# **Course Syllabus**

**PC/CP 320: Physical Computing - Digital Interaction with the Analog World**

Department of Physics and Computer Science

Faculty of Science

Waterloo Campus

Fall 2022

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| **Instructor Information:** | Mr. Terry Sturtevant |  |
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| Office: | N2092A |
| Ext:  | 2049 |
| Office Hours:  | By appointment |
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| **Course Information:** | Calendar Description: | Design and construction of computational systems that interact with the physical world for applications such as home or experiment automation. Basics of electrical circuits, reading from analog and digital sensors, controlling analog and digital actuators, single board computers such as Arduino or Raspberry Pi, analog components including diodes, transistors, and operational amplifiers. |
| Prerequisites: | CP164 and PC/CP220 |
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| Lecture: | TR 8:30-9:50 a.m. BA110**Note that the active learning exercises and the lecture quizzes happen during the lecture times, and these together account for 15% of your final grade.**  |
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| Labs:  | **All labs are in N2082.****Each week’s lab is in two parts, split between Tuesday and Thursday. You must complete the requirements for both parts each week.****The labs build upon each other. If you miss a lab, you will have to make it up before you do the next lab.** |
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| **Course Overview and Approach:** | *This course has a vital lab component. That means that much of your learning will happen through your hands-on experiences in the lab. The lectures and other on-line documents have been chosen to give you the background you will need to prepare you for the labs.**This course requires CP164 and PC/CP220, although some things will be easier if you have also taken PC221. If you haven't, then you may need to rely more on some of the online resources. Within a few weeks you should have caught up on the important points.*At the end of this course you will get a detailed, anonymous evaluation to fill out, where you can indicate your opinion on many aspects of the course. This is one of the most important resources to help me improve the course each time I teach it. |
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| **Course Tools and Learning Materials:** | *All of the information for this course and all of the available electronic resources are on the course website. I've tried to make it as complete as possible, so that you only have to look in one place for anything relevant to the course. If you find any other resources that are particularly useful, let me know.**You'll need to get a lab notebook for this course. This is very common in science and engineering disciplines, since it develops the habit of keeping all of your observations, thoughts, data, and other information in one place. You'll use notebooks for several electronics labs, and you can re-use notebooks if they have empty space in them since real-life information isn't split into courses. If you want to use the notebook for notes from the lecture material, you're welcome to do so.* |
| Text: | There is no required textbook; required reading will be in the MyLS pages |
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| MyLearningSpace : | <https://mylearningspace.wlu.ca/> |
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| **Student Evaluation:** |

| Lab demonstrations | 25% |
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| Postlab requirementsMyLS quizzesActive learning exercisesLecture Quizzes | 15%10%5%10% |
| Integration Project  | 20% |
| Exploration Project | 15% |
| **Total** | 100% |

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| **Learning Activities, Assignments, Tests, Quizzes and Examinations:** | *There are several different types of assessment that will happen in this course. No single method of assessment is best for contributing to your learning, so the variety reflects that.* |
| Lab demonstrations /postlab requirements* work demonstrated at every lab
* every lab will indicate what is to be demonstrated
* all labs weighted equally
* *Each lab will have points at which you have to show that you have accomplished the required task(s). Usually they also require you to explain something you have learned in your own words to verify that you've understood the key points.*

**Postlabs**There are different types of post-lab requirements for different labs. |
|   | Lab notebook summaries* sometimes including specific items for certain labs
* all labs weighted equally
* see [Lab Notebook](http://denethor.wlu.ca/common/lab_notebook.shtml) for requirements
* *The notebook is the vehicle for you to record all of what you learn for future reference.* ***You'll be able to use it for quizzes, so it should be your most vital resource.*** *The questions and summaries that you hand in ensure that what you have recorded for your own reference is useful and correct.*
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|   | Rewritten code* showing modifications to original sample programs
* observing all rules of good coding practice
* all labs weighted equally
* *The more you become accustomed to using good coding practices the more you will benefit in being able to understand and reuse your own code.*
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| **MyLS quizzes**These are short open-note quizzes to make sure you *understand* important concepts. **Lecture quizzes**These are short quizzes to see that you can *apply* key concepts.**Active learning exercises**These are designed to get you to apply new concepts *shortly after learnin*g them to help you understand. |
| Integration Project * Requirements and a detailed marking scheme will be provided in the course materials.
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| Exploration Project * Requirements and a detailed marking scheme will be provided in the course materials.

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|  ***Note: Because this course has not been offered in this format previously, the schedule for labs may change as the course progresses.***  |
| **Weekly Schedule:****(week of)** | **Component** |  |
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|   | Sept. 8 | Lab A: Resistors and Ohmmeters |
|   | Sept. 12 | Lab A: Voltage, current, and Ohm's Law *Lab B: Raspberry Pi GPIO Introduction* |
|   | Sept. 19 | Lab A: Function Generators and Oscilloscopes*Lab B: Raspberry Pi Python PWM* |
|   | Sept. 26 | Lab A: Zener Diodes and Photodiodes Lab B: Optical Isolators |
|   | Oct. 3 | Lab A: Introduction to Operational Amplifiers *Lab B: I2C Analog-to-digital converter* |
|  | Oct. 10 | Reading Week |
|   | Oct. 17 | Lab A: Analog Output Transducers (DC motor)*Lab B: Servo motors* |
|   | Oct. 24 | Lab A: Controlling Power *Lab B: Stepper motors* |
|   | Oct. 31 | Lab A: Operational Amplifier CircuitsLab B: Integration milestone 1 |
|   | Nov. 7 | Lab A: Lab B: Integration milestone 2 |
|   | Nov. 14 | Lab A: **Integration Project Due**Lab B: Exploration milestone 1 |
|   | Nov. 21 | Lab A:Lab B: Exploration milestone 2 |
|   | Nov. 28 | Project: **Exploration Project Due** |
|   |  Dec. 5 | *Last day of classes is* *December 7.* |
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| **Communication techniques:** | * maintain a research lab notebook
* design and execute formal demonstrations of circuits and software
* documentation standards for circuit designs
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| **Accessible Learning Students:** | Students who are **colour blind** should identify themselves to the lab instructor at the start of the first lab period. Students with disabilities who require classroom and/or laboratory accommodations should identify themselves to the course instructor as soon as possible; preferably before their first lab period. We assume all students requiring academic accommodations will have all accommodations approved by the Accessible Learning Office. |
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