UNSW Course Outline

ELEC4621 Advanced Digital Signal Processing - 2024

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General Course Information

Course Code : ELEC4621
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

FIR Lattice filters, All-pole IIR Lattice filters and their implementation; Fixed Point or finite word length implementations and effects; Random Processes, Auto-correlation,cross-correlation, and power spectrum estimation techniques; Leastsquare filter design, Adaptive filters, Wiener filters,

adaptive noise cancellation; Linear prediction, statistical and deterministic formulation. Applications of linear prediction. Time frequency analysis:short-time Fourier transform, quadrature mirror filter banks, multilevel filter banks and wavelet transform.

Relationship to Other Courses

This is a 4 th year professional elective course in the School of Electrical Engineering and Telecommunications.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the relationship between time and frequency domain interpretations and implementations of signal processing algorithms
CLO2 : Explain and implement adaptive signal processing algorithms based on second-order statistics
CLO3 : Describe fundamental statistical signal processing concepts of signal detection and parameter estimation
CLO4 : Identify some of the most important advanced signal processing techniques, including multirate processing and time-frequency analysis techniques

Course Learning Outcomes	Assessment Item
CLO1 : Explain the relationship between time and frequency domain interpretations and implementations of signal processing algorithms	• Laboratory Projects • Quiz • Final Examination
CLO2 : Explain and implement adaptive signal processing algorithms based on second-order statistics	• Laboratory Projects • Quiz • Final Examination
CLO3 : Describe fundamental statistical signal processing concepts of signal detection and parameter estimation	• Laboratory Projects • Quiz • Final Examination
CLO4 : Identify some of the most important advanced signal processing techniques, including multirate processing and time-frequency analysis techniques	• Laboratory Projects • Quiz • Final Examination

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

1. Formal online lectures that provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
2. Tutorials that allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material, while also providing opportunities for you to stretch your understanding to a variety of application domains;
3. Laboratory sessions that support the formal lecture material and allow you to develop confidence in your ability to convert the formal material into solutions to important practical problems. The teaching philosophy is heavily based on the interaction between the lecturer and students. The lecturer's main task is to impart the necessary insights and understanding to the students rather than simply deliver these concepts in a dry manner. So the lecturer is not there only to give you the mathematical equations on the board or for practice problem-solving. In fact, the practice of solving problems rests almost entirely with the students. Students are expected to seek help and ask questions to rectify any misunderstanding they may have or further deepen their knowledge. The course organisation provides many channels and ample opportunity for students to seek clarifications and support.

In addition to the above components, this course contains a number of other (innovative) elements that have been added for your benefit. These are:

1. Self-benchmarking exercise: This exercise requires you to rate your own knowledge of a list of fundamental concepts that you will encounter in this course. You will undertake this exercise both at the start and end of term. At the start of term the test effectively allows you to benchmark your prior knowledge, while at the end of term, it allows you to rate your learning and how far you have advanced during the term. This test is useful for you to make the most out of the course and to reflect on your knowledge both at the start and end of the course.
2. Benchmarking test: This is a non-assessable multiple choice quiz that you will take at the start of term. Again, this quiz allows you to test your prior knowledge and together with the selfbenchmarking exercise, they give you a very useful benchmark of your knowledge at the start of the course.
3. Challenge problems: These problems will be posted at various times during the term for you to attempt. These problems are chosen to enable you to exercise and validate the knowledge you have gained and to extend it by gaining new insights. Unlike tutorial problems, the challenge problems are not purely aimed at giving practice in the theory you have leraned, but they are inteded to be challenging and fun as well providing deeper insight into the concepts.
4. Videos and other resources: At various points, when seen to be useful or necessary, explanatory videos will be recorded and posted for your benefit on Moodle. Alternatively, other resources, such as documents or links to websites or videos on the internet, will be posted on

Moodle.

Other Professional Outcomes

Engineers Australia, Professional Engineer Stage 1 Competencies

The course learning outcomes (CLOs) contribute to your development of EA competencies:

PE1: Knowledge and Skill Base

- PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLOs 1, 2, 3, 4
- PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLOs 1, 2, 3, 4
- PE1.3 In-depth understanding of specialist bodies of knowledge: CLOs 1, 2, 3, 4
- PE1.4 Discernment of knowledge development and research directions: CLOs 1, 2, 3, 4
- PE1.5 Knowledge of engineering design practice: CLOs 2 and 3

PE2: Engineering Application Ability

- PE2.1 Application of established engineering methods to complex problem solving: CLOs 1, 2, 3, 4
- PE2.2 Fluent application of engineering techniques, tools and resources: CLOs 1, 2, 3, 4
- PE2.3 Application of systematic engineering synthesis and design processes: CLOs 2 and 3
- PE2.3 Application of systematic engineering synthesis and design processes: CLOs 2 and 3
- PE2.4 Application of systematic approaches to the conduct and management of engineering projects:

PE3: Professional and Personal Attributes

- PE3.1 Ethical conduct and professional accountability
- PE3.2 Effective oral and written communication (professional and lay domains): CLOs 1, 2, 3, 4
- PE3.3 Creative, innovative and pro-active demeanour
- PE3.4 Professional use and management of information: CLOs 1, 2, 3, 4
- PE3.5 Orderly management of self, and professional conduct:
- PE3.6 Effective team membership and team leadership:

Additional Course Information

Credits: This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10 week semester. The University defines a UoC as requiring 25 hours of total learning effort per semester (spread over lectures, tutorials, labs, and the student's own study time.) Therefore, it is expected that 150 hours will be allocated to this course. This covers the contact hours, including

lectures, tutorials and labs, as well as the self-study time.

Pre-requisites and Assumed Knowledge: The pre-requisite for this course is ELEC3104, Digital Signal Processing. It is also essential that you are familiar with elementary signal processing concepts and linear algebra, as well as various mathematical foundations such as complex analysis, functional analysis, and numerical methods before this course is attempted. It is further assumed that students have a working knowledge of Matlab, which is used in the laboratory projects.

Following Courses: The course is not a pre-requisite for any other courses offered by the School of EE&T. However, students undertaking postgraduate studies involving signal processing should find that this course provides an excellent preparation for such further study. As an undergraduate professional elective, this course provides a solid foundation for a surprisingly wide range of professional engineering design and development activities.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Laboratory Projects Assessment Format: Individual	30%	
Quiz Assessment Format: Individual	20%	
Final Examination Assessment Format: Individual	50%	

Assessment Details

Laboratory Projects

Course Learning Outcomes

- CLO1 : Explain the relationship between time and frequency domain interpretations and implementations of signal processing algorithms
- CLO2 : Explain and implement adaptive signal processing algorithms based on second-order statistics
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- CLO4 : Identify some of the most important advanced signal processing techniques, including multirate processing and time-frequency analysis techniques

Assessment information

The laboratories in this course are design exercises that will typically require you to revise your lecture notes to deepen your understanding of the topic that is covered by the laboratory. This is intended and it is expected that you can demonstrate familiarity with all the relevant lecture material while being assessed. It is, nonetheless, noted that you may have gaps in your knowledge and therefore need help. In this respect, the laboratory demonstrators are highly knowledgeable and helpful. They can assist you to resolve weaknesses in your understanding, but you must raise any concerns that need their assistance near to the beginning of the scheduled laboratory period. Most of the final hour of the lab session will be spent assessing your work. You should follow all instructions given by the laboratory demonstrators to facilitate efficient assessment of your work. Where analytical work is involved, you should have that work available for the laboratory demonstrators to inspect, in a separate neatly presented laboratory book. Note also that the labs are meant to stimulate discussions. As you attempt the exercises prior to the lab in your own time, you will have the opportunity to discuss the labs in the forums that are provided on Moodle. The questions you ask can be answered by your peers, or by the course teaching staff.

Quiz

Course Learning Outcomes

- CLO1 : Explain the relationship between time and frequency domain interpretations and implementations of signal processing algorithms
- CLO2 : Explain and implement adaptive signal processing algorithms based on second-order statistics
- CLO3 : Describe fundamental statistical signal processing concepts of signal detection and parameter estimation
- CLO4 : Identify some of the most important advanced signal processing techniques, including multirate processing and time-frequency analysis techniques

Assessment Length

50 minutes

Final Examination

Course Learning Outcomes

- CLO1 : Explain the relationship between time and frequency domain interpretations and implementations of signal processing algorithms
- CLO2 : Explain and implement adaptive signal processing algorithms based on second-order statistics
- CLO3 : Describe fundamental statistical signal processing concepts of signal detection and

parameter estimation
- CLO4 : Identify some of the most important advanced signal processing techniques, including multirate processing and time-frequency analysis techniques

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Lecture	Lecture 1: Introduction and housekeeping; Linear Spaces; Sampling Lecture 2: Signal Representation; Transforms
	Tutorial	Tutorial 1
	Laboratory	Introductory Lab.
Week 2 : 19 February - 25 February	Lecture	Lecture 3: Linear Time-Invariant (LTI) Operations; Filter Structures Lecture 4: Filter Design
	Tutorial	Tutorial 2.
	Laboratory	Lab Task 1.
Week 3 : 26 February - 3 March	Lecture	Lecture 5: Filter Implementation Lecture 6: Numerical Round-off Errors; Quantization Effects
	Tutorial	Tutorial 3
	Laboratory	Lab Task 2
Week 4 : 4 March - 10 March	Lecture	Lecture 7: Introduction to Multi-rate Signal Processing Lecture 8: Sub-band Transforms
	Tutorial	Tutorial 4
	Laboratory	Lab Task 3
Week 5 : 11 March - 17 March	Lecture	Lecture 9: Statistics; Information Theory Perspective Lecture 10: Power Spectrum Estimation
	Tutorial	Tutorial 5
	Laboratory	Lab Task 4
Week 6 : 18 March - 24 March	Other	Revision week for Lectures, Labs & Workshops.
Week 7 : 25 March - 31 March	Lecture	Lecture 11: Linear Prediction, Lecture 12: Quiz Lecture 13: tWeiner Filtering
	Tutorial	Tutorial 6
	Laboratory	Lab Task 5
Week 8 : 1 April - 7 April	Lecture	Lecture 14: Signal Detection; Hypothesis Testing Lecture 15: Likelihood Ratio Tests Lecture 16: Parameter Estimation
	Tutorial	Tutorial 7
	Laboratory	Lab Project
Week 9 : 8 April - 14 April	Lecture	Lecture 17: Time-Frequency Analysis Lecture 18: The STFT Lecture 19: Data-Adaptive Transforms (the MVE)
	Tutorial	Tutorial 8
	Laboratory	Lab Project
Week 10 : 15 April - 21 April	Lecture	Lecture 20: Space-Time Adaptive Processing Lecture 21: Flexible Session Lecture 22: Flexible Session
	Tutorial	Tutorial 9
	Laboratory	Lab Project (submission due)

Attendance Requirements

This course is quite challenging and high quality lecture recordings may not be available. Students are strongly encouraged to attend all classes in order to benefit from the interaction with the lecturer and teaching staff. The insights given in teh lectures and other classes are very difficult to convey otherwise.

Course Resources

Prescribed Resources

- Course Notes
- Other material posted on Moodle
- Class attendance is a must as the course is challenging

Recommended Resources

- Proakis & Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
- Simon Haykin, Modern Filters, Macmillan Publishing Company.
- Sanjit K. Mitra,Digital Signal Processing, A Computer-Based Approach, McGraw-Hill.
- Paulo S. R. Diniz, Eduardo A. B. da Silva and Sergio L. Netto, Digital Signal Processing, System Analysis and Design, Cambridge University Press.
- Bernard Mulgrew, Peter Grant, and John Thompson, Digital Signal Processing, Concepts and Applications, SpringerLink.

Course Evaluation and Development

Feedback will be gathered throughout the trimester both openly and anonymously. At the start of every lecture, the lecturer will ask students how they are progressing and if they have any questions. The lecturer will also has if they have any comments or suggestions. An anonymous feedback box will also be available throughout the trimester on Moodle for students to provide comments, suggestions and feedback.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Elias Aboutanios		EEB 445	430023047		No	No
Demonstrator	Rachel Lauren Gray					No	No
	Renjith Hari Kumar					No	Yes
	Jeffrey Shao					No	No
	James Gray					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage