UNSW Course Outline

MTRN4230 Robotics - 2024

Published on the 20 May 2024

General Course Information

Course Code : MTRN4230
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Mechanical and Manufacturing Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

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

Course Learning Outcomes
CLO1 : Employ a robot and robot programming environment effectively and efficiently to achieve a given task
CLO2 : Analyse and critically evaluate robot performance using robot mechanics
CLO3 : Formulate models of robot manipulators
CLO4 : Compare and evaluate different robot manipulator designs and their application

Course Learning Outcomes	Assessment Item
CLO1 : Employ a robot and robot programming environment effectively and efficiently to achieve a given task	• Individual projects • Safety and robot demonstration
CLO2 : Analyse and critically evaluate robot performance using robot mechanics	• Quizzes • Individual projects
CLO3 : Formulate models of robot manipulators	• Quizzes • Individual projects
CLO4 : Compare and evaluate different robot manipulator designs and their application	• Quizzes • Individual projects

Learning and Teaching Technologies

Moodle - Learning Management System | EdStem

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Quizzes Assessment Format: Individual	40%	Start Date: Moodle Quizzes on Fri 16:00 - 18:00 (Weeks:5,10) Due Date: Not Applicable
Individual projects Assessment Format: Individual	40%	Start Date: To be announced. Due Date: Week 8 for Project 1 and Week 12 for Project 2
Safety and robot demonstration Assessment Format: Individual	20%	Start Date: ROBOT1 will be released in week 1. ROBOT2 will be released in week 2 Due Date: ROBOT1: Week 2; ROBOT2: Week 4.

Assessment Details

Quizzes

Assessment Overview

Quiz 1 (70 minutes in week 5) and Quiz 2 (90 minutes in week 10)

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

Quizzes will be auto marked on Moodle against specific criteria in a marking guide and marks

will be returned within one day after each quiz.

Verbal class-wide feedback will be provided during the lectures (after the quizzes). Detailed feedback can be provided upon request.

Course Learning Outcomes

- CLO2 : Analyse and critically evaluate robot performance using robot mechanics
- CLO3 : Formulate models of robot manipulators
- CLO4 : Compare and evaluate different robot manipulator designs and their application

Assessment Length

Up to 90 minutes

Submission notes

via Moodle

Assignment submission Turnitin type

Not Applicable

Individual projects

Assessment Overview

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 and Trajectory Planning.

Project 2 (20% of overall marks) will focus on Path Planning.

Marking will be done with a rubric and specific marking criteria including project report, algorithm, and/or demonstration video where applicable. General feedback will be provided within two weeks after project submission. More specific feedback on each marking criteria can be provided upon request.

Indicative effort: Number of page for project reports (typically less than 10 pages) and successful demonstration (e.g., number of the accomplished tasks) with physical robots.

Course Learning Outcomes

- CLO1 : Employ a robot and robot programming environment effectively and efficiently to achieve a given task
- CLO2 : Analyse and critically evaluate robot performance using robot mechanics
- CLO3 : Formulate models of robot manipulators
- CLO4 : Compare and evaluate different robot manipulator designs and their application

Assessment Length

See assessment description

Submission notes

In person demonstration and Moodle submission. Further details will be provided during lectures and course announcements.

Assessment information

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

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

Project 2 (20% of overal marks) will focus on Application of Basic Computervision (Lecture 2), Coordinate transformation (Lecture 3), Inverse Kinematic (Lecture 5), and Path Planning (Lecture 8).

Assignment submission Turnitin type

Not Applicable

Safety and robot demonstration

Assessment Overview

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.

Marking will be against specific criteria in a marking guide and feedback will be provided during your lab sessions. You will be expected to complete ROBOT-1 in week 2 and ROBOT-2 in week 4.

Course Learning Outcomes

- CLO1 : Employ a robot and robot programming environment effectively and efficiently to achieve a given task

Assessment Length

See assessment description

Submission notes

Due in lab class

Assessment information

ROBOT-1 and ROBOT-2 will make up 5% and 15% of the overal 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.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

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.

Quiz 1 (70 mins) and Quiz 2 (90 mintunes) 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 Moodle announcement.

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 20 May - 26 May	Online Activity	Online induction, to be completed at your leisure (before week 1 labs). The instruction documents are provided in Moodle. If you have any technical issues, our demonstrator team will support during your lab session in week 1.
Week 1 : 27 May - 2 June	Lecture	Introduction to Robotics, Classification, and Safety.
	Laboratory	Lab induction, Universal Robotics simulator setup, safety
Week 2 : 3 June - 9 June	Lecture	Sensors (including basic computer vision) & Actuators, Modelling
	Laboratory	MATLAB programming, Basic Computer vision in MATLAB, marking of ROBOT-1
Week 3 : 10 June - 16 June	Lecture	Coordinate Frames and Homogeneous Transformation
	Laboratory	MATLAB Robot Programming (Scripting using RTDE/RVC Toolboxes)
Week 4 : 17 June - 23 June	Lecture	Denavit–Hartenberg (DH) Transformation
	Laboratory	Application of the DH Method, marking of ROBOT-2
Week 5 : 24 June - 30 June	Lecture	Inverse Kinematics and the Jacobian
	Laboratory	Jacobian and velocity calculation in MATLAB
	Assessment	Quiz 1 via Moodle
Week 6 : 1 July - 7 July	Laboratory	No lecture during the flexible week. Free Access to Labs (Three sessions on Tue, Wed, and Thu - to be announced during lectures) (Optional)
Week 7 : 8 July - 14 July	Lecture	Robot Trajectories
	Laboratory	Trajectory Planning in MATLAB
Week 8 : 15 July - 21 July	Lecture	Path Planning for Robot Manipulators
	Laboratory	Path Planning in MATLAB
Week 9 : 22 July - 28 July	Lecture	Joint Dynamics and Control, Euler-Lagrange Equations
	Laboratory	Joint Torque of 2 Link robots
Week 10 : 29 July - 4 August	Lecture	Revision lecture
	Laboratory	Free Access to Labs during scheduled lab session (for Project 2)
	Assessment	Quiz 2 via Moodle

Attendance Requirements

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

General Schedule Information

Please refer to the cousemap available in Moodle for lecture recording, lecture and lab documents, and assigment due dates.

Course 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=UNSWALMA51228764990001731&context=L&vid=UNSWS&lang=enUS

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.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Hoang-Phuong Phan		J17-208D		Weekdays, consultation on request	Yes	Yes
Administrator	James Stevens					No	No
Head demonstrator	Jasper Arnold				Lab session / Edstem	No	No
Demonstrator	Mitchell Torok				Lab session / Edstem	No	No
	Oltan Sevinc				Lab session / Edstem	No	No
	Taylor Chan				Lab session / Edstem	No	No
	Jamie Cerezo				Lab session / Edstem	No	No

Other Useful Information

Academic Information

I. 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, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, 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.

II. 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

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

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.

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 or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

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

Submission of Assessment Tasks

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

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, 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

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)

School-specific Information

Short Extensions

Short extensions are not currently applicable to Mechanical and Manufacturing Engineering Courses.

Review of Results

The purpose of a review of results is if there was a marking error. Review of results is for when you have cause to believe that there is a marking error. Review of Results cannot be used to get feedback. If you would like feedback for assessments prior to the final exam, you are welcome to contact the course convenor directly. No feedback will be provided on final exams.

Use of AI

The use of AI is prohibited unless explicitly permitted by the course convenor. Please respect this and be aware that penalties will apply when unauthorised use is detected, such as through Turnitin. If the use of generative AI, such as ChatGPT, is allowed in a specific assessment, they must be properly credited, and your submissions must be substantially your own work.

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