ELEC324

Feedback Control and Dynamic Systems

S1 Day 2019

School of Engineering

Contents

General Information

Unit convenor and teaching staff
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Credit points
3

Prerequisites
(ELEC240 or ELEC260) and (ELEC270 or ENGG270) and (MATH232 or MATH235)

Corequisites

Co-badged status

Unit description
This unit extends the foundations of time and frequency domain descriptions of linear systems and their dynamics to include feedback control. The unit introduces the concept of state-space and its application in modelling and design of feedback control systems, and the foundations of computer-based and optimal control systems are also introduced. Applications of feedback are explored, including regulation of physical and chemical processes, control of process dynamics, and stability and robustness in the presence of external disturbances. The latter concepts and applications are illustrated using examples from diverse areas, including biomedical, electronic, electrical, mechatronic, and wireless engineering. Experimental work is used to illustrate the impact of feedback on the dynamics, stability, and compensation of servo-motor systems and electronic circuits. MatLab is used extensively for system modelling and design. The unit provides a strong foundation for advanced topics in most engineering majors.

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:

- Describe a control system's design process and control systems analysis;
- Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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 Arduino based experiments;
- Demonstrate foundational learning skills including active engagement in their learning process.

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).
- 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 attend and participate in at least **9 of the 12 weekly laboratoriess** (Week 2 to Week 13) to pass this unit.

Late Submissions and Resubmissions

- Late report submissions will attract a penalty of <10/100, 10%> marks per day. Extenuating circumstances will be considered upon lodgement of an application for special consideration.
- Resubmissions of work are not allowed.

Students are reminded of the University policies regarding assessment, academic honesty and disruption to studies.

Requests for extension on assessable work are to be made to the Unit Coordinator but will only be considered in the event of illness or misadventure.

Assessment Tasks

Name	Weighting	Hurdle	Due
Lectorial assessment	25%	No	Week 2 to Week 12
Laboratory assessment	25%	Yes	Week 2 to Week 13
Project assessment	50%	No	see iLearn for unit schedule

Lectorial assessment

Due: **Week 2 to Week 12**
Weighting: **25%**

In class evaluation of students actively participating in Lectorials from Week 2 to Week 12. Students are awarded marks for answering questions and solving problems on paper and/or whiteboard.

More details about marking will be presented in Intro session in Week 1.

On successful completion you will be able to:

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- - Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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 Arduino based experiments;

Laboratory assessment

Due: **Week 2 to Week 13**
Weighting: **25%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Evaluation of Lab activity during semester starting from Week 2 to Week 13. This evaluation focuses on students' ability to perform modelling, design and implementation of control systems using MATLAB/Simulink and Arduino board.

- Evaluation of individual work (Week 2 to Week 7);
- Evaluation of team work (Week 8 to Week 13);
- Students must attend 9 of the 12 weekly laboratories. This is a hurdle requirement.

Students consistently helping their team members or other team members are awarded bonus marks.

On successful completion you will be able to:

- - Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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 Arduino based experiments;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Project assessment

Due: **see iLearn for unit schedule**
Weighting: **50%**

The major assessment of this Unit is for the team project. This will consist of 3 individual assessments and 1 team assessment:

- Individual assessments
    - Oral presentation and demonstration of the project (as per exam schedule);
    - Peer assessment regarding the actual contribution of each team member (Week 13);
    - Evaluation of project log book of each team member (Week 13).

- Team assessment
    - Project report to be submitted in iLearn by each team (end of Week 13).

On successful completion you will be able to:

- - Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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 Arduino based experiments;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Delivery and Resources

UNIT WEBSITE

The iLearn website for this unit can be found at: https://ilearn.mq.edu.au/login/MQ/

All information and communications relevant to this unit will be via the iLearn website.

TEXTBOOK

- Control Systems Engineering, 8th Australia & New Zealand Edition 2019, Norman S. Nise, Wiley, ISBN: 9781119561880 (recommended);
- or
- Control Systems Engineering, Norman S. Nise, 7th edition 2014, John Wiley & Sons, ISBN: 9781118170519.

All students are expected to have access to this textbook. The problems to be solved during the lectorials will be taken from this textbook.

- 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

The lectorials are organised in a flipped classroom fashion:

- Outside class
    - brief videos and lecture notes are posted in iLearn each week;
    - students are expected to watch these videos and read any posted notes prior to

attending the lectorial.

- Inside class
    - discussion session on fundamental knowledge;
    - plenty of practical examples;
    - interactive problem solving involving the students.

PROJECTS

The project is the core component of this unit. The projects will cover practical aspects of control theory to be used in future Electrical, Electronics and Mechatronic units.

- Students are required to form teams (in Week 2) and each team will choose one project topic (in Week 3) from a given list of projects;
- All laboratory and project activities are performed in teams;
- Students are expected to use at least 1/3 of the unit hours working on the project, with more effort expected towards the second half of the semester.

LABORATORIES

- Laboratory activities start from Week 2;
- Interactive Labs use MATLAB/Simulink and are correlated with the problems solved during the lectorials and project topics;
- Experimental Labs are also available, where students will use Arduino control boards and Simulink to assist them with the control design of various simple systems (e.g. RC circuits, DC motors, etc);
- All laboratory activities are to be performed in the same teams as for projects;
- *Food and drink are not permitted in the laboratory, nor are students with bare feet, sandals or thongs. Students not complying with these regulations will be removed from the laboratory.*

TECHNOLOGY

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

COMMUNICATIONS

- Students are reminded the University will communicate all official notices to you by email to your university email account. Please read your @student.mq.edu.au email regularly or forward it to an account you do read regularly.

- All announcements and other communications regarding this unit will be via iLearn.

REFERENCE BOOKS

- G.F. Franklin, J.D. Powell and A. Emami-Naeini, “Feedback Control of Dynamic Systems”, 4th edition, Addison-Wesley, 2002.
- K. Ogata, “Modern Control Engineering”, 4th edition, Prentice-Hall, 2001.

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 you 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/Simulink Training for Macquarie University Students
    - https://trainingenrollment.mathworks.com/selfEnrollment?code=TSH4E9QU6C9G

Unit Schedule

Refer to iLearn website and lecture notes for the unit schedule.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). 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
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4*

December 2017 and replaces the Disruption to Studies Policy.)

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

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/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

LABORATORIES

- All laboratory and tutorial work must be recorded in dedicated laboratory and/or exercise books, to be signed off by the tutor or lecturer at the end of each session. No mark will be given unless these conditions are followed.
- Food and drink are not permitted in the laboratory, nor are students with bare feet, sandals or thongs. Students not complying with these regulations will be removed from the laboratory.
- An excellent reference on engineering communication and writing reports may be found at: http://ecp.engineering.utoronto.ca/online-handbook/

COMMUNICATIONS

- Students are reminded the University will communicate all official notices to you by email to your university email account. Please read your @student.mq.edu.au email regularly, or forward it to an account you do read regularly.
- This document and other information relevant to this unit will be available on the unit website at https://ilearn.mq.edu.au/login/MQ/
- All announcements and other communications regarding this unit will be via the latter website.

Student Support

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

dents.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

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.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- - Design feedback control systems using tools such as MATLAB & Simulink to achieve specific performance requirements;
- - Characterise the behaviour of elementary feedback control systems using Arduino based experiments;

Assessment tasks

- Lectorial assessment

- Laboratory assessment
- Project assessment

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- - 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 Arduino based experiments;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Assessment tasks

- Lectorial assessment
- Project assessment

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge,

scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- - Describe a control system’s design process and control systems analysis;
- - Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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;
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- - Demonstrate foundational learning skills including active engagement in their learning process.

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- - Develop appropriate mathematical models of electrical and mechanical systems to be controlled, both in time domain and 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 Arduino based experiments;

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- - Design feedback control systems using tools such as MATLAB & Simulink to achieve specific performance requirements;
- - Characterise the behaviour of elementary feedback control systems using Arduino based experiments;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Assessment task

- Project assessment

Changes from Previous Offering

The entire unit has been redeveloped to incorporate:

- in-class problem solving during lectorials;
- in-class students' evaluation during lectorials and laboratories;
- laboratory and project activities in teams;
- oral examination and demonstration of project work.