

MTRN4230

Robotics

Term 2, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Hoang-Phuong Phan	hp.phan@unsw.edu.au	Weekdays, consultation on request	J17-208D	

Demonstrators

Name	Email	Availability	Location	Phone
Raghav Hariharan	r.hariharan@student.unsw.edu.au			
Dylan Sanusi-Goh	d.sanusi-goh@unsw.edu.au			
Edward Price	edward.price@student.unsw.edu.au			
Sarah Dinh	nhu.dinh@unsw.edu.au			
Farhan Sumantri	f.sumantri@student.unsw.edu.au			

Administrators

Name	Email	Availability	Location	Phone
James Stevens	james.stevens@unsw.edu.au	For the labs and projects related enquiries (via Teams)		

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

[School of Mechanical and Manufacturing Engineering](#)

[Engineering Student Support Services](#)

[Engineering Industrial Training](#)

[UNSW Study Abroad and Exchange](#) (for inbound students)

[UNSW Future Students](#)

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

[Engineering Student Support Services](#) – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

[Engineering Industrial Training](#) – Industrial training questions

[UNSW Study Abroad](#) – study abroad student enquiries (for inbound students)

[UNSW Exchange](#) – student exchange enquiries (for inbound students)

[UNSW Future Students](#) – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

[School Office](#) – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- [Student Wellbeing](#)
- [Urgent Mental Health & Support](#)
- [Equitable Learning Services](#)
- [Faculty Transitional Arrangements for COVID-19](#)
- [Moodle](#)
- [Lab Access](#)
- [Computing Facilities](#)
- [Student Resources](#)
- [Course Outlines](#)
- [Makerspace](#)
- [UNSW Timetable](#)
- [UNSW Handbook](#)

Course Details

Units of Credit 6

Summary of the Course

The course introduces students to the analysis and use of robot manipulators, by exposing them to the theoretical basis of robotics as well as their practical implementation. By the end of the course students are expected to understand the ways in which robots are used in industrial and service applications; the key parameters for selecting robots for industrial applications; the main categories of robot frames of reference; and the essentials of robot kinematics, dynamics, control and path planning. Where possible, students will make use of industrial robot manipulators.

Students enrolling in this course are assumed to have an understanding of:

- Programming equivalent to that taught in MTRN2500, and
- Rigid body dynamics equivalent to that taught in MMAN2300, and
- Introductory linear systems and control equivalent to that taught in MMAN3200 or ELEC3114.

Course Aims

This is a final year course in the Mechatronics stream and builds on much content from previous courses including dynamics, robot design, control systems and computing. It seeks to expose students to the whole field of robotics and prepare them for graduate roles in the mechatronics industry.

The following are the course aims:

O1: Increase awareness of the scope of robot applications, with a focus on industrial applications including past and present trends.

O2: Provide experience with safely operating and programming an industrial robot manipulator.

O3: Explain how robot manipulators work and are modelled.

O4: Highlight the advantages and disadvantages of different robot manipulator designs and provide insight into robot selection.

O5: Demonstrate how to solve practical problems involving: Coordinate frames, Robot kinematics and dynamics, Trajectory design and path planning

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Employ a robot and robot programming environment effectively and efficiently to achieve a given task	PE2.1
2. Analyse and critically evaluate robot performance using robot mechanics	PE2.2

Learning Outcome	EA Stage 1 Competencies
3. Formulate models of robot manipulators	PE1.1, PE1.2
4. Compare and evaluate different robot manipulator designs and their application	PE1.1, PE1.2

Teaching Strategies

This course employs a combination of project based learning and traditional content delivery. Examples will be given from educator experience and state of the art robot implementations. The division of assessment into smaller components will facilitate constructive and continuous feedback.

The following strategies will be used to teach the subject matter of this course:

- Presentation of the material in lectures and discussions so that the major content is understood.
- Lab demonstration sessions to increase familiarity with tools and techniques.
- Practical projects with time limits to assist understanding of industrial demands and boundary conditions on the use of robots.

Suggested approaches to learning in the course:

- Actively contribute in lectures and lab sessions.
- Careful reading, discussion and understanding of the material presented in lectures.
- Additional reading on and about the material presented in lectures to broaden the knowledge base.
- Paying attention throughout the lab demonstration sessions and asking questions when anything is not understood.
- Conscientiously working through the set assessments.

This course will be delivered via online synchronous lectures and in person lab demonstration classes where possible.

Assessment

To reflect professional practice, late submission of all assessments in this course is not permitted without applying for and being granted special consideration through the special consideration procedures outlined below.

Quizzes 1 and quizzes 2 (90 minutes each) are scheduled at 16:00-18:00, Friday of week 5 and week 10, respectively (via Moodle). Further information will be provided during the lectures or via the MTRN4230 Teams channel.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quizzes	40%	Week 5, Week 10	2, 3, 4
2. Individual projects	40%	Project 1: Week 8; Project 2: Week 12	1, 2, 3, 4
3. Safety and robot demonstration	20%	ROBOT-1: Week 2; ROBOT-2: Week 4	1

Assessment 1: Quizzes

Assessment length: Up to 90 minutes

Submission notes: via Moodle

Due date: Week 5, Week 10

Marks returned: Within 2 weeks of submission

Quiz 1 and Quiz 2 (90 minutes each) are scheduled between 16:00 and 18:00 on Friday of week 5 and week 10.

The contents of Quiz 1 will be from lectures 1 to 4, while Quiz 2 will be from all the lectures (1 to 9). The revision lecture in week 10 will help students review the lecture contents and prepare for Quiz 2.

Each Quiz will make up 20% of the overall course marks.

This is not a Turnitin assignment.

Assessment criteria

Refer to the announcements

Assessment 2: Individual projects

Assessment length: See assessment description

Due date: Project 1: Week 8; Project 2: Week 12

Marks returned: Within 2 weeks after the due date

Complete individual projects including kinematic modelling, trajectory planning and path planning for a robot manipulator.

These will involve the formulation of robot manipulator models; simulation of robot performance and subsequent performance evaluation; and comparison between different manipulator designs.

Project 1 (20% of the overall marks) will use the RVC Toolbox (MATLAB) to develop Kinematic Modelling (Lecture 4,5) and Trajectory Planning (Lecture 7).

Project 2 (20% of overall marks) will focus on Path Planning (Lecture 8 and MATLAB-based).

Assessment criteria

Refer to the assessment description and announcements.

Assessment 3: Safety and robot demonstration

Assessment length: See assessment description

Submission notes: Due in lab class

Due date: ROBOT-1: Week 2; ROBOT-2: Week 4

Demonstrate ability to use robot system and robot programming environment safely and effectively through several lab exercises.

ROBOT-1 and ROBOT-2 will make up 5% and 15% of the overall course marks, respectively.

The aims of ROBOT-1 include: (i) Read and understand safety documents for operating robots; (ii) Complete online training for UR5e; and (iii) Demonstrate safe operation of the UR5e.

The aims of ROBOT-2 is to gain experience in programming the UR5e robot.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

[View class timetable](#)

Timetable

Date	Type	Content
O-Week: 23 May - 27 May	Online Activity	Online induction, to be completed at your leisure (before week 1 labs). The instruction documents are provided in Moodle.
Week 1: 30 May - 3 June	Lecture	Introduction to Robotics, Classification, and Safety.
	Workshop	Lab induction, Universal Robotics simulator setup, safety
Week 2: 6 June - 10 June	Lecture	Sensors & Actuators, Modelling & Simulation
	Workshop	Advanced Polyscope programming, marking of ROBOT-1
Week 3: 13 June - 17 June	Lecture	Coordinate Frames and Homogeneous Transformation
	Workshop	MATLAB Robot Programming (Scripting using RTDE/RVC Toolboxes)
Week 4: 20 June - 24 June	Lecture	Denavit–Hartenberg (DH) Transformation
	Workshop	Application of the DH Method, marking of ROBOT-2
Week 5: 27 June - 1 July	Lecture	Inverse Kinematics and the Jacobian
	Workshop	Jacobian and velocity calculation in MATLAB
	Assessment	Quizzes: via Moodle
Week 6: 4 July - 8 July	Online Activity	No lecture this week
	Workshop	Free Access to Labs during scheduled lab session (Optional)
Week 7: 11 July - 15 July	Lecture	Robot Trajectories
	Workshop	Trajectory Planning in MATLAB
Week 8: 18 July - 22 July	Lecture	Path Planning for Robot Manipulators

	Workshop	Path Planning in MATLAB
Week 9: 25 July - 29 July	Lecture	Joint Dynamics and Control, Euler-Lagrange Equations
	Workshop	Joint Torque of UR5e
Week 10: 1 August - 5 August	Lecture	Revision
	Workshop	<i>Free Access to Labs during scheduled lab session (for Project 2)</i>
	Assessment	Quizzes: via Moodle

Resources

Prescribed Resources

The prescribed textbook for the course presents a very wide range of background material in an accessible manner with extensive examples:

Corke, P., **Robotics, Vision and Control: Fundamental Algorithms in Matlab**, 2017, Springer. This book is available in the UNSW Bookshop.

The full book is also available online for download through the UNSW library:

https://primoa.library.unsw.edu.au/primo-explore/fulldisplay?docid=UNSW_ALMA51228764990001731&context=L&vid=UNSW&lang=en_US

The first edition (2011) of this textbook is also appropriate.

Lecture slides and supporting course notes will be available on Moodle.

Recommended Resources

Spong, M., Hutchinson, S. and Vidyasagar, M., **Robot Modeling and Control**, 2006, John Wiley & Sons. - This text is a classic in robotics and contains well-presented derivations of the theoretical concepts covered in the course.

In this course, students are expected to take initiative for their own learning and these sites are a good place to start:

UNSW Library website: <https://www.library.unsw.edu.au/>

Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback. In this course, recent improvements resulting from student feedback include:

The use of a fully featured professional simulation environment was a positive outcome when the course was run in T2 2020. With the addition of 4 new physical UR5e robot arms in the lab, the simulation environment has been expanded and is intended to allow students to switch seamlessly to the physical robots. All assessments have been completely rewritten and the course content has been adapted in response to the mechatronic program review to best prepare students for graduate roles. This include improve sequencing of content between the lectures and assessments. We look forward to your feedback on this new and improved course.

Laboratory Workshop Information

Enclosed footwear is required to enter the labs.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For example:

- Your course has an assessment task worth a total of 100 marks.
- You submit the assessment 2 days (or part thereof) late (i.e. from 24-48 hours after the deadline).
- The submission is graded and awarded a mark of 65/100.
- A late penalty of 10 marks is deducted from your awarded mark (2 days @ 5% of 100 marks).
- Your adjusted final score is 55/100.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations,

these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the [Exams](#) webpage.

Special Consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW now has a [Fit to Sit / Submit rule](#), which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's [Special Consideration page](#).

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID-19 illness or isolation** will be required.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: <ul style="list-style-type: none"> - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: <ul style="list-style-type: none"> - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

Academic Honesty and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

****T2-2022 UPDATE****

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by [NSW health](#) or government authorities. Current alerts and a list of hotspots can be found [here](#). **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the FAQs: <https://www.covid-19.unsw.edu.au/safe-return-campus-faqs>

Guidelines

All students are expected to read and be familiar with UNSW guidelines and policies. In particular, students should be familiar with the following:

- [Attendance](#)
- [UNSW Email Address](#)
- [Special Consideration](#)
- [Exams](#)
- [Approved Calculators](#)

- [Academic Honesty and Plagiarism](#)

Note: This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Hoang-Phuong Phan

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	