UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Semester 2 2018

MTRN4230

ROBOTICS

1. Staff contact details

Contact details and consultation times for course convenor

Name: Mark Whitty
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Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=35681

Consultation concerning this course should in the first instance be made with your demonstrators, then using the Moodle discussion forums.

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

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

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

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 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	Location
Lecture	Monday	2pm – 4pm	Ainsworth 102
(Web)	Any	Any	Moodle
Tutorials	Monday	4pm – 5pm	Willis Annexe J18-212
	Monday	5pm – 6pm	Willis Annexe J18-212
	Tuesday	9am – 10am	Willis Annexe J18-212
	Tuesday	10am – 11am	Willis Annexe J18-212
	Tuesday	11am – 12pm	Willis Annexe J18-212
Lab	As per individual enrolment	various	Willis Annexe J18-213 Robot Cell

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes. Lectures run from week 1 until week 12. Tutorials and labs run from week 2 until week 13.

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 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.

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 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 lectures, problem solving sessions and practical group work.
- 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 problem solving sessions, and asking questions when anything is not understood.
- Conscientiously working through the set problem solving exercises and assignments.

This course will be delivered both in the classroom and online. Full participation in the class means that you will participate fully in both arenas. That is, you will be held accountable for all content, instructions, information, etc. that is delivered either in class or online.
Online: The online forum for participation in this class is the Moodle Platform, linked above. All official online interactions will take place or be linked from this site.

5. Course schedule

Week	Topic	Tutorial Content	Lab Content	Textbook sections (C = Corke book, S = Spong book)
Week 1 23/07/2018	Overview of course, Introduction to Robotics, Definitions and Classification, Safety.			C1, S1.1-1.3
Week 2 30/07/2018	Computer Vision for Robotics Applications	Lab induction. Install rvctools.	Robot cell safety training and test	C10.1-10.2, C11.1-11.2, C12, C13, S11
Week 3 06/08/2018	Kinematics 1: Coordinate Frames & 2-link Kinematics. Homogeneous Transformations.	PSE1: Computer vision	Asst 2	C2, C7.1-7.2, S2
Week 4 13/08/2018	Kinematics 2: Denavit Hartenberg Method.	PSE2: DH convention exercise	Asst 2	C7.1-7.5, S3
Week 5 20/08/2018	Kinematics 3: The Jacobian.	PSE3: Jacobian		C8, S4
Week 6 27/08/2018	Robot Motion Control. Accuracy and repeatability.	Asst 1 assistance		C3.1, C9.4, S5.5
Week 7 03/09/2018	Dynamics: The Lagrangian.	Asst 1 assistance		C9.1-9.3, S7
Week 8 10/09/2018	Path Planning.	PSE4: Trajectory control		C5.2, S5.1-5.4
Week 9 17/09/2018	Automated Work Cell – Concepts and Design.		Asst 2 System integration demo	-
Mid-semester break				
Week 10 01/10/2018	*Public holiday*	Asst 3 assistance	Asst 3	-
Week 11 08/10/2018	Mobile Robots	PSE5: Path planning		C4.1-4.2
Week 12 15/10/2018	Parallel Robots, Robot Selection, Economics, Simulation.	Asst 3 assistance		-
Week 13 22/10/2018	*No lecture*	Asst 3 assistance		
Stuvac 29/10/2018				
Exams 1 05/11/2018				
Exams 2 12/11/2018			Asst 3 Full System Implementation demo	

6. Assessment

Assessment overview

Assessment	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Safety	5%	3	Demonstrate ability to use robot cell		N/A	Immediately
Problem Solving Exercises (PSEs)	25%	1, 2, and 4	Demonstrate solution to demonstrator	End of PSS, weeks 4, 5, 6, 9 and 12	N/A	1 week after submission
Individual assignment	20%	4	Accuracy and quality of solution	11:55pm Friday week 6	N/A	2 weeks after submission
Group assignments	50%	1, 3, 4 and 5	Demonstrate solution to demonstrator	End of lab timeslot in week 9 and second full week of exams	N/A	2 weeks after submission

All details of assessment tasks will be found on Moodle. Team evaluation will be used to evaluate the contributions of peers to the two group assignments. The remaining assessments are to be completed individually.

Assignments

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

Late submissions are **not permitted** in this course. An extension may only be granted by means of special consideration (see below).

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.

Examinations

There is no final examination for this course, but the final assignment is due during the exam period as specified above.

Special consideration and supplementary assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the School intranet, and the information on UNSW's Special Consideration page.

7. Expected resources for students

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

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.

In this course, recent improvements resulting from student feedback include reducing the number of individual assessments and increasing the weighting of the group assessments to reflect the workload. Thorough revisions of lecture slides to bring the content up to date, clarify notation and streamline content. Laboratory timeslots are now enrolled through myUNSW, so are fully timetabled. Additional timeslots have been added to allow for increasing enrolment.

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: 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

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

10. Administrative matters and links

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

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support 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