UNSW AUSTRALIA

Course Outline

Semester 1 2015

Never Stand Still | Faculty of Engineering | School of Mechanical and Manufacturing Engineering

MTRN4230/9221
Robotics

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1. COURSE STAFF

Contact details and consultation times for course convener

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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.

2. COURSE DETAILS

Units of credit

Units of credit: Six (6).
For MTRN4230/9221 (6UoC) this means roughly:

In class	4.5 hours per week
Self-study	6 hours per week
Total	10.5 hours per week

Weekly Schedule

Lecture: Monday 1200-1400 **Lecture Location:** Electrical Engineering 418 (EE418)

Problem Solving Sessions (PSSs): Tuesday 1100-1200, 1200-1300, 1300-1400, 1400-1500, 1500-1600, Thursday 1000-1100
PSS Location: Mechatronics Labs, Blockhouse (G6), Room G9/G10

Robot Cell: 1.5 hours per group per week, times to be decided.

There is no parallel teaching in this course.

Aims of the course

This course introduces you to the analysis and use of robots in a variety of industrial settings. The course exposes you to the theoretical basis of robotics as well as their practical implementation. A group project involving designing and implementing robot behaviours in a robot cell and in simulation with an anthropomorphic robot places in context much of the content learnt throughout the course.

This is a core course for Mechatronics students and it aims to broaden your understanding of how robotics plays a significant role in achieving many industrial and service roles.

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 categorize end effectors and design them for specific roles.
- 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.

Context

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.

Expected student learning outcomes

Students who successfully complete this course will be able to:	**UNSW graduate attributes**[1]
1. Learn a robot environment and put it to use effectively and efficiently on a given task	1.2, 1.4, 1.7, 1.8, 3.1, 3.2
2. Understand robot mechanics and use this knowledge to calculate robot performance independently	1.3, 1.4, 3.1
3. Design a robot environment to meet a specific need	1.4, 1.7, 1.8
4. Implement good safety practices in the use of robots	3.3
5. Synthesise solutions drawing from all available resources, including the ability to critique online educational resources	3.1, 4.1

[1]UNSW's graduate attributes are shown at
https://my.unsw.edu.au/student/atoz/GraduateAttributes.html

UNSW graduates will be

1. Scholars who are:
   1.1. understanding of their discipline in its interdisciplinary context
   1.2. capable of independent and collaborative enquiry
   1.3. rigorous in their analysis, critique, and reflection
   1.4. able to apply their knowledge and skills to solving problems
   1.5. ethical practitioners
   1.6. capable of effective communication
   1.7. information literate
   1.8. digitally literate

2. Leaders who are:
   2.1. enterprising, innovative and creative
   2.2. capable of initiating as well as embracing change
   2.3. collaborative team workers

3. Professionals who are:
   3.1. capable of independent, self-directed practice
   3.2. capable of lifelong learning
   3.3. capable of operating within an agreed Code of Practice

4. Global Citizens who are:
   4.1. capable of applying their discipline in local, national and international contexts
   4.2. culturally aware and capable of respecting diversity and acting in socially just/responsible ways
   4.3. capable of environmental responsibility

3. RATIONALE FOR INCLUSION OF CONTENT AND TEACHING APPROACH

This course is included to give you the skills to design robot applications and solutions that will fulfil industry requirements, and to be able to analyse and understand the principal factors that contribute to successful outcomes.

Effective learning is supported when you are actively engaged in the learning process and by a climate of enquiry, and these are both an integral part of the lectures.

You become more engaged in the learning process if you can see the relevance of your studies to professional, disciplinary and/or personal contexts, and the relevance is shown in the lectures and assignments by way of examples drawn from industry.

Dialogue is encouraged between you, others in the class and the lecturers. Diversity of experiences is acknowledged, as some students in each class have prior knowledge and experience. Your experiences are drawn on to illustrate various aspects, and this helps to increase motivation and engagement.

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 categories of robot, role and peripheral items are 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 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=13589. All official online interactions will take place or be linked from this site.

Course Schedule

Date	Week	Topics	Textbook sections (C = Corke book, S = Spong book)
02/03	1	Overview of course, Introduction to Robotics, Types of Automation, Major Classifications, Terminology, End Effectors.	C1, S1.1-1.3
09/03	2	Computer Vision for Robotics Applications	C10.1-10.2, C11.1-11.2, C12, C13, S11
16/03	3	Robot Selection, Economics, Simulation, Safety Considerations.	-
23/03	4	Kinematics 1: Coordinate Frames & 2-link Kinematics. Homogeneous Transformations.	C2, C7.1-7.2, S2
30/03	5	Kinematics 2: Denavit Hartenberg Method.	C7.1-7.5, S3
06/04		Mid-semester break	
13/04	6	Kinematics 3: The Jacobean.	C8, S4
20/04	7	Dynamics: The Lagrangian.	C9.1-9.3, S4
27/04	8	Robot Motion Control. Accuracy and repeatability.	C3.1, C9.4, S5.5
04/05	9	Path Planning.	C5.2, S5.1-5.4
11/05	10	Automated Work Cell – Concepts and Design.	-
18/05	11	Parallel Robots.	-
25/05	12	Mobile Robotics and Course Revision.	C4.1-4.2
01/06	13	No lecture	

5. ASSESSMENT

You are assessed by way of both individual and group assignments and problem solving sessions, which involve both calculations and descriptive material. These assessments test your grasp of the principles of using robots and the theoretical basis of how they work.
There will not be a final examination at the end of the semester.
Further details of individual assessment tasks will be provided on Moodle, including submission procedures and the criteria by which grades will be assigned.

Late Submission Policy

Late submission of assessable items is **not** permitted in this course. Special consideration may be granted according to the policy listed in the section titled ‘Administrative Matters’ below.

Presentation Requirements

All assessed materials should be neat and clear, and demonstrate professionalism. Guidance can be found in the School's publications Standard Specification for the Presentation of Student Written Assignments and In a Nutshell, both of which are provided in The Guide (see School General Office if you do not have a copy).

All reports must be submitted to Moodle electronically and require a title page but do not require the school's standard cover sheet.

Assessment Schedule

Week	Assessments	Marks	Due Dates	Reason for Assessment	Student Learning Outcomes
2	Moodle Safety Tutorial	2	13/03	Test individual understanding of the principles behind safe operation of the robot cell.	4
2	Robot Cell Safety Test	3	13/03	Individually demonstrate safe operation of the robot cell.	4
4	Computer Vision Problem Solving Exercise	10	27/03	Test individual ability to apply image processing methods to near problems.	1
6	Assignment 1 Computer Vision	15	17/04	Test individual ability to apply image processing methods to far problems.	1, 5
7	Assignment 2 System Integration	15	24/04	Test group ability to integrate components of a robot cell.	1
9	Robot Dynamics Problem Solving Exercise	10	08/05	Test individual ability to apply dynamics principles to near problems.	2
11	Assignment 3 Robot Dynamics and Control	15	22/05	Test individual ability to apply dynamics principles to a far problem.	1, 2, 5
13	Assignment 4 Full Cell Implementation	30	05/06	Test group ability to design and implement an automated robot cell integrating vision, simulation, ABB rapid code and user interface.	1, 3, 4, 5

Special Consideration and Supplementary Assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see *Administrative Matters*, available from the School website.

6. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is using the words or ideas of others and presenting them 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 booklet which provides essential information for avoiding plagiarism: https://my.unsw.edu.au/student/academiclife/Plagiarism.pdf

There is a range of resources to support students to avoid 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. Information is available on the dedicated website Plagiarism and Academic Integrity website: http://www.lc.unsw.edu.au/plagiarism/index.html

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 a honours thesis) even suspension from the university. The Student Misconduct Procedures are available here: http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, *Administrative Matters*, available on the School website.

7. 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. www.library.unsw.edu.au

Several recently developed MOOCs by Peter Corke will cover much of the same content and are recommended as reference material.

Robotics: https://moocs.qut.edu.au/learn/introduction-to-robotics-february-2015-814

Computer Vision: https://moocs.qut.edu.au/learn/robotic-vision-april-2015

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.

8. COURSE EVALUATION AND DEVELOPMENT

The UNSW CATEI process will be used to survey your responses to this course. In this way, we can identify the goods bits to keep for next time and the bits that need improving.

Feedback from previous instances of this course recommended more structured assessment and less partitioning of tasks between group members. In response several individual projects have been added which will cover the basic operation of the robot cell and act as stepping stones towards the final group project. In addition, problem solving exercises to be completed both online and in problem solving sessions have been

integrated to reduce the content in the major assignments. Thus the assignments will be more appropriately sized for the course. Additional resources will be provided to assist students in completing assignments (particularly in computer vision), without removing the requirement for independent study.

Positive feedback included the use of a real robot system and this has been maintained. Up to date videos and robotics news provided and insight into the current state of the art and this will be continued and students are invited to contribute material they have found themselves. Integration between theory and practice was a highlight, and the assignments will continue to be linked to course content and practical implementation to ensure this is maintained.

You are also encouraged to comment on all aspects of the course using the discussion forum within Moodle while the course is being conducted.

9. ADMINISTRATIVE MATTERS

You are expected to have read and be familiar with Administrative Matters, available on the School website. This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Information on general Occupational Health and Safety policies and expectations is available here: www.ohs.unsw.edu.au

Enclosed footwear is a prerequisite for entering the school laboratories. It is a requirement that the first two assessment tasks to be satisfactorily completed before you will be allowed to use the robot cell. Further information regarding the OHS requirements for laboratory work will be available on Moodle.

Examination procedures and advice concerning illness or misadventure are detailed in the Administrative Matters document, and in the event of any discrepancy between this course outline and that document precedence will be given to this course outline.

Dr Mark Whitty
February 2015