# EE313 ANALOG ELECTRONICS LABORATORY

# FALL 2016 TERM PROJECT

## Introduction:

This document contains the project definition of the EE313 laboratory. Here are the important points about the project:

• Note that this is not a weekend project. Start working on it now. If you would like to test your designs you can use the equipment in the EE313 lab in working hours unless there is a laboratory session proceeding. During weekends, laboratory will be closed.

• The aim of this project work is to make you more familiar with some subjects you were introduced in analog electronics class. However, you may need to do some research and study extra material to accomplish the task. This will be a good first step for 4th year graduation projects.

• The project groups will contain at most 2 students. Although it is not recommended, you may do your project alone. So, determine your project partner as soon as possible. It is not necessary that your lab partner and project partner is the same person.

• You are free and encouraged to use your own ideas. Although your design approach is not limited, the systems are supposed to be economical.

• You are not required to implement your circuit designs on a printed circuit board and you do not have to mount your circuits into a box. Doing so will not increase your grade, but nor will it negatively affect your grade. But your projects should have an aesthetic look (even a circuit on protoboard can have an aesthetic look)

• All assistants are responsible for the project. Primary contact mechanism with the assistants is via email.

•No early demonstration will be allowed (apart from the crucial reasons, such as Erasmus, foreign student, etc.).

**Important Dates**

-4$^{th}$ January: Proposal Report

-21$^{st}$-22$^{nd}$ January: Project Demonstrations

-23$^{rd}$ January 17:00: Final Report Submissions

## Report Format

**Proposal Report:** The aim of the proposal report is for you to start your research early on so that you can have a solid idea about the project. This report will contain preliminary work on your project. A good report should include your proposed way to solve the problem, the equipment required for the solution, some block diagrams of the overall system and any additional info (circuit schematics, mathematical calculations etc.) you see fit. Maximum page limit for the preliminary report is 3 pages (Times New Roman, 10 point font). Longer reports will be rejected. It is crucial that you determine your project partner, and do some brain storming to come out with solutions well before the preliminary report deadline. You have to upload your proposal report in pdf format to ODTUCLASS until 4$^{th}$ January, 23:59. Late submissions will not be accepted.

**Final Report:** The final report should be in the IEEE double column paper format (please check the IEEE paper format) and it should not exceed 10 pages in total, any more pages will decrease your grade. The formatting is one of the most important parts of the project. If the final report is not in the IEEE paper format, the project will not be graded and you will get zero from the whole project. Any formatting mistake (such as no figure captions, not referral to the figure in your main text, etc.) will result in grade deduction. You have to upload your proposal report in pdf format to ODTUCLASS until 25$^{th}$ of January, 17:00. Late submissions will not be accepted. Your report should include the following items:

- Theoretical background and literature research
- Design methodology and mathematical analysis of the subsystems
- Simulation results verifying that your subsystems and overall system is working properly.
- Experimental results
- Comparison of the experimental results with the simulation results and mathematical calculations and explanation of any discrepancies.

## Grading:

-Proposal Report: 10 pts

-Project Demonstrations: 50 pts

-Final Report: 40 pts

## Project Definition:

**Wireless Heating Control System**

**Aim:** In this project you are going to design a system which equate the heat of two stations with a controlled cooler according to the wirelessly received heat information. The system includes 3 parts as depicted in Figure 1. The first and second parts consist of a sensor, a heater. The first part is the reference sensor part. These parts measure the temperature and sends the information wirelessly to the controller. The third part, controller, tries to the balance the temperature of the first and the second parts (temperature difference less than 5 °C) by controlling the cooling element which is near to the second part. Basically, inputs of the third part are the temperature information of the first and second parts and the output is the controlling signal of the cooler.

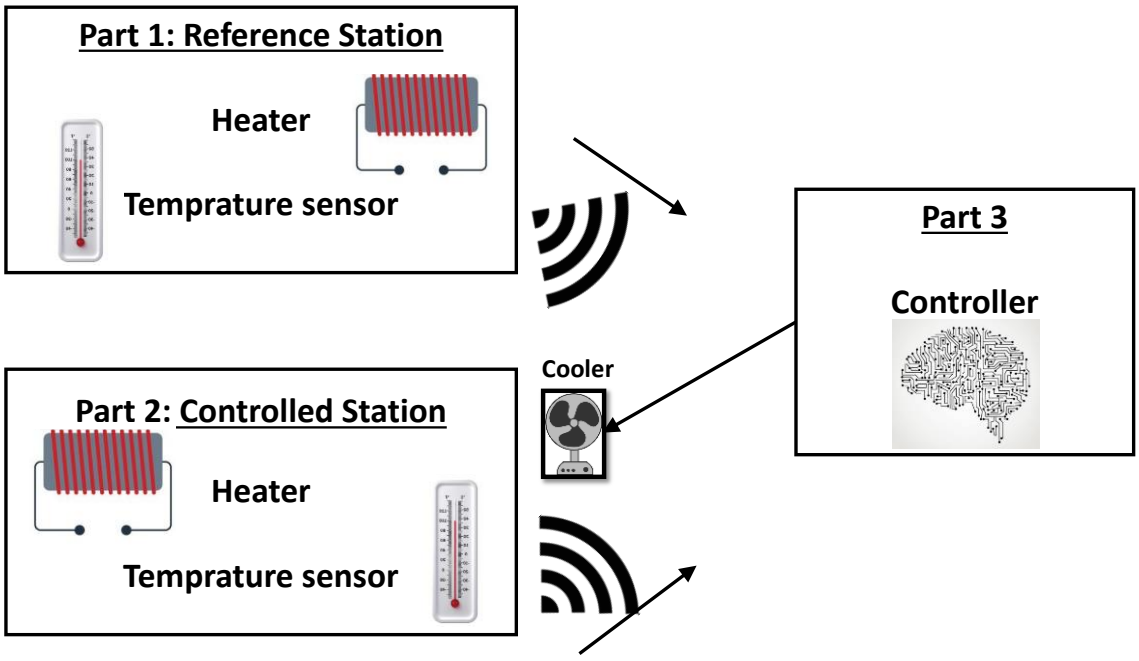


Figure 1: Block Diagram of the project

There are many ways for the wireless communication. In this project, you are supposed to find a way of wireless communication without using any commercial modules; i.e. bluetooth, microcontroller, WiFi, infrared, etc. Transmitting the sound waves by a speaker and microphone pair or using LEDs and light dependent circuit elements are good examples of the methods that can be applied. You are encouraged to find a creative solution.

LM35 is the temperature sensors that you are going to use in your project. You can reach the related documents with simple search. A power resistor and a DC motor whose resistor is connected to a fan can be selected for the heater and the cooler.

The system should have following blocks with given specifications.

**Wireless Communication Module:** You are supposed to implement two transmitters one receiver wireless communication module. You should transmit temperature information of your reference station and controlled station to controller wirelessly. There are different ways of wireless

communication. You are free to create a wireless communication module and protocol. There should be **only one receiver** in your controller. The minimum distance between your stations and controller is **20 cm**.

**Heater:** Basically it should produce heat when power is on. You can use a power resistor as heater.

**Temperature Sensor and Read-out Circuit:** You can use any temperature sensor with analog output. The simplest and most common analog temperature sensor is **LM35**. Your sensor should be placed close to your heater in order to sense the temperature more accurately. You should transmit temperature information wirelessly.

**DC Motor Driver:** You will use a **DC motor** as your cooler. You should arrange the speed of your cooler comparing the temperature of controlled station. If the temperature difference is larger than **5°C** the cooler should start to work. If the temperature difference increases, the cooler should rotate faster. You can drive and control your DC motor however you want (i.e. arranging duty cycle of PWM signal or controlling the current flowing on your DC motor.)

**Bonuses (5 pts each)**

**-Having wireless communication module working at more than 1-meter distance between receiver and transmitters.**

**-Controlling the temperature with 1°C sensitivity:** The cooler should start working when the temperature difference is 1 °C. At steady state the temperature difference of your controlled station reference station should be less than 1 °C.

**-LED Display of controlled station's temperature:** If you can indicate the temperature of the controlled station at your controller, you will take extra bonus grade.

Note that to take extra bonus grades, your demo grade should be at least 70 % of the maximum possible demo grade.

**Components Allowed:**

**-**You can use any DC motor available at the market.

-The instruments available in the laboratory.

-Any type of battery, if needed

-Any type of opamps, transistors, resistors, capacitors, inductors, diodes, LEDs available at the market

-Any temperature sensor with analog output

-Antennas, speakers, microphones, infrared sensors, infrared LEDs etc.

If you are not sure whether you can use a component you find, please contact Eren Aydın or Mustafa Kangül before using it.