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| **COMMUNITY COLLEGE OF PHILADELPHIA** | | | | |
| Course Development Template | | | | |
| 1. Course Designation | AET 101 | | | |
| 1. Course Title | Introduction to Robotics | | | |
| 1. Abbreviated Course Title for Banner | Introduction to Robotics | | | |
| 1. Division | Division of Math, Science and Health Careers | | | |
| 1. Department | Physics | | | |
| 1. Course Description | This course introduces students to the field of robotics with a focus on investigating careers in STEM fields. Students will be introduced to concepts in electronics, nanotechnology, medical technology, computer science, and advanced manufacturing techniques while applying the topics to create functioning robots. | | | |
| 1. Prerequisites/Corequisites | None | | | |
| 1. Placement | English 098/099 or ESL ENGL 098/099 ready or placement, ESL ENGL 073 or higher; No math placement | | | |
| 1. Hours and Credits | 3-2-4 | | | |
| 1. Class size (maximum) | 24 | | | |
| 1. Programs where this course appears | Applied Engineering Technology | | | |
| 1. Faculty Developer(s) | Randy Libros  Laurence Liss | | | |
| 1. Facilitator (s) |  | | | |
| 1. Recommended Starting Semester | Fall 2021 | | | |
| 1. Course Revision or New Course? | New | | | |
| 1. If this is a **course revision**, indicate which are being revised | Prerequisite(s) and/or placement | | Course Title | Course Description |
| Credit Hours | CLOs and/or Methods of Assessment | | |
| 1. Course Attributes | SCRE: Scientific Reasoning  LBSC: Lab Science | | | |
| 1. **Today’s Date** | January 20, 2021 | | | |

**A. Rationale**

The field of robotics is changing the structure of society. From advanced assembly lines that run entirely in the dark (because there are no human workers)[[1]](#footnote-1) to autonomous vehicles, drones, and the Internet of Things, robots are becoming an important fixture of daily life—and one that is likely to grow in importance over the coming decades. However, the field of robotics is not an isolated and independent field. The principles of robotics overlap several disciplines that are all taught at the College in isolation. Because robotics occurs as the intersection of several important STEM fields, a basic robotics class offers an opportunity for a course in the Science and Technology pathway that explores these fields. Through exploration of robotics students will learn about the fields of electronics, nanotechnology, advanced manufacturing, medical technology, computer science, and other careers and fields of study. This exploration can happen naturally as part of hands on lab activities designed to synthesize these concepts into functional robots.

Beyond the scientific teachings, an introductory course in robotics also offers an opportunity to introduce students to ethical and critical thinking topics that should provide a compass for navigating the societal and legal changes that robots will inevitably introduce. Questions such as responsibility and liability in the event of an autonomous vehicle collision[[2]](#footnote-2), the morality of unmanned warplanes capable of attacking targets without human oversight[[3]](#footnote-3), and the inherent public safety concerns related to the commercial use of drones within heavily populated areas[[4]](#footnote-4) [[5]](#footnote-5) can be addressed and contextualized.

In the process, the course can provide students with opportunities to learn about the College and its services and offerings related to financial planning and stability, career and academic advising, and library resources and research offerings.

**Scientific Reasoning:** AET 101 meets the definition of the Essential Skill of Scientific Reasoning. Students will implicitly utilize scientific method in the lab as they carry out lab procedures, apply principles learned in class and interpret results of their experiments. During the final project, students will be challenged to build on the results of earlier lab experiments to find solutions to challenges that arise in the completion of their project. Students will communicate their lab results in written and graphical form in their lab reports. Students will also explore legal and ethical considerations related to the expanding use of robots in our society.

**B. Course Learning Outcomes and Methods of Assessment**

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| **Course Learning Outcome**  Upon successful completion of the course, students will be able to: | **Method of Assessment** |
| 1. Identify and properly apply terminology related to the field of robotics. | Lab reports, homework assignments, quizzes, and exams. |
| 1. Create simple circuits and produce basic circuit diagrams. | Lab reports, homework assignments, quizzes, and exams. |
| 1. Produce basic computer programs and identify components of them including variables, data types, conditional statements and loops. | Lab assignments, quizzes, and exams. |
| 1. Use the Scientific Method to apply the principles of scientific reasoning to the solution of problems | Final lab project |
| 1. Demonstrate an understanding of legal and ethical issues related to robotics | Homework assignments. |
| 1. Identify and describe STEM careers and their associated educational requirements. | Homework assignments, quizzes, exams. |
| 1. Produce financial plan and timeline related to an academic and career plan. | Homework assignments. |
| 1. Demonstrate the ability to work as part of a team | Lab, lab project |

**C. Grading**

The course requires a combination of hands-on activities and conceptual material related to robotics as well as planning and research assignments related to STEM education and careers. Grades should reflect a combination of these two goals, with a heavier weight on knowledge and application of robotics concepts.

The following is a possible breakdown of grades throughout the semester. This may be modified by the individual instructor.

|  |  |
| --- | --- |
| Quizzes (5 @ 4%) | 20% |
| Budget and timeline plan | 5% |
| STEM career report | 5% |
| Lab Assignments (8 @ 5%) | 40% |
| Final Project | 15% |
| Final Examination | 15% |
| **Total** | **100%** |

**D. Planned Sequence of Topics**

The following is a possible sequence of topics. It may be modified by the individual instructor in order to provide the best learning outcomes.

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| --- | --- |
| **Week** | **Topic** |
| **1** | What is robotics – What is a robot – What disciplines are involved—Basic applications of robotics |
| **2** | Introduction to electronics – Voltage, Current, Resistance |
| **3** | Creating Basic Circuits – Reading Circuit Diagrams |
| **4** | Introduction to Computer Programming – Variables |
| **5** | Electronics – Sensors and Actuators |
| **6** | Applications of Robotics Revisited-Advanced Manufacturing, nanotechnology, medical, autonomous vehicles, drones, Internet of Things, etc. |
| **7** | Computer Programming – Conditional Logic |
| **8** | Electronics – Pulse Width Modulation |
| **9** | Computer Programming – Loops |
| **10** | Computer Programming – Functions |
| **11** | Careers related to robotics |
| **12** | Developing an academic, career and financial plan |
| **13** | Robots, Ethics, and the Law |
| **14** | Final Project Lab |
| **15** | Final Project Lab |

**E. Student Learning Activities and Assignments**

The class focuses on the application of course material to create simple robotics projects. Students should apply the concepts from readings and lectures to **lab assignments** and a **final project**, which should be a group project to provide students with an opportunity to develop their teamwork skills. **Quizzes** should be used to assess concepts and theory, though individual instructors may utilize some combination of quizzes and examinations that achieve the same purpose.

Students will demonstrate knowledge of the field of robotics through hands-on lab activities culminating in the production of simple robots. Evaluation of these work-products will be based on lab reports, software samples, and schematic diagrams. Additionally, quizzes and or tests will assess understanding of concepts and terminology.

A final exam and final project offer additional opportunities for assessment of course learning outcomes.

Career understanding and academic planning will be assessed based on written homework assignments that require research and citations. In order to accommodate students whose placement is not college-ready, assignments will be designed so that they will not require extensive reading, writing and/or mathematical skills not covered in class, while still providing intellectual challenge for students at all levels.

A **final exam** should be given; however, instructors may substitute another cumulative assessment method, such as a final project, if appropriate.

**Written assignments** will be used to assess outcomes related to STEM careers and educational planning.

**F. Required and Optional Course Materials**

The textbook used for this class should include practical examples as well as conceptual information related to both programming and the creation of circuits with sensors and actuators.

The following two resources provide a good combination of the two subjects:

A screenshot of a cell phone

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**Electronics Cookbook: Practical Electronic Recipes with Arduino and Raspberry Pi**

by Simon Monk

Publisher: O'Reilly Media; 1st edition

Language: English

ISBN-10: 1491953403

ISBN-13: 978-1491953402

A picture containing text, book

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**Arduino Cookbook**

by Michael Margolis

Publisher: O'Reilly Media; 2nd edition

Language: English

ISBN-10: 1449313876

ISBN-13: 978-1449313876

**G. Resources Needed for This Course**

Students will be provided with digital microcontrollers such as Arduino UNO boards and an appropriate array sensors and actuators, such as light sensors, LEDs, servo-controllers and motors.

This course will need to be taught in a classroom with computers, advanced manufacturing tools (3D printers), oscilloscopes, and digital multimeters. The classroom space will need to provide large tables with clean working areas and space on the floor to running vehicles such as robotic cars.

Currently, the classroom that provides all these features is W4-37

# Appendix

**Quiz – Computer Programming Control Flow**

1. Which of the following code samples does NOT produce a Boolean value?

a. a = 10

b. a == 10

c. a > 10

d. a < 10

e. a <= 10

2. Which of the following is true of a code block associated with a conditional statement (“if” statement) that does have an associated “else” statement?

a. It may or may not run.

b. It will always run.

c. It will never run.

d. It will return a Boolean value.

e. Only the first line will run.

3. To check that two conditions are met simultaneously which operator should be used?

a. &&

b. ||

c. <>

d. <=

e. ==

4. To trigger a block of code to run with either one of two possible conditions are met, which operator should be used?

a. ||

b. &&

c. ==

d. >=

e. <>

5. “else if” is used in a program to do which of the following?

a. Create an additional condition that will be tested if the previous conditions fail.

b. Ensure there is always a code block that will run in a conditional branch.

c. Provide a second case that should run in addition to the first one that is tested.

d. Test for the opposite condition of the first test.

e. Test multiple conditions simultaneously.

6. Which of the following operators is used to test that two pieces of data are not equivalent?

a. !=

b. ==

c. <>

d. ><

e. >=

7. What is the difference between the following two code expressions:  
a = 10  
a == 10

a. The first assigns a value to the variable “a”. The second returns a Boolean value if the value of “a” is 10.

b. The first returns a Boolean value if the value of “a” is 10. The second assigns a value to the variable “a”.

c. Nothing. They are equivalent.

d. If the value of “a” is already 10, the first will fail but the second will succeed.

e. If the value of “a” is not 10, the first will succeed but the second will fail.

8. Which of the following can be placed into the blank?  
if (\_\_\_\_\_\_) {  
 print(“hello”);

}

a. Any Boolean value.

b. Only an integer.

c. Only text.

d. Only a Boolean expression.

e. Only a Boolean value.

9. Which of the following is NOT true of “if”, “else if”, and “else” control structures.

a. You must use a terminating “else” block if you use “else if”.

b. Any “if” block can have an associated “else” block.

c. Any “if” block can have an associated “else if” conditional block.

d. The “else” block will always run if the “if” or “else if” conditions before it fail.

e. An “if” block must occur before an “else if” or “else” block.

10. If you had 10 conditions that needed to be tested, what control structure could you use instead of “if-else if-else” blocks?

a. A switch.

b. A loop.

c. A Boolean.

d. A variable.

e. A value.

**Lab Assignment – Creating a controllable robotic arm**

**Description:** In this lab you are going to create a robotic arm that uses servos and can move with three degrees of freedom. To control this robot, you will create a control device that uses potentiometers. Your Arduino controller will measure how far each of the joints of the control device have moved and then move the servos on the robotic arm the same amount. In this way, your movements on the control device will be translated to the robotic arm.

**Purpose:** Based on our prior work, we have seen how to measure information coming from sensors and use this to trigger changes to various actuators. This lab gives us the chance to work with servo motors which are a key component in many robots and a chance to implement a real-time control of our robotic device.

**Tasks:** You will be given the robotic arm and the control device as well as servos and potentiometers. To start, connect both a spare servo motor and a spare potentiometer to your Arduino device so that the potentiometer is connected to one of the analog input pins and the servo is connected to one of the analog output pins. Your kit will include a circuit diagram to assist you with this task. Your goal is to read the value from the potentiometer and then output a value to the servo motor to make it rotate the same amount. As a hint, the **“map”** function that was discussed in lecture will be useful to convert the values from the first system to the values for the second.

Once you have accomplished this task, connect the three servo motors from the robot arm to three of the analog outputs of the Arduino and the three potentiometers from the controller to three analog inputs of the Arduino. Adapt your code so that each of the potentiometers on the controller controls the movement of the appropriate servo on the robotic arm.

**Lab Report:** In addition to the source code for the program, you must submit a lab report that includes a circuit diagram for your devices, a discussion of your problem-solving approach, issues you faced, and an analysis of your submitted solution. This report should be 300 words at minimum.

**Criteria for success:** You will be graded on your ability to create a working program that controls the devices, the proper construction of the circuits to connect the servos and potentiometers to the Arduino board, the circuit diagram and lab report, and an overall evaluation of the functionality produced by your program and circuit (i.e., does the controller successfully control the robotic arm).

1. https://www.autodesk.com/redshift/lights-out-manufacturing/ [↑](#footnote-ref-1)
2. https://www.forbes.com/sites/meriameberboucha/2018/05/28/uber-self-driving-car-crash-what-really-happened/ [↑](#footnote-ref-2)
3. https://www.nytimes.com/2018/01/29/opinion/killer-robots-weapons.html [↑](#footnote-ref-3)
4. https://www.faa.gov/news/press\_releases/news\_story.cfm?newsId=24277 [↑](#footnote-ref-4)
5. https://www.ups.com/us/en/services/shipping-services/flight-forward-drones.page [↑](#footnote-ref-5)