Electronic and Signal module
Project Based Learning

Project based Learning Booklet

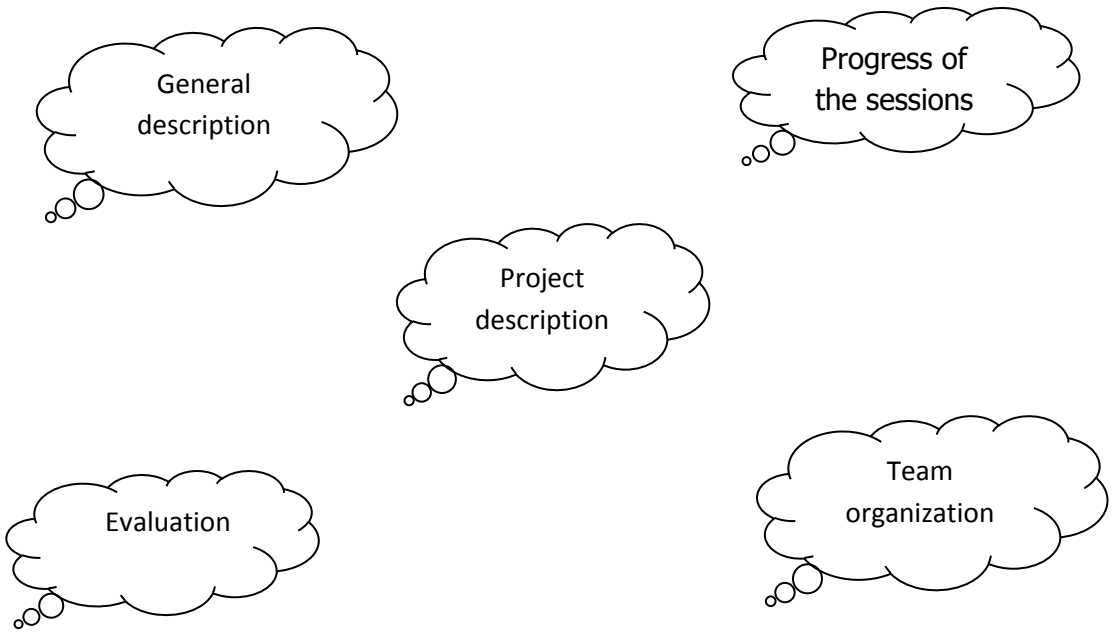
Electronic subsystem part

Engineer – 2nd Year

Mains objectives:

Learn by project
Learn with the group

Document contens:



1. Summary

2. Instructions of the manual and work operation

This booklet has been prepared to help you plan and manage your team's work and individual work. The objective is to acquire through this project-based learning (PBL) techniques and skills that are recorded in the record in the objective description of this booklet. To start your Project Based Learning correctly, the first full reading of this manual is required.

You will have three seances per week, during some seances you'll have a tutor to guide you, and you'll work as a team without tutor for some others. You'll have to work as a team of around 5 students by distributing the work and sharing knowledge.

You have to be present to all seances.

At the beginning of the project, you'll get a key and a box with tools, components, and boards.

At the end of the project, you will give the key and the box with its elements back.

During this PBL program, you will be supervised by two different tutors, one will handle your work in electronic and another one will conduct your team during signal processing algorithm definition and implementation.

One goal of the PBL is to realize the project but the real objective is to learn and get competences on the technical fields used to accomplish the project. Then you will be evaluated on some partial objectives as described on the "mission description" part of this manual.

During the weeks, your tutor can give you some exercises or small realization to perform which should be useful to help you on the understanding of some aspects of your project.

You will also have an information carrier which will be posted on Moodle: Course handouts, references, as well as appendices to the project or even a series of exercises to train you...

You will not be free to use any techniques and you will be strongly guided by this manual and your tutors, as the real objective is to learn:

- Fundamentals of microcontrollers
  - Basics on peripherals
- Fundamentals of C programming
  - Use of libraries
  - Peripheral programming / communication
- Basics of electricity / electronics
  - Voltage / current measurement
  - Power consumption
- Basic of signal processing analysis
  - Sampling
  - Filtering
  - MATLAB programming

3. Evaluation

You will be evaluated during the project by different procedures. The evaluation will concern sometime the entire team but also each team member.

a. Day-to-day evaluation

The latter will be made by your tutor according to an evaluation grid (an excel file) on different criteria bearing on your lived in communication, presentation, presence, proposal, team managing, technical ability and others. You will have access to this form each time your tutor will fill it. The form itself will be described at the beginning of the project.

Your tutor will also take in accompt your physical presence during the seances.

During the Project Based Learning process, you will have the opportunity to present current state work.

b. Examination

Depending on your tutor you can have some small on table examination or multiple-choice questionary to fill. In Electronics, you will be evaluated on the one hand on the basic knowledge in analog and on the other hand on the fundamentals in the microcontroller.

c. Cross evaluation

Possibly and depending on your tutor you will have to evaluate the work of your team mate on various criteria. This will be a confidential questionary used by your tutor to confirm its own evaluation of the team members.

d. Evaluation by final defense

At the end of the period, you'll have to defend your work and to answer to some questions front of a jury. You will demonstrate your synthetic spirit, your work quality and your subject mastering.

Please make attention that the attendance is obviously a key factor in your success. The result of all the evaluation will be synthetized by the module responsible to compose a final appreciation and the final grade.

4. Document and logistic

During this work you will use some documents provided on Moodle. You also will use internet to get information on some subjects. You also can find some exercises accessible to help you to master a particular subject.

Depending on your tutor you can have some formal courses.

Some components and boards will be given, and you must use those specific components and tools. You will not be free to develop on another platform.

5. General project description

The project proposed by an external company is to develop a central unit able to measure the environmental characteristics in different use cases. This unit will communicate its information on a smartphone via a Bluetooth link.

From given parameter like ambient temperature, sound environment, Co2, your objective is to propose a functional prototype taking in account of power consumption and its carbon print.

Your work will be controlled during your development, and at the end of the project you will present your solution and explain in detail your conception, clearly expose the accuracy of the used sensors, the price of your system, and you will justify your architectural choices. You will also present a demonstration of your system or a video demonstration of your unit.

6. Specification - recipe

During your work, you will use the V cycle development method.

The specification of the system is naturally placed at the top left of V-model cycle. The recipe book is located at the top right of the V-model cycle.

On the other hand, a schedule will help you master the different phases of system design.

a. Specifications (left part of the V cycle)

The Infinite Measure company requires:

- A fully autonomous system power possibly supplied by batteries.
- The system should sense multiple information on air quality, and eventually sense some gaz presence.
- The system should also sense the sound ambiance of the workplace and propose a criterion to evaluate it.

- A local display should permit to indicate information.
- The system should respond to a smartphone via a Bluetooth link and send information of sensors measurements on demand with a time buffer of one week. (The sampling period should be adjustable).
- The Bluetooth link should permit to fix parameters, and a minimum control must be performed to prevent pirate programming.
- Optional functionalities could be proposed.

b. Recipe (right part of the V cycle)

Test of the functions.

- The system work on a battery – What is the autonomy?
- The power consumption is clearly described.
- What are the parameters sensed by the system?
- The sound ambiance is sensed? How is established the quality criteria?
- The system report to a smartphone?
- The system could be parametrized by a smartphone.
- The security of parametrization change is guaranteed?
- What are the options?

c. Missions description

Following the V-model cycle, you have defined the top of the V-cycle: the specification of system. In the next, all the subsystems must be defined. The booklet will guide you in their definition and design. On the other hand, your PBL project will be organized into various "missions" that will be detailed in the following. They keep coming in chronological order or in parallel. At the end of each mission, the group will submit a design report and give a 10-minute defense to the tutor. APPENDIX indicates the guide to good practice for writing transparencies of defense.

Mission 1: Microcontroller programming discovery - 3 weeks

General description

During this mission, you will learn to program a microcontroller in C language. You will read and write some digital and analogical values on the input / output of the microcontroller, display some messages on a text console, use the Bluetooth link to communicate with a computer or a smartphone. You will use an OLED display to write local messages.

You will also measure currents and voltages and calculate power consumption.

A 10 minutes presentation will conclude this mission.

details

Discovered Kit PBL

Identify all the elements of the given box.

Make sure you have installed all the drivers on your computer if you use it: available on Moodle.

Connect the TIVA board on the USB port of your computer. It is better to work with Windows. Run the ENERGIA program and use examples:

Files ⟹ Examples ⟹ 0.1 Basics ⟹ Blink

You can also look the tutorial available on MOODLE: [**01] _Tiva-start.mp4.** You can find lot of tutorials on INTERNET.

In order to understand how to connect and display message on a console, use the following program:

```
void setup() {
//Initialize serial and wait for port to open:
Serial.begin(9600);
Serial.println("Bonjour");
}
Int I=0;
void loop()
{
Serial.println ("i = ");Serial.println(i++);
}
```

To display the messages, you will use the **PUTTY** program of your computer instead of the serial monitor integrated in ENERGIA.

TO DO:

1. Explain what is V cycle
2. Connect a tricolor LED on ports of the microcontroller and generate the following colors: BLUE – RED – GREEN – YELLOW
    a. Measure the current inside the LED when they are ON. Explain the result with a theoretical analysis.
    b. What is the maximum current provided by a digital port of the microcontroller at level 1 and at level 0. (Measure it and find the theoretical value inside the documentation).
3. Connect a potentiometer to an analog input of the microcontroller
    a. Read the analog value and display the result in volt every second to the console (via PUTTY).
4. Measure the power consumption of the board.
    a. Precise the test condition (what is active on the board).
    b. What will be the autonomy with a battery (choose a battery on the WEB)
    c. What is the carbon equivalent of this power consumption?

5. Indicate the microcontroller parameters (see **TIVA-Data-Sheet** documentation available on Moodle):
    a. Size of the memories (explain the different kind of memories)
    b. Clock frequency (explain)
    c. Explain the utility of a floating-point unit
    d. Describe some embedded peripherals
6. You can access to the Bluetooth link when using Serial1.xxx instead of Serial.xxx. But you have to pair the Bluetooth link of your board with the computer before.
    a. Display the values of question 2.a via the Bluetooth link.
    b. Download terminal emulator in your phone and display the value of question 2.a on it.
7. Sold the OLED display
    a. Use the given library to display messages on it.
    b. Display a logo on the OLED display

First delivery

Prepare a 10 minutes presentation (see Appendix). You will defend it front of your tutor.

Mission 2: Sensor connexion – 3 weeks

During this mission, you will connect different sensors to your microcontroller, and you will write programs to display the measures on a connected console.

1. Connect the temperature sensor on an analog port and display the temperature.
    a. What is the accuracy of the measurement?
2. Explain what Co2 measurements are from the provided sensor
    a. Connect the sensor to your system and display the measures.
3. Connect the micro electret sensor.
    a. Get a sound :
        i. Explain how this sensor works
        ii. How to make it work?
        iii. What's the voltage generated by the sensor with your assembly?
    b. Amplified the sound to Increase reception sensitivity
        i. What are the parameters of the amp to be used?
        ii. Design, calculate and simulate an amplifier.
        iii. Simulate your assembly
        iv. Realize and test the assembly
    c. Filter the sound (2nd order filter) : The frequencies you process will be less than 2500 kHz.
        i. What are the possible filter schemes
        ii. Use the parameters of the filter (s) that will be useful to you to determine the value of your schema components (analytically).
        iii. Simulate filter using the TINA or Tspice

iv. Implement an analog filter and test it independently.

4. Connect the sound sensors to your board
    a. Read the sensor with a sampling frequency of 10KHz and put the result in an array of 1000 cells.
    b. Compute the power of your samples and check if it's work by testing with different noise condition. Calibrate it with the decibel measure sensor.

Prepare a report describing those different sensors and your results.

Mission 3 – Sound analysis - 6 weeks

During this mission, you will discuss with another tutor who will explain more in depth the signal analysis part. During the last week you will implement your algorithm in C language on the TIVA microcontroller board and apply it to the sampling sound in order to display the sound quality criteria.

Mission 4 – Final programming – Defense preparation – 2 weeks

During this mission you will program the final application able to manage all sensors with the sound criteria in one general application. You'll determine the useful parameters to fix by the smartphone and implement a method to prevent identify and prevent pirate programming.

During your defense you'll explain the limits of your approach. A least, you'll prepare a 20 minutes presentation of your project (which will be followed by 20 minutes of questions), and a document describing your final conception with all details.

7. APPENDIX

a. Presentation format

During your presentation, you'll have to:

- prepare one presentation based on electronic transparencies (PowerPoint)
- don't forget to number the pages
- make each member of the team talk
- respect the timing of your presentation.

REMARKS:

- Generally, Slide should not be overloaded.
- Prefer illustrating by graphics, photos with few texts.
- Avoid writing sentences, prefer keywords enclosing you oral presentation.
- Provide all the information you need to avoid "black space" on your slide.

The presentation permits to:

- Present the overall project
- Explain the problems and their solutions
- Summarize
    - What I learned?
    - What was working well and how you've worked to get the solution
    - What was not working and why?
- Demonstration.

The report must be a complete technical file of your design.

b. End of project

At the end you have to give:

- The kit you used during the project.
- A zip file which includes your final report and the final presentation