UNSW Course Outline

ELEC4632 Computer Control Systems - 2024

Published on the 05 Sep 2024

General Course Information

Course Code : ELEC4632
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Almost all industrial control systems today include microprocessors and microcontrollers that provide high performance and functionality. All electrical engineers need to have an understanding of computer control systems as well as knowledge of modern tools for the

analysis and design of digital/computer control systems.

Course content includes 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

The course builds on the knowledge gained in the first three years of studying electrical engineering and provides students with advanced computer control systems analysis and design skills. It aims to provide an introduction to computer control systems from both an input/output and a state space point of view. At the end of the course, students should be able to analyse and design computer control systems using advanced computational and analytical tools.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Develop mathematical models for linear computer control systems
CLO2 : Analyse stability of linear discrete-time control systems
CLO3 : Analyse observability and controllability of linear discrete-time control systems
CLO4 : Design digital control systems using the input-output approach
CLO5 : Design digital control systems using the pole placement state space approach
CLO6 : Design digital control systems using an optimal control approach
CLO7 : Analyse stability of singular points of non-linear discrete-time systems

Course Learning Outcomes	Assessment Item
CLO1 : Develop mathematical models for linear computer control systems	• Laboratory Practical Experiments
CLO2 : Analyse stability of linear discrete-time control systems	• Mid-term test • Final examination • Laboratory Practical Experiments
CLO3 : Analyse observability and controllability of linear discrete-time control systems	• Mid-term test • Final examination • Laboratory Practical Experiments
CLO4 : Design digital control systems using the input-output approach	• Mid-term test • Final examination • Laboratory Practical Experiments
CLO5 : Design digital control systems using the pole placement state space approach	• Final examination • Laboratory Practical Experiments
CLO6 : Design digital control systems using an optimal control approach	• Final examination
CLO7 : Analyse stability of singular points of non-linear discrete-time systems	• Final examination

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Other Professional Outcomes

Relationship to Engineers Australia Stage 1 competencies:

The Course Learning Outcomes (LOs) contribute to the Engineers Australia (National Accreditation Body) Stage I competencies as outlined below

Engineers Australia (EA), Professional Engineer Stage 1 Competencies

PE1: Knowledge and Skill Base:
PE1.1 Comprehensive, theory-based **understanding of underpinning fundamentals**: LO 1, 2
PE1.2 Conceptual understanding of underpinning maths, **analysis**, statistics, **computing**: LO 1, 2
PE1.3 In-depth understanding of specialist bodies of **knowledge**: LO 2, 3, 4
PE1.4 Discernment of knowledge development and research directions: NA
PE1.5 Knowledge of **engineering design** practice: LO 3, 4
PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice: NA

PE2: Engineering Application Ability:
PE2.1 Application of established engineering methods to **complex problem solving**: LO 2, 3, 4
PE2.2 Fluent **application of engineering techniques**, tools and resources: LO 1, 2, 3, 4
PE2.3 Application of systematic engineering synthesis and design processes: NA
PE2.4 Application of systematic approaches to the conduct and management of engineering projects: NA

PE3: Professional and Personal Attributes:
PE3.1 Ethical conduct and professional accountability: LO 4
PE3.2 Effective **oral and written communication** (professional and lay domains): LO 4
PE3.3 **Creative, innovative** and pro-active demeanour: LO 3, 4
PE3.4 Professional use and management of information: NA
PE3.5 Orderly management of **self, and professional conduct**: LO 4
PE3.6 Effective team membership and team leadership: NA

This course is also designed to provide the course learning outcomes which arise from targeted graduate capabilities. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (also listed below).

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

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 independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens who can apply their discipline in other contexts, are culturally aware and environmentally responsible, through interdisciplinary tasks, seminars and group activities

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.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Laboratory Practical Experiments Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Not Applicable
Mid-term test Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Not Applicable
Final examination Assessment Format: Individual	60%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

Laboratory Practical Experiments

Assessment Overview

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. After completing each experiment, your work will be assessed by the laboratory demonstrator. Both the results sheet and your lab book will be assessed and feedback given. 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.

Course Learning Outcomes

- CLO1 : Develop mathematical models for linear computer control systems
- CLO2 : Analyse stability of linear discrete-time control systems
- CLO3 : Analyse observability and controllability of linear discrete-time control systems
- CLO4 : Design digital control systems using the input-output approach
- CLO5 : Design digital control systems using the pole placement state space approach

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate

information or answers.
For more information on Generative AI and permitted use please see here.

Mid-term test

Assessment Overview

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 held in week 5; all the details will be announced two weeks in advance. Class-wide feedback will be verbally given during a later lecture.

Course Learning Outcomes

- CLO2 : Analyse stability of linear discrete-time control systems
- CLO3 : Analyse observability and controllability of linear discrete-time control systems
- CLO4 : Design digital control systems using the input-output approach

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Final examination

Assessment Overview

The exam in this course is a two-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 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.

Course Learning Outcomes

- CLO2 : Analyse stability of linear discrete-time control systems
- CLO3 : Analyse observability and controllability of linear discrete-time control systems
- CLO4 : Design digital control systems using the input-output approach
- CLO5 : Design digital control systems using the pole placement state space approach
- CLO6 : Design digital control systems using an optimal control approach
- CLO7 : Analyse stability of singular points of non-linear discrete-time systems

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

General Assessment Information

Grading Basis

Standard

Requirements to pass course

Achieve a composite mark of at least 50 out of 100.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	Digital control systems, mathematical models of digital systems.
Week 2 : 16 September - 22 September	Lecture	Discrete-time systems, stability analysis of linear discrete-time systems.
Week 3 : 23 September - 29 September	Lecture	Digital controller synthesis, digital PID controllers, dead beat controllers, design of digital controllers, state-space models, observability and controllability.
Week 4 : 30 September - 6 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 : 7 October - 13 October	Assessment	Mid-term Exam.
Week 6 : 14 October - 20 October	Homework	Flexibility week.
Week 7 : 21 October - 27 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 : 28 October - 3 November	Lecture	Optimal design methods, dynamic programming (Bellman optimality principle), linear quadratic optimal control, model predictive control.
Week 9 : 4 November - 10 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 : 11 November - 17 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.

Attendance Requirements

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

General Schedule Information

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.

Course 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.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Andrey Savkin		Room 341	93856359	TBA	No	Yes
Tutor	Mohsen Eskandari		TBA	TBA	TBA	No	No
Demonstrator	Satish Chandra Verma		TBA	TBA	TBA	No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

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, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, 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.

II. Administrative matters and links

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

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

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.

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 or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) 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. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be 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 will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, 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

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)

School-specific Information

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.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

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