# ELEC4621: ADVANCED SIGNAL PROCESSING
# SESSION 1, 2009

### *1.1 Staff :*

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|---|---|---|
| **Academic in Charge:** | **Dr D. Sen,** | Room EE-306, d.sen@unsw.edu.au |
| Laboratory Co-ordinator: | Mr Borislav Savkovic, | b.savkovic@student.unsw.edu.au |
| Lab Demonstrators: | Mr Wenliang Lu, | wenliang@ieee.org |
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### *1.2 Subject Pre-Requisites:*

Signal Processing 1 (Elec3004), or equivalent**.**

### *1.3 Course Objectives:*

This subject builds upon the material introduced in the third year course (ELEC3104: Digital Signal Processing), focusing exclusively on advanced DSP techniques. By the end of the session, the student should:

a) have a better understanding for the mathematical *foundations of digital signal representation and processing*.

b) have a more thorough understanding of the *relationship between time and frequency domain interpretations and implementations* of signal processing algorithms;

c) understand and be able to implement *adaptive signal processing algorithms* based on second order statistics; and

d) be familiar with fixed point representation and its consequences in signal processing.

e) understand the concept of *least squares optimisation and linear prediction concepts and techniques*.

f) be familiar with *time-frequency analysis* techniques.

g) Be in a position to analyse signal processing problems and implement algorithms to target various applications including speech, audio, seismic, biomedical and image signal processing.

### *1.4 Credits:*

The course is a 6 UoC course; expected workload is 10–12 hours per week throughout the 12 week session.

### *1.5 Contact Hours:*

The course consists of 3 hours of lectures per week. The lectures are supplemented by a 1-hour tutorial, and a 3-hour laboratory both of which are on alternate weeks.

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|---|---|
| Lectures: | Wed, 2–5 pm, Room: OMB 150 |
| Tutorials: | Friday, 1-2 pm, EE 222 |
| Labs: | Friday, 1-4 pm, EE 214 |

**Consultation hours:** best time is right after tutorials and lectures.

## 1.6 *Topics:*

- Sampling, aliasing and the relationship between discrete and continuous signals
- Review of Fourier transforms, the Z-transform, FIR and IIR filters, and oscillators
- Filter implementation techniques, structures and numerical round-off effects
- Filter design techniques
- Auto-correlation, cross-correlation, and power spectrum estimation techniques
- Linear prediction
- Wiener filters, LMS adaptive filters, and applications.
- Sub-band decomposition & QMF.
- Time-frequency analysis, the short time Fourier transform, and wavelet transforms.

## 1.7 *Assessment*

**1) Laboratory (12+8 = 20%):**

There are four labs, each with two components – a component that will be assessed during the laboratory hours and a component that is recommended for homework that will not be immediately assessed. The laboratory component of the labs will have a maximum of 3 marks each (for a total of 12% at the end of the session). to To earn the three (3) marks, the students will have to show an understanding of the underlying theory, their implementation and how the results correspond to the theory.

The lab assessments will begin in the third week and end in the tenth week. To be eligible for the full 3 marks, students will have a maximum of two weeks per lab – with a penalty of 1 mark, for each week that they are late.

During weeks 11, 12 and 13 students will be assessed by a "laboratory exam" where they will be quizzed over all four labs (including the homework component). The questions will be random, involve matlab implmentations and theory. Each student can expect to be asked different questions. This component will carry a mark out of 8.

**2) Mid session quizzes (2 x15 =30%):**

There will be two mid-session quizzes in Week 6 and Week 11. The lower of the two quiz marks (as a percentage of the full mark) will be replaced by the maximum of the other quiz mark and your exam mark (both as percentages of their respective full marks) - whichever is greater.

**3) Final Exam (50%):**

## 1.8 *Recommended Texts*

- *Lecture materials, tutorial questions, lab material can be collected from the school office*.
- Recommended Reading:
  1) Proakis & Manolakis, "*Digital Signal Processing: Principles, Algorithms and Applications"*, 3rd Edition, Prentice Hall, 1995.
  2) Oppenheim, Schafer & Buck, "*Discrete-Time Signal Processing*", 2nd Edition, Prentice Hall, 1999.

## *1.9 Academic honesty and plagiarism*

### What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.* Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students 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 items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.

## *1.10 Graduate Attributes*

The graduate attributes contributed by this course includes:

- The skills involved in scholarly enquiry
- The capacity for analytical and critical thinking and for creative problem-solving
- The ability to engage in independent and reflective learning
- Information literacy - the skills to appropriately locate, evaluate and use relevant information
- The capacity for enterprise, initiative and creativity
- The skills required for collaborative and multidisciplinary work

## *1.11 Tentative Program*

| **Week (Date)** | **Lab** | **Tut** | **Planned Topic(s)** |
|---|---|---|---|
| 0<br>2/3 | Open Lab | | |
| 1<br>9/3 | Open Lab | Tut 1 | Foundations: Convolution, FT, DTFT, sampling, and discrete vs. continuous time. |
| 2<br>16/3 | Open Lab | Tut 1 | Z-transforms, filters and oscillators |
| -<br>23/3 | **Lab 1 Deadline** | Tut 2 | Filter implementation structures and techniques |
| 3<br>30/3 | Open Lab | Tut 2 | Filter implementation and the DFT |
| 4<br>6/4 | Good Friday | Tut 3 | Filter design techniques |
| 5<br>13/4 | | | Mid Session Break |
| 6<br>20/4 | **Lab 2 Deadline** ** | Tut 3 | ***In-class quiz #1**;* Random processes ($2^{nd}$ & $3^{rd}$ Hour) |
| 7<br>27/4 | **Lab 3 Deadline** | Tut 4 | Linear prediction |
| 8<br>4/5 | Open Lab | Tut 4 | Linear prediction (continued) |
| 9<br>11/5 | **Lab 4 Deadline** | Tut 5 | Power spectrum estimation |
| 10<br>18/5 | **Lab Quiz** | Tut 5 | Wiener and adaptive filtering |
| 11<br>25/5 | **Lab Quiz** | Tut 6 | ***In-class quiz #2;*** Sub-band decomposition/Quadrature Mirror Filters ($2^{nd}$ & $3^{rd}$ Hour) |
| 12<br>1/6 | **Lab Quiz** | Tut 6 | Wavelet transforms; Time-frequency analysis |