# JEE4440 – Sensors and Actuators, Spring 2021

# Class Project

# Date: January 20, 2021

### Introduction

The project for this class has the purpose to provide a fun, hands-on approach to learning about sensors and actuators. The project serves to expand your comfort and knowledge level in order to make the class material more meaningful. Students will work in small groups and deliver a class presentation just before the conclusion of the semester.

### Description

Design a closed loop electro-mechanical system that is interesting to you and your group. The system may be a plant or process that is existing or notional, as long as you describe it in sufficient detail. The system is to be modeled via prototyping with the furnished Arduino Lab Kit. You are to stimulate the closed system so that it reaches steady state.

Students are to form a group of three (3) class members which you will register on Canvas. Selecting students with complementary skills is encouraged. Each group member will receive the same grade.

Using an Arduino as the system controller, prototype the design with a minimum of (3) unique sensors and (1) actuator selected from a WUSTL provided kit. **Only the components from the project kit are permitted, but you can design any sensor you wish from those available. Only one digital or temperature/thermal sensor are to be counted toward the minimum.**

**Note: This project should be new work and not duplicative of similar work in other classes and should be your group’s own work**.

### Design Requirements

Define the operating and performance characteristics for the system and the individual sensors and actuators under normal control. You can measure these once your prototype is finished or you can solve them analytically, but it should be clear what approach you used. Some of the characteristics include accuracy, resolution, speed, linearity, stability, and operating bandwidth. You must have a stimulus for your system as well.

Additionally, analysis of the individual (3) sensors and actuators should show either an analytical or derived transfer function. I want each transfer function shown as a function of customary variables for that particular sensor with plot and particular region that it is defined. The sensitivity is to be derived from the transfer functions and plotted versus a customary function for that particular sensor. Include the specifications on each sensor and actuator as modeled. Any data used from the manufacturer must be cited.

### Presentation Requirements

At the conclusion of the semester, each group will make a required presentation.

1. I will set aside two class periods for presentations and expect all students to attend both classes and ask questions.
2. The presentation is to contain a summary of key findings, technical description of the project, what you enjoyed/not enjoyed and what you learned will be presented near the last week of class.
3. The presentations are generally 5 to 7 minutes in length, but the grading is not time dependent. The demonstration should be prepared to reach steady state within 2 minutes.
4. The presentations are to be made through Zoom. The breadboard design can be a series of photographs inserted into the Powerpoint to compliment the presentation. However, the class should visually see the breadboard design operational during the implementation showing the real-time output of sensor and actuator results shown on a PC and shared via Zoom.
5. The same presentation file that is presented shall be submitted as a single “pptx” uploaded to Canvas by the end of the day of your presentation. **It should not be a pdf, nor a zip file nor a Google docs file**. The file name should follow the convention “xx\_yy.pptx”, where xx is the 2 digit group number in Canvas (i.e. “01”) and yy is a brief title with words separated by “\_”.
6. I would suggest that your group perform several practice runs via Zoom prior to the “real” presentation.
7. A checklist of additional material for the presentation is included below.

### Checklist

The following represents a minimum amount of content in the presentation that should be included (no particular order). These can represent multiple slides in the presentation:

* Cover page with team members, project title, and group photo.
* Introduction of the project design and what problem you are trying to solve.
* Define the operating characteristics (performance specifications) for the system and the individual sensors and actuators under normal control.
* Block diagram of the closed loop system.
* Electrical diagram showing power source(s), interfaces to controller and all other related electro-mechanical equipment.
* Analysis and specifications of each individual sensor and actuator as modeled.
* Project Gantt chart indicating major tasks, duration and individual roles.
* Define at least four regulatory standards for your design.
* Safety features that are needed if the prototype was to be implemented as designed,
* Referencing the NSPE code of ethics, describe any ethics that you would apply to your implementation,
* Provide a Bill of Material (BOM), indicating estimate costs of the prototype if you were to build a single unit. Reasonable estimates are acceptable.

### Grading

Everyone on the team will receive the same grade. It is important that you surface team issues early on. It might be worthwhile to assign some responsible individual to be the team coordinator or “project manager” that keeps a watchful eye on the calendar and your proposed project schedule. Please refer to the project rubric\* for more specific grading criteria.

The grading criteria\*:

* Engineering Design = 35%
* Demonstration = 35%
* Project Management = 10%
* Final Presentation = 20%

### Planned Semester Schedule (dates are approximate and defined on Canvas)

* Project Announcement and rubric posted to Canvas.
* Project/Lab kits distributed.
* Deadline for each team to form and be established within Canvas.
* Class presentations and submittal.