



# ELEC240

## Signals and Systems

S2 Day 2018

*Dept of Engineering*

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#### **Disclaimer**

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## General Information

Unit convenor and teaching staff

Lecturer (weeks 1-7) and Convenor

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Friday 4-5pm

tutor

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Lecturer (weeks 8-13)

Iain Collings

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Friday 4-5pm

Credit points

3

Prerequisites

ENGG150 and (MATH136 or MATH133)

Corequisites

MATH235

Co-badged status

Unit description

The aim of this unit is to give students a comprehensive introduction to the theory of signal processing and analysis that is used in many areas of electronic and telecommunications engineering including: circuit analysis; amplifiers and electronic systems; analogue and digital communications; audio and image processing; and control systems. The unit covers time and frequency analysis for both continuous-time and discrete-time signals. Topics covered in the unit include: linear time-invariant systems; convolution; Fourier series; Fourier transforms; Discrete Fourier transforms; and Z transforms.

## 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:

Demonstrated use of Matlab to solve problems in Signals and Systems

Be able to solve signal processing problems involving Complex Numbers

Demonstrated understanding of how signals can be scaled in space, time, flipped in time (time-reversal), delayed (right and left shifted), and other signal properties (mean, energy, power, periodicity)

Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.

Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.

Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.

Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## General Assessment Information

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/ HD).

The hurdle test is a hurdle requirement. A grade of 60% or more in this test is a condition of passing this unit.

The final examination is a hurdle requirement. A grade of 40% or more in the final examination is a condition of passing this unit.

Late submissions of assignments or practicals are not accepted. Extenuating circumstances will be considered upon lodgment of an application for special consideration.

## Assessment Tasks

Name	Weighting	Hurdle	Due
<u>In class test questions</u>	10%	No	weekly
<u>Weekly Projects</u>	15%	No	weekly
<u>Hurdle test</u>	3%	Yes	week 2
<u>Mid semester test</u>	12%	No	week 7
<u>Assignment 1</u>	2%	No	4/9/2017
<u>Assignment 2</u>	3%	No	3/10/2016
<u>Assignment 3</u>	3%	No	23/10/2016
<u>Assignment 4</u>	2%	No	10/11/2016
<u>End of Semester Exam</u>	50%	Yes	scheduled in final exam period

### In class test questions

Due: **weekly**

Weighting: **10%**

A test question will be given to the class every week (except week 1) during the usual lecture times and graded. The final mark for this assessment (worth 10% of assessment overall) will be taken from the best 6 answers given by the student during the semester.

On successful completion you will be able to:

- Demonstrated understanding of how signals can be scaled in space, time, flipped in time (time-reversal), delayed (right and left shifted), and other signal properties (mean, energy, power, periodicity)
- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.

- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

## Weekly Projects

Due: **weekly**

Weighting: **15%**

Projects and test questions during each practical session scheduled in weeks 1-13. There will be a practical session in week 1.

On successful completion you will be able to:

- Demonstrated use of Matlab to solve problems in Signals and Systems

## Hurdle test

Due: **week 2**

Weighting: **3%**

**This is a hurdle assessment task (see [assessment policy](#) for more information on hurdle assessment tasks)**

There will be a class test in week 2 worth 3%. The test will take 30 minutes, and all will take place in the lecture room on Thursday August 9 at 2pm. The test will be on complex numbers and signal properties. This test is a hurdle requirement. A grade of 60% or more in this test is a condition of passing this unit.

On successful completion you will be able to:

- Be able to solve signal processing problems involving Complex Numbers
- Demonstrated understanding of how signals can be scaled in space, time, flipped in time (time-reversal), delayed (right and left shifted), and other signal properties (mean, energy, power, periodicity)
- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.

## Mid semester test

Due: **week 7**

Weighting: **12%**

The mid semester test will take place on Thursday September 13 at 2pm. It will be a 45 minute test.

The test will be on continuous time signal processing (not including sampling or aliasing, but on everything up to end of week 6).

On successful completion you will be able to:

- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.

## Assignment 1

Due: **4/9/2017**

Weighting: **2%**

Problems on signal properties, linear time-invariant systems, convolution and impulse response. There will be 5-6 questions on each assignment and you will have at least two weeks to work on each assignment. Assignments will be submitted electronically in pdf format via learn. Late submissions will not be accepted.

On successful completion you will be able to:

- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## Assignment 2

Due: **3/10/2016**

Weighting: **3%**

Problems on Fourier Series, Fourier Transform, and Transfer function of a linear time-invariant system. There will be 5-6 questions on each assignment and you will have at least two weeks to work on each assignment. Assignments will be submitted electronically in pdf format via learn. Late submissions will not be accepted.

On successful completion you will be able to:

- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## Assignment 3

Due: **23/10/2016**

Weighting: **3%**

Problems on sampling, aliasing and Nyquist criterion in time and frequency domain, and discrete time convolution. There will be 5-6 questions on each assignment and you will have at least two weeks to work on each assignment. Assignments will be submitted electronically in pdf format via learn. Late submissions will not be accepted.

On successful completion you will be able to:

- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.
- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## Assignment 4

Due: **10/11/2016**

Weighting: **2%**

Problems on Z Transform, and Discrete-time Fourier Transform. There will be 5-6 questions on each assignment and you will have at least two weeks to work on each assignment. Assignments will be submitted electronically in pdf format via learn. Late submissions will not be accepted.

On successful completion you will be able to:

- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## End of Semester Exam

Due: **scheduled in final exam period**

Weighting: **50%**

**This is a hurdle assessment task (see [assessment policy](#) for more information on hurdle assessment tasks)**

Final exam. Students must obtain at least 40% on final exam to pass the unit.

On successful completion you will be able to:

- Demonstrated understanding of how signals can be scaled in space, time, flipped in time (time-reversal), delayed (right and left shifted), and other signal properties (mean, energy, power, periodicity)
- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.
- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

## Delivery and Resources

### Required and Recommended texts and/or materials

**There is no text book. The following books are useful references.**

There are many other books in signal processing in the library. Books which cover similar material to ELEC240 include:

“Signals, Systems and Transforms” 4th ed, by Phillips, Parr and Riskin. Pearson publishers. 2008.

“Signals and systems”, M. J. Roberts, McGraw-Hill.2004.

“An Introduction to Signals and Systems”, J. A. Stuller, Thomson publishers, 2008.

“Linear Systems and Signals”, 2nd ed, B. P. Lathi, Oxford University Press, 2005.

“Signals and systems”, S. Haykin and B. Van Veen, John Wiley & Sons. 1999.

More advanced books include:

“Signals & Systems”, A. V. Oppenheim and A. S. Willsky with S. H. Nawab, Prentice-Hall, 1997.

“Discrete-time signal processing”, A. V. Oppenheim and R. W. Schafer with J. R. Buck, Prentice-Hall, 1999.

Matlab & Simulink Student Version Software by the MathWorks is highly recommended.

## Unit Web Page

Unit lecture notes, resources, assignments and other information about the unit can be accessed through iLearn.

## Technology used

Library and internet search engines, word processing software. The primary software tool used in practicals is Matlab.

### Practical Sessions

Test questions will be undertaken during the practical sessions and marked by the tutors during those sessions.

### Practical Session Safety

No student will be permitted to enter the laboratory without proper footwear. THONGS OR SANDALS ARE NOT ACCEPTABLE. NO FOOD OR DRINK may be taken into the laboratory.

## Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central\)](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) (<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](http://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central) (<http://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 shown in *iLearn*, 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](http://ask.mq.edu.au).

## Student Support

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

## Learning Skills

Learning Skills ([mq.edu.au/learningskills](http://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](http://ask.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/](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

### 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

- Demonstrated use of Matlab to solve problems in Signals and Systems
- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

#### Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4

### 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:

#### Learning outcome

- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## Assessment tasks

- In class test questions
- Weekly Projects
- Hurdle test
- Mid semester test
- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4

## 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

- Demonstrated use of Matlab to solve problems in Signals and Systems
- Be able to solve signal processing problems involving Complex Numbers
- Demonstrated understanding of how signals can be scaled in space, time, flipped in time (time-reversal), delayed (right and left shifted), and other signal properties (mean, energy, power, periodicity)
- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.
- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of

applications (eg circuits, filters, communication channels)

## **Assessment tasks**

- In class test questions
- Weekly Projects
- Hurdle test
- Mid semester test
- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4
- End of Semester Exam

## **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**

- Demonstrated use of Matlab to solve problems in Signals and Systems
- Demonstrated understanding of the concept of a linear time-invariant system and its use in modeling the input-output relationship for signals in many applications.
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
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- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

## **Assessment tasks**

- Weekly Projects

- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4
- End of Semester Exam

## 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

- Demonstrated use of Matlab to solve problems in Signals and Systems
- Demonstrated understanding of the concept of signal domains: how the same signal can be represented in different domains (in time or in frequency) and how to transform from one representation to another.
- Demonstrated understanding of the role of sampling and filtering in converting between continuous-time to discrete-time signals, including the Nyquist criterion, and concept of aliasing.
- Demonstrated understanding of the relationship between the tools used in discrete-time and continuous-time signal processing, and to be able to find the appropriate signal domain and transform method to find system outputs from system inputs in a variety of applications (eg circuits, filters, communication channels)

### Assessment tasks

- Weekly Projects
- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4
- End of Semester Exam

## 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:

## **Learning outcome**

- Demonstrated ability in the following areas of professional engineering practice: –self motivation and self learning –Production of quality work to meet a given deadline

## **Assessment tasks**

- Weekly Projects
- Hurdle test
- Mid semester test
- Assignment 1
- Assignment 2
- Assignment 3
- Assignment 4
- End of Semester Exam

## **Changes in response to student feedback**

There will be less use of powerpoint, and more worked examples in the lectures.