ELEC3104: Digital Signal Processing

Course Convenors:
Dr Zhaocheng Huang
Professor Eliathamby Ambikairajah

Tut-Lab Demonstrators: Gajan Suthokumar (Head Lab Tutor),
Tharshini Gunendradasan,
Buddhi Wickramasinghe,
Namalka Kananke Liyanage,
Deboshree Bose,

Online Tutors: Benjamin Close
Brent Mitchley

Course Summary

Contact Hours:

This course consists of the following delivery options:

- 2 hours of lectures, 2 hours of group tutorials and 2 hours laboratory session each week, face-to-face, **OR**
- All classes online, **OR**
- A combination of the above

✓ These optional face-to-face hours are supplemented by pre-recorded lectures and pre-recorded tutorial problem solutions, which can be downloaded online from Moodle.

Consultations:

✓ All course and lab related emails should be directed to **Dr Zhaocheng Huang** (zhaocheng.huang@unsw.edu.au) in the first instance.

✓ Online group discussion with tutors for 2 hour/week will be available from week 2 onwards.

✓ **ALL email enquiries should be made from your student email address with ELEC3104 in the subject line**; otherwise they will not be answered.

Course Summary

	Day	Time	Location	Name
Lectures	Thursday	6 pm – 8 pm	Rex Vowels Theatre	Dr Zhaocheng Huang Prof E. Ambikairajah
Group tutorials	Monday	12 noon- 2 pm	ChemicalSc M17	Course Conveners and Tut-lab Demonstrators
Labs (W2 – W10)	Tuesday Tuesday Thursday	10 am – 12 noon 12 noon – 2 pm 3 pm – 5 pm	ElecEng108 Interactive Lab	Tut-Lab Demonstrators
Online Discussion and Consultation (W2 – W10)	Tuesday & Friday	6 pm – 8 pm	Moodle	Online Tutors

Course Context and Aims

Signal Processing is the process of measuring, manipulating and analysing real-world signals. ELEC3104 Digital Signal Processing is an introductory course which takes students through the fundamentals of discrete time signal and systems theory.

Aims

The course aims to equip students with:

- An understanding of the time and frequency domain representations of signals and systems.
- The skills to identify the correct type of filter required for a given problem and to demonstrate the design and implementation of a digital filter.
- An understanding of multi-rate processing and multi-rate systems.

Indicative Course Schedule

	Topic
Week 1	Signals and Systems (Chapter 1a & 1b video lectures); [LO: 1, 2]
Week 2	DSP Fundamentals (Chapter 2a, 2b, 2c, 2d & 2e video lectures); [LO: 1, 2]
Week 3	Discrete-Time Systems (Chapter 3a & 3b video lectures); [LO: 1, 2]
Week 4	Introduction to z-Transform (Chapter 4a & 4b video lectures); [LO: 1, 2]
Week 5	Introduction to Digital Filters (Chapter 5a, 5b & 5c video lectures); [LO: 1, 2]
Week 6	Class Exam 1 (Thursday, 26 March 2020, 6 pm - 8 pm, Rex Vowels Theatre, must be face-to-face); Release of the Mini-project
Week 7	Discrete-Time Fourier Transform (Chapter 6 video lectures); [LO: 1, 2]
Week 8	Analog Filters (Chapter 7 video lectures) & Digital Filter Design (Chapter 8a & 8b video lectures); [LO: 1, 2, 3]
Week 9	Digital Filter Design (Chapter 8c & 8d video lectures); [LO: 1, 2, 3]
Week 10	Multirate DSP (Chapter 9 video lectures); [LO: 1, 2, 3, 4]
Week 11	Class Exam 2 (Monday, 27 April 2020, 6 pm - 8 pm, Sir John Clancy Auditorium, must be face-to-face) Mini-Project Assessment (Tuesday, 28 April 2020, must be face-to-face)

Assessment

Assessment:

- Exam 1 (Chapters 1 to 5) (1 hour and 30 minutes) – closed book exam — 30 marks
- Exam 2 (Chapters 6 to 9) (1 hour and 30 minutes) – closed book exam — 30 marks
- Mini-Project (Part A [20 marks] + Part B [10 marks] + *Mini-Project Progress Report [4 marks]) — 34 marks
- **Reflection Sheets (Weeks 3, 5, 8, 10) [4 x 4 marks] — 16 marks

The total marks for this course add up to 110. Your final course mark will be capped at 100.

* At the conclusion of **week 9**, you must submit a Mini-Project progress report (sample available on Moodle) that should be uploaded on your course Moodle by **Friday, 5 pm (week 8)**.

At the conclusion of ***weeks 3, 5, 8 & 10*, you must reflect on the content that you have learnt via the production of reflection sheets (sample attached) that should be uploaded on your course Moodle by **Friday, 5 pm**.

Note: After submission of the reflection sheet, online tutors may contact you through Blackboard Collaborate Ultra to discuss your reflection sheet.

Student Reflection Sheet (Handwritten ONLY)

Name: **zID:** **Week:**

1. Please provide a list of DSP related concepts you learnt this week:

2. Please reflect on everything related to DSP that you learnt this week and write a short summary of what you think you learnt well (and what skills it led to) and what you think you did not learn well.

3.Please rate how well you think you acquired the following skills this week (as a score out of 100):

Program Intended Learning Outcomes (Engineers Australia Stage 1 Competency)	**Learning contribution to skill (out of 100)**
1. Knowledge and skill base Analytical skills, understanding of fundamental theory, and lifelong independent learning	
2. Engineering application ability Complex problem-solving skills, effective application of electrical engineering techniques, critical thinking, and design skills	
3. Professional and personal attributes Communication skills, professional ethics, interpersonal skills, and creativity	

4. Did you spend the stipulated 12-15 hours studying for this course? If not, why? And what extra support do you need to reach this 12-15 hours?

Course Details

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 3rd year course in the School of Electrical Engineering and Telecommunications at the University of New South Wales. It is a core course for students following a BE (Electrical) or (Telecommunications) program and other combined degree programs, and an elective for Computer Engineering students.

Pre-requisites and Assumed Knowledge

The pre-requisite for this course is ELEC2134, Circuits and Signals. It is essential that students are familiar with basic circuit theory, signal analysis and transform methods. It is further assumed that students are familiar with the MATLAB environment, and have good computer literacy.

Note: MATLAB Tutorial Videos:
http://eemedia.ee.unsw.edu.au/MatlabTutorial/index.htm

Learning outcomes

At the end of the course students should be able to:

1. Analyse linear time-invariant systems
2. Demonstrate competency in time and frequency domain analysis of signals and systems including transform methods
3. Design and analyse digital filters for a given specification
4. Implement a simple multi-rate system

This course addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix A***.

Appendix A: Engineers Australia (EA) Professional Enginee Competency

Program Intended Learning Outcomes
1. Knowledge and skill base **Analytical skills**, **understanding of fundamental theory**, specialist and in-depth electrical engineering knowledge, **lifelong independent learning** and research skills
2. Engineering application ability **Complex problem-solving skills**, **effective application of electrical engineering techniques**, **critical thinking**, **design skills**, project management, application of environmentally sustainable practice
3. Professional and personal attributes **Communication skills**, **professional ethics**, team building and **interpersonal skills**, **creativity** and entrepreneurship, leadership skills, safe engineering practice

Those **bold** skills and competencies listed above are addressed by this course.

Syllabus

Processing and analysis of continuous (analogue) and discrete-time (digital) signals. Sampling continuous signals: the sampling theorem, reconstruction, aliasing and the z-transform. Filter impulse and frequency responses, stability and digital oscillators. The Discrete Fourier Transform (DFT). Fundamentals of the design and realisation of finite impulse response (FIR) and infinite impulse response (IIR) digital filters. Linear and non-linear phase filters. Decimation, interpolation, multi-rate digital signal processing.

Learning in this course

1. You are expected to learn from all online lectures every week and additionally you may attend optional face-to-face classes (lectures/tutorials/labs).
2. During weeks 3, 5, 8 & 10, you must reflect on the content that you have learnt via the production of a weekly reflection sheet.
3. At the conclusion of week 8, you must submit a Mini-Project progress Report
4. You must attend all the class exams and mini-project assessments.
5. Reading additional texts will further enhance your learning experience.
6. For an online course such as this, it is *vital* that you undertake adequate self-directed study every week during the term.

Requirements to pass the course

Requirements to pass the course

A satisfactory performance (50% or greater) overall in the course, and in each of the following, is a necessary requirement to pass this course:

- Mini-Project Part A (Individual)
- At least one class exam (week 6 and 11)

Relationship of Assessment Methods to Learning Outcomes

	Learning Outcomes			
Assessment	**1**	**2**	**3**	**4**
Class Exam 1 (30 marks)	✓	✓	-	-
Class Exam 2 (30 marks)	✓	✓	✓	✓
Mini-Project (Part A [20 marks] + Part B [10 marks]) + Mini-Project Progress report [4 marks]	✓	✓	✓	✓
Reflection Sheets (Weeks 3, 5, 8, 10) (16 marks)	✓	✓	✓	✓

Course Resources

Reference books

- A. V. Oppenheim, R. W. Schafer, & P. Buck, Discrete-Time Signal Processing, Prentice-Hall, 2010.
- S. K. Mitra, Digital Signal Processing, McGraw-Hill, 2011.
- J. Proakis & D. Manolakis, Digital Signal Processing, Prentice-Hall, 2007.
- A. Antoniou, Digital Signal Processing – Signals, Systems and Filters, McGraw-Hill, 2016

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Continual Course Improvement

This course is being offered in both face-to-face and online delivery modes, and your feedback is valuable to improve the course. Please forward any feedback (positive or negative) on the course to the course convener or via the myExperience process.

In recent years, the course has been modified based on student feedback in the following ways:

(i) online support from tutors has been increased,

(ii) a miniproject has been introduced to allow the application of DSP theory to practical design problems,

(iii) the course has undergone a Digital Uplift, to introduce new animations, interactive visualisations and interactive problem-solving for self-learning, and

(iv) reflection sheets have been introduced to encourage self-learning skills.