XMUT315 Control Systems Engineering

Course Outline 2026

Prescription

This course presents the analysis and modelling of linear dynamic systems and the design of linear feedback controllers for such systems. There is a focus on electrical, mechanical, and electromechanical systems and the dynamic response of these systems. Properties and advantages of feedback control systems and the design of such systems using various design techniques are covered, as well as the implementation of PID controllers.

Course Learning Objectives

Students who pass this course will be able to:

1. Understand analogies between different dynamic systems and to be able to mathematically model such systems in continuous time. In addition, modelling of dynamic systems using software packages such as MATLAB and Simulink will be required (BE graduate attribute 3(c)).

2. Understand the response of a dynamic system to an input signal and to be able to predict the response of a particular system. This applies the mathematical and engineering sciences, including physics, to real-life problems (BE graduate attribute 3(a)).

3. Understand the concept of feedback and how it influences the response of a system (BE graduate attribute 3(a)).

4. Understand the operation and implementation of lead, lag and PID compensation and be able to design such compensators in continuous time using Root Locus and frequency response techniques (BE graduate attribute 3(b)).

5. To synthesise and demonstrate the efficacy of solutions to part or all of complex engineering problems, including formulating models from first principles of engineering science and mathematics ((BE graduate attributes 3(a), 3(b), & 3(c)).

6. To perform practical experiments, such that an engineering goal is achieved, where additional information requires identification, evaluation and conclusions drawn prior to the goal being reached. Understand the issues of uncertainty and the limitations of the applied methods including practical issues in the implementation of PID controllers (BE graduate attribute 3(d)).

Course Content

The course studies dynamic systems encountered in a variety of instrumentation and mechatronic systems. It will begin with a study of mathematical modelling of such systems which allows the response of these systems to disturbances to be predicted and their stability to be assessed. The effects of feedback on dynamic systems will be studied, leading to the development of a number of different design techniques for producing control systems.

Teaching Staff

The course lecturers for the course are Jimmi Rosa and Xu Jinghong (Jeff) and their contact details:

- Jimmi Rosa, VUW Kelburn Campus, Alan MacDiarmid Building, Room CO252, Phone: +64 04 463 6031 and Email: jimmi.rosa@ecs.vuw.ac.nz

- Xu Jinghong (Jeff), XMUT Campus, Jinggong Building, Room 9-303, and Email: 2015000089@t.xmut.edu.cn

Teaching Assistant, Lab Demonstrator and Tutorial Assistant: T.B.C.

Announcements and Communication

The main means of communication outside of lectures will be the XMUT315 at XMUT web area in the VUW's School of Engineering and Computer Science wiki website.

https://ecs.victoria.ac.nz/Courses/XMUT315_2026T1/WebHome

There you will find, among other things, this document, lectures, laboratory, and assignment handouts. There is also XMUT315 course WeChat group that is used for announcement and info.

Lectures, Tutorials and Laboratories

In 2025, the classes for the course are held tentatively in compressed schedule from Week 9 (Monday, 4th May 2026) to Week 16 (Friday, 26th June 2026) at the following times:

Activities	Timetable	Venue	Student Cohort
Lecture	Monday, 10:15 – 11:50 Wednesday, 10:15 – 11:50	Mingli 3-104 Mingli 3-104	Group 1 and 2
Tutorial	Thursday, 10:15 – 11:50	Mingli 3-104	Group 1 and 2
Computer Laboratories	Monday afternoon & Tuesday evening Thursday evening & Friday afternoon	Jinggong 4-501	See co-teacher for details

The lectures, tutorials and labs are scheduled in more details as follows:

Week	Lecture	Tutorial	Laboratory	Assessment
9	Lecture 1: Intro to control system & engineering		Demo 1a	
	Lecture 2: Laplace transform	Tutorial 1		
10	Lecture 3: Physical systems modelling		Lab 1	

	Lecture 4: Block diagram modelling	Tutorial 2	Demo 1b	Assignment 1
11	Lecture 5a: Feedback system Lecture 5b: Feedback and control system		Demo 2	
	Lecture 6a: Stability analysis Lecture 6b: Stability with Routh-Hurwitz criterion Lecture 6c: Other stability analysis	Tutorial 3	Lab 2	
12	Lecture 7: Time-response analysis		Demo 3	Assignment 2
	Lecture 8: Steady-state analysis	Tutorial 4	Demo 4	Lab Report 2
13	Lecture 9a: Controllers & Compensators (Introduction) Lecture 9b: Controllers & Compensators (Applications)		Lab 3	
	Lecture 10a: Introduction to Bode plots	Tutorial 5		Midterm Test
14	Lecture 10b: Analysis with Bode Plots		Demo 5	Assignment 3
	Lecture 11a: Introduction to Root locus	Tutorial 6	Demo 6	
15	Lecture 11b: Analysis with Root Locus		Lab 4	
	Lecture 12a: Introduction to Nyquist Diagram Lecture 12b: Analysis and Design with Nyquist Diagram and Nichols Chart	Tutorial 7	Demo 7	Assignment 4
16	Lecture 13a: Design with Bode Plots Lecture 13b: Design with Root Locus		Demo 8	Lab Report 4
	Lecture 13c: Examples of Design of Control System	Tutorial 8		
17-18				Final Exam

A weekly laboratory session will be in the allocated laboratories. A laboratory demonstrator will be available for a subset of that time, but there should be no expectation of demonstrator assistance at other times. Students may make use of the laboratories outside of the specified time when the lab is otherwise unoccupied.

Set Texts and Recommended Readings

Required

We do not closely follow a particular textbook for this course, though students are strongly advised to routinely use a textbook to gain a different perspective on the material. We mostly follow the notation used in the recommended textbook by Norman Nise, Control Systems Engineering (7th edition, but any edition is fine).

However, different texts suit different students, so a visit to the library is suggested to peruse the different possibilities. Some additional recommendations may be found in the course reading list.

Recommended

The library contains several other excellent control engineering textbooks which can be consulted for additional explanation or practice. Some additional reading material is also listed in the course reading list.

- Modern Control Engineering by Katsuhiko Ogata.
- Automatic Control Systems by Farid Golnaraghi and Benjamin Kuo.
- Modern Control Systems by Richard Dorf and Robert Bishop.

Lecture notes, laboratory scripts and assignments will be posted to the course's ECS wiki page. While notes will be provided, students are advised to also take down their own notes in class. These should then be supplemented with further reading from the recommended reading for the course.

In the appendix, see a table that outlines the mapping between the topics in the course and the relevant chapters in the recommended textbook.

Mandatory Course Requirements

In addition to achieving an overall pass mark of at least 60% (XMUT scale), students should achieve a grade of at least 40% in the final exam and should submit all assignments and lab reports.

If you believe that exceptional circumstances may prevent you from meeting the mandatory course requirements, contact the Course Coordinator for advice as soon as possible.

Assessment

This course will be assessed through laboratories, assignments, a midterm test, and a final examination. The test will cover all material from the first half of the course and the final exam includes all materials in the course.

Assessments	Schedule	Learning Outcome	Weighting
Laboratory reports (2 out of 4)	Every 2 weeks	CLO: 1, 5, 6	10%
Assignments (4)	Every 2 weeks	CLO: 1, 2, 3, 4	20%
Midterm Test	Week 13	CLO: 1, 2, 3, 4	20%
Final Exam	Week 17-18	CLO: 1, 2, 3, 4	40%
Attendance & Active Participation	All weeks		10%

Required Equipment

Students must have a ruler and a protractor. Several coloured writing instruments of some form will also be required. Availability of a scientific calculator having the capacity to perform trigonometric and complex number calculations will be assumed. You should have access to a PC with MATLAB/Simulink software for performing simulations in analysis and design of control systems.

Plagiarism

We encourage you to discuss the principles of the course and assignments with other students, to help and seek help with programming details and problems involving the lab machines. However, any work you hand in must be your own work.

The School policy on Plagiarism (claiming other people's work as your own) is available from the course home page. Please read it. We will penalise anyone we find plagiarising, whether from students currently doing the course, or from other sources. Students who knowingly allow other students to copy their work may also be penalised. If you have had help from someone else (other than a tutor), it is always safe to state the help that you got. For example, if you had help from someone else in writing a component of your code, it is not plagiarism as long as you state (e.g. as a comment in the code) who helped you in writing the method.

Workload

On average, students should plan to spend 20 hours per week on in this course for the compressed 8 weeks schedule. A plausible and approximate breakdown for these hours would be:

- Lectures and tutorials: 4.5 hours.
- Readings and self-study: 2-4 hours.
- Assignments: 2 hours.
- Labs: 3 hours (1.5 hours lab session time + 1.5 hours research).

Expectations of Students in ECS courses

The School of Engineering and Computer Science strives to anticipate all problems associated with its courses, laboratories and equipment. We hope you will find that your courses meet your expectations of a quality learning experience.

If you think, we have overlooked something or would like to make a suggestion, feel free to talk to your course organiser or lecturer.

Appendix

Lecture	Lecture Topic	Tutorial	Book Chapter	Page
1	Introduction to control system and engineering		Chapter 1 - Introduction.	1-20
2	Laplace transform	Tutorial 1	Chapter 2 – Modelling in the Frequency Domain	33-91
3	Physical systems modelling		Chapter 2 – Modelling in the Frequency Domain	33-91
4	Block diagram modelling	Tutorial 2	Chapter 5 – Reduction of Multiple Subsystems	235-271
5	5a: Feedback system 5b: Feedback and control system		Chapter 5 – Reduction of Multiple Subsystems	235-271
6	6a: Stability analysis 6b: Stability with Routh-Hurwitz criterion 6c: Other stability analysis	Tutorial 3	Chapter 6 – Stability	299-320
7	Time-response analysis		Chapter 4 - Time Response	157-201
8	Steady-state analysis	Tutorial 4	Chapter 7 – Steady-State Errors	335-361
9	9a: Controllers and compensators (introduction)		Chapter 11 – Design via Frequency Response	613-637
	9b: Controllers and compensators (applications)		Chapter 9 – Design via Root Locus	449-499
10	10a: Intro to Bode plots	Tutorial 5	Chapter 10 – Frequency Response Techniques	525-594
	10b: Analysis with Bode Plots		Chapter 10 – Frequency Response Techniques	525-594
11	11a: Intro to root locus	Tutorial 6	Chapter 8 – Root Locus Techniques	381-416
	11b: Analysis with root Locus		Chapter 8 – Root Locus Techniques	381-416
12	12a: Intro to Nyquist diagram	Tutorial 7	Chapter 10 – Frequency Response Techniques	525-594
	12b: Analysis with Nyquist diagram			
	12c: Intro to Nichols chart			
13	13a: Design of control systems with Bode plots	Tutorial 8	Chapter 11 – Design via Frequency Response	613-637
	13b: Design of control systems with root locus		Chapter 9 – Design via Root Locus	449-499