ENGG5402 Advanced Robotics
Academic Year: 2022-2023, Term 2

Course Code & Title: ENGG5402 Advanced Robotics

Description: This course provides a comprehensive overview of robotics for postgraduate level study in robotics. Topics include kinematics, inverse kinematics, dynamics, control, sensors. Students will also be involved in hands-on programming projects with physical robotic manipulator/arm to reinforce the basic principles developed in lectures as well as develop robot algorithm implementation skillsets. The course will also expose students to the latest developments in robotics.

Course Objectives:

- Gain exposure to the latest developments in robotics
- Study the kinematics and dynamics of robot manipulators
- Understand the use and application of sensors and actuators
- Understand how to design and use controllers for the motion/force control of robots
- Gain exposure to the robotic methods implementation by programming
- Gain hands-on experience on robot motion planning and control for real world robots

Instructor: Prof. Fei Chen
Office: Room 411, Ho Sin-Hang Engineering Building (SHB)
Phone: +852-39431601
E-mail: fchen@mae.cuhk.edu.hk

Tutors: Junjia Liu *(Leading TA)*
Office: 2/F, AB1, CUHK
E-mail: jjliu@mae.cuhk.edu.hk

Chenzui Li
Office: 2/F, AB1, CUHK
E-mail: czli@mae.cuhk.edu.hk

Zhihao Li
Office: 2/F, AB1, CUHK
E-mail: zhihaoli@mae.cuhk.edu.hk

Hengyi Sim
Office: 2/F, AB1, CUHK
E-mail: hysim@mae.cuhk.edu.hk

Office hour: please contact the Instructor/TAs for questions and reservation office hour or meeting. You are encouraged to put all people as receivers if writing emails to guarantee you receiving prompt response.

Schedule/Location: Tue 12:30-14:15 Classroom: William M W Mong Eng Bldg 404
Thu 13:30-14:15 Classroom: William M W Mong Eng Bldg 803

Textbook: **"Robotics: Modeling, Planning and Control"**, by **Bruno Siciliano**, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer, 2010

Grading Policy (see timetable):

- Homework (15% for each assignment, 30% in total)
- Mid-Term Exam (30%)
- Term Project (40%)

Other Policies:

1. Homework problems should be completed individually, nevertheless discussing homework questions with others is highly encouraged. (Academic Integrity: https://integrity.mit.edu/handbook/collaboration)
2. Term projects are completed in groups. Each group member will receive same score. As rare case, bonus or penalty may be applied to individual when extreme outstanding or under performance is observed by Instructor and TAs.
3. Exams are closed-noted. However, you are allowed to bring **one double-sided A4-size sheets** of notes for your own usage.

Course Outline and Timetable (Tentative):

Weeks	Date	Topic	Lab/Tutorial	Events
1	10/01/2023 (Tue)	About ENGG5402 Introduction		
	12/01/2023 (Thu)	Position Orientation		
2	17/01/2023 (Tue)	Position Orientation Euler RPY Homogeneous		Add/Drop Deadline: Two weeks from the class starts
	19/01/2023 (Thu)	Euler RPY Homogeneous Direct Kinematics		
3	24/01/2023 (Tue)	Happy Chinese New Year!		
	26/01/2023 (Thu)	Happy Chinese New Year!		
4	31/01/2023 (Tue)	Direct Kinematics		
	02/02/2023 (Thu)	Direct Kinematics (project example) Actuators and Sensors		
5	07/02/2023 (Tue)	Inverse Kinematics		
	09/02/2023 (Thu)	Inverse Kinematics		
6	14/02/2023 (Tue)	DifferentiaI Kinematics		Publish Homework Assignment 1 (Feb 13th, 2023, Mon)
	16/02/2023 (Thu)	DifferentiaI Kinematics		
7	21/02/2023 (Tue)	Inverse DifferentiaI KinStatics		
	23/02/2023 (Thu)	Inverse DifferentiaI KinStatics		
8	28/02/2023 (Tue)	Kinematic Control		Submit Homework Assignment 1 (Mar 2nd, Thu)
	02/03/2023 (Thu)	Kinematic Control		
9	07/03/2023 (Tue)	Lagrangian Dynamics		Publish Homework Assignment 2 (Mar 7th Tue)

	09/03/2023 (Thu)	Lagrangian Dynamics Newton Euler Dynamics		
10	14/03/2023 (Tue)	Newton Euler Dynamics		Submit Homework Assignment 2 (Mar 14th, Tue)
	16/03/2023 (Thu)	Mid-Term Exam Revision		
11	21/03/2023 (Tue)	Mid-Term Exam		
	23/03/2023 (Thu)	Introduction to Control		
12	28/03/2023 (Tue)	Trajectory Control		
	30/03/2023 (Thu)	Trajectory Control		
13	04/04/2023 (Tue)	Adaptive Control	**Special Lecture** by Prof. **Bruno Siciliano** (on-site at CUHK)	
	06/04/2023 (Thu)	Adaptive Control		
14	11/04/2023 (Tue)	Cartesian Control		
	13/04/2023 (Thu)	Cartesian Control		
15	18/04/2023 (Tue)	Force Control		
	20/04/2023 (Thu)	Force Control		
16	25/04/2023 (Tue)	Class Make-Up If Any		
	27/04/2023 (Thu)		Term Project Report/Demo/Presentation at Prof. Chen's Lab located on 2F, AB1.	
17	02/05/2023 (Tue)	Exam Week	(Not for students)	
	04/05/2023 (Thu)	Exam Week		
18	09/05/2023 (Tue)	Exam Week	(Not for students) Instructor submits grading (24/05/2023)	
	11/05/2023 (Thu)	Exam Week		

Grade Description:

1. **'A': EXCELLENT** - exceptionally good performance and far exceeding expectation in all or most of the course learning outcomes; demonstration of superior understanding of the subject matter, the ability to analyze problems and apply extensive knowledge, and skillful use of concepts and materials to derive proper solutions.
2. **'B': GOOD** - good performance in all course learning outcomes and exceeding expectation in some of them; demonstration of good understanding of the subject matter and the ability to use proper concepts and materials to solve most of the problems encountered.

3. **'C': FAIR** - adequate performance and meeting expectation in all course learning outcomes; demonstration of adequate understanding of the subject matter and the ability to solve simple problems.
4. **'D': MARGINAL** - performance barely meets the expectation in the essential course learning outcomes; demonstration of partial understanding of the subject matter and the ability to solve simple problems.
5. **'F': FAILURE** - performance does not meet the expectation in the essential course learning outcomes; demonstration of serious deficiencies and the need to retake the course.