IMPERIAL

Module Specification

Basic details

			Earliest cohort
UID		Cohorts covered	
Long title	Robotic Manipulation		
New code	ELEC60030	New short title	

Brief description of module
(approx. 600 chars.)

Robotic technology continues to increase in presence, with growing demands for semi-autonomous systems that can perform manipulation on physical objects in a wide range of scenarios (e.g industrial, warehouse, domestic, exploratory). This module will focus on the design, modelling and control of robotic arms and grippers. Theoretical approaches to low-level robot modelling and motion generation will be complemented by hands-on laboratory sessions using desktop-size robotic arms. Further applied aspects will involve using CAD software to design and 3D print robotic grippers for different tasks.

Available as a standalone module/ short course? No

Statutory details

	ECTS	CATS	Non-credit	
Credit value	5	10	N	HECOS codes
FHEQ level	L6			

Allocation of study hours

	Hours	
Lectures	10	
Group teaching	10	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	25	
Other scheduled	0	*Incl. project supervision, fieldwork, external visits.*
Independent study	80	*Incl. wider reading/ practice, follow-up work, completion of assess*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	125	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught / Campus	Other	
Delivery term	Term 2	Other	

Ownership

Primary department: Department of Electrical and Electronic Engineering

Additional teaching departments	0

Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery? No

External institution	
External department	
External campus	

Associated staff

Role	CID	Given name	Surname
Module leader		Adam	Spiers

Learning and teaching

Module description

Learning outcomes

Upon successful completion of this module, students will be able to:
1. Critically formulate and analyse kinematic models of robotic manipulators, including rigorous treatment of position and orientation in 3D space.
2. Develop and apply typical forward and inverse kinematic solutions, assessing their limitations and suitability for serial chain robotic systems.
3. Design, implement, and optimise motion planning and control strategies in both joint and task space for precise trajectory execution.
4. Critically evaluate appropriate dynamic modelling approaches, force/torque control schemes, and grasping strategies for diverse manipulation tasks.
5. Integrate modelling, control, and hardware considerations to design, implement, and experimentally validate robotic manipulation systems, demonstrating initiative and technical judgement

Module content

- Introduction to Robotic Manipulators
- Spatial Representations for Robotics
- Constructing Kinematics Models
- Forward and Inverse Kinematics
- The Manipulator Jacobian
- Generating Motion Trajectories
- Dynamic Modelling of Objects and Manipulators
- Force / Torque Control
- Introduction to Robot Grasping Techniques
- Force Closure vs. Form Closure
- Introduction to CAD design for 3D Printing
- Implementation of above principles on physical robot hardware, including the design and testing of 3D printed grippers.
- Machine Learning in Robotic Manipulation

Note: These elements do not require pre-requisite knowledge of Mechanics, Physics or Control Theory. The only pre-requisite knowledge is matrix

Learning and Teaching Approach	This module is delivered through weekly lectures, hands-on labs and interactive sessions with the course leader and GTAs.
Assessment Strategy	This module is assessed through coursework and an online multiple-choice test. The coursework will involve working in teams to design and implement robotic manipulation software controllers and custom grippers to achieve several manipulation tasks on physical robot arms. The coursework will be evaluated by a report and demonstration of the goal tasks.
Feedback	You will be provided with written comments on coursework reports and oral feedback during labs and problem classes.
Reading list	1. Robot Modelling and Control by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar. ISBN: 9781119523994 2. Introduction to Robotics: Mechanics and Control by John J. Craig. ISBN: 9781292040042

Quality assurance

Date of first approval	July 2021
Date of last revision	May 2026
Date of this approval	July 2025
Module leader	Dr. A. Spiers
Notes/ comments	

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Template version

Assessment details

Pass mark

Grading method: Numerical

40%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Coursework	Live demonstration of 3 tasks, video recording, and 3-page report covering the control of lab based robot arms and design of 3D-printed parts	80%	40%	N
Examination	One hour online multiple choice question test.	20%	40%	N
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
		100%		