



MTRN4010

Advanced Autonomous Systems

Term One // 2021

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Jose Guivant	j.guivant@unsw.edu.au	TBA	Building J17, Room 510D	(02) 9385 5693

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

Course Details

Credit Points 6

Summary of the Course

The course is aimed at learning basic and advanced techniques necessary for sensing and control of autonomous mechatronic systems. Contents covered in this course include Bayesian state estimation / Sensor data fusion and certain relevant nonlinear control techniques (Dynamic Programming, MPC and PSO). Half of the course is lecture-based. In the other half, students implement those techniques.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Understanding of the general theory of Bayesian Estimation. Understanding of the theory and application of the Kalman Filter (KF and EKF) for solving diverse problems in the area of Engineering	PE1.3
2. Understanding of methods such as MPC, Dynamic Programming and PSO	PE1.3
3. Be able to develop software for applying the theory and actually solving complex problems. Get experience in using data from real sensors which are typical in Field Robotics and Autonomous Systems	PE2.3

Teaching Strategies

Teaching of this course is implemented through lectures to cover the theory, and project sessions to put those concepts in practice. All laboratory/project work is individual work, and attendance is necessary.

The provision of the learning environment in the laboratory is to facilitate students developing confidence in managing laboratory tasks as projects. Demonstrators in the laboratories are there to provide guidance and assistance in managing the laboratory tasks.

Examples (e.g. source code) for the projects are provided by the Lecturer, to help in the understanding and full implementation of the projects. Project complexity is incremental, to allow the student to finally complete the solution of a complex problem.

Lectures have a nominal duration of 2.5 hours. However, the last ½ hour is intended to be dedicated to discussions, and clarification of concepts; and for showing related material, which may be useful for helping the understanding of the previously presented material.

Assessment

Students must demonstrate understanding of learning outcomes 1 and 2 (corresponding to PE1.3), for which a minimum mark of 40% for the final exam is required in order to pass this subject.

Students must demonstrate competency of learning outcome 3 (corresponding to PE2.3), for which a minimum mark of 40% combined across all projects is required in order to pass this subject.

Failure to meet both of these minimum marks will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Project 1	1%	Friday, week 3	3
Project 2: Applying EKF	14%	Friday, week 6	3
Project 3: Processing data from real Sensors - EKF Localizer	20%	Friday, week 9	3
Project 4: Solving problems, applying MPC and PSO	15%	Friday, week 10	3
Final Exam	50%	Exam period	1, 2

Assessment Details

Assessment 1: Project 1

Start date: Week 1

Details:

Implement simulations of certain non linear discrete time systems, in Matlab/Simulink (useful for Project 2)

Additional details:

Deadline: Friday week 3

Submitted, electronically, via Moodle.

Results will be released by Friday, week 4.

Absolute fail deadline: Friday week 4.

Assessment 2: Project 2: Applying EKF

Details:

The student implement an EKF for estimating the states of a given system, in simulation.

Additional details:

Deadline: Friday week 6

Submission site will be open during weeks 5 and 6.

Submitted, electronically, via Moodle.

Results will be released by Friday, week 7.

Absolute fail deadline: Friday week 7.

Assessment 3: Project 3: Processing data from real Sensors - EKF Localizer**Details:**

The students are given data files, having measurements from real sensors (LIDAR, Inertial, encoders). They need to integrate the data from those different sources, via an EKF, for estimating the 3DoF pose of a wheeled platform.

Submission notes: Submission of software implementation, via Moodle. Demonstration in person or via Teams.

Assessment 4: Project 4: Solving problems, applying MPC and PSO**Details:**

A set of problems to be solved using MPC and PSO techniques.

Additional details:

Deadline: Friday week 10

Submitted, electronically, via Moodle.

Results will be released by Friday, "week 11".

Absolute fail deadline: Friday "week 11".

Assessment 5: Final Exam**Details:**

Exam at the end of the session.

Attendance Requirements

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

Course Schedule

[View class timetable](#)

Timetable

Date	Type	Content
O Week: 8 February - 12 February		
Week 1: 15 February - 19 February	Lecture	<i>Refreshing concepts (Statistics, Control, Programming). Typical Sensors and Models.</i>
Week 2: 22 February - 26 February	Lecture	<i>Estimation part 1</i>
Week 3: 1 March - 5 March	Lecture	<i>Estimation part 2</i>
Week 4: 8 March - 12 March	Lecture	<i>Estimation part 3. Localization part 1.</i>
Week 5: 15 March - 19 March	Lecture	<i>Localization part 2</i>
Week 6: 22 March - 26 March	Lecture	<i>Flexibility week / Extra Consultation / Revision of previous lectures.</i>
Week 7: 29 March - 2 April	Lecture	<i>Principle of Optimality, Dynamic Programming, Dijkstra's Approach</i>
Week 8: 5 April - 9 April	Lecture	<i>Model Predictive Control (MPC)</i>
Week 9: 12 April - 16 April	Lecture	<i>Particle Swarm Optimization (PSO).</i>
Week 10: 19 April - 23 April	Lecture	<i>Revision of previous lectures. Case of study EKF-SLAM.</i>

Resources

Recommended Resources

All the academic material is provided by the lecturer (lecture notes, example data, software libraries, example code, sensors and equipment).

Datasets of real sensors' measurements are provided for allowing the students to perform playback sessions and work at home when needed.

Course Evaluation and Development

A full lecture is now dedicated to the application of EKF to systems of other areas of Engineering (in addition Localization in the Robotics Field)

Projects have been reorganized, for better adaptation to the trimester modality, and for offering the option to work at home.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

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.

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.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) 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.

Work submitted after the 'deadline for absolute fail' is not 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 are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the [Exams](#) webpage.

Special Consideration

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 submitting an assessment or sitting an exam.

UNSW now has a [Fit to Sit / Submit rule](#), which means that if you attempt an exam or submit a piece of assessment, 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](#).

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID 19 illness or isolation** will be required.

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, 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.

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

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to a **limited** number of on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by [NSW health](#) or government authorities. Current alerts and a list of hotspots can be found [here](#). **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the FAQs: <https://www.covid-19.unsw.edu.au/safe-return-campus-faqs>

Guidelines

All students are expected to read and be familiar with UNSW guidelines and policies. In particular, students should be familiar with the following:

- [Attendance](#)
- [UNSW Email Address](#)
- [Special Consideration](#)
- [Exams](#)
- [Approved Calculators](#)
- [Academic Honesty and Plagiarism](#)

Important Links

- [Moodle](#)
- [Lab Access](#)
- [Health and Safety](#)
- [Computing Facilities](#)
- [Student Resources](#)
- [Course Outlines](#)
- [Engineering Student Support Services Centre](#)
- [Makerspace](#)
- [UNSW Timetable](#)
- [UNSW Handbook](#)
- [UNSW Mechanical and Manufacturing Engineering](#)
- [Equitable Learning Services](#)

Image Credit

Synergies in Sound 2016

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	