

## Engineering Tripos Part IIB, 4M25: Advanced Robotics, 2021-22

### Module Leader and Lecturer

[Prof F Iida](#) [1]

### Lecturer

[Dr A Prorock](#) [2]

### Lecturer

[Dr F Forni](#) [3]

### Timing and Structure

Lent term, 100% coursework

### Prerequisites

4M20 useful

### Aims

The aims of the course are to:

- Learn advanced topics of robotics (underactuated robotics, robot learning, soft robotics, human robot interactions, and distributed robotics)
- Fundamentals (theories and methodologies) of advanced robotics researches
- Practical implementation of advanced robotics technologies

### Objectives

As specific objectives, by the end of the course students should be able to:

- Extend the knowledge of introductory robotics to more advanced ones to carry out research
- Learn research techniques and skills for robotics projects
- Work effectively with collaborators in robotics projects
- Deliver professional presentations and communication of robotics projects

### Content

This course aims to extend the knowledge and skills of students in designing and developing autonomous machines and researching robotics-related topics. Beyond the *Introduction to Robotics* course given in MT, the *Advanced Robotics* course will focus on more advanced topics such as Robot Learning, Underactuated Robot Control, Soft Robotics, Human-Robot Interaction, and Multi-Agent Systems, which are not covered in the introductory course.

**Lectures (2 lectures per week, a total of 16 lectures):**

1. Introduction (2L; F lida, F Forni)
  - a. Course overview;
  - b. History and landscape of robotics;
  - c. basic knowledge and theories (kinematics, dynamics, planning/search);
2. Underactuated Robotics (4L; F Forni)
  - a. Problem formulation and modelling
  - b. Control approaches of underactuated systems
  - c. Case studies
3. Robot Learning and Adaptation(2L; F lida)
  - a. Model-based learning approaches
  - b. Model-free learning approaches
  - c. Optimization methods and case studies
4. Soft Robotics (2L; F lida)
  - a. Soft material/body robot modelling;
  - b. Soft actuators and sensors;
  - c. Control and learning of soft robots;
5. Human-Robot Interaction 1 (2L; H Gunes)
  - a. Introduction to human-robot interaction
  - b. Theoretical frameworks (spatial, nonverbal, verbal interactions)
  - c. Research methods, applications, robots in society
6. Distributed Robotics, Multi-Agent Systems (2L; A Prorok)
  - a. Planning and control in multi-robot systems
  - b. Methods for learning coordination and cooperation in multi-agent systems
7. Coursework Presentations (F lida, F Forni)

**Coursework**

The assessment will be 100% coursework and consist of three elements (1) first individual written report (30%), (2) intermediate group project presentation (20%), and (3) final individual written report (50%). The first report is about theoretical questions on the topics of advanced robotics, which should be submitted by Week 5. The project will be conducted in groups of 2-3 students, and the topics should be either or both simulation/hardware. The intermediate presentation will be delivered by groups in Week 8). The final report is expected to be a professional presentation about the project, extended from the intermediate presentation, and should be handed in by Week 12 as a 6-page double-column report (conference-formatted). The report will clearly state what each group member contributed. Project marks will reflect the contribution of each team member. Every team member is expected to make a similar, significant contribution to the project, and where this happens all team members will receive the same mark.

**Booklists**

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

**Examination Guidelines**

Please refer to [Form & conduct of the examinations](#) [4].

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**Links**

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