**Online Research Seminar Syllabus**

**1. Overview**

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| --- | --- | --- | --- |
| Title | Introduction to Robotics | | |
| Mode | Online lectures and mentor sessions | | |
| Hours | 4\*2 hours lectures + 2\*2 hours research workshops + 1\*2 hours final presentation sessions + 6\*1.5 hours mentor sessions (conducted by mentor) | | |
| Targeted Students | This course is for those students who want to cover the basic principles of designing robots. This course will make a solid foundation for those who want to build robots in the future and become an engineer. This course will be especially good for those students who are interested in automation, programming, and control. | | |
| Prerequisites | High School  Students | Required course/Knowledge | Not recommended |
| Recommended Materials for preparing for the course | N/A |
| College Students | Required course/Knowledge | Calculus 1, python 3(in a basic level), C++ (in a basic level), MATLAB (desirable but not mandatory). |
| Recommended Materials for preparing for the course | Calculus 1 course (Khan Academy or another online platform). python 3, C++, MATLAB introduction online courses (Coursera or another online platform) |

**2. Program Introduction and Objectives**

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| Course Description In a paragraph, please specify：What kind of program is it? What field is the program based in? What knowledge/concepts does the program include? What is the final outcome of the program (types of projects/ What did the students do to demonstrate their learning outcome, etc.) | The course will give a basic introduction to methods of robotics. We will briefly discuss the various disciplines related to robotics and show example applications of them. The aim of the course is not an in-depth exploration, but rather to give students a good overview of what techniques are commonly employed. |
| Software/Tools (if any) | Python3, C++ (opensource programming languages), MATLAB/MATLAB online (MathWorks provide 30 free trials for everyone), Autodesk Fusion 360(3D modeling program. Autodesk provide free 1 year license for students), smartdraw (online opensource program for electrical block diagram design), KiCAD (opensource program for circuit design), Arduino IDE (opensource program for microcontrollers programming on C++), Visual code studio (opensource program for code editing) |

**3. Program Schedule**

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| --- | --- | --- | --- | --- | --- |
| Week | | Lecture | Mentor Session  (lab/case study, etc.) | Assignment | Reading Materials |
| 1 | Topic | Introduction to course | Introduction to 3D modeling | Pick a specific  machine(robot) and prepare an in-depth presentation of it. Try to make the 3D model of the robot using 3D modeling software.  (The details on assignment will be provided in Assignment 1) | CHAPTER 1-Introduction to Robotics Mechanics and Control,III Edition,John J. Craig |
| Detail | In this lecture, we will give a brief definition of robotics, point out the problems related to the use of robots in industrial applications, as well as the perspectives offered by advanced robotics. Classification of the most common mechanical structures of robot manipulators and mobile robots is presented. Topics of modeling, planning, and control are introduced. | In this session, we will go through the process of mechanic design of the robots. The student will learn how to design simple parts and assemble them. This session aims to familiarize the students with the basics of 3D modeling, CAM and CAD tools. |
| 2 | Topic | Sensors, actuators and power electronics | Electrical systems design | Draw the electrical block diagrams of the presented device in assignment 2.  Design the circuit and layout of the presented electrical circuit in assignment 2 using circuit design software.  (The details on assignment will be provided in Assignment 2) | Part5. Actuators and Sensors - Robotics Modelling, Planning and Control - Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo |
| Detail | In this lecture we will discuss the actuating systems in  terms of the power supply, power amplifier, servomotor and transmission. Also, we will discuss different types of sensors like distance sensors, force sensors, etc. | In this session we will learn how to draw the electrical diagram for robot. And also, we will learn how to design the basic double layer PCB using dedicated software program. |
| 3 | Topic | Dynamical system analysis, modeling and control | Controller design | Design controller (find controller specification in Assignment 3) for microcontroller using Arduino IDE. Also design the same controller on python and MATLAB (use SIMULINK tool). | CHAPTER 2 - Feedback Systems, Karl Johan Aström ˚ Richard M. Murray  CHAPTER 1 –Feedback Systems, Karl Johan Aström ˚ Richard M. Murray |
| Detail | In this lecture we present an introduction to the basic concept of feedback and the related engineering discipline of control. We focus on both historical and current examples, with the intention of providing the context for current tools in feedback and control. Also, we provide an introduction to the concept of modeling and present some basic material on two specific methods commonly used in feedback and control systems: differential equations and difference equations. | In this session, we will learn basic tools (SIMULINK module for MATLAB) for designing the controller. Also, we will learn to generate code for Arduino and Raspberry PI directly from MATLAB, and also, we will learn how to design the controller using C++ and python 3(writing code by hand). |
| 4 | Topic | Hardware/computer interfacing and programming. | Hardware/Sensors interfacing | Write code on C++ using Arduino IDE which reads, analyzes, and sends the sensor data to the computer via a microcontroller. In addition, write code on python for the computer which reads the sensor data analyzes it, and generates some output.  (sensor types, data analysis and output specifications will be provided in Assignment 4) | Part 6. Control Architecture - Robotics Modelling, Planning and Control - Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo |
| Detail | This chapter is devoted to presenting a reference model for the functional architecture of an industrial robots control system. The hierarchical structure and its articulation into functional modules allow the determination of the requirements and characteristics of the programming environment and the hardware architecture. The architecture refers to robot manipulators, yet its articulation in levels also holds for mobile robots. | In this session we will learn how to operate different type of sensors, how to connect them to microcontroller and how to interface the sensor data on the computer. |
| 5 | Topic | Research Workshop I | | | |
| Detail | see below section 5 | | | |
| 6 | Topic | Research Workshop II | | | |
| Detail | see below section 5 | | | |
| 7 | Final Oral Presentation and Written Reporting | | | | |

**4. Problem Sets/Written Assignments/Quizzes**

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| --- | --- |
| Total Number of Assignments | \_ 4\_ times |
| Submission Deadline | \_4\_Days after class |
| Is Mentor needed to review and grade assignment? | Yes |
| Will a standard answer be provided? | Yes |
| Will there be Quizzes? How often/how many? | Yes, during lectures and mentor sessions. 2-3 quiz questions for each lecture/mentor session. |
| Other Requirements (if any) |  |

**5. Final Oral and Written Project**

The final project should be Group work, because the final project covers large areas of disciplines. There should be 3-5 students per group.

The final project should contain all areas covered in this course. The students should design robot. The robot should include mechanical part (perform some action or motion), electrical part, sensors and also the design and program for robot control. (The details on final project will be provided in final project requirements).

Students are required to meet the following objectives before attending the session in Week 5:

* Students should prepare a short review of what they achieve during week 5, what are problems, and how they solve them. The review can be as a presentation (with slides) or in text format (.pdf file).
* Prepare questions.

Students are required to meet the following objectives before attending the session in Week 6:

* Same requirements as in week 5.

5.1 Final Oral Presentation

* Oral Project Theme: Group Robot design review.
* Oral Project Requirements:

The students should prepare a presentation. The oral presentation must be presented by all members of the group, the student should present part of the project on which they work on.

5.2 Will you require a written final report as well?

* Written Project Requirements:

The students should prepare an in-depth report of the project. There should be presented all material that the group worked on. The report should include all problems that they overcome during weeks 5 and 6. The students should mark their name/names under the problem on which they worked.

Report should include

* all the steps of designing the robot
* 3D modeling tool usage
* the electrical circuits design process
* control system design process
* programming process

Also

* students should write what they have learned through the course
* What are their accomplishments?
* are they planning to extend on the final project, if yes, why? if not what they are planning to do and why?

Format

* photos, demo videos
* links and resources used thought course
* link to all source file of the project

**6. Suggested Future Research Fields/Direction/Topics**

The students may choose to strengthen their background in the hardware technology, especially advanced sensing equipment. The students with desire to earn Ph.D. may choose to strengthen their mathematical background. Students can look into finding jobs in aerospace industry, robotics, automotive industry, agriculture and many other fields.

**7. Instructor Introduction**

7.1 Instructor Title:

7.2 Instructor Bio

7.3 Instructor Profile Photo