The goal of the final project is to demonstrate the acquired skills on design for testability, use of serial access devices, and orientation to defensive programming and professional development methodologies. ***In this course we will not assess what was done but rather how it was done.***
Remember that you will not be evaluated by the complexity of your project, but rather by the way you organize and carry out the development work and solve unexpected problems that may appear and by the level of proficiency shown on each one of the three components under assessment:

- design for testability (at least one category of tests),
- use of serial access devices (at least two protocols),
- defensive programming (use of appropriate style guidelines like e.g. Misra C) and professional development methodology - project management, proper debugging techniques, use of version control (SVN, GIT) and of a code repository.

Below you can find a few simple ideas. Use them as starting point to prepare your own proposal to be discussed. You will have to define all the requirements of your system, define the most adequate work plan and structure it on work packages and tasks, define the time line, milestones and deliverables. You will have to adopt controlled software/hardware development procedures, including the choice of an adequate programming style, the mandatory use of a version control system and code repository and the adoption of proper debug methodologies to face any unexpected bugs and problems.

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1. Design of a robust controller for a railway traffic light.

A railway signal is a mechanical or electrical device, erected beside a railway line, to pass information relating to the state of the line ahead to train train or engine drivers. The driver interprets the signal's indication and acts accordingly. Typically, a signal might inform the driver of the speed at which the train may safely proceed or it may instruct the driver to stop. Operating rules generally dictate that a faulty signal must be interpreted as displaying its most restrictive indication (generally "Stop").
Imagine your team was designated to develop a robust controller for such device.
You will need to control one red and one green light in a way that must be robust and capable of assuring graceful degradation if a malfunction appears. Commands and status requests are received and sent by an asynchronous serial port. The controller must manage all its power-on self-test procedures, according to the most adequate test methodologies, must store in non-volatile mass storage all operational data (like in an air-plane flight recorder) and should maximize the lifespan of the light bulbs. It can have redundant light bulbs to be used in case of failure. It can have watchdogs to monitor the execution of software and whatever feature you decide to make it more robust.

2. Redesign of a domestic soap dispenser

An automatic, battery driven, soap dispenser is already being commercialized. The current control electronics has no intelligence – it's just a simple analog monostable that activates the soap pump for a short period of time when it detects a hand in range.
Imagine your team was requested to completely redesign this product in order to introduce robustness and embedded intelligence, capable of supporting new high-valued features like, for example, operational counters, usage statistics, power-on self-test, communication features, etc.

3. Design of a distributed voting system

Your team was requested to design an automatic distributed voting system to be installed at the National Parliament. Each member has a small device at least with two push buttons (Yes/No) and one LED for user interface. A centralized system, connected to the remote devices by an asynchronous communication line collects the votes and displays the result. The controller must manage all its power-on self-test procedures, according to the most adequate test methodologies and must store in non-volatile mass storage all operational data. It can have whatever feature you decide to make it more robust and reliable for the purpose. This work is suitable for two groups.

4. Design of a distributed caller id system

Your team was requested to design an automatic caller id system to install at an hospital. Each bed has a smart device that allows the patient to call a nurse. That device has a push button and an LED as user interface. A central system in the nurse's room is connected to all the devices using an asynchronous multi-drop interface. The device controller and the central controller must manage all its power-on self-test procedures, according to the most adequate test methodologies and must store in non-volatile mass storage all operational data. It can have whatever feature you decide to make it more robust and reliable for the purpose. This work is suitable for two groups.

5. Design of a speed-limit enforcing traffic light

A speed limit enforcing traffic light is a special traffic light that stops any vehicle running over the local speed limit. Typically, the signal is green and when it detects a vehicle running over the local speed limit it will go from green to yellow to red for a given (usually long) amount of time. The traffic lights are positioned at a proper distance from the place where the speed id measured to allow the vehicle to stop safely. Your team was requested to develop a robust controller for that system. You will need to control one red, one yellow and one green light in a robust way and be capable of assuring graceful degradation if a malfunction appears. The controller must manage all its power-on self-test procedures, according to the most adequate test methodologies, must store in non-volatile mass storage all operational data and should maximize the lifespan of the light bulbs. It can have watchdogs to monitor the execution of software and whatever feature you decide to make it more robust. This work is suitable for two groups.

6. Design of a coin identification system

Your team was assigned the redesign of an existing coin identification system to be installed at a vending machine. You will use an existent closed system and redesign it in order to introduce robustness and embedded intelligence, capable of supporting new high-valued features like, for example, operational counters, usage statistics, power-on self-test and synchronous communications. Your team is also requested to design a proper way to test the system.

7. Design of a road traffic logger

A road traffic logger is an autonomous system capable of counting the vehicles crossing a given point in a road and store this information in non-volatile storage for later upload to a processing system. The system should be capable of working unattended for extended periods of time (weeks). The controller must manage all its power-on self-test procedures, according to the most adequate test methodologies, and should maximize the battery life. It can have watchdogs to monitor the execution of software and whatever feature you decide to make it more robust.

8. Interface with a four-digit dot-matrix display

Writing of messages in a 4 digit 5 × 7 dot-matrix LED display. The interface between the microcontroller and the display is provided by the MAX6953 cathode-row display driver that interfaces microprocessors to 5 × 7 dot-matrix LED displays through an I2C™-compatible serial interface. The MAX6953 drives up to four digits (140 LEDs).

9. Impedance measurement system

Develop the interface of the microcontroller with the ADS9933 integrated circuit to implement a built-in

impedance measurement system. The ADS9933 IC is an impedance converter system solution that combines an on-board frequency generator with a 12-bit, 1 MSPS, analog-to-digital converter (ADC). The values with which the final impedance is calculated are captured from the IC via a serial I2C interface.

10. Environment Light Intensity Regulator

Implement an automatic environment light intensity regulator with the MAX44009 ambient light sensor, which features an I2C digital output (22-bit dynamic range from 0.045 lux to 188,000 lux). The lightning device should be implemented with a LED matrix based bulb. The user should be able to define a set point. A Pulse Width Modulation based regulation should be used to drive the bulb.
https://github.com/dantudose/MAX44009

11. Thermistor Based Temperature Sensor with Linearizing Circuit

Implement a realized temperature measurement system based on a thermistor sensor bridge. The linearization process is implemented with the MLX90308 Programmable Sensor Interface. This chip is a dedicated microcontroller which performs signal conditioning for sensors wired in bridge or differential configurations.

12. Detection of Hot Spots with an Infrared Optical Sensor

Implement a hot spot detector system with a IR thermometer module, which performs signal conditioning, linearization and ambient temperature compensation. The MLX90601KZA-CKA is a module that comprises sensors and the MLX90313 ASIC placed on a flexible substrate. The module has a 10 pole connector, which has all relevant interconnections to the ASIC. An SPI interface is available. Next to reading the temperature information, the SPI interface also allows changing the module's settings and calibration.

13. Signal Generator with the ADS9951 IC

Implement a programmable signal generator using the DDS (Direct Digital Synthesize) ADS9951 IC. The AD9951 is a complete high frequency synthesizer capable of generating a variable frequency analogue output sinusoidal waveform at up to 200 MHz, resorting to a digitally programmable DDS and an internal high speed, high performance 14-bit DAC, operating up to 400 MSPS. The frequency tuning and control words are loaded into the AD9951 via a (SPI compatible) serial I/O port.