**Course Objectives**

1. Exposure to different sensor types to measure multiple classes of physical parameters:
2. Identify and/or list different types of actuator technology
3. Define the advanced applied math topics and describe their potential applications

**Learning Outcomes**

1. **Experimentation and data collection:** Use actuators, data acquisition equipment, and sensors to create and measure system input and output signals, and vary experimental parameters as needed to produce useful data

a. Recognize useful vs. useless measured signals and if necessary resolve issues such as inadequate signal to noise ratio, resolution limitations, inadequate sample rate, and clipping by varying experimental parameters.

b. Ensure useful frequency information can be obtained from a measured signal by recognizing and removing aliasing by increasing the sample rate until the Nyquist frequency is greater than the highest frequency present in the signal or by adding an anti-aliasing filter to remove signal frequencies greater than the Nyquist frequency.

2. **Data analysis:** Draw conclusions from measurements using both numerical and analytical methods

a. Use filtering to remove noise or signal at unwanted frequencies, e.g. to increase the signal to noise ratio.

b. Create a parametric model from data by using curve fitting (parameter estimation) tools to determine a function of best fit and the values of the best-fit parameters with uncertainty and evaluate whether the assumed functional form is statistically significant

3. **Communication:** Communicate an experimental background, methods, results, and conclusions through oral, visual, and written communication, including an abstract, in a style and format suitable for publication in a refereed journal or presentation at a conference in the field.

a. Present data in a graphical form acceptable for publication in a peer-reviewed journal or presentation at a professional conference in the field.

**Lecture Schedule：**荔园6栋403, W 10:00AM-12:00 noon

Tentative Class Schedule (subject to change, check Wechat For updates)

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| --- | --- | --- | --- | --- |
| **#** | **Day** | **Date** | **Topic** | **Problem Set** |
| 1 | W | 28 Feb | Introduction, Strain gauge and Uncertainty analysis |  |
| 2 | W | 7 Mar | Acoustic sensors, RC filter, Op Amp and Bode Plot, Introduction to FFT |  |
| 3 | W | 14 Mar | Accelerometers, Identification of 2nd order systems |  |
| 4 | W | 21 Mar | Presenting Visuals and Analyzing Data, Probability Density Functions, Minimization and Functional Fitting via WebEX |  |
| 5 | W | 28 Mar | Introduction to dynamometer |  |
| 6 | W | 4 Apr | Introduction to different commutated motors, Aliasing and ADC |  |
| 7 | W | 11 Apr | Introduction to Dual Range Force sensors |  |
| 8 | W | 18 Apr | Experimental Design, Results, and Discussion |  |
| 9 | W | 25 Apr | Temperature and Image sensors, Video Analysis |  |
| 10 | W | 2 May | EEG and EMG sensors |  |
| 11 | W | 9 May | Amplitude and time domain techniques for data analysis |  |
| 12 | W | 16 May | Laser Interferometer, Gas and Pressure sensors |  |
| 13 | W | 23 May | Measurement of vibration and small amplitude signals using interferometry |  |
| 14 | W | 30 May | How to write your Background (or Theory), Formatting Guidelines for Written Reports |  |
| 15 | W | 6 Jun | Advanced sensors and applications |  |
| 16 | W | 13 Jun | Advanced sensors and applications (part II) |  |

**Lab Schedule：**TBD

Tentative LAB Schedule (subject to change, check Wechat For updates)

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| **#** | **Day** | **Date** | **Topic** | **Problem Set** |
| 1 | W | 28 Feb | Getting ready for Arduino setup; uncertainty analysis |  |
| 2 | W | 7 Mar | **Sound:** Identifying Music lab, Introduction to FFT, PSD and how to use Bode plot |  |
| 3 | W | 14 Mar | **Acceleration:** Mass-Spring Lab, Identification of 2nd order systems |  |
| 4 | W | 21 Mar |  |
| 5 | W | 28 Mar | **Distance:** More Signal Analysis, amplitude and time domain techniques |  |
| 6 | W | 4 Apr |  |
| 7 | W | 11 Apr | **DC Motor Experiment**, intro to dynamometer, the difference between electronically commutated (brushless) and mechanically commutated motors |  |
| 8 | W | 18 Apr |  |
| 9 | W | 25 Apr | Tensile Testing system: intro to Dual-Range Force Sensor for strength measurements |  |
| 10 | W | 2 May |  |  |
| 11 | W | 9 May |  |  |
| 12 | W | 16 May |  |  |
| 13 | W | 23 May |  |  |
| 14 | W | 30 May |  |  |
| 15 | W | 6 Jun |  |  |
| 16 | W | 13 Jun |  |  |