

IAS0430

MICROPROCESSOR

SYSTEMS

Fall 2018

Martin Jaanus

U02-308

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620 2110, 56 91 31 93

Learning environment : <http://isc.ttu.ee>

Materials : <http://isc.ttu.ee/martin>

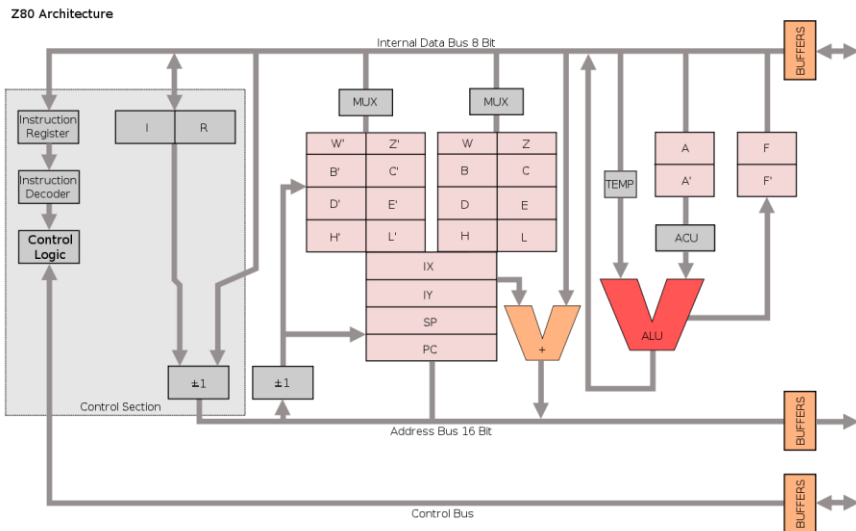
Who I am ?

- Graduated Jõhvi Gümnaaium
- Phd degree from TUT
- Lecturer, electronic engineer.
- www.skeemipesa.ee www.elfafoorum.ee



Microprocessor

- <https://en.wikipedia.org/wiki/Microprocessor>
- A **microprocessor** is a computer processor that incorporates the functions of a central processing unit on a single integrated circuit



Covered topics

- Digital blocks – working principles.
- Memory and processor management
- Low level programming
- Electrical connections

About course and learning

- Course uses isc system:

ISC.TTU.EE

- Online e-learning environment
 - Everything will be done there – online
 - Can be accessed everywhere
 - Automatic evaluation (no teacher intervention)
- 100% web- based :
 - Internet is full of materials
 - Work in internet
 - communication in internet
- ***This does not exclude talking, asking, ..***

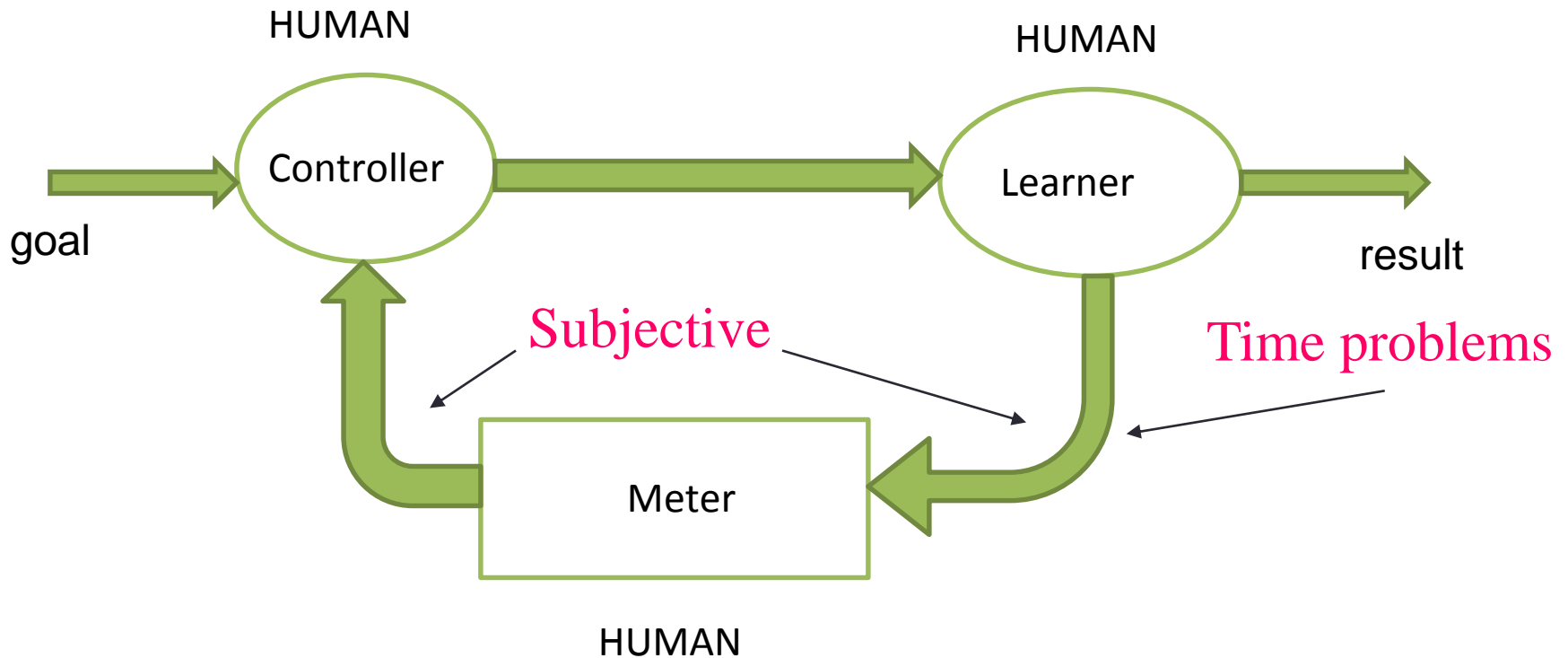
Assessment

- No official final exam:
 - Grade will be earned over the semester
 - Student him/herself decides what grade to take (more later)
- Tasks & lab experiments
 - Task are small exercises that can be done anywhere
 - Lab experiments will need lab kit (can be borrowed or can be used on-site lab)
 - What we measure, that we get (Proverb of automation people).
 - I hear- I forget, I see- i can remember, I do – I understand (Confucius)
 - **The main goal – just to become smarter !**
 - **Subject ends at 23. January 2019 .**

Lectures

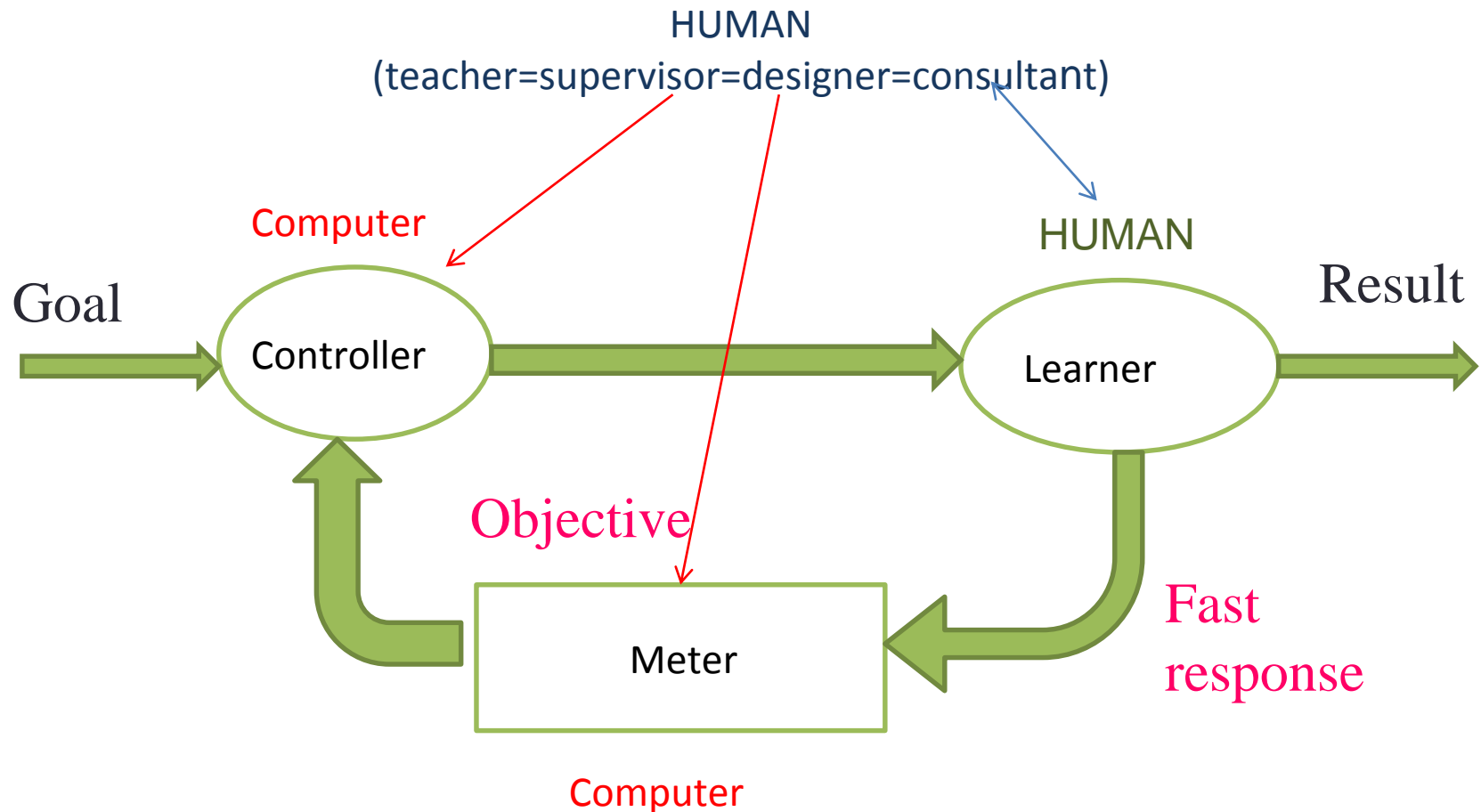
- Only first 4 week
 - „Learn by doing“
 - So, instead sitting in lectures, register to lab and start solving exercises.
 - I do not speak fluent English , as well as you. Much information will be lost !
 - The effectiveness of lecture is quite small.
 - You are different !!! (Skills, background, needs, motivation.)
 - We do'nt know your background !
- If you want to listen very good lecture about Microprocessors
<https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-033-computer-system-engineering-spring-2009/video-lectures/>

Learning as Closed Loop System



- E-tools only for organization

Learning as Closed Loop System



Learning environment

- <http://isc.ttu.ee>



ISC

Competence-based Learning Environment

[Forgot password?](#) | [Not registered](#)

Announcements

There is open course ISC0100 Cyberelectronics
1.st lecture of Martin Jaanus (estonian) 31.01.2018 (pdf)
[Martin Jaanus materials](#)

[Read more](#)

[About](#) | [User Guide](#) | [Course description](#) | [Publications](#)



IT Akadeemia
toetab Skype



If you haven't registered before:



If you haven't registered before:

...and you are not in database

Fill those fields carefully !!!

ISC

Competence-based Learning Environment

Code **0899006** cannot be found from ISC database.
If the code is correct, please submit your data for verification.

0899006	*
First name	*
Last name	*
Estonian ID code	*
Email	*
<input type="button" value="Send"/>	

<-Back

ISC

Competence-based Learning Environment

Code **0899006** cannot be found from ISC database.
If the code is correct, please submit your data for verification.

0899006	*
Test	*
Kasutaja	*
37706162218	*
martinj@martinjott.ee	*
<input type="button" value="Send"/>	

<-Back

If you haven't registered before:

ISC

Competence-based Learning Environment

Data has been saved. You will be contacted when Your data has been verified.

[<-Back](#)

- Teacher must confirm you data. And you will get mail like this.

↶ | 📧 Sinu kood on lisatud ISC andmebaasi

Kustuta	Vasta	Vasta kõikidele	Edasta	Spämm	Liiguta ▾	Tähista kui ▾	Veel ▾
Kellelt: kadri.umbleja@ttu.ee ▾							
Kellele: martin38@mail.ee ▾							
<p>Tere</p> <p>Sinu andmed on 🎯pej🎯u poolt 🎯le vaadatud ja kontrollitud vastavust 🎯ISiga. Sa saad n🎯🎯d registreerida end ISC s🎯steemis.</p> <p>Kui sul on veel k🎯simusi v🎯i probleeme, palun p🎯🎯rdu 🎯ppej🎯u poole.</p>							
Kustuta	Vasta	Vasta kõikidele	Edasta	Spämm	Liiguta ▾	Tähista kui ▾	Veel ▾

If you haven't registered before:

- If you have teacher response

ISC
Competence-based Learning Environment

Student code

Password

Log in

Forgot password? **Not registered**

Announcements

There is open course ISC0100 Cyberelectronics
lecture of Martin Jaanus (estonian) 31.01.2018 (pdf)
Martin Jaanus materials

ISC

Competence-based Learning Environment

Please register yourself in the system. Insert your student code and click 'Continue'

0899006

Continue

<-Back

If you haven't registered before:

ISC

Competence-based Learning Environment

Please select your name from the list:

A-G	H-O	P-T	U-Y
<div></div> <div>Ago</div> <div>Anni</div> <div>Antonina</div> <div>Anu</div> <div>Are</div> <div>Brita</div> <div>Cariina</div> <div>Carl Christian</div> <div>Carol</div> <div>Cleelia</div> <div>Eerika</div> <div>Emmanuel Ovie</div> <div>Ene</div> <div>Eric</div> <div>Eva</div>	<div></div> <div>Heinar</div> <div>Heivi</div> <div>Helmet</div> <div>Iivika</div> <div>Irene</div> <div>Iris</div> <div>Jaan</div> <div>Kristi-Jana</div> <div>Leila</div> <div>Lemme</div> <div>Maritta</div> <div>Maxim</div> <div>Muhammad Qais</div> <div>Nikolay</div> <div>Oluwadare Isaac</div>	<div></div> <div>Raigo</div> <div>Rain</div> <div>Rami</div> <div>Raner</div> <div>Ready</div> <div>Rebekka</div> <div>Ruben</div> <div>SandeepJaganna</div> <div>Sepo</div> <div>Tago</div> <div>Taire</div> <div>Tauri</div> <div>Terje</div> <div>Terttu</div> <div>Test</div>	<div></div> <div>Uku</div> <div>Uku-Rasmus</div> <div>Ülar</div> <div>Ülari</div> <div>Uljana</div> <div>Ullabritt</div> <div>Ülle</div> <div>Ülo</div> <div>Ulvi</div> <div>Urho</div> <div>Urmass</div> <div>Urmo</div> <div>Ursula</div> <div>Urvika</div> <div>Uzochukwu Eddi</div>

Continue

If you cannot find your first name from the list, please contact the teaching staff.

The name spellings are taken from university database. In case of errors, please contact the teaching staff.

<-Back

ISC

Competence-based Learning Environment

Please add the additional information:

51107121760

*

martin38@mail.ee

*

5122336

Register

<-Back

If you haven't registered before:

- You will get a password ! **Remember it !**
- The password can't be changed.
- If you forget the password, ask us !

ISC

Competence-based Learning Environment

Registration done!

From now on, you can log into system using following passwords:

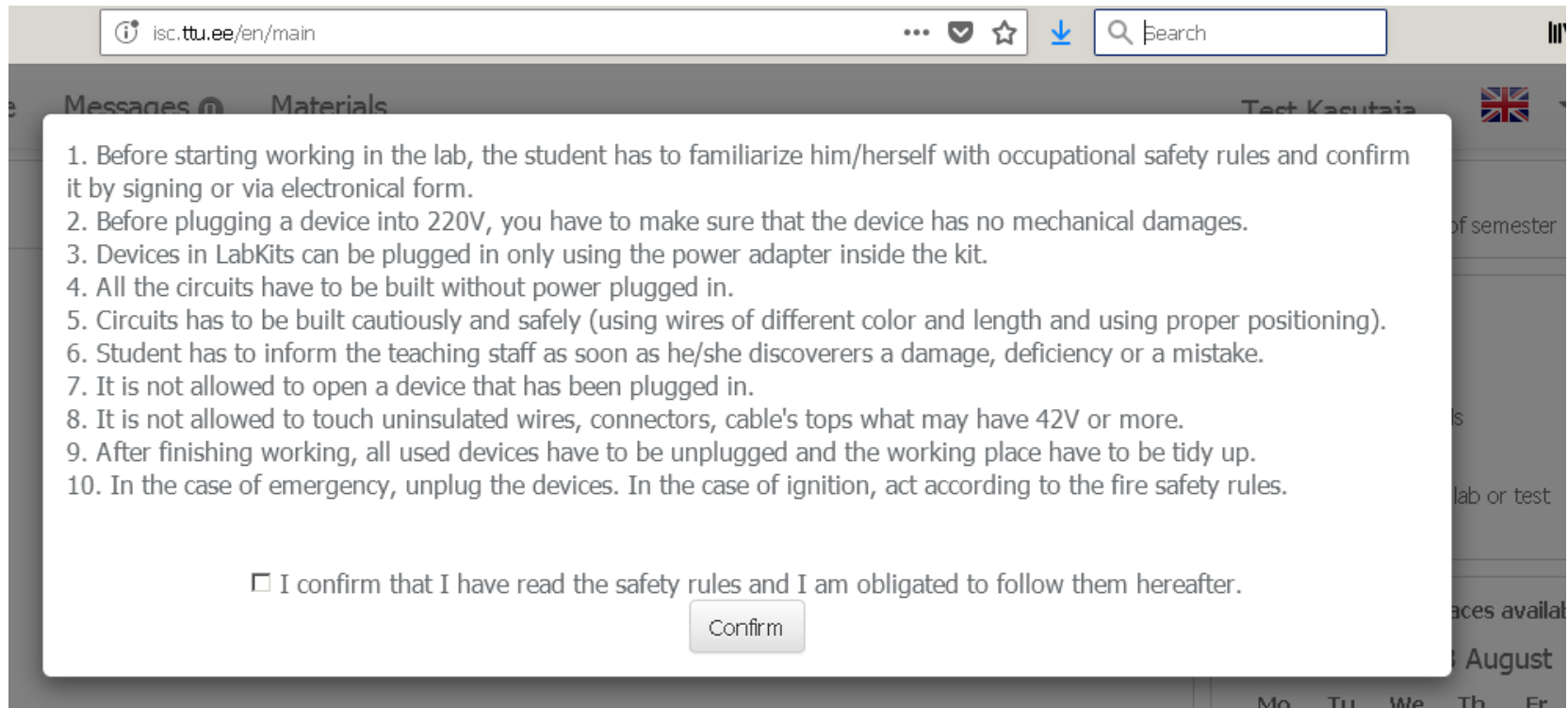
12345678 or 12345678

Those have also been sent to your email.

Continue

If you haven't registered before:

- You must agree..



The screenshot shows a web browser window with the address bar displaying 'isc.ttu.ee/en/main'. The browser interface includes a search bar and navigation icons. A modal dialog box is centered on the screen, containing a list of 10 safety rules for working in a lab. At the bottom of the dialog, there is a checkbox for confirmation and a 'Confirm' button. The background of the browser shows a navigation menu with 'Messages' and 'Materials', and a sidebar with a UK flag and text about semester and lab availability.

isc.ttu.ee/en/main

Messages Materials Test Kasutaja

1. Before starting working in the lab, the student has to familiarize him/herself with occupational safety rules and confirm it by signing or via electronical form.

2. Before plugging a device into 220V, you have to make sure that the device has no mechanical damages.

3. Devices in LabKits can be plugged in only using the power adapter inside the kit.

4. All the circuits have to be built without power plugged in.

5. Circuits has to be built cautiously and safely (using wires of different color and length and using proper positioning).

6. Student has to inform the teaching staff as soon as he/she discoverers a damage, deficiency or a mistake.

7. It is not allowed to open a device that has been plugged in.

8. It is not allowed to touch uninsulated wires, connectors, cable's tops what may have 42V or more.

9. After finishing working, all used devices have to be unplugged and the working place have to be tidy up.

10. In the case of emergency, unplug the devices. In the case of ignition, act according to the fire safety rules.

☐ I confirm that I have read the safety rules and I am obligated to follow them hereafter.

Confirm

of semester

lab or test

aces availat

August

Mo Tu We Th Fr

Adding new course

The screenshot shows the website isc.ttu.ee/en/main. The navigation bar includes links for **MyField**, **Profile**, **Messages** (with a notification icon), and **Materials**. On the right side of the navigation bar, there is a **Test Kasutaja** (Test User) section with a UK flag, a help icon (?), and a close icon (X).

The main content area on the left has a red arrow pointing to a small plus icon (+) located at the top left of the main content area, indicating where to click to add a new course.

The sidebar on the right contains the following sections:

- Summary:** 144 days till the end of semester
- Book a kit** (with a briefcase icon)
- Time proposals** (with a calendar icon showing the number 13)
- Register for a lab or test** (with a computer monitor icon)
- Free lab and test places available:** A calendar for August 2018.

The calendar for August 2018 shows the following dates:

Mo	Tu	We	Th	Fr	Sa	Su
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

Adding new course

MyField

Profile

Messages 0

Materials



Here you can add courses to your fields.

Adding a course here does not replace official declaration. You add and study whichever courses you want - you do not have to have official declaration to go with it.

If you have declared the course before and taken a grade, all the confirmations of the competences will be removed and you have to prove those skills again in class test.

Courses			
IAS0430	Add	ISC0100	Add



Done !

MyField

Profile

Messages 0

Materials

IAS0430

ISC0100

+

My points: 0(0)

Homework

Summary:

144 days till the end of semester

Book a kit

Time proposals

Register for a lab or test

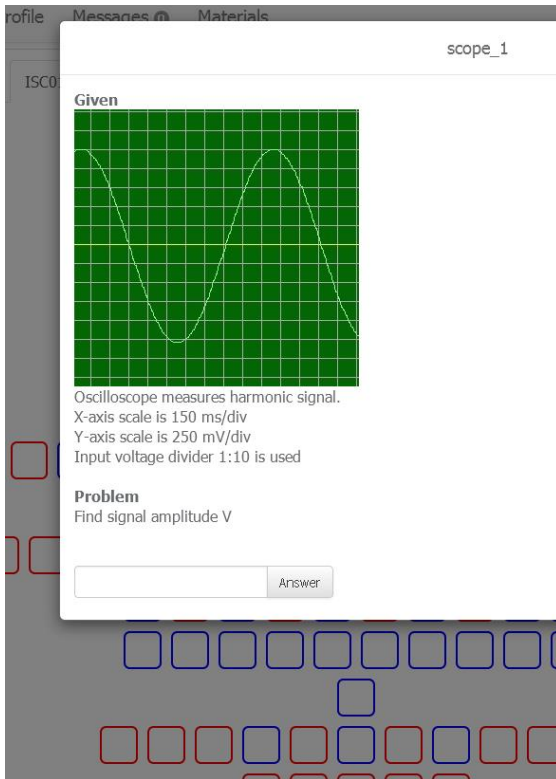
Free lab and test places available:

« 2018 August »						
Mo	Tu	We	Th	Fr	Sa	Su
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

How to learn using this environment can be found here:
<http://isc.ttu.ee/en/userGuide>

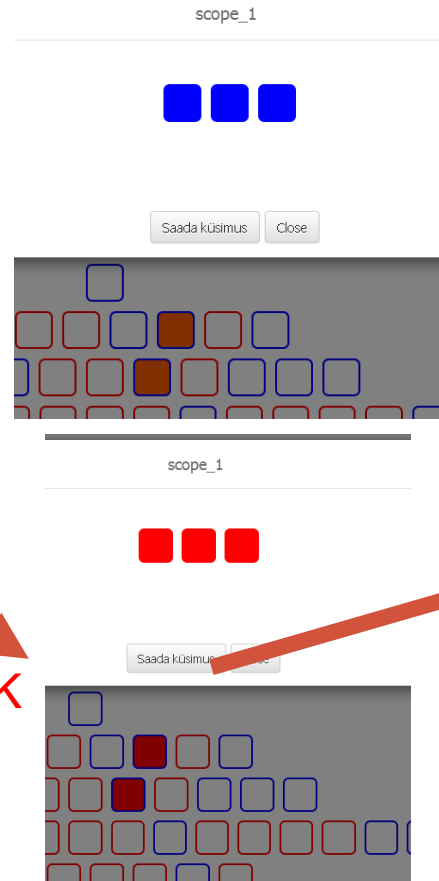
Learning environment

- Tasks



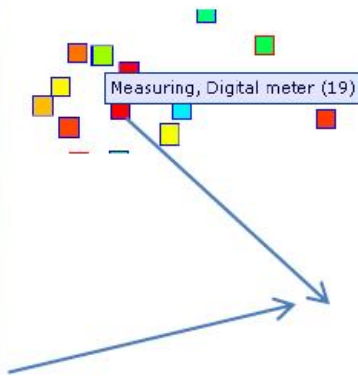
Result OK

Result NOT OK



Question to teacher about task.

Learning Environment (labs)

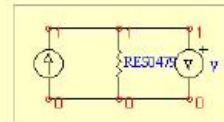


Katse CS145

Pinge mõõtmine ja mõõteviga

Seadmed: vooluallikas, resistor
RES0479, multimeter DMM M830
ning multimeetri kasutusjuhend.

	Tulemus	Ühik
Mõõtepiirkond	20	V
Mõõta pinge V	4.2	V
Arvutada mõõteviga	± 48	mV



Pinge mõõdetakse voltmeeetriga. Selleks ühendatakse voltmeter ahelasse rööbiti. Valida tuleb optimaalne mõõtepiirkond ehk see, kus mõõtemista näit on suurim, kuid ei ületa skaala maksimumväärtust.

Tester näitab V klemmi pinget COM klemmi suhtes.



Result by components:



Lab tasks are included in Class Test !

HomeWorks

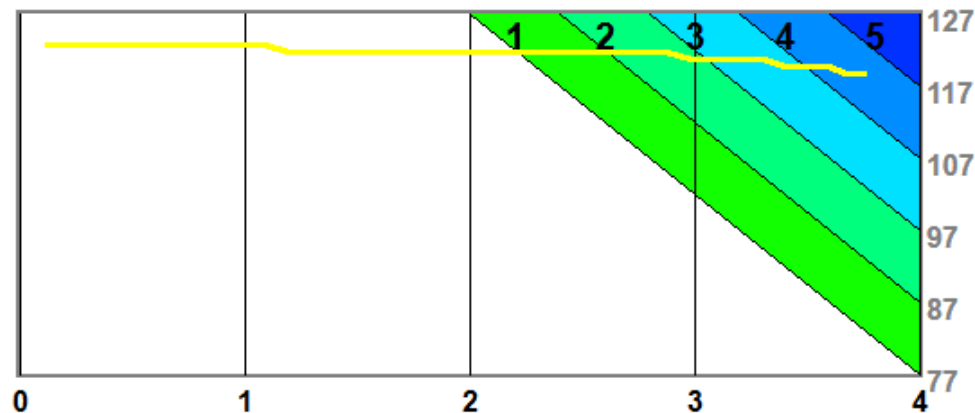
- 5 Low level (assembly) programming tasks.
- It is possible to use Arduino board (or any prototyping board you have) to program in assembly language.

Class tests

- You work on your own and on lab until you have got the competences high (level over 77 of 127).
- If you have more than 1000 mCu, you can register for class test and come to lab to to class test.
- Same kind of exercises than before – you just have to do it in „controlled“ environment to prove you did it yourself
- All points have to be confirmed this way.
- Those points count towards your grade
- Class tests include lab tasks (not programming tasks) !

Grade taking

- You can take your grade whenever you want – when you have the points, take the grade and you are done. You do not have to wait till the end of semester



Lab times

- On-site labs will consist of you working with a labkit on laboratory. There is someone there to help you with all the questions you have



- You can start with few sessions on the lab and then do experiments home with borrowed HomeLabKit

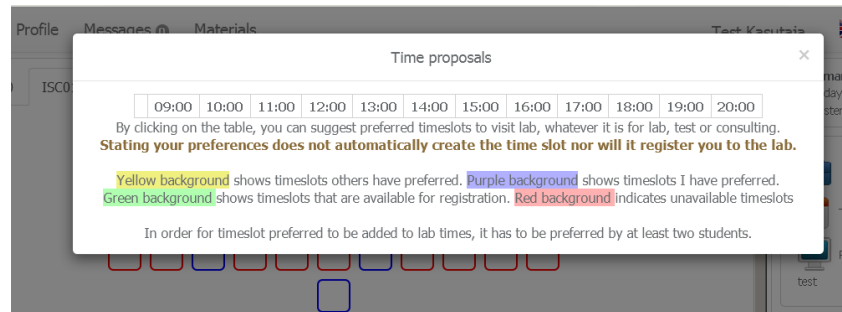
Before you can borrow HomeLabKit, you have to go for a lab once

Labs



From next week .

You can use time proposal.



Hints

- Don't wait with this course – start working now! There is forgetting model and you just won't do it with 1 week at the end of semester
- You will see your process – use it, plan your time!
- If you have problems – come to lab, send email or use messaging system in the ISC !

About doctors ...

- You need to study...years (think the number by yourself)
- The doctors are under rigid supervision
- If the doctor errs , what will happen?



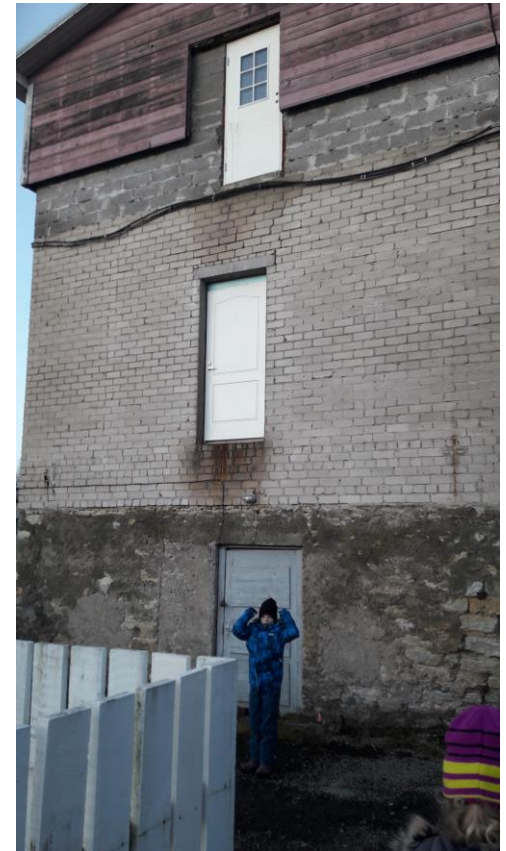
Image -lists10.com

Correct, but victim is usually one .

Result – Good days for journalists,
law court..etc.

About engineers...

- You need to study...years (think the number by yourself)
- The engineers are not under very rigid supervision
- If the engineer errs , what will happen?



About engineers...

You see, what will happen

Tens or hundreds of victims

Questions

- Who made a mistake?
 - Which engineer made a mistake ??
 - Who is guilty ?
 - There are few justice solutions .
- ..But politicians take responsibility....



Photos: postimees.ee



About politicians...

- You need to study...years to be a politician .
- Who is supervisor ?
- If the politician errs , what will happen?



Photos: postimees.ee

About politicians...

- Only one wrong word can destroy more people than may caused by collapsing any building.
- Who takes response ?

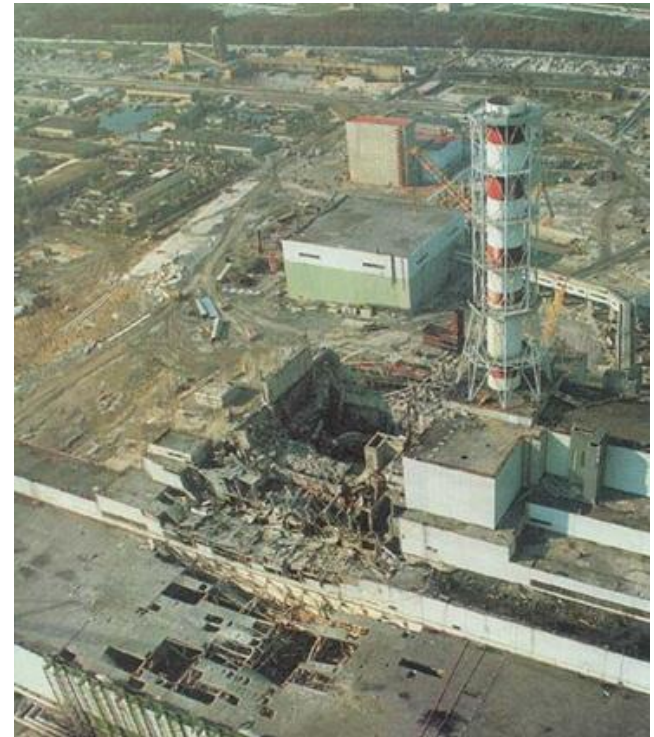


Image: delfi.ee

Why to study at university ?

- It is cheaper than in real life, much cheaper !
- If you err, you can try again .
- In real world there is no sutch possibility or it costs a lot of money.

The nuclear accident in Thernobol is good example.

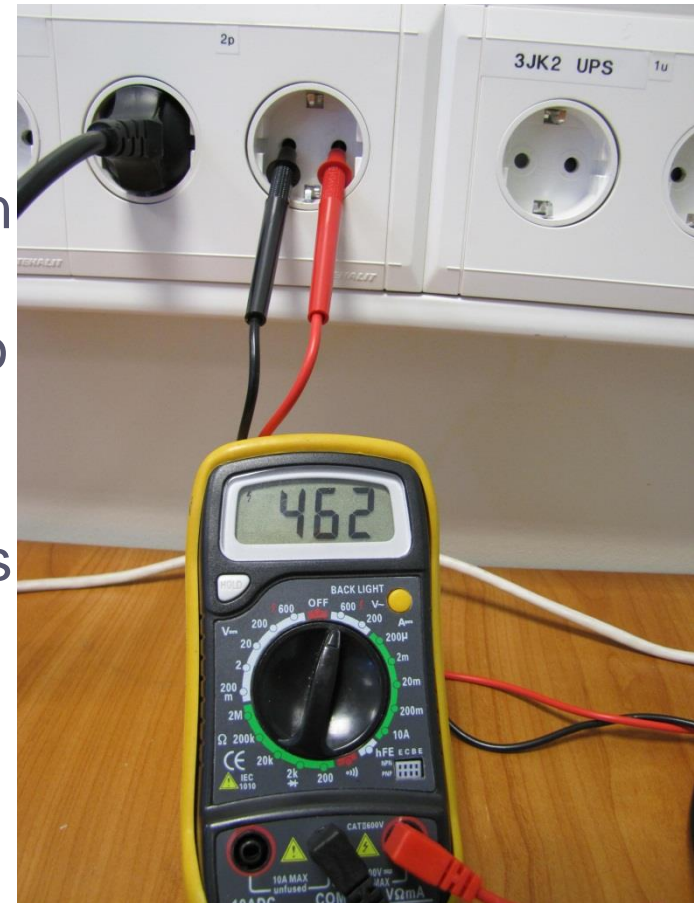


From real life

The technician of IT company is making routine check of environmental parameters in office .All is fine. Computers are working, the lights are glowing normally. In addition to other parameters there is needed to measure the mains voltage. He connects the multimeter into mains outlet and it shows 462 V.

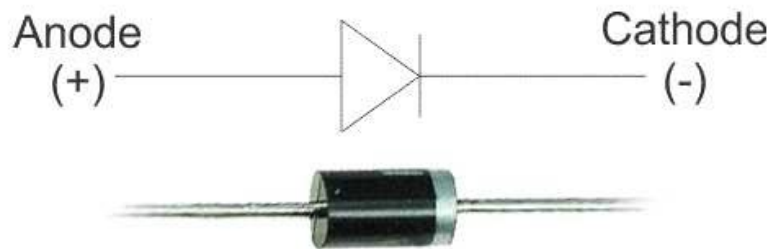
What should he do next?

Answer : To buy new multimeter .



About history(1)

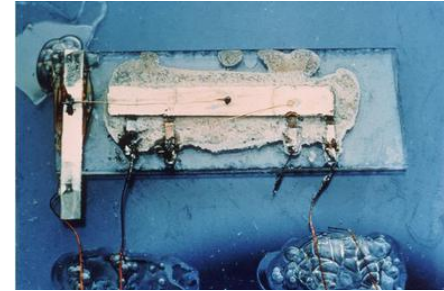
- The semiconductor diode (Crystal diode) comes from year 1874, when German scientist Ferdinand Braun discovered semiconductor effect in crystals.
- Singularity of diode – to make different resistance depending direction of charge flow.



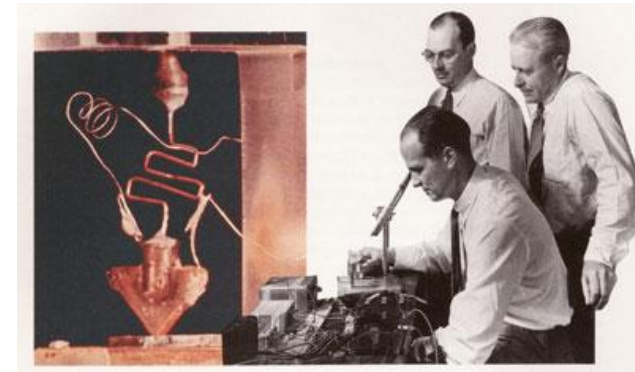
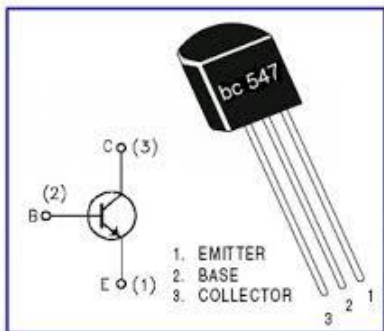
Pilt- wikipedia (Crystal detector)

About history (2)

- The birth of transistor is at 1947 , when John Bardeen, William Shockley and Walter Brattain were demonstrating bipolar transistor.
- Field effect transistor was patented at 1925 but it was only an idea.
- 1951 – was possible to buy transistors from store.
- 1953 – The first computer based on transistors.
- 1954 – **The first silicon transistor.**
- 1958 – **The first integral circuit.**



-
- 2016 - 25 millions of transistors per 1 cm² .



Images- wikipedia (Transistor)

About history (3)

- 1939 - Electronic computers using valves
- 1953 – The first computer based on transistors.
- 1958 – **The first integral circuit.**
- 1968 – term „microprocessor“ – custom integrated circuit
- 1971 – The first microcontroller

Microcontroller

- A microcontroller is an integrated circuit that is programmed to do a specific task.
- Microcontroller includes microprocessor+peripherals
- Microcontrollers are really just “mini-computers”.
- Widely used in embedded systems
- Internet of Things



By Seattle Municipal Archives - Flickr: General Motors exhibit at World's Fair, 1962, CC BY 2.0,
<https://commons.wikimedia.org/w/index.php?curid=22208719>



Can contain the same microcontroller

(Personal)Computer vs (Micro)Controller

PC (phones , tablets...)

- Flexible configuration
- Standard I/O
- High level programming
- Software designer may not know hardware working principles
- Built in controllers (HDD, Display...)
- This is not **embedded system** !

MCU

- Usually inflexible
- Specific I/O
- Low level programming (C,ASM)
- Software designer must cooperate with hardware designer and familiar with electronics !
- Program code depends on connections !
- Usually are used in embedded systems !

Microprocessor vs Microcontroller

MPU system

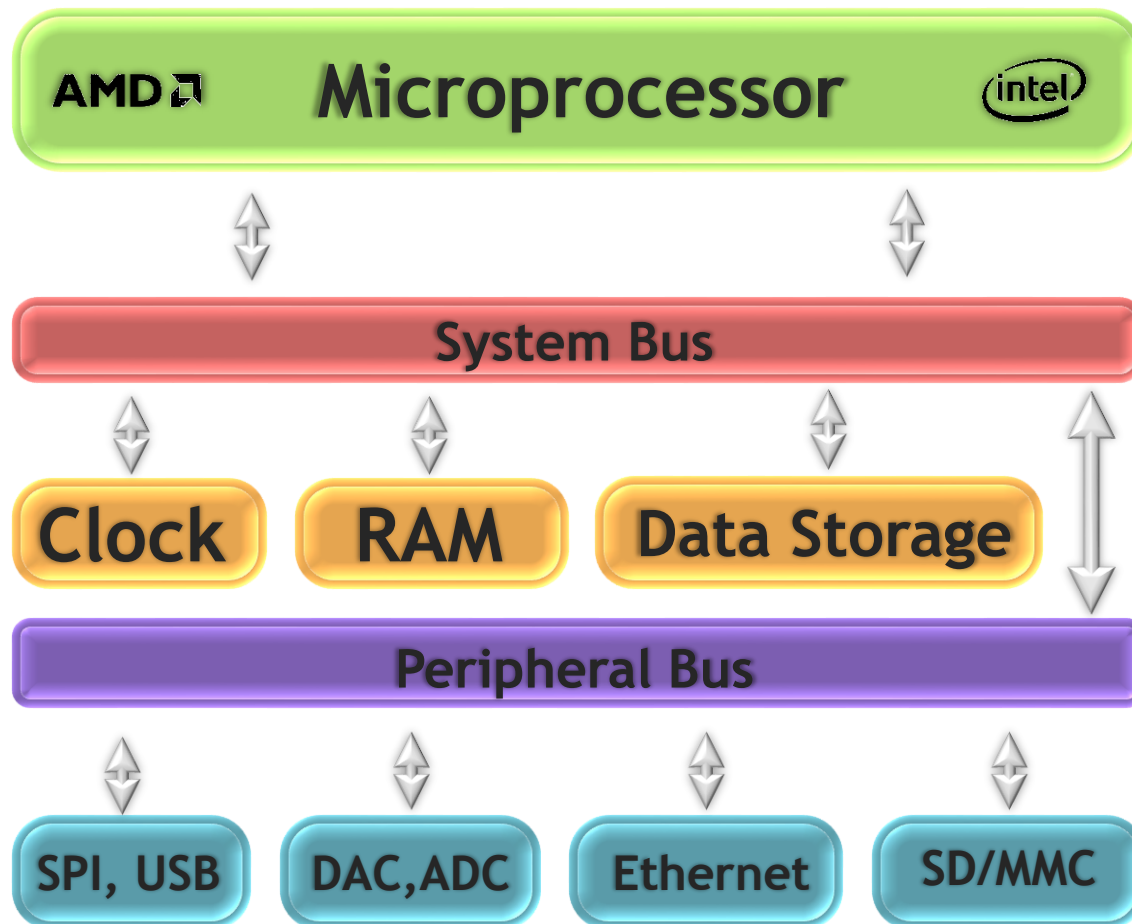
- General Computing
- (PC, tablets, phones)
- Very fast (as fast as possible) !
- Many external parts
- High Cost
- Can be part of embedded system

MCU system

- Appliances, specialized devices
- Relatively slow (as slow as possible – to minimize energy consumption)
- Few external parts
- Low cost
- Replacement for logic gates (if possible)

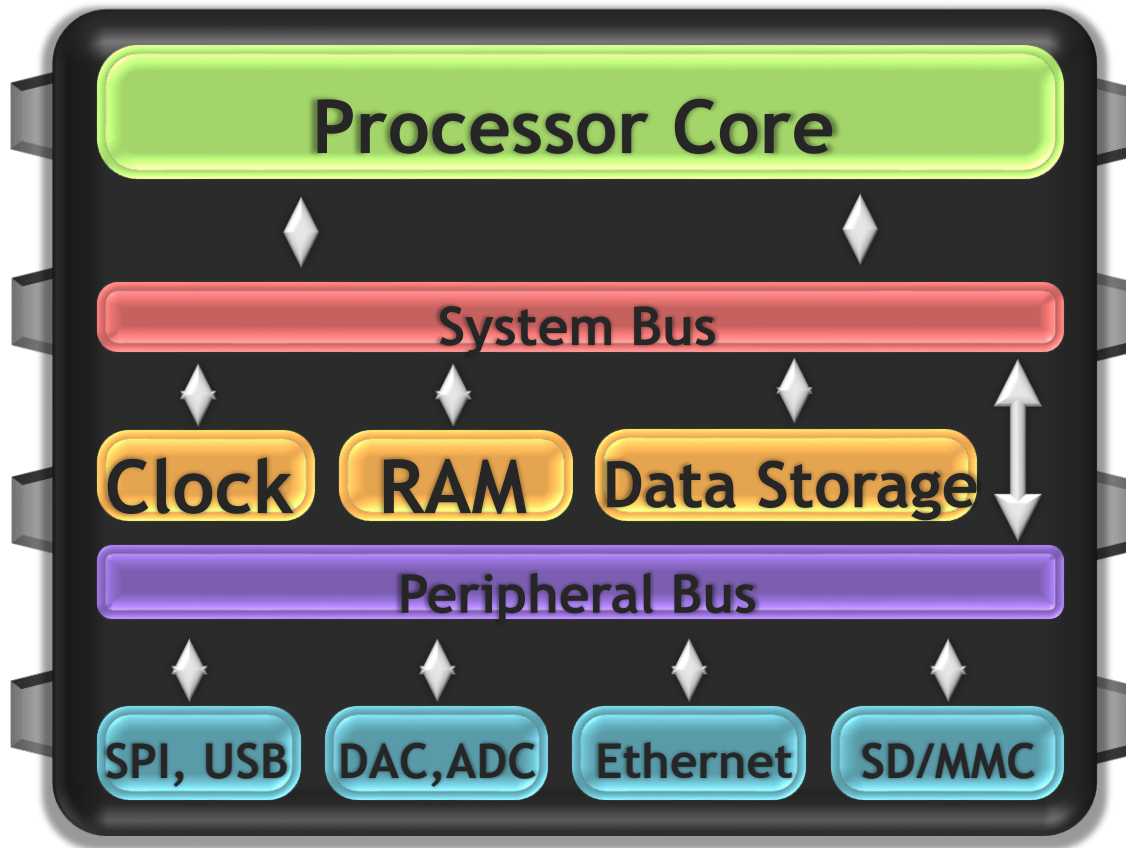
Microprocessor vs Microcontroller

- Microprocessor system



Microprocessor vs Microcontroller

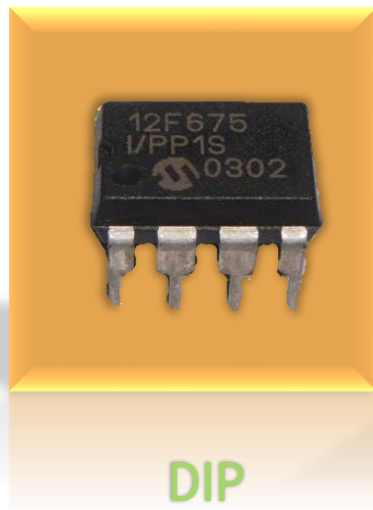
- Microcontroller includes the most of additional components needed by microprocessor.



Microcontroller Programming

- Code is usually written for the microcontroller in an integrated development environment, a PC program.
- The code is written usually in a low level programming language. (e.g. C or Assembly).
- To write code you must be familiar with technical issues (external connection, at least basics knowledge in analog and digital electronics) !
- The IDE debugs the code for errors, and then compiles it into binary code which the microcontroller can execute.
- A programmer (a piece of hardware, not a person) is used to transfer the code from the PC to the microcontroller.

MCU and MPU packaging



DIP

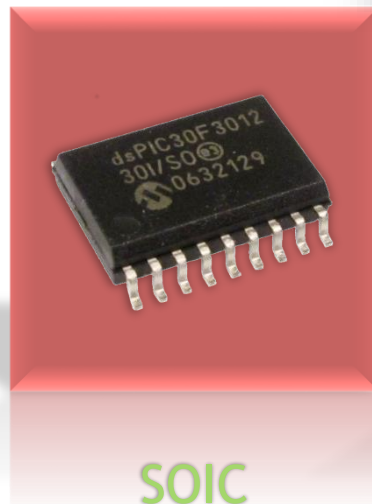
(Dual Inline Package)

Through hole

8 pins

9mm x 6mm

0.15pins/mm²



SOIC

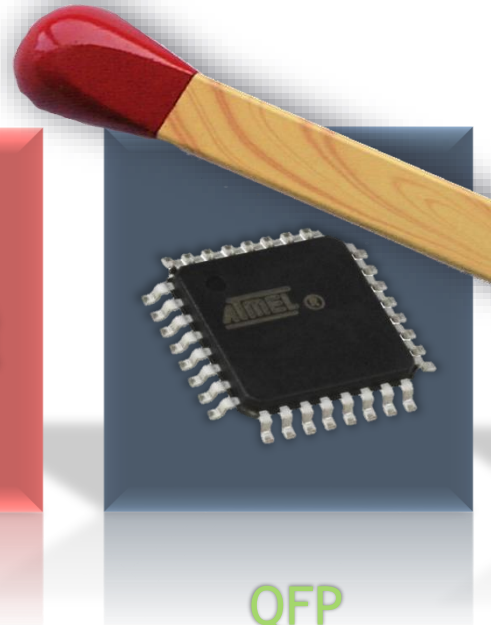
(Small Outline IC)

Surface Mount

18 pins

11mm x 7mm

0.23pins/mm²



QFP

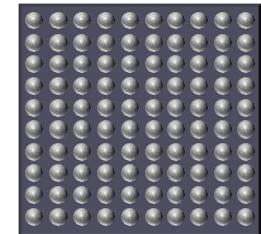
(Quad Flat Package)

Surface Mount

32 pins

7mm x 7mm

0.65pins/mm²



BGA

(Ball Grid Array)

Surface Mount

100 pins

6mm x 6mm

2.78pins/mm²

From real life (2)