UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 2 2020

MTRN4230

Robotics

Contents

1. Staff contact details 2
Contact details and consultation times for course convenor 2
Microsoft Teams Video Chat Hours 2
Contact details and consultation times for additional lecturers/demonstrators/lab staff 2
2. Important links 3
3. Course details 3
Credit points 3
Contact hours 3
Summary and Aims of the course 4
Student learning outcomes 4
4. Teaching strategies 5
5. Course schedule 6
6. Assessment 7
Assessment overview 7
Assignments 8
Presentation 8
Submission 8
Marking 8
Special consideration and supplementary assessment 9
7. Expected resources for students 9
Additional References 9
8. Course evaluation and development 10
9. Academic honesty and plagiarism 10
10. Administrative matters and links 11
Appendix A: Engineers Australia (EA) Competencies 12

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr Javad Taghia
Tel: (02) 9385 4230
Email: j.taghia@unsw.edu.au
Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=41761
MSTeams:
https://teams.microsoft.com/l/team/19%3afb0d7a48ad6e4b438cd0f7e2acea21e9%40thread.tacv2/conversations?groupId=57c07ece-3d24-439b-83ee-7e73eb82184c&tenantId=3ff6cfa4-e715-48db-b8e1-0867b9f9fba3

Microsoft Teams Video Chat Hours

	Tutor	Live Event Weeks:1-5, 7-10	
Tutorial G W09	Yuen Chan	Wed 09:00 - 11:00	Live MS Teams
Tutorial G W12	Yuen Chan	Wed 12:00 - 14:00	Live MS Teams
Tutorial G T09	Rishav Raj	Thu 09:00 - 11:00	Live MS Teams
Tutorial G T12	Mengying Hu	Thu 12:00 - 14:00	Live MS Teams
Tutorial G T15	Mengying Hu	Thu 15:00 - 17:00	Live MS Teams
Tutorial G F09	Rishav Raj	Fri 09:00 - 11:00	Live MS Teams
Tutorial G F12	Xujie Gu	Fri 12:00 - 14:00	Live MS Teams

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Mengying Hu	z5154278@unsw.edu.au
Yuen Chan	z5062106@unsw.edu.au
Rishav Raj	z5177168@unsw.edu.au
Xujie Gu	z5076002@unsw.edu.au
Hiranya Jayakody	hiranya.jayakody@unsw.edu.au
Javad Taghia	j.taghia@unsw.edu.au

Please use MS Teams for communication and any inquiry regards to the course.

Please see the course Moodle and Teams.

2. Important links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 5 hours per week (h/w) of scheduled online contact.

The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 12 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	**Time**	**Delivery Mode**
Lectures	N/A	2 hrs/wk	MSTeams Recorded Lectures
Tutorial	Wednesday	09:00 - 11:00	Microsoft Teams Chat Channel
	Wednesday	12:00 - 14:00	Microsoft Teams Chat Channel
	Thursday	09:00 - 11:00	Microsoft Teams Chat Channel
	Thursday	12:00 - 14:00	Microsoft Teams Chat Channel
	Thursday	15:00 - 17:00	Microsoft Teams Chat Channel

	Day	Time	Delivery Mode
	Friday	09:00 - 11:00	Microsoft Teams Chat Channel
	Friday	12:00 - 14:00	Microsoft Teams Chat Channel

All classes in T2 2020 will be online. Please consult this course's Moodle module for details about delivery.

Summary and Aims 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 how 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. Major projects require students to apply the theory to integrate a robot manipulator, simulation software, vision system and safety system to demonstrate the operation of a simulated robot cell. Problem-solving, project management and group work skills are developed throughout the semester as a foundation for graduate positions.

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 objectives:

- Understand the main categories of robot frames of reference.
- Understand the essentials of robotic kinematics and dynamics and calculate predictive paths.
- Be able to learn and then use the programming environment of a robot to perform a particular task.
- Be able to learn and then use high-level robot simulation software integrating the results with a real robot.
- Enable you to work in groups to improve problem-solving skills using computation.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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

Learning Outcome		EA Stage 1 Competencies
1.	Learn a robot environment and put it to use effectively and efficiently on a given task	2.1, 2.2, 2.4, 3.4, 3.6
2.	Understand robot mechanics and use this knowledge to calculate robot performance	1.3, 1.4, 2.1, 2.2, 3.2, 3.4, 3.5
3.	Implement good safety practices in the use of robots	1.6, 2.2, 3.5
4.	Apply and evaluate image processing techniques in robotics	1.1, 1.2, 1.3, 2.1, 2.2
5.	Apply engineering management and technical tools fluently and systematically	2.2, 2.4, 3.1, 3.2, 3.4, 3.5, 3.6

4. Teaching strategies

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.
- Practical assignments in individual and group form with time limits to assist understanding of industrial demands and boundary conditions on the use of robots.

Suggested approaches to learning in the course:

- Be present and attentive at all labs, follow the lectures online.
- 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 lecture and lab and asking questions when anything is not understood.
- Conscientiously working through the set tutorial exercises and assignments.

This course will be delivered by the help on MS Teams meeting arrangement and downloadable lectures. Full participation in the labs means that you get the chance to get more engaged in the course. That is, you will be held accountable for all content, instructions, information, etc.

5. Course schedule

Week	Lecture Topic	Assignments	Online tutorial	Group project
1	Introduction to robotics, definitions, classification, parallel robots, safety	Assignment 1: - Robot safety - UR5 online training - UR5 offline program	Introduction to Matlab toolbox Peter Corke	The group project is distributed
2	Computer vision for robotics applications	Assignment 1 submission deadline Assignment 2 - Computer vision and image processing	Introduction to the group project and simulation environment	
3	Kinematics: coordinate frames, homogeneous transforms	Assignment 2 submission deadline Assignment 1 marks available Assignment 3 - Robot Kinematics	-Introduction to ROS -Matlab ROS toolbox	
4	Kinematics: Denavit Hartenberg method	Assignment 2 marks available	-Software architect Python in ROS	
5	Kinematics: the Jacobian		QA	
6	**Flexibility Week**			
7	Kinematics: Robot trajectory design, path planning 1		*Object detection in Matlab*	Group project checkpoint 1
8	Path planning 2 and joint dynamics and control	Assignment 3 submission deadline Assignment 4 - Trajectory planning and dynamics	*Object detection in Matlab*	
9	Dynamics: Rigid-body equations of motion		State control in Matlab	Group project checkpoint 2
10	Dynamics: manipulator control		QA	
11		Assignment 4 submission deadline Assignment 3 marks available		Group project Individual report
11-13 Exams	-	Assignment 4 marks available Individual Research Assignment		Group project final checkpoint

6. Assessment

Assessment overview

Assessment Type	Item	Group Project? (# Students per group)	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Individual Assignment	Assignment 1	No	10%	1,2,3,4	Upload completed assignment + code	Week 2: 11:59pm, Friday via Teams	Week3:11:59pm, Wed.	1 week after submission
	Assignment 2	No	20%		Upload completed assignment + code	Week 3: 11:59pm, Friday via Teams	Week4:11:59pm, Wed.	1 week after submission
	Assignment 3	No	15%		Upload completed assignment + code	Week 8: 11:59pm, Friday via Teams	Week9:11:59pm, Wed.	1 week after submission
	Assignment 4	No	15%		Upload completed assignment + code	Week 11: 11:59pm, Friday via Teams	Week12:11:59pm, Wed.	1 week after submission
Group Assignment	Group project checkpoint 1	Yes (up to 7 *people*)	5%	1,3,4,5	Upload r intermediate report + video + code	Week 7: 11:59pm, Friday via Teams	Week8:11:59pm, Wed.	1 week after submission
	Group project checkpoint 2	Yes (up to 7 *people*)	5%		Upload intermediate report + video + code	Week 8: 11:59pm, Friday via Teams	Week9:11:59pm, Wed.	1 week after submission
	Group project checkpoint 3	Yes (up to 7 *people*)	5%		Upload intermediate report + video + code	Week 11: 11:59pm, Friday via Teams	Week12:11:59pm, Wed.	1 week after submission
	Group project final checkpoint	Yes (up to 7 *people*)	15%		Upload final report + video + code	Week13: 11:59pm, Friday via Teams	Week14:11:59pm, Wed.	1 week after submission
Individual Research Project	Industrial robot application and tools	No	10%	1,2,3,4,5	report	Week13: 11:59pm, Friday via Teams	Week14:11:59pm, Wed.	1 week after submission

This course will include the following hurdle requirements that are closely linked to a set of learning outcomes which demonstrate that you have acquired the required skills and competencies within this discipline:

Assignments

There are 4 individual assignments. These assignments are based on the course content and the lecture material as well as introductory material presented in the lab.
There is also 1 individual assignment for safety.

- This assignment needs to be completed and uploaded for marking
- The deadline to submit the completed assignment is 1 week. The next week when you receive the second assignment, the deadline has passed.

There is one group project.

- There are 4 group project checkpoints for it when each team needs to present their group progress and submit an intermediate short report,
- and there is one final group project assignment checkpoint at the end of the term

Presentation

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.

Submission

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) 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.

Work submitted after the ‘deadline for absolute fail’ is not accepted and a mark of zero will be awarded for that assessment item.

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:

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

Marking

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.

Special consideration and supplementary assessment

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.

Please note that 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.

7. Expected resources for students

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=UNSWS&lang=en_US
The first edition (2011) of this textbook is also appropriate.

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

Additional References

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.

Spong, M. and Vidyasagar, M., Robot Dynamics and Control, 1989, John Wiley & Sons.

Craig, J. J., Introduction to Robotics (3rd Ed), 2005, Pearson Prentice Hall.

A source of comparable material from around the world is:
http://www.roboticscourseware.org/courses.html

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
MSTeams:
https://teams.microsoft.com/l/team/19%3afb0d7a48ad6e4b438cd0f7e2acea21e9%40thread.tacv2/conversations?groupId=57c07ece-3d24-439b-83ee-7e73eb82184c&tenantId=3ff6cfa4-e715-48db-b8e1-0867b9f9fba3

8. 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.

This course has been updated to include modern simulation tools and robots that are currently in the market.

9. 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

10. Administrative matters and links

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

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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