# ECE437: Sensors and Instrumentation

# Lab 10: Accelerometer and Magnetometer Sensor

## Introduction

In this lab we will learn about magnetic and accelerometer sensors. We will use a sensor from ST Microelectronics which integrates both magnetic and acetometer sensing capabilities in a single integrated device. The sensing is realized via micro-electro-mechanical system (MEMS) structures integrated with CMOS technology. This monolithic integration of MEMS and CMOS technology has enabled a boom in the sensor technology by creating miniature, low power, digital sensors. We will use LSM303DLHC sensor for this lab. The datasheet for this sensor is located on the course website.

The sensor provides magnetic and acceleration data via $I^2C$ serial protocol. You will implement an $I^2C$ protocol to read the data and test the sensors capabilities in this lab.

## Relevant Documents for this Lab

Required reading material for this lab:

1. The datasheet for LSM303DLHC is located on the course website.

Additional reference material for this lab:

1. None.

## The Goals of This Lab Are:

1. The objective of this lab is to acquire magnetic and acceleration data from LSM303DLHC sensor. The data will be acquired via I2C communication protocol between the FPGA and the sensor. Once the FPGA acquires the sensor's data, it will transfer the data to the PC via OpalKelly interface.

## Prelab Questions (20 pts):

1. Look over the online documentation for the sensor. How many registers are there in the sensor? (5 pts)
2. What is the address for the registers that contain the acceleration and magnetic data? (5 pts)
3. How many bits is the output data per channel (meaning X, Y and Z direction for either magnetic or acceleration data)? (5 pts)
4. Figure 1 of the sensor's datasheet presents a block diagram of the entire system. How do you think capacitors can be used to sense acceleration information? (5 pts)

## Checkpoint 1 (100 points)

The goal of this lab is to write the necessary firmware (Verilog code) and software (Python) that will enable you to continuously acquire magnetic and acceleration data from the sensor, transmitted it to the PC and display it on the screen.

- You can use any of the OpalKelly modules for transmitting data to the PC, including OKWires or BTPipes. You will need to demonstrate that your code work properly to the TA.
- Move the sensor in the X, Y and Z direction and observe the data recorded by the sensor. Does the sensor data make sense? How is the data different when you move the sensor faster or slower in any direction?
- Print your Verilog and Python code and include it in your report.