ELEC3024

Control Systems

Session 1, In person-scheduled-weekday, North Ryde 2023

School of Engineering

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
A/Prof. Ray Eaton
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50 Waterloo Road, Level 1
Thursday 2-4pm (upon email appointment)

Senior Lecturer
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Contact via email
online
Monday 1-3pm (upon email appointment)

Lecturer
Dr. Leonardo Callegaro
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44 Waterloo Road, Level 1, Room 123
Tuesday 10am-12pm (upon email appointment)

Lecturer
Dr. Foad Taghizadeh
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Friday 2-4pm (upon email appointment)

Credit points
10

Prerequisites
((ELEC2040 or ELEC240) or (MTRN2060 or ELEC260)) and (MATH2055 or MATH235) and (ELEC2070 or ELEC270)

Corequisites

Co-badged status

Unit description
This unit develops fundamental knowledge and skills in the area of control design and analysis of dynamic systems. Topics covered include: an introduction to control system design process and applications; mathematical modelling of electrical and mechanical systems in the frequency domain; performance and stability analysis of single-input single-output linear control systems; design of feedback control systems using root locus and frequency response techniques; an introduction to digital control systems; and design of digital versus analogue control systems. This unit uses problem/team based learning approach, where students have to choose a project topic and their team members. Each team performs the modelling, analysis, control design, and simulation of the control system related to their project. Simulink/ MATLAB and a control board are used to implement a real-time digital control system.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: Describe a control system's design process and control systems analysis

ULO2: Develop appropriate mathematical models of electrical and mechanical systems to be controlled in the frequency domain

ULO3: Analyse the performance and stability of single-input single-output linear control systems

ULO4: Design feedback control systems using tools such as MATLAB & Simulink to achieve specific performance requirements

ULO5: Characterise the behaviour of elementary feedback control systems using microcontroller based experiments

General Assessment Information

Grading and Passing Requirement for Unit

- In order to pass this Unit a student must:
  - obtain a mark of 50 or more for the Unit (i.e. obtain a passing grade P, CR, D, or HD), and
  - satisfy all Hurdle Requirements.
- For further details about grading, please refer below in the policies and procedures section.
- If you receive Special Consideration for the oral presentation and demonstration of the

Project, a supplementary conventional exam will be scheduled by the faculty during a supplementary exam period, typically about 3 to 4 weeks after the normal exam period. By making a Special Consideration application for the oral presentation and demonstration of the Project you are declaring yourself available for a conventional exam during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to applying. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

Hurdle Requirements

- Students must participate in at least **6 of the 7 weekly PC Labs** (Weeks 1-7).
- Students must participate in at least **5 of the 6 weekly Project Labs** (Weeks 8-13).

Late Assessment Submission Penalty

- Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark of the task) will be applied for each day a written report or presentation assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. The submission time for all uploaded assessments is **11:55 pm**. A 1-hour grace period will be provided to students who experience a technical concern.
- For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, please apply for Special Consideration.

Assessments where Late Submission will (and will not) be accepted

- Pre-Class Quiz (Lectorials) - NO, unless Special Consideration is granted.
- Assignments (PC Labs) - NO, unless Special Consideration is granted.
- Class Quiz (Lectorials) - NO, unless Special Consideration is granted.
- Assessment (Project) - YES, Standard Late Penalties applies to the iLearn submission.

Re-Submission of work

Re-submission of work is not accepted.

Special Consideration

The Special Consideration Policy aims to support students who have been impacted by short-term circumstances or events that are serious, unavoidable and significantly disruptive, and which may affect their performance in assessment. If you experience circumstances or events that affect your ability to complete the assessments in this unit on time, please inform the

convenor and submit a Special Consideration request through ask.mq.edu.au.

Assessment Tasks

Name	Weighting	Hurdle	Due
Pre-Class Quiz (Lectorials)	10%	No	Week 2, 3, 4, 5, 6, 7
Assignments (PC Labs)	20%	No	Week 2, 3, 4, 5, 6, 7
Class Quiz (Lectorials)	20%	No	Week 8
Assessment (Project)	50%	No	Week 13, 14

Pre-Class Quiz (Lectorials)

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 5 hours
Due: **Week 2, 3, 4, 5, 6, 7**
Weighting: **10%**

Students are expected to go through the iLearn content, understand the theory and attempt the online quiz each week prior to attending the class activities of that week.

On successful completion you will be able to:

- Describe a control system's design process and control systems analysis
- Develop appropriate mathematical models of electrical and mechanical systems to be controlled in the frequency domain
- Analyse the performance and stability of single-input single-output linear control systems

Assignments (PC Labs)

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 12 hours
Due: **Week 2, 3, 4, 5, 6, 7**
Weighting: **20%**

Evaluation of Lab activity during first part of the semester. This evaluation focuses on students ability to solve problems and perform modelling, design and implementation of control systems using MATLAB/Simulink.

On successful completion you will be able to:

- Develop appropriate mathematical models of electrical and mechanical systems to be controlled in the frequency domain
- Analyse the performance and stability of single-input single-output linear control systems
- Design feedback control systems using tools such as MATLAB & Simulink to achieve specific performance requirements

Class Quiz (Lectorials)

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 5 hours
Due: **Week 8**
Weighting: **20%**

A quiz is scheduled right after the mid-semester break. The quiz will assess both factual knowledge and problem solving.

On successful completion you will be able to:

- Describe a control system's design process and control systems analysis
- Develop appropriate mathematical models of electrical and mechanical systems to be controlled in the frequency domain
- Analyse the performance and stability of single-input single-output linear control systems

Assessment (Project)

Assessment Type [1]: Project
Indicative Time on Task [2]: 20 hours
Due: **Week 13, 14**
Weighting: **50%**

This is the major assessment of this Unit. It will consist of 3 individual assessments and 1 team assessment, as follows: - Individual assessments: ◦ Oral presentation and demonstration of the project; ◦ Peer assessment regarding the actual contribution of each team member; ◦ Evaluation of project log book of each team member. - Team assessment: ◦ Project report to be submitted in iLearn by each team.

On successful completion you will be able to:

- Describe a control system's design process and control systems analysis
- Develop appropriate mathematical models of electrical and mechanical systems to be controlled in the frequency domain
- Analyse the performance and stability of single-input single-output linear control systems
- Design feedback control systems using tools such as MATLAB & Simulink to achieve specific performance requirements
- Characterise the behaviour of elementary feedback control systems using microcontroller based experiments

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

METHODS OF COMMUNICATIONS

- Students are reminded the university will communicate all official notices by email to official MQ student's account. Students should read their @student.mq.edu.au email regularly (or forward it to an account they check regularly).
- All announcements and other communication regarding this Unit will be delivered via the iLearn platform.
- Queries to convenors can either be placed on the iLearn discussion board or sent to ELEC3024@mq.edu.au from your **university email** address.

UNIT WEBSITE

- The iLearn website for this unit can be found at: https://ilearn.mq.edu.au/login/.
    - *Note: All information and communications relevant to this Unit will be via the iLearn website.*

TEXTBOOK

- Control Systems Engineering (Digital or Print), 8th edn, Australia & New Zealand Edition 2019, Norman S. Nise, Wiley, ISBN: 9781119594352 (Digital version recommended).
    - *Note: Links will be provided to specific sections of the Digital version in iLearn for each Lectorial.*

    - *Remark: this textbook is used extensively as a reference in all activities of this Unit. All students are expected to have access to this textbook.*
- or, Control Systems Engineering (Print), 7th Edition 2014, Norman S. Nise, John Wiley & Sons, ISBN: 9781118170519.
    - *Note: Older editions of this textbook suffice for individual study, although links to weekly readings posted on iLearn refer uniquely to the 8th edn (Digital) version only.*
- Student Companion Site: http://bcs.wiley.com/he-bcs/Books?action=index&itemId=1119474221&bcsId=11568 is a complimentary resuource to the textbook, including a wealth of MATLAB examples classified according to each chapter.
- Support Website: http://www.wileydigitalsolutions.com.au/support/article/student/ – link to the Wiley's digital solutions support page and live chat for students.

LECTORIALS

- There will be a Lectorial (3 hours) for every week in the first part of the semester (Weeks 1-7). The Lectorial will comprise of: - discussion session on fundamental knowledge. - practical examples. - interactive problem solving involving students.
- Lectorials are a combination of traditional lecture and tutorial teaching modes and are designed to improve student engagement inside/outside classes.
- The Lectorials are organised in a flipped classroom fashion, students are expected to go thorugh the recommneded weekly contents before each Lectorial takes place.
- Outside class
    - links to E-Text specific sections, brief videos and/or lecture notes are posted in iLearn each week.
    - students are expected to read these E-Text sections, try to solve any given examples, and watch any videos and/or read any posted notes prior to attending the Lectorials.
- Inside class
    - brief discussion sessions on fundamental principles.
    - practical examples.
    - interactive problem solving involving students.

LABORATORIES

- PC Lab activities start from Week 1 and take place once a week (Weeks 1-7) according to the Unit schedule.
    - *Note: Students must enrol in one of the available weekly Lab sessions.*

- Interactive PC Labs use MATLAB/Simulink software platform to assist with the modelling and design of control systems.

On-campus activities commence in Week 1. Students should contact the Unit convenor as soon as possible if they are unable to get back to campus in time.

PROJECTS

- Project activities take place once a week (Weeks 8-13) according to the Unit schedule.
    - *Note: Teams must enrol in one of the available weekly Project sessions.*
- The team Project is the core component of this Unit. The Project covers practical aspects of control theory to be used in future Electrical, Electronics and Mechatronics units.
- Students are required to form teams to work on the Project.
    - *Note: When forming teams, students should agree in which weekly Project session they want to enrol.*
    - *All Project activities are performed in teams.*

TECHNOLOGY

- The laboratory work will rely on the use of MATLAB/Simulink software platform.
- The software is available through AppStream and/or on Faculty PCs.
- Each team will be given an Arduino kit for the second half of the semester to perform experimental activities.

WEB RESOURCES

- **Control Tutorials for MATLAB and Simulink (CTMS):**
    - http://ctms.engin.umich.edu/CTMS/index.php?aux=Home
    - These tutorials are designed to help students learn how to use MATLAB/ Simulink for the analysis and design of automatic control systems.
    - They cover the basics of MATLAB/Simulink and introduce the most common classical and modern control design techniques.
- **MathWorks Website (MATLAB, Simulink, user-guides, tutorials, etc):**
    - MATLAB Courseware
        - https://au.mathworks.com/academia/courseware.html
    - MATLAB Onramp
        - https://au.mathworks.com/learn/tutorials/matlab-onramp.html

Unit Schedule

Refer to the Unit iLearn website for a detailed Unit schedule.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues
- Student Advocacy provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Engineers Australia Competency Mapping

Engineers Australia Competency Standard		Unit Learning Outcomes
Knowledge and Skill Base	1.1 Comprehensive, theory-based understanding of the underpinning fundamentals applicable to the engineering discipline.	ULO1, ULO2, ULO3, ULO4, ULO5
	1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing.	ULO1, ULO2, ULO3, ULO4, ULO5
	1.3 In-depth understanding of specialist bodies of knowledge	ULO1, ULO2, ULO3, ULO4, ULO5
	1.4 Discernment of knowledge development and research directions	ULO1
	1.5 Knowledge of engineering design practice	ULO1, ULO2, ULO3, ULO5
	1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice.	ULO5
Engineering Application Ability	2.1 Application of established engineering methods to complex problem solving	ULO1, ULO2, ULO3, ULO4, ULO5
	2.2 Fluent application of engineering techniques, tools and resources.	ULO1, ULO2, ULO3, ULO4, ULO5
	2.3 Application of systematic engineering synthesis and design processes.	ULO1, ULO2, ULO3, ULO4, ULO5
	2.4 Application of systematic approaches to the conduct and management of engineering projects.	ULO1, ULO2, ULO3, ULO4, ULO5
Professional and Personal Attributes	3.1 Ethical conduct and professional accountability.	
	3.2 Effective oral and written communication in professional and lay domains.	
	3.3 Creative, innovative and pro-active demeanour.	ULO5
	3.4 Professional use and management of information.	ULO1, ULO3, ULO4, ULO5
	3.5 Orderly management of self, and professional conduct.	ULO4, ULO5
	3.6 Effective team membership and team leadership	ULO5