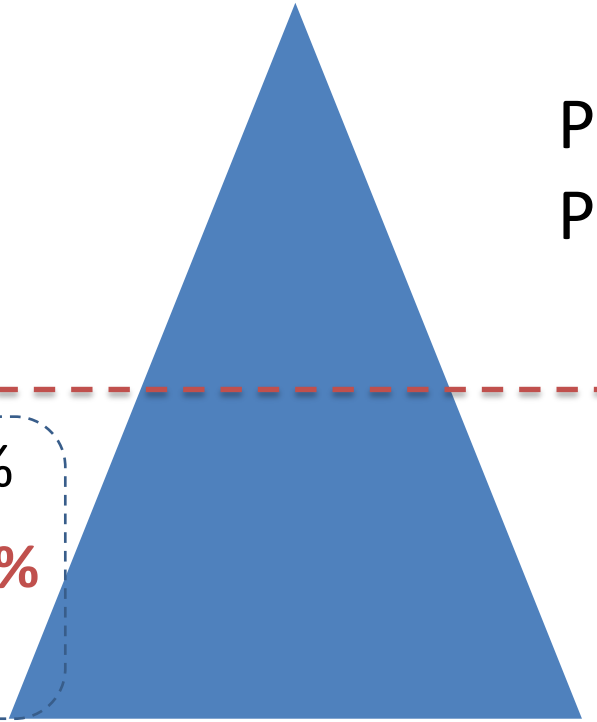
Lectures – 5%

Reading– 10%

Hear and See – 20%

Demonstrations – 30%

Passive Learning Principles



Discuss in Groups – 50%

Practical Exercises – 75%

Teaching others – 90%

Active Teaching Principles

Student centric focus

Problem-based learning (PBL)

Putting the Pieces together

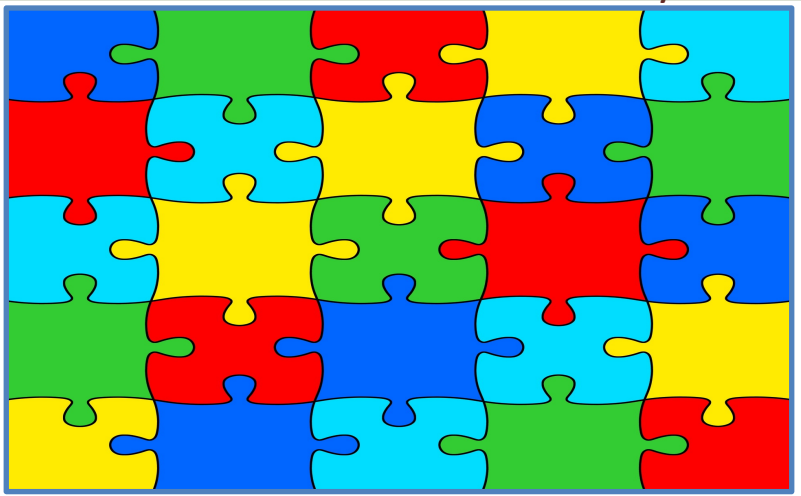
Apply Theoretical Topics from other courses

Industrial IT

OPC

Explore Hardware, Software and Programming

Build Systems



"The Big Picture"

Control Engineering

Simulations

Put all the pieces together

Implementation and Practical skills

Practical Problem Solving

PID

Modelling

Programming

Automation

Instrumentation

Data Communication

Software Engineering

Sensor Technology

Microsoft Teams

- Do you need **Help**? Want to **Collaborate**? Want to **Discuss Technical Issues** with Others? **Share Knowledge**?
- Do you have Questions regarding this Course or some of the Assignments or Lab Work? We will use Microsoft Teams.
- In Microsoft Teams you can get help from one of the supervisors or from other students. You can chat, have video meetings, ask questions, respond to questions, etc. Basically, you can use Teams to communicate with the persons involved in this course.
- Very often someone else is wondering about the same as you - or perhaps someone else has experienced the same thing and found a solution for the problem? Then post information about this in the Teams room.
- Need help outside normal office hours? Perhaps a fellow student can help you if you ask your questions here? For example, if you have installation problems, etc., a fellow student can usually respond better than the supervisor can (outside scheduled hours, evenings, weekends, etc.). You also learn a lot from helping each other.
- You can also use Microsoft Teams for collaboration with other students.

Final Lab Gathering

- **Online** and **Industry Master** Students
- Purpose: Finishing the Lab Assignments
  using available Hardware in the Laboratory at the University
- Collaboration and sharing: Learn from each other and get to know each other better
- Activities: Self-paced work in the Laboratory
- It is important that you do as much as possible in advance - otherwise you will be very busy at the Lab Gathering!
- Make sure to update your work based on the feedback given earlier in the semester for each of the assignments
- Demonstrations of the work and results where all the pieces are put together as a fully working system (Hardware + Software)
- The Lab Gathering is compulsory

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