School of Engineering

ELEC6410: Control System Design

Callaghan
Semester 1 - 2024

COURSE OUTLINE

OVERVIEW

Course Description
This course covers both classical as well as optimal control design methods widely used in the industry. The topics include internal model control, state feedback control, noise modelling, observer design, and constrained optimal control.

Academic Progress Requirements
Nil

Requisites
If you have previously completed ELEC4410 or ENGG3440 or ENGG6440, you cannot enrol in this course.

Assumed Knowledge
ENGG2440 Modelling and Control, STAT2110 Engineering Statistics and ELEC2430 Circuits and Signals.

Contact Hours

Callaghan
Laboratory
Face to Face On Campus
2 hour(s) per week(s) for 11 week(s) starting Week 3

Lecture
Face to Face On Campus
4 hour(s) per week(s) for 13 week(s) starting Week 1

Tutorial
Face to Face On Campus
1 hour(s) per week(s) for 13 week(s) starting Week 1

Unit Weighting
10

Workload
Students are required to spend on average 120-140 hours of effort (contact and non-contact) including assessments per 10 unit course.

CONTACTS

Course Coordinator

Callaghan
Prof Zhiyong Chen
Zhiyong.Chen@newcastle.edu.au
(02) 4921 6352
Consultation: Tuesday, 12:00-14:00, EAG20

Teaching Staff

Other teaching staff will be advised on the course Canvas site.

School Office

School of Engineering
EAG02
EA Building
Callaghan
+61 2 4921 5798
9.00am-1.00pm and 2.00pm-5.00pm (Monday to Friday)

SYLLABUS

Course Content

- Review of Classical Control and Modelling
- Internal Model Control design procedure for SISO systems; (Q parameterisation, relationship to state feedback) with implications for PID, Smith predictors; and extensions to unstable plants
- State Space models, and systems theory (controllability, observability, stability, minimal realisations)
- State feedback control
- Linear observers
- LQ Control
- Gaussian noise and density
- Introduction to estimation with special cases (LS, Kalman filter)
- Separation principle and LQG
- Linear MPC

Course Learning Outcomes

On successful completion of this course, students will be able to:

1. Design internal model controllers.
2. Tune controllers for optimal performance.
3. Identify noise models from experimental data.
4. Design state feedback controllers and associated observers.
5. Design optimal controllers by minimising quadratic costs.
6. Incorporate application driven linear constraints in optimal control design.
7. Implement the designed controllers in practical applications.
8. Select appropriate control system architecture for a given practical application.
9. Extend the concept learnt to design more advanced optimal control systems.

Course Materials

Lecture Materials:

- Lecture notes are available from Canvas

Recommended Reading:

- J.M. Maciejowski - Multivariable Feedback Design
- Skogestad & Postlethwaite - Multivariable Feedback Control: Analysis and Design

Recommended Text:

- Goodwin, Graebe and Salgado - Control System Design
- Chen - Linear System Theory

ASSESSMENTS

This course has 3 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	Quiz	Weeks 6 and 10	Individual	20%	1, 2, 3, 4, 5, 6
2	Lab Assignments	Week 5 - Lab exercise 1 Week 9 - Lab exercise 2 Week 13 - Lab exercise 3	Combination	30%	1, 2, 3, 4, 5, 6, 7, 8, 9
3	Examination	The final exam will be conducted in the formal examination period.	Individual	50%	1, 2, 3, 4, 5, 6

Late Submissions The mark for an assessment item submitted after the designated time on the due date, without an approved extension of time, will be reduced by 10% of the possible maximum mark for that assessment item for each day or part day that the assessment item is late. Note: this applies equally to week and weekend days.

Assessment 1 - Quiz

Assessment Type Quiz
Purpose The purpose and benefit of the quiz is to provide students with feedback on student learning. These tests highlight areas of concern and may stimulate discussion with tutors and lecturers.
Description There are 2 quizzes that will examine the first 10 weeks of material presented in class. Each quiz contributes 10% to the final grade.
Weighting 20%
Length 1 hour for each quiz
Due Date Weeks 6 and 10
Submission Method In Class
Assessment Criteria The quizzes will examine the lecture material presented in class.
Return Method In Class
Feedback Provided Returned Work
Opportunity to Reattempt Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 2 - Lab Assignments

Assessment Type Written Assignment
Purpose The purpose of the lab exercises is to develop problem based learning skills; develop team work skills and the ability to record data; learn to analyse a problem and synthesise a solution; present results in a clear, well presented and articulate manner.
Description The course will have 3 lab exercises to complete that will enhance and evaluate the students knowledge on the material presented in lectures and tutorials. Three lab reports are required, one for each lab exercises. Demonstration is required at the submission of each report. Each report will have a weighting of 10%.
Weighting 30%
Length 4 hours for each lab exercise
Due Date Week 5 - Lab exercise 1
Week 9 - Lab exercise 2
Week 13 - Lab exercise 3
Submission Method In Class
Reports are to be submitted to the lab assistant at the time of the lab demonstration. Demonstrations are scheduled by the lab assistant for marking in the lab.
Assessment Criteria Detailed assessment criteria for each lab exercise and any additional material will be available on the course Blackboard site.
Return Method In Class
Feedback Provided Returned Work
Opportunity to Reattempt Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 3 - Examination

Assessment Type	Formal Examination
Purpose	The final formal examination is designed to test the individual student's knowledge of the course material and their ability to describe, analyse and hypothesise from this material.
Description	The final exam will examine all material presented in the lectures, tutorials and laboratories.
Weighting	50%
Length	2 hours
Due Date	The final exam will be conducted in the formal examination period.
Submission Method	Formal Exam
Assessment Criteria	The final exam will examine all material presented in lectures, tutorials and laboratories.
Return Method	Not Returned
Feedback Provided	Returned Work
Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

ADDITIONAL INFORMATION

Grading Scheme

This course is graded as follows:

Range of Marks	Grade	Description
85-100	High Distinction (HD)	Outstanding standard indicating comprehensive knowledge and understanding of the relevant materials; demonstration of an outstanding level of academic achievement; mastery of skills*; and achievement of all assessment objectives.
75-84	Distinction (D)	Excellent standard indicating a very high level of knowledge and understanding of the relevant materials; demonstration of a very high level of academic ability; sound development of skills*; and achievement of all assessment objectives.
65-74	Credit (C)	Good standard indicating a high level of knowledge and understanding of the relevant materials; demonstration of a high level of academic achievement; reasonable development of skills*; and achievement of all learning outcomes.
50-64	Pass (P)	Satisfactory standard indicating an adequate knowledge and understanding of the relevant materials; demonstration of an adequate level of academic achievement; satisfactory development of skills*; and achievement of all learning outcomes.
0-49	Fail (FF)	Failure to satisfactorily achieve learning outcomes. If all compulsory course components are not completed the mark will be zero. A fail grade may also be awarded following disciplinary action.

*Skills are those identified for the purposes of assessment task(s).

Communication Methods

Communication methods used in this course include:

- Canvas Course Site: Students will receive communications via the posting of content or announcements on the Canvas course site.
- Email: Students will receive communications via their student email account.
- Face to Face: Communication will be provided via face to face meetings or supervision.

Course Evaluation

Each year feedback is sought from students and other stakeholders about the courses offered in the University for the purposes of identifying areas of excellence and potential improvement.

Oral Interviews (Vivas)

As part of the evaluation process of any assessment item in this course an oral examination (viva) may be conducted. The purpose of the oral examination is to verify the authorship of the material submitted in response to the assessment task. The oral examination will be conducted in accordance with the principles set out in the Oral Examination (viva) Procedure. In cases where the oral examination reveals the assessment item may not be the student's own work the case will be dealt with under the Student Conduct Rule.

Academic Misconduct

All students are required to meet the academic integrity standards of the University. These standards reinforce the importance of integrity and honesty in an academic environment. Academic Integrity policies apply to all students of the University in all modes of study and in all locations. For the Student Academic Integrity Policy, refer to https://policies.newcastle.edu.au/document/view-current.php?id=35.

Adverse Circumstances

The University acknowledges the right of students to seek consideration for the impact of allowable adverse circumstances that may affect their performance in assessment item(s). Applications for special consideration due to adverse circumstances will be made using the online Adverse Circumstances system where:

1. the assessment item is a major assessment item; or
2. the assessment item is a minor assessment item and the Course Co-ordinator has specified in the Course Outline that students may apply the online Adverse Circumstances system;
3. you are requesting a change of placement; or
4. the course has a compulsory attendance requirement.

Before applying you must refer to the Adverse Circumstance Affecting Assessment Items Procedure available at:
https://policies.newcastle.edu.au/document/view-current.php?id=236

Important Policy Information

The Help button in the Canvas Navigation menu contains helpful information for using the Learning Management System. Students should familiarise themselves with the policies and procedures at https://www.newcastle.edu.au/current-students/respect-at-uni/policies-and-procedures that support a safe and respectful environment at the University.

This course outline was approved by the Head of School on 30.01.2024. No alteration of this course outline is permitted without Head of School approval. If a change is approved, students will be notified and an amended course outline will be provided in the same manner as the original.

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Graduate Profile Statements – ELEC6410 – S1 2024

This course builds students' capacity in the following University of Newcastle Bachelor of Engineering Graduate Profile Statements (based on 2011 Engineers Australia revised Stage 1 Competency Standards for Professional Engineers):

UON Att.	University of Newcastle Bachelor of Engineering Graduate Profile Statements/ Engineers Australia Stage 1 competency statements	Taught	Practised	Assessed	Skill Level (1-4)
	Professional Attributes				
11	3.1. Ethical conduct and professional accountability				
12	3.2. Effective oral and written communication in professional and lay domains.			X	2
13	3.3. Creative, innovative and pro-active demeanour.				
14	3.4. Professional use and management of information.				
15	3.5. Orderly management of self, and professional conduct.				
16	3.6. Effective team membership and team leadership.				
	Engineering Ability				
7	2.1. Application of established engineering methods to complex engineering problem solving.	X	X	X	4
8	2.2. Fluent application of engineering techniques, tools and resources.	X	X	X	4
9	2.3. Application of systematic engineering synthesis and design processes.	X	X	X	4
10	2.4. Application of systematic approaches to the conduct and management of engineering projects.				
	Knowledge Base				
1	1.1. Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	X	X	X	4
2	1.2. Conceptual understanding of the, mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	X	X	X	4
3	1.3. In-depth understanding of specialist bodies of knowledge within the engineering discipline.	X	X	X	4
4	1.4. Discernment of knowledge development and research directions within the engineering discipline.	X	X	X	4
5	1.5. Knowledge of contextual factors impacting the engineering discipline.				
6	1.6. Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.				