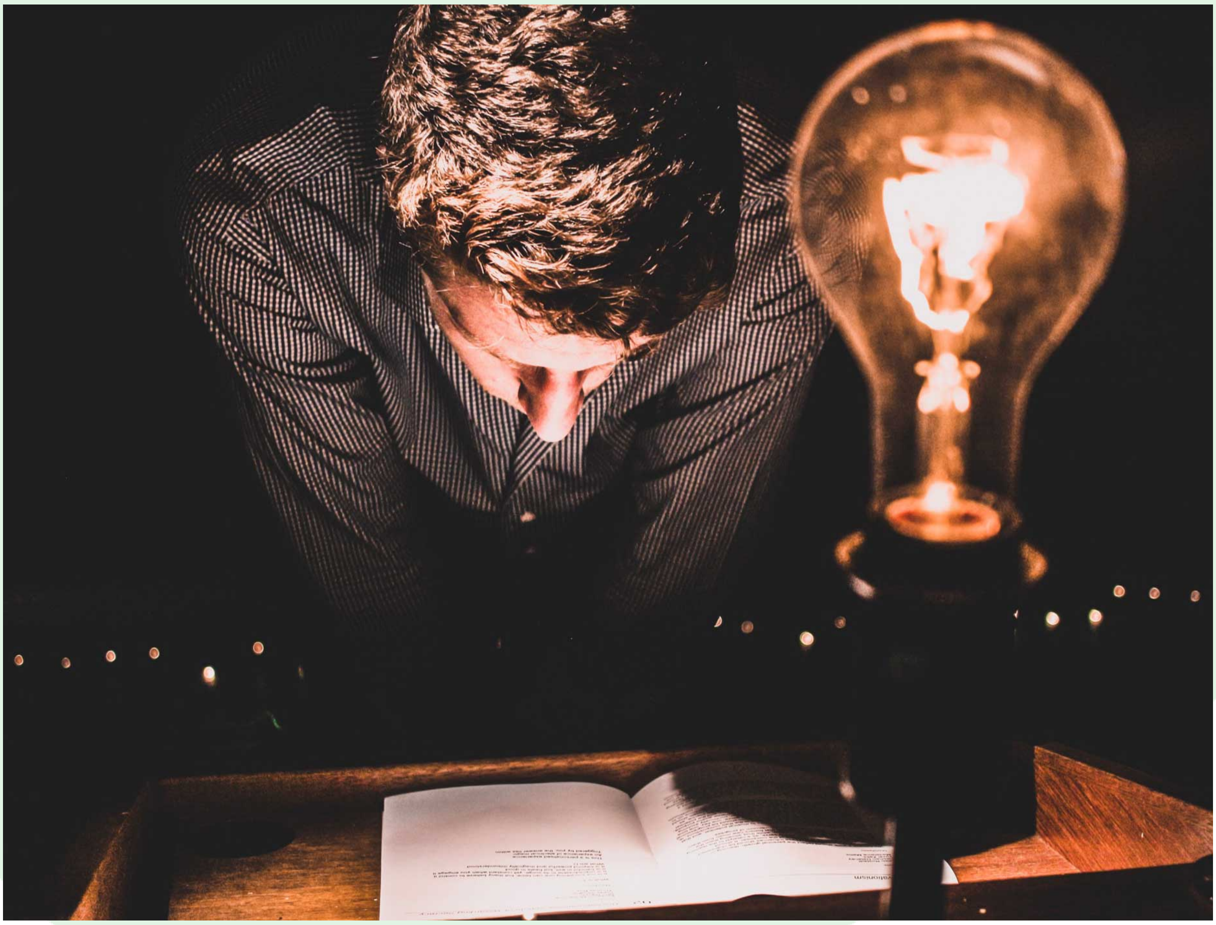
ELEC4632

Computer Control Systems

Term 3, 2022



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Andrey Savkin	a.savkin@unsw.edu.au	TBA	Room 341	93856359

Tutors

Name	Email	Availability	Location	Phone
Mohsen Eskandari	m.eskandari@unsw.edu.au	TBA	TBA	TBA

Demonstrators

Name	Email	Availability	Location	Phone
Satish Chandra Verma	satishchandra.verma@student.unsw.edu.au	TBA	TBA	TBA

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage

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)

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

Course Details

Units of Credit 6

Summary of the Course

Examples of digital control systems, differences and similarities between digital and analog control systems, discrete-time systems, stability analysis, observability and Controllability, state space models, digital PID controllers, pole placement design, digital control systems characteristics, nonlinear discrete-time systems, optimal control design methods, discrete Kalman filter, identification, case studies.

Course Aims

Provide an introduction to computer control systems from both an input/output and a state

space point of view. Provide an introduction to pole placement and optimal design methods,

nonlinear digital systems, and digital control of biomedical systems.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Develop mathematical models for linear computer control systems	PE2.1, PE2.2, PE2.3, PE2.4, PE3.1, PE3.2, PE3.3, PE3.4
2. Analyse stability of linear discrete-time control systems	PE1.1, PE1.2, PE1.3, PE3.2, PE3.3, PE3.4
3. Analyse observability and controllability of linear discrete-time control systems	PE1.1, PE1.2, PE1.3, PE3.1, PE3.2, PE3.3
4. Design digital control systems using the input-output approach	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE2.1, PE2.2, PE2.3, PE2.4, PE3.1, PE3.2, PE3.3, PE3.4
5. Design digital control systems using the pole placement state space approach	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE2.1, PE2.2, PE2.3, PE2.4, PE3.1, PE3.2, PE3.3, PE3.4
6. Design digital control systems using an optimal control approach	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE2.4, PE3.1, PE3.2, PE3.3, PE3.4
7. Analyse stability of singular points of non-linear discrete-time systems	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2,

Learning Outcome	EA Stage 1 Competencies
	PE2.3, PE3.2, PE3.4

Teaching Strategies

Please refer to the information in Moodle

Additional Course Information

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

This is a 4th year course in the School of Electrical Engineering and Telecommunications. It is an elective course. The prerequisite for this course is ELEC3114. It is essential that you are familiar with a standard introductory undergraduate course on control engineering such as ELEC3114 before this course is attempted.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Laboratory Practical Experiments	20%	Not Applicable	1, 2, 3, 4, 5
2. Mid session test	20%	Not Applicable	2, 3, 4
3. Final examination	60%	Not Applicable	2, 3, 4, 5, 6, 7

Assessment 1: Laboratory Practical Experiments

Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to maintain a lab book for recording your observations. A lab book is an A4 size notebook containing a mix of plain pages and graph sheets. You have to purchase your own lab book from any stores. It is essential that you complete the laboratory preparation before coming to the lab. You are required to write the aim of the experiment and draw the circuit diagram if any in your lab book. This will be verified and signed by your demonstrators in the lab. You will be recording your observations/readings in your lab book first and then completing and submitting the results sheet before leaving the lab. After completing each experiment, your work will be assessed by the laboratory demonstrator. Both the results sheet and your lab book will be assessed by the laboratory demonstrator. Assessment marks will be awarded according to your preparation (completing set preparation exercises and correctness of these or readiness for the lab in terms of pre-reading), how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, the quality of the code you write during your lab work (according to the guidelines given in lectures), and your understanding of the topic covered by the lab.

Assessment 2: Mid session test

The mid-term examination tests your general understanding of the course material, and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any course material (lecture and tutorials) up to the end of week 4. It may contain questions requiring some knowledge of theoretical material, and will definitely contain numerical and analytical questions. Marks will be assigned according to the correctness of the responses. The mid-term exam will be given in week 5. All the details will be announced two weeks in advance.

Assessment 3: Final examination

The exam in this course is a 2 hour written examination, comprising six 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. Questions 5 may be drawn from any aspect of the course (lectures and tutorials), unless specifically indicated otherwise by the lecturer. It will contain questions requiring some knowledge of theoretical material, and numerical and analytical questions. Marks will be assigned according to the correctness of the responses.

Attendance Requirements

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

Course Schedule

Workload:

It is expected that you will spend at least ten to twelve hours per week studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face 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.

View class timetable

Timetable

Date	Type	Content
Week 1: 12 September - 16 September	Lecture	Digital control systems, mathematical models of digital systems.
Week 2: 19 September - 23 September	Lecture	Discrete-time systems, stability analysis of linear discrete-time systems.
Week 3: 26 September - 30 September	Lecture	Digital controller synthesis, digital PID controllers, dead beat controllers, design of digital controllers, state-space models, observability and controllability.
Week 4: 3 October - 7 October	Lecture	Pole placement design, Ackermann's formula, design of state estimators and output feedback controllers. Digital control system characteristics, robustness, reduction of parameter variations and external disturbances by feedback.
Week 5: 10 October - 14 October	Assessment	Mid-term Exam.
Week 6: 17 October - 21 October	Homework	Flexibility week.
Week 7: 24 October - 28 October	Lecture	Nonlinear discrete-time systems, stability of singular points of nonlinear discrete-time systems, linearization of non-linear discrete-time systems,

		Lyapunov functions.
Week 8: 31 October - 4 November	Lecture	Optimal design methods, dynamic programming (Bellman optimality principle), linear quadratic optimal control, model predictive control.
Week 9: 7 November - 11 November	Lecture	.Digital control of biomedical systems, case studies. Case studies present examples of recent state-of-the-art engineering research and include: Case study 1: Non-invasive estimation and deadbeat control of pulsatile flow in an implantable rotary blood pump for heart failure patients; Case study 2: Model predictive control of hemodynamic variables during hemodialysis; Case study 3: Modelling and LQR/dead beat control of heart rate response to treadmill exercise.
Week 10: 14 November - 18 November	Lecture	.Digital control of wind power systems, case studies. Case studies present examples of recent state-of-the-art engineering research and include: Case study 4: Model predictive control for wind power smoothing with controlled battery energy storage; Case study 5: Maximizing income of a wind power plant integrated with a battery energy storage system using dynamic programming.
Study Week: 21 November - 24 November	Homework	Final exam preparations.

Resources

Prescribed Resources

Textbooks:

Prescribed textbook:

Astrom, K.J. and Wittenmark, B. Computer-Controlled Systems. Prentice-Hall, 2004.

Reference books:

Dorf, R.C. and Bishop, R.H. Modern Control Systems. Addison Wesley, 1998.

Franklin, Powell, and Workman. Digital Control of Dynamic Systems. Addison-Wesley, 2000.

B.C. Kuo, Digital Control Systems, Saunders College Publishing, 2002.

On-line resources:

Moodle As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes.

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

Course Evaluation and Development

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 Course and Teaching Evaluation and Improvement Process. 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. In particular, several practical case studies have been developed based on past students' feedback. Furthermore, tutorial materials have been updated and improved.

Academic Honesty and Plagiarism

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.

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.

Academic Information

COVID19 - Important Health Related Notice

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.

If you are required to self-isolate and/or need emotional or financial support, please contact the Nucleus: Student Hub. If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for special consideration through the Special Consideration portal. To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this form.

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the Safe Return to Campus guide for students for more information on safe practices.

Dates to note

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

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/policy), 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 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.

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.

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

Disclaimer

This Course Outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

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	