School of Electrical Engineering and Telecommunications

Term 2, 2020
Course Outline

ELEC3114: Control Systems

COURSE STAFF

Course Convener:	Dr. Arash Khatamianfar, Room 313, a.khatamianfar@unsw.edu.au
Tutor and Mentors:	Dr. Arash Khatamianfar, Room 313, a.khatamianfar@unsw.edu.au Mentors TBA
Laboratory Contact:	Mr. Nelson Fu, nelson.fu@unsw.edu.au

Consultations:
You are encouraged to ask questions on the course material after the lecture class times in the first instance, via email, through online discussion forums (highly encouraged), and during tutorials and labs. Lecturer consultation times will be advised on Moodle, https://moodle.telt.unsw.edu.au/login/index.php, which is the official online learning management system (LMS) used at UNSW. You may also be interested in using other online platforms outside Moodle to communicate with your peers who are currently taking the course or have taken it before. ALL email enquiries should be made from your student email address with *ELEC3114* in the subject line; otherwise there may be delays in answering your query. **Microsoft Teams** (MS Teams) will also be used alongside Moodle for conducting live lectures, tutorials, and remote labs.

Keeping Informed: All announcements regarding the course and its assignments will be made on Moodle. Announcements may also be made during lectures, as well as on MS Teams, but everything will be formally posted on the "**Course Announcements**" **forum** on the **ELEC3114 Moodle page**. Please note that it is your responsibility to carefully read this information, and it is expected that you have done so.

COURSE Overview

Contact Hours
The course consists of the following learning activities:

- **4 hours** of **lecture** (two 2-hour live-streamed lecture sessions from **Week 1** to **Week 10**)
- **1.5 hours** of **tutorial** (live streamed from **Week 2** to **Week 10**)
- **2 hours** of online recorded **tutorials** (from **Week 2** to **Week 10**)
- **3 hours** of **laboratory** (from **Week 3** to **Week 10**).

Session	Day	Time	Location
Lectures (W1 – W10)	Tuesday	2pm - 4pm	Online streaming via MS Teams
	Friday	10am - 12pm	
Tutorials (W2 – W10)	Tuesday to Thursday	Check Your Timetables*	Online streaming via MS Teams
Laboratories (W3 – W10)	Monday to Friday	Check Your Timetables*	Remotely accessed Labs via MS Teams

* The full **tutorial** and **lab schedule** can be found at: http://classutil.unsw.edu.au/ELEC_T2.html#ELEC3114T2 or at http://timetable.unsw.edu.au/2020/ELEC3114.html .

Indicative Lecture Schedule

Week	Summary of Lecture Program
Week 1	Introduction to Control Systems – Laplace Transform Revision
Week 2	Mechanical and Electrical Modelling in the Frequency Domain
Week 3	Permanent Magnet DC Motor – State Variable Models in the Time Domain
Week 4	Time Response of LTI Systems – Feedback Control System Characteristics ***Assignment A due date (Friday of Week 4)***
Week 5	Stability of LTI Systems – Steady State Error
Week 6	***Flexibility Week***
Week 7	PID Controllers
Week 8	State Variable Feedback Systems ***Assignment B due date (Friday of Week 8)***
Week 9	Root Locus Technique
Week 10	Frequency Response Method – Robust Control Systems
Week 11	***Catch-up/Revision lecture***

Indicative Laboratory Schedule

Period	Summary of Laboratory Program
Week 1	*No Lab*
Week 2	*No Lab*
Week 3	Lab 0: Remote Lab Familiarisation
Week 4	Lab 1: MATLAB & Simulink Training
Week 5	Lab 2: DC Motor Modelling with Load
Week 6	***Catch-up lab***
Week 7	Lab 3: Flexible Joint Robotic Arm Modelling
Week 8	Lab 4: DC Motor Speed Control
Week 9	Lab 5: DC Motor Position Control
Week 10	Lab 6: Flexible Joint Robotic Arm Control
Week 11	***Catch-up/optional lab***

Assessment

Assessment type	Weight
1. Assignments	30 %
2. Laboratory assessments	24 %
3. Online quizzes	6 %
4. Final exam (2 hours):	40 %
Total:	**100%**

- The two **assignments** are due on Friday of **Week 4** and **Week 8**.
- The date of the **final exam** will be announced by the University.
- You **MUST** at least achieve **12%** out of **24%** of total **lab assessment** to **pass the course.**
- You **MUST** at least achieve **16%** out of **40%** of the total **final exam paper** mark to **pass the course**.

For further details on each assessment task, please refer to the Assessment section on Page 6.

Introduction to the Course: Context and Aims

The Control Systems course is a third-year core course offered in the School of Electrical Engineering and Telecommunications at the undergraduate level. Control engineering is one of the **most multidisciplinary subjects** in Engineering, and as such, relies heavily upon prior foundational courses taken in the Electrical Engineering degree. This is because most modern control systems are themselves the synthesis of multiple electromechanical, hydraulic and embedded systems in one coherent structure. The successful design of control systems is an example of the '*marriage between theory and practice'*, where the various powerful mathematical tools from control theory are successfully applied to real-world control engineering problems. The study of control theory enables us to translate these practical problems into workable engineering solutions.

For instance,

- *Have you ever thought about how your air-conditioning system in your car automatically regulates the temperature inside the cabin when you set your preferred value on the front panel, even when your vehicle moves into and out of shade?*
- *Have you ever come across or heard about the autopilot feature on a Tesla automobile?*
- *Have you seen how adaptive cruise control maintains your vehicle at a safe distance from the car ahead no matter how fast or slow they drive (see Fig. 1)?*

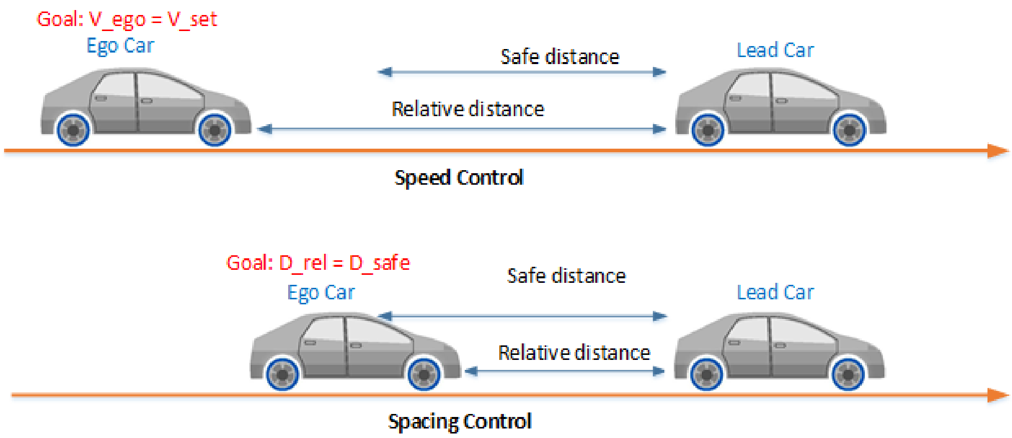

Fig. 1: Schematic of speed and distance control principles in adaptive cruise control
https://au.mathworks.com/help/mpc/examples/design-an-adaptive-cruise-control-system-using-model-predictive-control.html

The objective of this course is to equip you with the fundamental tools of control theory required for the design and implementation of these control systems. These tools are broadly applicable to other disciplines and are not just limited to the examples discussed above. For example, control theory finds application in the control of complex financial systems, the teleoperated control of unmanned aerial and underwater vehicles, and also in the control of disease spread in a population (i.e. limiting the spread of COVID-19 via rigorous testing and social distancing policies). In this course, we are only going to touch the surface of this vast field, but it is our hope that you take away valuable skills which may be generally applied to a multitude of practical engineering problems.

To support your learning, the laboratory component of this course has been carefully designed to help you develop the ability to design real control systems from scratch. It is our hope that through the complementary activities of lectures, tutorials, and the laboratories that you will learn how to analyse and implement effective control strategies for real systems which work even in the presence of input constraints and external disturbances.

This course is challenging, but we will cater the learning and teaching process to your needs in a way that encourages active learning and participation through proven *learner-centred approaches*. As such, we will be holding several *in-class and out-of-class learning activities* to keep you *engaged* with the material, to be *motivated* to *learn more*, and to develop *critical thinking skills* which may be broadly applied to real engineering problems. As mentioned previously, the laboratory exercises and experiments are going to be a *crucial* part of this course as they will provide you with the necessary *hands-on experience* to develop these skills.

In summary, the overall objective of this course is for you to gain true competence in the fundamentals of control theory, and also to learn how to:

- examine a physical process and abstractly represent it in block diagram form,

- assess whether it may be difficult or easy to control the process,
- specify a reasonable control performance in the view of input constraints,
- design a simple controller to achieve that performance, and
- deploy the controller to real hardware and be able to tune the controller to meet the design specifications in a laboratory environment.

The fundamentals that will enable you to do this are:

- feedback and feedforward concepts,
- the response of linear time-invariant (LTI) systems to standard inputs,
- the analysis of stability and robustness in linear systems, and
- the design of linear feedback systems capable of achieving specified performance criteria.

COURSE DETAILS

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 3rd year course in the School of Electrical Engineering and Telecommunications. It is a core/elective course for students following a BE (Electrical) or (Telecommunications) program and other combined degree programs. Related courses are shown in Fig. 2 below. Solid arrows indicate hard pre-requisites, while dashed arrows indicate soft pre-requisites.

Pre-requisites and Assumed Knowledge

The pre-requisites for this course are Mathematics 2A, Mathematics 2B, MATH2069, MATH2099, and ELEC2134 Circuits and Signals. It is also essential that you are familiar with ELEC3104 Digital Signal Processing and ELEC2142 Embedded Systems Design before this course is attempted.

Following Courses

This course is a pre-requisite for ELEC4631 Continuous-Time Control System Design, ELEC4632 Computer Control Systems, ELEC4633 Real-Time Engineering, and ELEC4123 Electrical Design Proficiency.

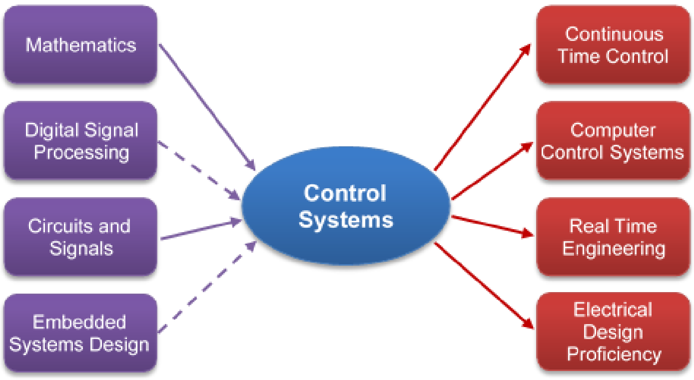

Fig. 2: Relationship of ELEC3114 to other courses.

Learning outcomes (LO)

After successful completion of this course, you should be able to:

LO1. identify an approximate linear/linearized model for a physical dynamic system.
LO2. analyse linear time-invariant (LTI) systems in both the time and frequency domain.
LO3. understand the concept of control system stability and the effect of adding feedback.
LO4. apply time- and frequency-domain techniques to analytically design linear controllers.
LO5. acquire practical skills in applying control systems theory through in-depth hands-on experience in the laboratory.
LO6. utilize software tools to help with the analysis, design, evaluation, and implementation of control systems for real-world applications in both a simulated and a real-time environment.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

Recognition of what a control system is, and the distinction between simple and complex control systems. Analysis and design tools for dealing with simple control systems: Differential equations, Laplace transforms, transfer functions, poles and zeros, state space models, modelling, first and second order systems, stability, steady-state errors, root locus, Bode plots, transient response analysis and design, PID control, simple frequency response techniques. Stability of feedback control systems via the analysis of transfer function and state-space models.

TEACHING STRATEGIES

Delivery Mode

The teaching in this course aims to establish a good fundamental understanding of the areas mentioned, using:

- **Formal online live-streamed lectures (synchronous lectures)**, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding.
- **Online live-streamed Tutorials**, which allow you to practice problem solving techniques and troubleshooting the problems you might have in understanding lecture material, as well as performing *formative learning activities* through *flipped* tutorials.
- **Remote Laboratory sessions**, which support the formal lecture material and provide you with practical construction, measurement and debugging skills through our newly developed **remotely accessed labs**.
- **Recorded lecture videos**, which support the scheduled online-streaming lectures for revision purposes. Please note that watching recordings is **no substitute** for attending the live lectures, where questions can be asked. Please note that *having access to recorded lectures does not imply improved exam preparation*, *without significant and consistent additional self-directed study throughout the term.*
- **Online weekly quizzes,** which allow you to review the lecture topics by completing small periodic quizzes online for feedback on your progress and performance in the course.

Learning in this course

You are expected to *attend all lectures*, *tutorials and laboratories* in order to maximize your learning. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will further enhance your learning experience. *Group learning is highly encouraged*. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending formal classes throughout the course.

Tutorial classes

Tutorial classes are scheduled for **2 hours per week starting from Week 2 but** we use **1.5 hours** of the tutorial time. MS Teams will be used to live-stream the tutorials where you will have the chance to discuss the problems with your tutor. These tutorials are problem solving sessions. A variety of worked tutorial questions will be available on Moodle, including some recorded tutorials from previous years. A selection of the uploaded set of questions will be solved during the tutorials to elaborate on the problem-solving techniques. The rest of the tutorial will be dedicated to discussion on some more challenging problems and for students' consultation. It is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

You should try to attempt all the problem sheet questions before attending the tutorial classes. The importance of *adequate preparation prior to each tutorial cannot be overemphasized*, as the effectiveness and usefulness of the tutorial depends to a large extent on your preparation.

Laboratory program

The laboratory classes are scheduled for **3 hours per week starting from Week 3.** The lab experiments have been deliberately designed to provide practical, hands-on exposure to the concepts covered in lectures soon after they are covered in class. You are required to attend all laboratories. Laboratory *attendance WILL be kept*.
In response to COVID-19, a new system of **remote labs** has been developed by Dr. Arash Khatamianfar in collaboration with Nelson Fu and the professional staff of the School of EET for this term. This allows students to

get access to the lab computer remotely via MS Teams. This new approach enables students to still work in pairs as they would be doing in the face-to-face labs. Students can work collaboratively to control the lab equipment and will have access to live video feed of the device being controlled. **Week 3** will be a **practice session** for students to get familiar with the new **remotely accessed labs.**

Laboratory Exemption

*There is **NO** laboratory exemption for this course*. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course must successfully complete the laboratory component of this course. If, for medical reasons, you are unable to attend a lab (note that a valid medical certificate must be provided), you will need to request to attend the catch-up labs, arranged by the head lab demonstrator.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the term and make sure they are *constructively aligned with Learning Outcomes*. Ongoing summative assessment is delivered through lab checkpoints (see the lab manual for more details), assignments, and online quizzes.

Laboratory Assessment

Laboratories reinforce both theoretical and practical learning, and thus the laboratory assessment is **worth 24 marks** of your **total course mark**. You must achieve **at least 12 out of 24** of the total lab marks to ***PASS* the course** (double-pass criteria). You are required to keep records of your observations either in digital or paper-based form and present these observations during assessment.

In addition to the non-assessment practice lab in Week 3, there are **6 assessable lab experiments** which are scheduled for **3 hours per week**. To increase the effectiveness and efficiency of learning through a self-directed learning approach, a new format of lab assessment has been developed as below:

- *Pre-Lab Exercises and Pre-Lab Quizzes.*
  - You ***MUST*** *complete* the Pre-Lab exercises **before attending** the lab. These include both simple analytical questions and simulation exercises using *MATLAB* and *Simulink* that serve as preparation for the actual lab experiment. You won't be able to benefit from the lab experiments if you don't attempt the Pre-Labs before coming to the lab.
  - The Pre-Lab exercises serve as **formative assessment**, which means they will **not** be marked. However, you **MUST submit** all of your **worked solutions and simulation files** into the relevant Moodle submission box **before** the **first 15 minutes of your allocated lab time have elapsed.** You will forfeit **half of the marks for the Pre-Lab Quiz** for every **30 minute delay** in submitting your pre-lab results (i.e. you will get **zero** if you delay the submission of your worked solutions to the pre-lab exercise by 1 hour).
  - You must also attempt a short **Pre-Lab Moodle quiz** before attending the lab. This quiz is based on your understanding of the results of the pre-lab exercises. They serve as a **reflection on your learning** from pre-lab exercises, and thus, should be completed after you have finished your Pre-Lab exercises. You have up to **2 attempts** to complete this quiz.
  - The **pre-lab online quizzes for each lab** are worth **20%** of the **mark of that lab**.
  - You can discuss any questions that you have about the pre-lab exercises with a lab demo by **tagging them** in the **private channel** dedicated to your lab time slot on **Microsoft Teams** at the start of your lab (more details will be provided in the relevant lab documents).
- *Lab Exercises*.
  - You are expected to *work in pairs* and **must** maintain a record of your observations in either a digital or written form. This includes all of your observations, results, working, and answers to the lab questions. This work must be presented during assessment and uploaded on Moodle after the lab.
  - There are **3 checkpoints** for each lab. After finishing each checkpoint, you must send a request for marking through a purpose-made **Microsoft Form** (more details will be provided in the relevant lab documents). You will be able to see your position on the marking list through a live Excel sheet. When all prior students have been assessed, a lab demo will attend to you to assess your work. However, it is recommended that you continue working towards the next checkpoint if the waiting list is long.
  - Your work will be assessed based on **satisfying the task requirements** (**Req**) and also on your **understanding of the experiment** (**Und**). The **Req** mark is worth **40%** of the mark for **each lab**. The **Und** mark is also worth **40%** of the mark for **each lab**. A variety of understanding questions will be

asked which are related to the lab exercises and the experiment. You may also be asked about some of the **pre-lab** questions as it is assumed that you have completed them and the Pre-Lab Quiz before attending the lab.

  - The **Req** mark is also **capped** by the **Und** mark. This means that if you cannot satisfactorily answer the understanding questions, particularly those from the Pre-Lab, regardless of whether all of your results are correct, your Req mark will be reduced. Additionally, please do **not** plagiarise or cheat as we have discovered and heavily punished cheating in prior courses. Plagiarism will result in a mark of zero being awarded for the entire laboratory component of the course.

- *Post-lab quizzes*
  - You **must** attempt a short **post-lab quiz** after your lab is finished. You must complete this quiz within **24hrs** after your lab finishes. This serves as a **formative assessment** as well as a **reflection** on your lab exercises.
  - If you do **NOT** complete the Post-Lab Quiz on Moodle, you will **forfeit** all of the marks from your **Pre-Lab** quiz. It is highly recommended that you complete this Post-Lab quiz right after the lab with your lab partner. This is in fact encouraged. There will be a **peer evaluation** question at the end of the quiz.
  - You **MUST submit** all of your lab results in one .zip file, including all of your MATLAB/Simulink files, collected data, working and observations, and upload them on Moodle within **24hrs** of your own lab time. The relevant naming conventions required can be found in the lab manuals. If you do **NOT submit** all of your lab results for one lab within **24hrs**, you will **forfeit** half of your marks for the in-lab component of that lab. Only **one student** from each **pair** needs to submit the .zip file. Note that separate submission portals in Moodle will be created to submit your pre-lab and lab results.

Warning: It is of **paramount importance** that you *complete the Pre-Lab exercises before coming to each lab* since the content of the Lab experiments relies upon the Pre-Lab work. It is ***infeasible*** to finish the lab experiments on time if you have NOT completed the Pre-Lab exercises beforehand. You should *NOT expect* your lab demonstrator to sacrifice their time in helping you do the Pre-Labs during in the lab which would be otherwise be utilised to mark and help those who have correctly finished their Pre-Lab exercises before the lab. We believe that it is OK to collaboratively complete the Pre-Lab exercises with your lab partner and your friends (but not the Pre-Lab Quiz). However, any attempt to directly *COPY* the results from others without trying to learn how the questions should be solved, or how the simulations should be done, will result in a ***mark of zero*** being awarded for that lab (i.e. all marks will be forfeited for that lab). The UNSW rules and policies on **plagiarism** have been provided in the OTHER MATTERS section this document.

Laboratory guidance videos have been made available on Moodle to help you get familiar with lab equipment and how to conduct the experiments and do simulations.

Online Quizzes

Each week starting from **Week 3**, there will be an online quiz related to the materials covered in the previous weeks of the course:

- These are weekly quizzes to review the content delivered in the previous week.
- Once the quiz is made available online, you can complete the quiz at your own convenience.
- The **deadline** for each of review quizzes is **one week** from its opening date.
- The length of each quiz may vary depending on the difficulty level of that quiz.
- You have *unlimited attempts* at each of review quizzes before they are closed.
- The overall mark for review quizzes is **worth 6 marks** of the **total course mark**.
- The *highest mark* from all of your attempts will be your final mark for each quiz.

Assignments

There are two assignments that you need to submit throughout the term.

- **Assignment A** is due on **Friday of Week 4.** It covers the topics up to the end of Week 3 (i.e. all topics up to State Variable Models in the Time Domain).
- **Assignment B** is due on **Friday of Week 8**. It covers the topics up to the end of Week 7 (i.e. all topics up to PID controllers).
- They will be **released 2 days in advance** on **Wednesday** of these weeks.
- Each assignment is **worth 15 marks** (so both assignments are worth a total **30 marks** of the **course mark**).
- You will submit the assignment online on Moodle.

- These assignments will test your general understanding of the course material and are designed to give you feedback on your progress through the analytical component of the course.
- Questions will be drawn from any material already covered in the course schedule.
- They may contain questions requiring some basic knowledge of the lab material as well as supporting simulations.

Final Exam

The final exam in this course is a standard 2-hour written examination, comprising five compulsory questions.

- University approved calculators are allowed.
- The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion.
- The final exam will be held online (more information will be provided close to the end of the term on how the exam will be run remotely as arrangements may change by the university).
- Questions may be drawn from any aspect of the course (including the laboratory), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.
- Please note that you must ***PASS*** the final exam in order to ***PASS*** the course (necessary condition). This means you must achieve at least **40 marks out of 100 marks of final exam paper**. This is equivalent to attaining at least **16 out of 40 marks** of the Final Exam contribution to total **course mark**.
- After the marks from all of the assessments have been totaled, if your total course mark is **greater than or equal to 50**, you will pass the course (assuming you have also attained a minimum of 12% out of 24% of the Lab mark which is another necessary condition for passing the course).

Optional Project

We are working on preparing a project for those who are eager to learn more about building a full-scale control system. This will be valuable experience in helping you prepare for ELEC3117 and ELEC4123. It could potentially be worth bonus marks depending on the mode of the delivery, but it is still under review and may NOT be ready to roll out for this term.

Relationship of Assessment Methods to Learning Outcomes

Learning outcomes / *Assessment*	LO1	LO2	LO3	LO4	LO5	LO6
Laboratory assessments	✓	✓	✓	✓	✓	✓
Online quizzes	✓	✓	✓	✓	-	✓
Assignments	✓	✓	✓	✓	-	✓
Final exam	✓	✓	✓	✓	-	-

Relation of Learning and Teaching Activities to Learning Outcomes

Theme	**Review of knowledge (Pedagogy: Reflection and Peer Assessment)**
Key Learning Outcomes	Recalling the learning and knowledge from the pre-lab and lab exercises by doing a short online quiz afterward, serving as a recap which could be done individually. (LO1 to LO4 and LO6)
Activity	1) You participate in short online quiz individually. 2) No answer is given straight away (in some cases only whether it is right or wrong). 3) You can discuss your answers with your lab partner and share ideas. 4) The correct answers are revealed after the lab week. 5) You can assess your lab partner contribution at the end of the post-lab quiz which will be confidential.

Theme	Review of knowledge (Pedagogy: Reflection and Peer Assessment)
Timing	• Online activity before and after the lab time. • Between 5 to 10 minutes for each online quiz.
Assessment	The Pre-Lab quiz is a summative assessment and Post-Lab quiz is a formative assessment.

COURSE RESOURCES

Textbooks

Prescribed textbook

- N. S. Nise, *Control Systems Engineering*, 7th or 8th Edition, John Wiley & Sons.
- R.C. Dorf and R.H., Bishop, *Modern Control Systems*, 13th Edition., Harlow: Pearson

The majority of the content presented in the lectures will be from the first textbook. Occasionally, some of the contents will be adopted from the second textbook, and infrequently from some other reference textbook. All reference

Reference books

- M. W. Spong, S. Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*. Hoboken, NJ: John Wiley and Sons, 2006
- G. F. Franklin, J. D. Powell and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, Addison Wesley, latest edition.
- G.C. Goodwin, S. F. Graebe and M. E. Salgado, *Control System Design*, Prentice Hall, latest edition

On-line resources

Lecture slides and lecture recordings, lab guidance videos, tutorial questions and solutions, lab manuals and all related MATLAB and Simulink files will be available on Moodle.

Mailing list

Announcements concerning general course information will be given in the lectures and/or on Moodle (particularly in the Course Announcements section) and/or via email (which will be sent to your student email address).

OTHER MATTERS

Dates to note

Important Dates are available at: https://student.unsw.edu.au/dates

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both formal classes and *independent, self-directed study*. In periods where you need to need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes, they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the “fit to sit/submit” rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the online student survey myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

As part of these evaluations, in Term 2 of 2019, the following new improvements were introduced:

- *There has been* ***a complete overhaul*** *of laboratory exercises. There are now total 6 completely redesigned lab experiments with increased focus on connecting theory to practical aspects of control systems.*
- *The lab guidance videos are integrated with the virtual lab tour allowing students to click on each piece of lab equipment to watch the related video and download/read relevant documents.*
- *Introduction of flipped tutorials for students to work on more challenging problems in a team-based learning mode.*
- *Newly designed weekly online quizzes as a method of ongoing feedback for students as they progress through the course.*
- *An optional project for students who want to learn more about the practical implementation of control systems.*

Due to COVID-19, the entire in-person lab component has transitioned into a ***remotely accessed*** **format** developed by Dr. Arash Khatamianfar in collaboration with Nelson Fu and the professional staff of the School of EE&T.

- In this new delivery mode, all of the lab contents (which were completely redesigned in Term 2 2019) have been preserved, with new revisions to enhance the student learning experience.
- MS Teams is used to enable students get remote access to lab computers
- The use of webcams allows students to access a live video feed of the equipment they are working with.
- The lab assessment structure is redesigned to better engage students with lab demonstrators and improve the learning and teaching experience in the lab by introducing reflective activities before and after the lab (the Pre-Lab and Post-Lab quizzes).

- The mid-term exam has been replaced with two assignments with more in-depth questions, enabling better assessment of student learning outcomes.

Administrative Matters
On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
https://student.unsw.edu.au/guide
https://www.engineering.unsw.edu.au/electrical-engineering/resources

APPENDICES

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.
- Developing digital and information literacy and lifelong learning skills through assignment work.
- Developing ethical practitioners who are collaborative and effective team workers, through group activities, seminars and tutorials.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	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	✓