**ELG4157** Case/Lab3 (Project) (50 marks)

**IoT Control System (Embedded Arduino PID Controller)**

Design and Simulation (10 marks), Implementation (20 marks), Report (20 marks)

**(Copy and Paste of any Kind is not Accepted)**

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| Student 1  |   |
| Student 2  |   |
| TA |  |

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| PlantControllerSensorTransformation**Arduino** |

**Task**

* Develop embedded P-I-D Controller + low pass filter in Arduino code.
* Create Arduino Library with functions.
* Create “analog out”, using digital to analog (DAC) chip and use a simple RC circuit on a breadboard.
* Test P-I-D controller using hardware in the loop (HIL) simulations and testing.
* Create model of a process (motor, for example) in MATLAB or LabVIEW and connect to Arduino embedded PID controller.
* Publish data to server/cloud.

Cloud

Arduino IDE

ThingSpeek

Physical Process

Analog

Analog

Arduino PID

Controller

Virtual Process

Feedback System

**Software:**

* **ThingSpeak** is an IoT service to collect and store sensor data in the cloud and develop IoT applications. It works with Arduino, Raspberry Pi, and MATLAB. The “ThingSpeak support “Toolbox” helps use desktop MATLAB to analyze and visualize data stored on “ThingSpeak.com”. ThingSpeak Support from Desktop MATLAB is available at: http://se.mathworks.com/hardware-support/thingspeak.html
* **Fritzing** is an open source software for design of electronics circuit diagrams.
* **MATLAB/MULTISIM; LabVIEW.**
* **Arduino Software:**
	+ <https://www.arduino.cc/en/Main/Software>
	+ <https://www.arduino.cc/en/Reference/Libraries>

**Hardware:**

* Your personal computer
* Arduino
* Breadboard; Motor; Capacitor (10 µF); Resistor (3.9 kΩ); DAC (Microchip MCP4911, MCP4725 or similar).
* Process: Heater or motor

**Convert PWM to Voltage**

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**Arduino PID Controller**

Find a discrete PID algorithm and implement the PID algorithm using Arduino Programming.

**Tasks 1:** Draw a block diagram for a feedback (PID) control system with all details.

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**Task 2:** Develop the PID algorithm (<http://www.mic-journal.no/PDF/ref/Haugen2010.pdf>)

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**Task 3:** Develop the mathematical model of the process. Use the step response method to find initial model parameters. Then use trial and error method to verify and fine-tune if necessary

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**Task 4: Discrete LPF**

Create and use a LPF together with the PID Controller. Implement the LPF as a separate function.

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| Write the LPF Transfer function.Use the Euler backward method to find the filter output algorithm. |  |

This above open-ended project presents investigation, design, simulation and implementation of a digital control system that uses a microcontroller (Arduino) platform. The research and investigation part discusses the structure of a controller algorithm. An Arduino-based controller should be designed, simulated and built in the lab to control any physical quantity, using hardware parts and software portion including possible C/C++ programming.

**Design and Simulation (10 marks)**

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| * Identify an actuator, understand its function, and connect it into a circuit
* Use pulse-width modulation (PWM) to mimic analog output for actuation
* Identify a sensor, understand its function, and connect it into a circuit
* Write a program to integrate all above.
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**Implementation (20 marks)**

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| * Implement the project and tune a PD, PI, or PID on a microcontroller and the rest of the components.
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**Report (20 marks)**

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| * Develop an IEEE format report of about 5 pages describing the details of the project. The report should include title, names of students, abstract, introduction, theory and design, software and simulation, implementation, conclusion, and references.
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A good e-poster is the one that reflects the four disciplines of Electrical, Computer, Software engineering and Computer Science through a Canadian or global technology, where the high school students see that cluster of programs integrated into that technology and beyond. The above rationalises the presence of these programs under one school and the presence of students in one class like CSI/ELG/SEG2911. The poster should not be about defining these programs in separate statements, but about integrating them under one theme and motivating the high school students to embrace one of programs due to their relevance to each other as well as to the most innovative real life applications.