

**Goals:** To apply the embedded and real-time systems concepts learned in the course. These are:

1. Ability to design and construct a complex hardware and software system, component, or process to meet desired needs using relevant software engineering principles, within realistic constraints such as economic, environmental, social, political, ethical, health & safety, manufacturability, and sustainability.
2. Ability to identify, formulate, and solve hardware and software computer engineering problems using sound computer engineering principles.
3. Ability to effectively communicate technical information in speech, presentation, and in writing.
4. Continue the learning in the course to engage in lifelong learning.
5. Ability to understand contemporary issues in this area.

**Objectives:** We plan to address the goals stated above using a hands-on project that will involve original design, and implementation, demonstration and presentation of embedded/realtime system. This is a demonstration project that includes a presentation of your completed project. For this project you will work in groups of two.

**Problem Statement:** Choose a concept/idea after discussion with your team mate, TA and your instructor. The idea has to be approved by either the TA or the instructor. The scope of project should be implementable within the time and the resources available.

- Choose/Identify an idea that has economic, environmental, social, ethical, health and safety, manufacturing and sustainability (say, in energy) impact.
- Formulate the solution for the problem identified using best practices learned in the course.
- Implement and test the solution. Prepare for the demo and presentation.

We will work with Adruino ([www.arduino.cc](http://www.arduino.cc)) Uno hardware as the primary base hardware. You can use other similar small embedded system such as Rasberry PI (<http://www.raspberrypi.org/>) and maple (<http://leaflabs.com/devices/maple/>). Arduino itself has many variations such as Arduino Mega, Arduino Duo etc. Arduino is a very popular hardware used in many modern/contemporary systems. Ford OpenXC is arduino compatatible, for example. “The OpenXC kit includes a vehicle interface module based on the popular Arduino platform developers can use to read data from the vehicle’s internal communications network. The hardware module provides real-time access to parameters like the vehicle sensors, GPS receiver and vehicle speed. The hardware module is connected to a smartphone or tablet on which apps can be written to consume and use these data.” <http://openxcplatform.com/>

How about google’s driverless car? How about Carnegie Mellon’s driverless car? How about the drones for various purposes?

### What to do?

1. Choose your group members. At most two in a group. (Note: some other embedded systems have been provided you can support yourself for technical details.)
2. We will be using Arduino Uno hardware; For Arduino details look at the link:  
<http://arduino.cc/en/Main/Software> ;

This page has download details and also details of many examples. Go through the examples before deciding on your problem. (For example, do not repeat “blinking LED” as your project.)

3. You will have to get approval for your project idea either from Brian, Bruce or myself. I want the ideas finalized by this Friday (11/1) class time.
4. Once the idea is approved you will work on the project design, implementation and presentation and the documentation (in the form of Report).
5. You will submit the presentation and the report online for grading.
6. Your presentation should include a Classes, Responsibilities and Collaboration (CRC) diagram of how you divided the responsibilities of your project among the team members.
7. Your report should include a Use Case diagram and a class diagram explaining the design of your application.
8. CRC card method, use case diagram class diagrams are some of the best tools and best practices that can be used anytime in the future when you are designing hardware and software solutions.
9. Your grade will be based on completion of your project, presentation, and your report.
10. Also part of your project 3 grade will include grade for attending the presentation by others.
11. The presentation will be short about 5 minutes, and will be during the week of 12/2 in class and during recitations; we will plan the order of presentation soon.
12. Finally, the due date for the submission of the Report and presentation online is: 12/7/2013.

### **What to do with Arduino?**

1. Once the Arduino development Env. is installed, go to Getting Started in the Help menu, to upload and run a sample program, “LED Blink”; observe the *setup* and *loop* functions. *Setup* function is used to initialize the conditions and *loop* function is the cyclic executive.
2. Understand the Arduino Uno hardware on the board.

See <http://docs-asia.electrocomponents.com/webdocs/0e8b/0900766b80e8ba21.pdf>

3. Look at File → Examples and run the many examples that are provided with the IDE.
4. Understand the Sketchbook concept and also sketches.
5. Arduino Uno (R3) is connected via USB port and the File → Upload is used to load the “Sketch” into the board.

### **Arduino Hints:**

Here are some links for Arduino:

1. <http://arduino.cc/en/Guide/HomePage>
2. <http://arduino.cc/en/Main/Software> (get the Arduino IDE software from here)
3. <http://mattters.com/science-projects/news/tft01-arduino-lcd-shield-in-stock>

4. <http://www.meetup.com/buffalolab/members/1627521/>
5. <http://arduino.cc/en/Reference/HomePage>
7. <http://docs-asia.electrocomponents.com/webdocs/0e8b/0900766b80e8ba21.pdf>
9. <http://www.ladyada.net/library/arduino/unofaq.html>
10. <http://randommusicdesign.blogspot.com/>

Here is a solution for a problem you may or may not encounter:

"If your computer doesn't recognize your Arduino and won't install the proper drivers, this fix may work. I used it for my Arduino UNO with Windows 7 64-bit, so steps may vary for other devices and operating systems. I'm writing this from memory so sorry if there are some gaps.

- 1) Go to the "Unknown device" which is the Arduino.
- 2) Click around in the "Hardware" tab to open a window with the "Update Driver" button on it. Click it.
- 3) Choose the option to find the driver from a list on your computer. Then choose "Let me pick from a list of device drivers on my computer".
- 4) Scroll down and choose "Ports".
- 5) Choose "Arduino LLC" and then "Arduino UNO". If there is no "Arduino LLC" option, follow the steps below:
  - a) Click the "Have Disk" button.
  - b) Point to the Arduino folder, then to the "drivers" folder, then select the .inf file for your particular device (In my case it was Arduino UNO.inf).
- 6) Install the driver. Ignore any warning messages about verification of publication.
- 7) The Arduino should now be listed as a COM port instead of an unknown device. In the IDE click Tools > Serial Port and select the new COM port. In my case it was COM5."