Course Outline

Semester 1 2016

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MTRN4230

Robotics

Contents

1. Staff Contact Details

Contact details and consultation times for course convenor

Name: Mark Whitty
Office location: Ainsworth 510G
Tel: (02) 9385 4230
Email: m.whitty@unsw.edu.au

Consultation concerning this course should in the first instance be made with your demonstrators, then using the Moodle discussion forums and as a last resort by email to the course coordinator.

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

Details will be provided on Moodle.

2. Course details

Credit Points:

This is a 6 unit-of-credit (UoC) course, and involves 6 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.

There is no parallel teaching in this course.

Contact Hours

	Day	**Time**	**Location**
Lectures	Monday	2pm – 4pm	Tyree Energy Technologies Building (TETB) room G16
Problem Solving Sessions	Monday	4pm – 5pm	Willis Annexe 212
	Monday	5pm – 6pm	Willis Annexe 212
Laboratory Times	Tbd in week 1	3 hour timeslots	Willis Annexe 213 (robot cell)

Lectures and Problem Solving Sessions (PSSs) will run from weeks 1 to 13 inclusive, with no classes on Monday of week 8 due to the public holiday. Laboratory times will run from weeks 2 to 13 inclusive.

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 selection process of robots for industrial applications; the main categories of robot frames of reference and the essentials of robot kinematics, dynamics and path planning. Specific topics covered include robot history, populations and main uses, profitability, simulation, kinematics, dynamics, trajectory planning, mobile robots, parallel manipulators, safety and robot workcell concepts and design. Major projects require students to apply the theory to integrate a real robot manipulator, simulation software, vision system and safety system to demonstrate the operation of a robot cell. High levels of problem solving, project management and group work skills are developed throughout the semester as a foundation for graduate positions.

Aims of the Course

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 ways in which robots are used in industrial and service applications.
- Understand the selection process of robots for industrial applications.
- 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 below learning outcomes 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 independently	1.3, 1.4, 2.1, 2.2, 3.2, 3.4, 3.5
3.	Design a robot environment to meet a specific need	2.1, 2.2, 2.3, 2.4, 3.2, 3.6
4.	Implement good safety practices in the use of robots	1.6, 2.2, 3.5
5.	Synthesise solutions drawing from all available resources, including the ability to critique online educational resources	1.4, 1.6, 2.1, 2.2, 3.4, 3.6

3. 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, specifically the Robotics course at http://moodle.telt.unsw.edu.au/course/view.php?id=19839. All official online interactions will take place or be linked from this site.

4. Course schedule

Date	Topic / Lecture Content	Location	PSS Content	Lab Content	Textbook sections (C = Corke book, S = Spong book)
Week 1 29/02/2016	Overview of course, Introduction to Robotics, Definitions and Classification, Safety	TETB G16	-	-	C1, S1.1-1.3
Week 2 07/03/2016	Kinematics 1: Coordinate Frames & 2-link Kinematics. Homogeneous Transformations	TETB G16	Introduction	Robot cell safety training and test	C2, C7.1-7.2, S2
Week 3 14/03/2016	Kinematics 2: Denavit Hartenberg Method	TETB G16	PSE1	Asst 1	C7.1-7.5, S3
Week 4 21/03/2016	Kinematics 3: The Jacobian	TETB G16	PSE2	Asst 1	C8, S4
Week 5 04/04/2016	Computer Vision for Robotics Applications	TETB G16	PSE3	Asst 1 Demo	C10.1-10.2, C11.1-11.2, C12, C13, S11
Week 6 11/04/2016	Dynamics: The Lagrangian	TETB G16	Asst 2 assistance	Asst 3	C9.1-9.3, S7
Week 7 18/04/2016	Robot Motion Control. Accuracy and repeatability.	TETB G16	PSE4	Asst 3	C3.1, C9.4, S5.5
Week 8 25/04/2016	No lecture or PSS due to public holiday	-	-	Asst 3	-
Week 9 02/05/2016	Path Planning	TETB G16	PSE5	Asst 3	C5.2, S5.1-5.4
Week 10 09/05/2016	Automated Work Cell – Concepts and Design	TETB G16	Asst 3 and 4 assistance	Asst 3	-
Week 11 16/05/2016	Robot Selection, Economics, Simulation	TETB G16	Asst 3 and 4 assistance	Asst 3	-
Week 12 23/05/2016	Mobile Robots	TETB G16	Asst 3 and 4 assistance	Asst 3	C4.1-4.2
Week 13 30/05/2016	Parallel Robots	TETB G16	Asst 3 and 4 assistance	Asst 3 Demo	-

5. Assessment

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Marks returned
Moodle safety quiz	-	2%	4	Knowledge of robot operating procedures	11:55pm, Friday week 2, 11/03/2016	Immediately
In-person safety test	20 minutes	3%	4	Demonstrate ability to use robot cell	End of week 2 lab class	Immediately
PSE1 DH Convention	-	3%	2, 5	Demonstrate solution to demonstrator	End of PSS, 6pm, Monday week 3, 14/03/2016	1 week
PSE2 Jacobian and velocities	-	3%	2, 5	Demonstrate solution to demonstrator	End of PSS, 6pm, Monday week 4, 21/03/2016	1 week
PSE3 Computer vision	-	3%	2, 5	Demonstrate solution to demonstrator	End of PSS, 6pm, Monday week 5, 04/04/2016	1 week
Asst1 System Integration (group work)	-	15%	1, 4, 5	Demonstrate solution to demonstrator in robot cell	End of week 5 lab class	2 weeks
PSE4 Trajectory control	-	3%	2, 5	Demonstrate solution to demonstrator	End of PSS, 6pm, Monday week 7, 18/04/2016	1 week
Asst2 Computer vision	-	15%	2, 5	Accuracy of submitted code solution	11:55pm Friday week 7, 22/04/2016	2 weeks
PSE5 Path planning	-	3%	2, 5	Demonstrate solution to demonstrator	End of PSS, 6pm, Monday week 9, 02/05/2016	1 week
Asst3 Full system demo (group work)	-	30%	1, 4, 5	Demonstrate solution to demonstrator in robot cell	End of week 13 lab class	2 weeks
Asst4 Robot cell design	30 pages	20%	1, 2, 3, 5	Quality of report submitted to Moodle	11:55pm, Friday 17/06/2016	2 weeks

All details of assessment tasks will be found on Moodle (link below). Team evaluation (such as WebPA) will be used to evaluate the contributions of peers to the two group projects. The remaining assessments are to be completed individually.

Assignments

Presentation

All submissions must be made through Moodle and may require uploading of your code when directed in the assignment description. No school cover sheets are required, however reports should include a title page containing your name and student number.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work. Presenting them 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 in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor ***before the due date***. Special consideration for assessment tasks of 20% or greater must be processed through student.unsw.edu.au/special-consideration.

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.

6. 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**, 2013, Springer. This book is available in the UNSW Bookshop.
The full book is also available online for download through the UNSW library:
http://link.springer.com.wwwproxy0.library.unsw.edu.au/book/10.1007%2F978-3-642-20144-8

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.

Students seeking resources can also obtain assistance from the UNSW Library.
http://info.library.unsw.edu.au/web/services/services.html

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.

7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) 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 a review of the workload of the course, with several assessment tasks reduced in complexity and their weightings also reduced. Three hour lab sessions have also doubled the amount of time students have to actively use the robot cell. Extensive hand-written calculations have also been streamlined with more of an emphasis on Matlab simulations. Team evaluation will also be used to adjust relative contributions to group assignments where necessary.

8. 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.

9. Administrative Matters

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)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support Services

Dr Mark Whitty
February 2016

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	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