

[node:field-syllabus-course-year:parent:name], Engineering Tripos Part IIB, 2021-22

Module Leader

[Dr F Iida](#) [1]

Lecturers

Dr F Iida, Dr F Forni, Dr A Prorok, Dr H Gunes

Timing and Structure

Lent term. 16 Lectures. Assessment: 100% coursework (1 project report and presentation)

Prerequisites

4M20 is recommended

Aims

The aims of the course are to:

- Advanced robotics topics including underactuated robotics, robot learning, soft robotics, human-robot interactions, multi-robot systems
- Fundamental theories and concepts of advanced robotics topics
- Practical methods and tools to simulate and build robots

Objectives

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

- Learning different design strategies and architectures of robots
- Group projects to collaborate with others to develop research proposal and perform research projects
- Learning of effective presentations and report writing

Content

1. Introduction (2L; F Iida, 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 Iida)
 - a. Model-based learning approaches

- b. Model-free learning approaches
- c. Optimization methods and case studies
- 4. Soft Robotics (2L; F Iida)
 - 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 Iida, F Forni)

Coursework

The assessment will be 100% coursework and consist of three elements (1) first group report (30%), (2) intermediate group project presentation (20%), and (3) final individual written report (50%). The first report is a research project proposal that your group will work in the second half of this module, 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, individually extended from the intermediate presentation, and should be handed in by Week 14 as a 6-page double-column report (conference-formatted). In addition, the summary of lecture topics (up to 4 pages) should be submitted together with the final report.

Booklists

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

- Ronald C. Arkin 1949- author. *Behavior-Based Robotics / Ronald C. Arkin*. Cambridge, Mass.?: MIT Press, c1998.; 1998.??
- Bruno Siciliano 1959- editor., Oussama Khatib editor., eds. *Springer Handbook of Robotics / Edited by Bruno Siciliano, Oussama Khatib*. 2nd Edition. Cham?: Springer International Publishing, 2016.; 2016.
- Rolf Pfeifer. *Understanding Intelligence / Rolf Pfeifer and Christian Scheier?; with Figures by Alex Riegler and Cartoons by Isabelle Follath*. (Christian Scheier, ed.). MIT Press; 1999.
- Fantoni, Isabelle, Lozano, Rogelio, *Non-linear Control for Underactuated Mechanical Systems*, Springer, 2002

Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [2].

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