MTRN4230/9221
Robotics

Course Outline

Contents

1. COURSE STAFF ................................................................................................. 1
2. COURSE DETAILS ............................................................................................. 1
3. RATIONALE FOR INCLUSION OF CONTENT AND TEACHING APPROACH .. 3
4. TEACHING STRATEGIES .................................................................................. 3
5. ASSESSMENT .................................................................................................... 4
6. ACADEMIC HONESTY AND PLAGIARISM ........................................................ 6
7. RESOURCES FOR STUDENTS ......................................................................... 7
8. COURSE EVALUATION AND DEVELOPMENT ................................................. 7
9. ADMINISTRATIVE MATTERS............................................................................. 8
1. COURSE STAFF

Course convener

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Consultation concerning this course should in the first instance be made with your tutors, 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 5.5 hours per week
Self-study 4.5 hours per week
Total 10 hours per week

Weekly Schedule

Lecture: Monday 1200-1500  Lecture Location: Central Lecture Block Theatre 2 (CLB2)

Tutorials: Tuesday 1300-1400, 1400-1500, Wednesday 1600-1700, 1700-1800 Tutorial 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

<table>
<thead>
<tr>
<th>Students who successfully complete this course will be able to:</th>
<th>UNSW graduate attributes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learn a robot environment and put it to use effectively and efficiently on a given task</td>
<td>1.2, 1.4, 1.7, 1.8, 3.1, 3.2</td>
</tr>
<tr>
<td>2. Understand robot mechanics and use this knowledge to calculate robot performance</td>
<td>1.3, 1.4, 3.1</td>
</tr>
<tr>
<td>3. Design a robot environment to meet a specific need</td>
<td>1.4, 1.7, 1.8</td>
</tr>
<tr>
<td>4. Implement good safety practices in the use of robots</td>
<td>3.3</td>
</tr>
</tbody>
</table>

¹UNSW’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, tutorials 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 tutorials, and asking questions when anything is not understood.
- Conscientiously working through the set assignments.
- Learning of the lecture material in preparation for examinations.

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=5685. All official online interactions will take place or be linked from this site.

Course Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Week</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/3</td>
<td>1</td>
<td>Overview of course, Introduction to Robotics, Types of Automation, Major Classifications, Terminology, End Effectors.</td>
</tr>
<tr>
<td>10/3</td>
<td>2</td>
<td>Computer Vision for Robotics Applications</td>
</tr>
<tr>
<td>17/3</td>
<td>3</td>
<td>Robot Selection, Economics, Simulation, Safety Considerations.</td>
</tr>
<tr>
<td>24/3</td>
<td>4</td>
<td>Kinematics 1: Coordinate Frames &amp; 2-link Kinematics. Homogeneous Transformations.</td>
</tr>
<tr>
<td>31/3</td>
<td>5</td>
<td>Kinematics 2: Denavit Hartenberg Method.</td>
</tr>
<tr>
<td>7/4</td>
<td>6</td>
<td>Kinematics 3: The Jacobean.</td>
</tr>
<tr>
<td>14/4</td>
<td>7</td>
<td>Dynamics: The Lagrangian.</td>
</tr>
<tr>
<td>21/4</td>
<td></td>
<td>Mid-semester break.</td>
</tr>
<tr>
<td>28/4</td>
<td>8</td>
<td>Robot Motion Control. Accuracy and repeatability.</td>
</tr>
<tr>
<td>5/5</td>
<td>9</td>
<td>Path Planning.</td>
</tr>
<tr>
<td>12/5</td>
<td>10</td>
<td>Automated Work Cell – Concepts and Design.</td>
</tr>
<tr>
<td>19/5</td>
<td>11</td>
<td>Parallel Robots.</td>
</tr>
<tr>
<td>26/5</td>
<td>12</td>
<td>Mobile Robotics and Course Revision.</td>
</tr>
<tr>
<td>2/6</td>
<td>13</td>
<td>No lecture</td>
</tr>
</tbody>
</table>

5. ASSESSMENT

You are assessed by way of both assignments and an examination, 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 be a final examination at the end of the semester. This examination will contribute 20% of the total grade in the course. The assignments will provide the remaining marks of the grade.

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.

Criteria

The following criteria will be used to grade assignments:

For project reports:
- Identification of key facts and the integration of those facts in a logical development.
- Clarity of communication—this includes development of a clear and orderly structure and the highlighting of core arguments.
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation.
- A comprehensive approach to identifying key issues, hypotheses, data requirements, analyses and knowledge thus gained and how this knowledge is incorporated in decision making.
- Correct referencing in accordance with the prescribed citation and style guide.

For numerical calculations:
- Accuracy of numerical answers.
- All working shown.
- Use of diagrams, where appropriate, to support or illustrate the calculations.
- Use of graphs, were appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.
- Neatness.

For demonstrations:
- Correctness of solution.
- Timeliness and reliability of solution.
- Clarity of communication and understanding of the processes implemented.
<table>
<thead>
<tr>
<th>Week</th>
<th>Assessments</th>
<th>Marks</th>
<th>Due Dates</th>
<th>Reason for Assessment</th>
<th>Student Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Moodle Safety Quiz</td>
<td>2</td>
<td>14/3</td>
<td>Test individual understanding of the principles behind safe operation of the robot cell.</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Robot Cell Safety Test</td>
<td>3</td>
<td>14/3</td>
<td>Individually demonstrate safe operation of the robot cell.</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Assignment 1 Computer Vision</td>
<td>15</td>
<td>28/3</td>
<td>Test individual ability to apply image processing methods robustly.</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Assignment 2 System Integration</td>
<td>15</td>
<td>2/5</td>
<td>Test group ability to integrate components of a robot cell.</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Assignment 3 Robot Dynamics and Control</td>
<td>15</td>
<td>16/5</td>
<td>Test individual ability to apply theoretical analysis in simulation.</td>
<td>1, 2</td>
</tr>
<tr>
<td>13</td>
<td>Assignment 4 Full Cell Implementation</td>
<td>30</td>
<td>6/6</td>
<td>Test group ability to design and implement an automated robot cell integrating vision, simulation, ABB rapid code and user interface.</td>
<td>1, 3, 4</td>
</tr>
<tr>
<td>Exams</td>
<td>Final Exam</td>
<td>20</td>
<td>TBA – Exams Period</td>
<td>Test individual understanding and ability to apply theoretical concepts.</td>
<td>2</td>
</tr>
</tbody>
</table>

The final examination will cover the whole syllabus.

### 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](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:

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:


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

7. RESOURCES FOR STUDENTS

It is strongly recommended that you purchase the prescribed textbook for the course as it presents a very wide range of background material in an accessible manner with extensive Matlab examples:


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

Additional References:


Students seeking resources can also obtain assistance from the UNSW Library.

www.library.unsw.edu.au

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 good 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.

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 for All Courses, 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 for 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 for All Courses document, and in the event of any discrepancy between this course outline and that document precedence will be given to this course outline.

Dr M Whitty                                                February 2014