Advanced Robotics

ENGG5402 Spring 2023

Fei Chen

Topics:

- Course Outline

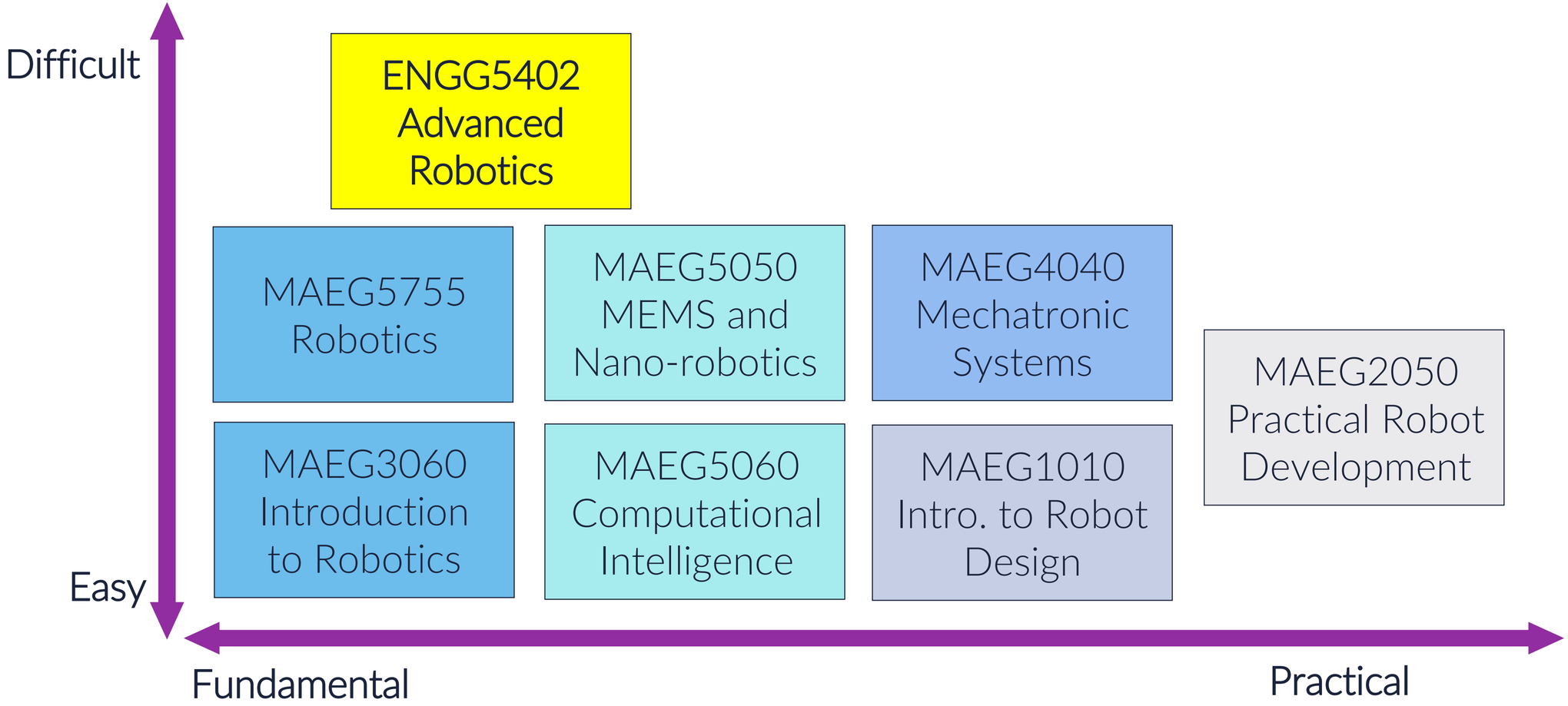
Readings:

ENGG5402 General Information

- Instructor:
  - Prof. Fei Chen, Room 411, Ho Sin-Hang Engineering Building (SHB)
  - E-mail: fchen@mae.cuhk.edu.hk
- Tutors:
  - Junjia Liu (Leading TA), AB1 2/F, email: jjliu@mae.cuhk.edu.hk
  - Chenzui Li, AB1 2/F, email: czli@mae.cuhk.edu.hk
  - Zhihao Li, AB1 2/F, email: zhihaoli@mae.cuhk.edu.hk
  - Hengyi Sim, AB1 2/F, email: hysim@mae.cuhk.edu.hk
- Lecture time and venue:
  - 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
- Main Textbook:
  - Robotics: Modeling, Planning and Control, B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Springer, 2010
- Other Reference:
  - Robot Modeling and Control. M. W. Spong, S. Hutchinson, and M. Vidyasager
  - Introduction to Robotics: Mechanics and Control, 3rd edition, John J. Craig, Prentice Hall, 2005
  - Handbook of Robotics, Editors: Bruno Siciliano, Oussama Khatib, Springer, 2008

ENGG5402 General Information

This course is more focused on the advanced fundamental topics of robotics and practice on real-world robots



ENGG5402 General Information

- 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

- Pre-requisite:
  - Linear algebra, differential equation
  - Classical mechanics background such as kinematics, dynamics
  - Control system knowledge such as classical control system, state-space control system, nonlinear control system
  - Programming background in Matlab/Python for homework assignments
  - **Programming background in Python on Ubuntu

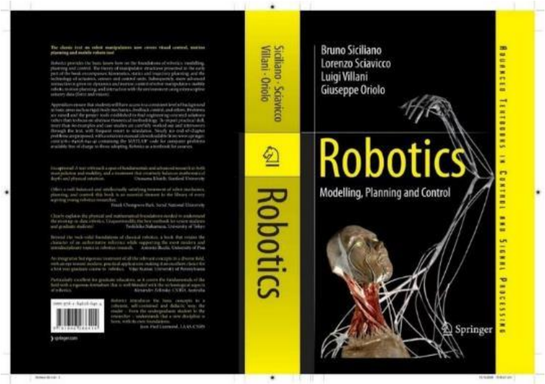
- Course Structure:
  - Lecture
  - Invited Lecture – Prof. Bruno Siciliano
  - Homework (30% with 2 assignments in total)
  - Mid-Term Exam (30%)
  - Term Project (40%)

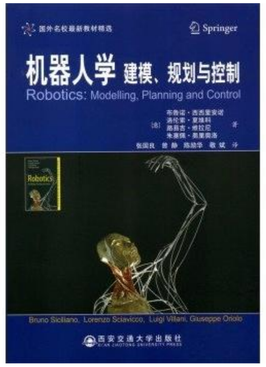
Textbook

Handbook of Robotics

Refer to instructions in Blackboard for how to download the textbook from CU library.

Robotics: Modeling, Planning and Control



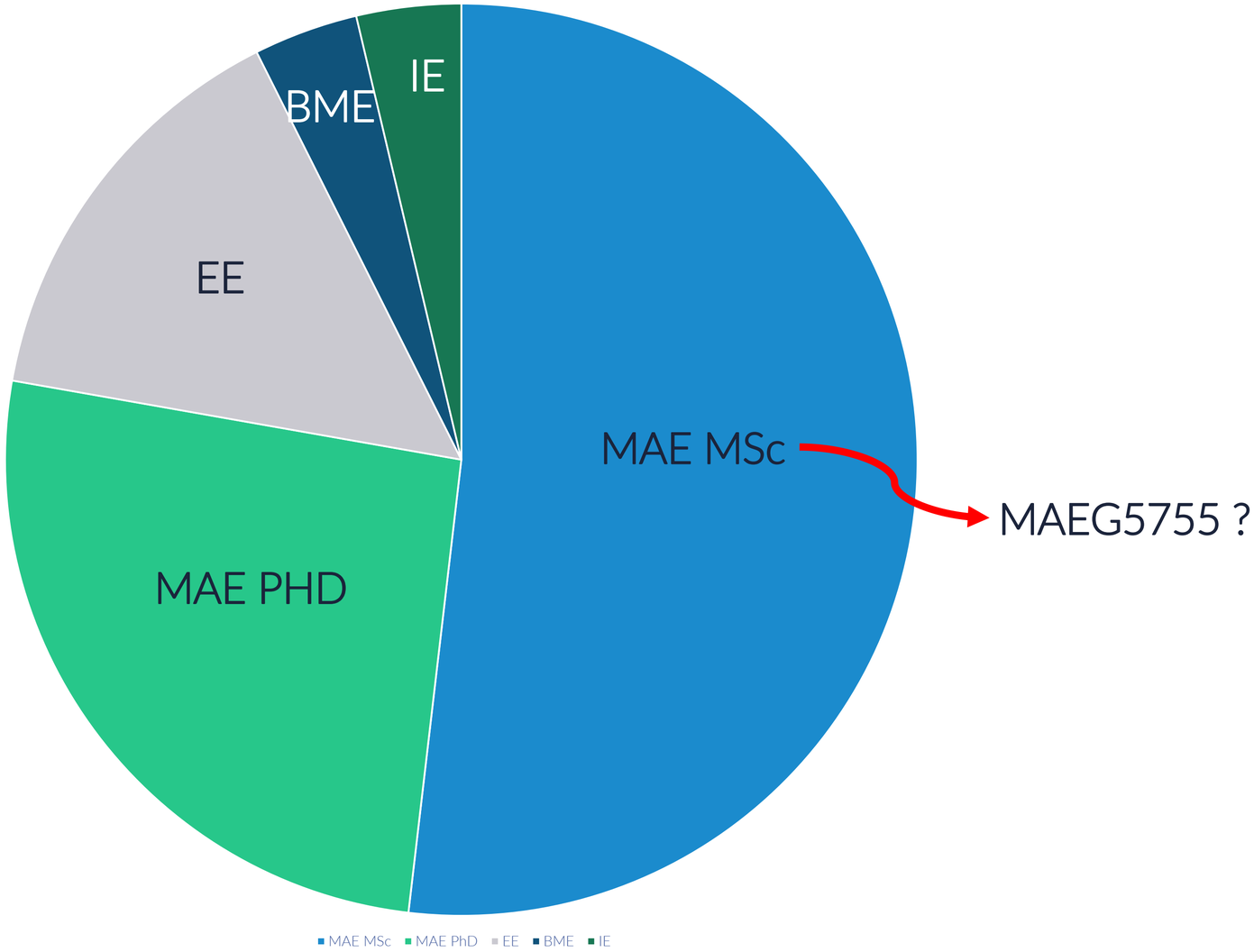


Tentative Outline With Topics

Speed Adjust

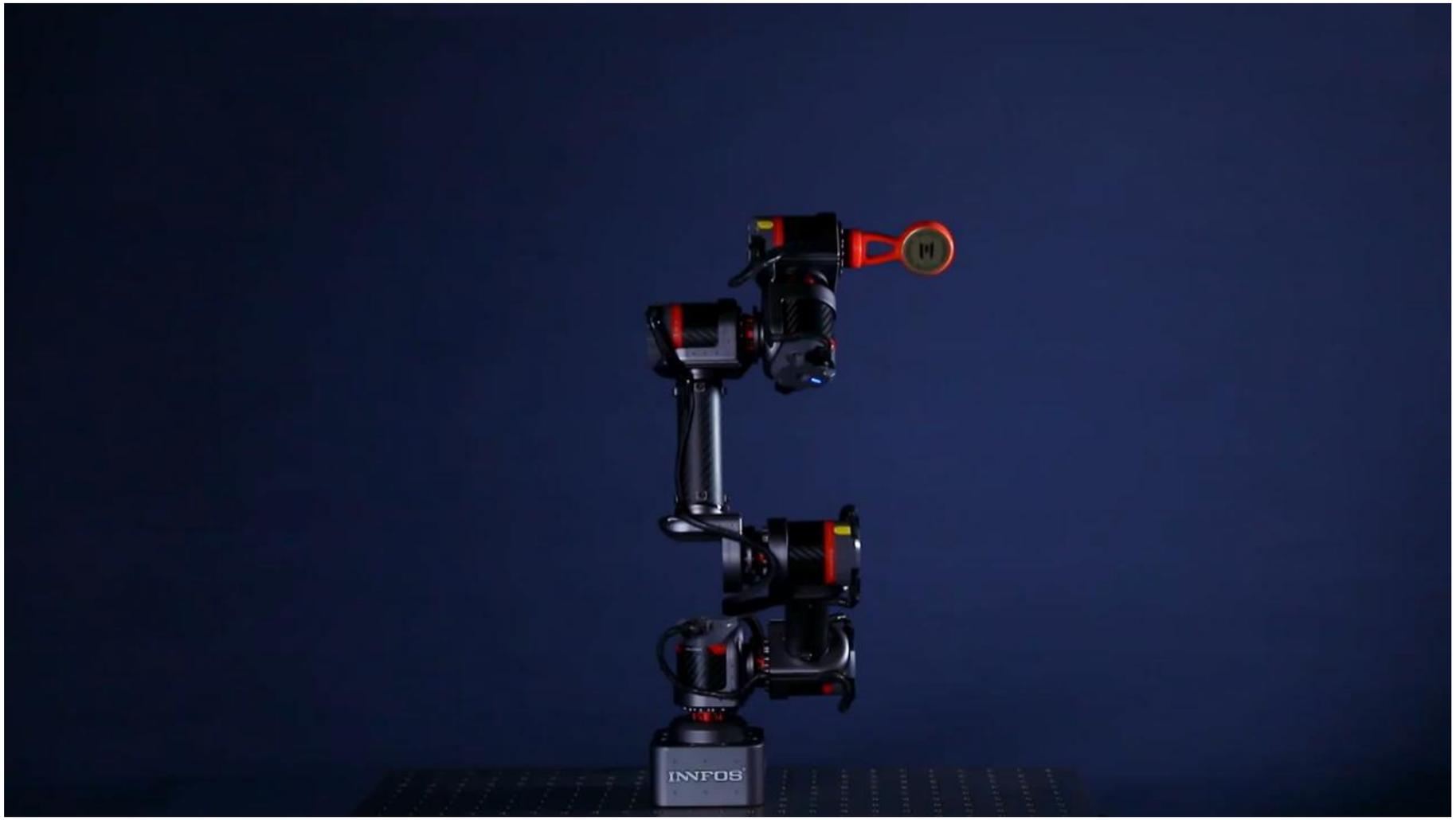
Weeks	Date	Topic	Lab/Tutorial	Events
1	10/01/2023 (Tue)	About ENGG5402 Introduction		
	12/01/2023 (Thu)	Position Orientation		
2	17/01/2023 (Tue)	Euler RPY Homogeneous		Add/Drop Deadline: Two weeks from the class starts
	19/01/2023 (Thu)	Euler RPY Homogeneous		
3	24/01/2023 (Tue)	Happy Chinese New Year!		
	26/01/2023 (Thu)	Happy Chinese New Year!		
4	31/01/2023 (Tue)	Direct Kinematics	Sensors (Tue)	
	02/02/2023 (Thu)	Direct Kinematics		
5	07/02/2023 (Tue)	Inverse Kinematics		Publish Homework Assignment 1 (Tue)
	09/02/2023 (Thu)	Inverse Kinematics		
6	14/02/2023 (Tue)	Differential Kinematics		
	16/02/2023 (Thu)	Differential Kinematics		
7	21/02/2023 (Tue)	Inverse Differential KinStatics		
	23/02/2023 (Thu)	Inverse Differential KinStatics		
8	28/02/2023 (Tue)	Kinematic Control		Publish Homework Assignment 2 (Tue) Submit Homework Assignment 1 (Thu)
	02/03/2023 (Thu)	Kinematic Control	Tutorial for Mid-Term Exam	
9	07/03/2023 (Tue)	Lagrangian Dynamics		
	09/03/2023 (Thu)	Lagrangian Dynamics		
10	14/03/2023 (Tue)	Newton Euler Dynamics		Submit Homework Assignment 2 (Thu)
	16/03/2023 (Thu)	Summary		
11	21/03/2023 (Tue)	Mid-Term Exam		
	23/03/2023 (Thu)	Newton Euler Dynamics		
12	28/03/2023 (Tue)	Introduction to 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 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		

Statistics – Robotics Background?



Project 1

- **6DOF Robot Arm Motion Planning and Control (Innfos Gluon Robot)**



Project 2

- **Leg-Wheel Mobile Robot Motion Planning and Control (DDT Diablo Robot)**

Projects

Rules:

- Form a team by 3-4 ppl (pending on the add/drop results)
- Discuss with Instructor and TA to determine a real-world scenario and task
- Apply the knowledge learned from ENGG5402 to control the robot

Grading (40%)(*Tentative*):

- Group Report: 20pts – problem formulation, solution realization (difficulty level considered)
- Group Presentation: 10pts – present the key ideas to Instructor and TAs for achieving the tasks
- Group Demo: 10pts – demonstrate the robot motion in real world

Academic Honesty

- Zero Tolerance
  - Plagiarism, cheating, misconduct in test/exam will be reported to the Faculty Disciplinary Committee for handling.
- Penalty
  - Zero marks for the concerned assignments/test/exam/whole course, reviewable demerits, non-reviewable demerits, suspension of study, dismissal from University.
- University Guidelines to Academic Honesty
  - http://www.cuhk.edu.hk/policy/academichonesty/

Note: Exams are closed-noted. However, you are allowed to bring **one double-sided A4-size sheets** of notes for your own usage.

Q&A