

ECE-CT580 Spring 19-20  
Homework/Reading Week 2

**Lecture Material:**

Go over posted notes in Week 2 folder:

- Arduino\_Arch\_RISC
- Data\_types
- Sketches\_Size (note some code cut off but is should be obvious)
- Oversampling with averaging (read the link it talks about statistics)
- Week 2 Wed
- EIT\_Logic only pages cited in Week2 Wed
- DGCH-RED data sheet
- Ultrasonic Sensor

**Familiarization with Arduino Mega 2560 – this is to be done by each student**

- First use <https://www.arduino.cc/> Under resources: Tutorials and References)
- Then search web (see some of the links we used before such as **sparkfun** or **instructables** etc.)

**Things to look up and try in a simple sketch so you understand (you can turn in for extra points – but not necessary)**

- Commands for timing: millis() micros()
- Command one way to read ultrasonic transducer: PulseIn() not very accurate
- Commands for bit shifting left and right: <<, >> (C language)

Look these up for later use

- Commands for interrupts: see language reference focus on external interrupts – we will do time interrupts later.

**HW Problems**

- 1) Look up “Q Math” or Q Arithmetic (Wikipedia is a good first look) Focus on TI processors. Write a maximum 1 page overview of what it is, give simple examples. Do this in your own words and compare to we we did in class. What does the TI processor do to support Q arithmetic?
- 2) Based on the information in Week 2 on the ultrasonic sensor – dig a bit deeper to see what you can find about
  - accuracy, and repeatability and temperature sensitivity (look up definitions)
  - see if you can find the “antenna pattern” . (not a cone as we described in lecture, it has multiple lobes)
  - You might not be able to find this information for your exact sensor, but the general form of the information will be extremely helpful.
  - Do a one page write up (some bullets are fine)

**Coding Problems:** (you can collaborate with your partner on these however each person must turn in different codes)

**Instructor Problem 1:** Fixed Point Computations

Using the Arduino write a program that computes the product of two numbers (from lecture) 6.5625 and 4.25 as a base line test

- Use float to find the answer, hard code the two numbers as constants
- Use fixed point :  $6.5625 (W=(8,3,4)) * 4.25 (W=(8,5,2))$
- Use the micros() command to time how long it takes to do the multiply for each , you may need to do the process n =1000 times and then divide to get some resolution.
- Use the serial port to print out the two answers and times AFTER both have been run the n times. You may need to do some bit shifting etc to get the correct number of binary points – don't do this in the timing loop
- This ends the baseline

Variations

- What happens to execution if you change the values (say one is negative, larger and smaller values)
- What happens if  $W = 16$ ?

Show codes and screen shot of serial output

**Instructor Problem 2:** First Cut Ultrasonic Transducer

This is a familiarization process – not what we are going to finally do

- Search the web and find two different Arduino coding techniques to interface the ultrasonic transducer - one should be interrupt based the other could use the PulseIn() command
- Look at the file Mounting\_Ultrasonic\_Sensor for some ideas
- Set up the sensor taking consideration of the cone as described in the mounting document – you only need one or two distance for now say 10 and 30 inches between the sensor face and a wall.
- With the sensor fixed at say 10 inches try each of the codes you found
  - discuss if the results are the same the try for another distance.
  - You should print out values using the serial monitor.
  - Take a number of readings – do the values change with time
  - Try “fanning air in front to the transducer and the wall – do the readings change?
  - Compare the reading to a ruler how close is it – you need to use the equation in the documents to convert pulse timing to cm or inches
- Include a photo of you setup

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**What to turn in:**

Document your code with your name, date, sketch/program name, what it does and anything important. Cut and paste into document or screenshot of IDE that shows all code

A single document in pdf form with

- Header page (see next page)
- Answers to HW 1 and HW 2 single page each separate pages
- Code and discussion for Instructor problems

**Keep these Sketches and knowledge of your wiring/setup from instructor problems**

Cover sheet follows

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**Please submit the filled in cover sheet as the first page of you HW submission.**

**Last Name:**\_\_\_\_\_ **First Name:**\_\_\_\_\_

Students must indicate the status of each problem by:

- **C:** completed,
- **P:** Partially completed,
- **N:** not attempted

**Instructor Problem**

Problem	Status	Grade/Comments
HW 1 Q Math		
HW 2 Ultrasonic Sensor Digging deeper		
Optional XC Sketches Demonstrating commands		Optional Extra 2 points max
Instructor 1 Fixed point computations		
Instructor 2 First cut on Untrasonic Sensor		

Final Score:\_(10 points)