Advanced Signal Processing - Course Outline

ECEN 421: 2010 Trimester 2

This document sets out the workload and assessment requirements for ECEN 421. It also provides contact information for staff involved in the course. If the contents of this document are altered during the course, you will be advised of the change by an announcement in lectures and/or on the course web site. A printed copy of this document is held in the School Office.

Course Description

The course introduces the fundamentals of Information Theory and Signal Estimation and Detection. It introduces the basic concepts of entropy and mutual information, leading into the study of Shannon's Source Coding Theorem and data compression techniques including Huffman and Arithmetic Codes. Shannon's Channel Coding Theorem and Rate-Distortion Theory will also be introduced. The Estimation and Detection module will cover topics of Wiener and matched filtering, time series and ARMA processes, spectrum estimation using AR processes, subspace methods as well as Maximum likelihood estimation. The course will conclude with the introduction to Bayesian Estimation.

Prerequisites

Prerequisites: ECEN 320 (or ELEN 303 or ECSE 420 or PHYS 420 or TECH 420)

Restrictions: PHYS 421, TECH 421

Objectives

Upon completion of the course, the students should be able to demonstrate

- the understanding of the Source Coding Theorem and its application to data compression 3(a)
- the understanding of the Noisy Channel Coding Theorem and its implications on communications system performance 3(a)
- the understanding of the Rate-Distortion Theory 3(a)
- the understanding of Stochastic processes and correlation functions and be able to derive and apply the Wiener filter 3(a)
- the understanding of the concept of estimation, and be able to derive the maximum likelihood estimator for a variety of problems. 3(c)
- the understanding of time series, ARMA models and estimation methods based on AR models 3(a)

Objectives 1--3 are assessed primarily by written assignments and the examination. Objectives 4-6 are assessed by assignments, laboratory experiments and examination.

Textbook

There main references for the Information Theory component of the course are:

- T. M. Cover and J. A. Thomas, Elements of Information Theory, Oxford (either 1st or 2nd edition is suitable)
- D. J. C. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge (available online)

And for the Estimation Theory module:

- S. M. Kay, Fundamentals of Statistical Processing, Volume I: Estimation Theory, Prentice Hall
- C.W. Therrien, Discrete Random Signals and Statistical Signal Processing, Prentice-Hall

Lectures, Tutorials, Laboratories, and Practical work

- Lectures: Monday, Friday 2-3, Von Zedlitz 515
- Tutorial: Thursday 2-3, Von Zedlitz 515
- Laboratories: Friday 9-12, Cotton 249

Assignments

There will be four assignments (2 each on Information Theory and Estimation Theory) tentatively due in the first lecture of weeks 4, 7, 10 and 12. Late submissions will be penalised at the rate of 10% for every day that the assignment is late. The lecturers may refuse to mark work that has been handed in over a week late, and will also refuse if the assignment has been marked and returned to the class. In such instances a zero grade for that assignment shall result.

Practical Work

The course includes several laboratory experiments focusing on the Estimation Theory component. In addition, assignments will include Matlab-based components. Students are expected to work individually on these, although informal collaboration is encouraged. Submission of laboratory assignments for assessment will be done via the electronic submission system where possible. Late submissions will be penalised at a rate of 10% per day.

Tests and Exams

As indicated by the assessment breakdown, in addition to the final examination an in-class test on the Information Theory module will be held during the trimester. It is tentatively scheduled for the tutorial slot in week 7. If you are unable to attend this test, please notify the instructor *as soon as possible* so that alternate arrangements can be made.

The timetable for final examinations will be available from the University web site and will be posted on a notice board outside the faculty office. The final examination will be three hours long. No computers, electronic calculators or similar device will be allowed in the final examination. Paper non-English to English dictionaries will be permitted. The study and examination period for trimester T2 is 23 October - 14 November

Workload

To maintain satisfactory progress in ECEN 421, you should spend on average at least *10* hours per week on this course. A plausible and approximate weekly breakdown for these hours would be:

- Lectures and tutorials: 3 hours
- Laboratory sessions and project work: 3 hours
- Assignments: 2 hours
- Preparatory reading and problem solving: 3 hours.

Course Content

The following is a preliminary outline of the topics covered in the lectures.

Information Theory (Dr. Pawel Dmochowski)

- Entropy and Mutual Information
- Asymptotic Equipartition Theorem
- Source Coding: Kraft Inequality, Optimal Codes, Huffman Codes
- Channel Capacity and the Channel Coding Theorem
- Hamming Codes
- Differential Entropy
- Gaussian Channel
- Rate-Distortion Theory (time permitting)

Estimation Theory (Dr. Paul Teal)

- Introduction to Random variables and Stochastic Processes. Moments.
- Correlation functions
- Stochastic processes and systems
- The Wiener filter
- The Matched Filter
- Time series, ARMA processes
- Spectrum estimation using AR processes, Yule-walker equations
- Subspace methods, MUSIC.
- Maximum likelihood estimation
- Cramer Rao bounds
- Introduction to Bayesian Estimation

School of Engineering and Computer Science

The School office is located on level three of the Cotton Building (Cotton 358).

The notice board for ECEN 421 is located on the second floor of the Cotton Building.

Staff

The course organiser for ECEN 421 is Pawel Dmochowski . The lecturers are Pawel Dmochowski and Paul Teal

Contact details are:

- Pawel Dmochowski
- AM227

- 463 5948
- pawel.dmochowski@vuw.ac.nz

- Paul Teal
- TBD
- 463 5966
- paul.teal@vuw.ac.nz

Announcements and Communication

The main means of communication outside of lecture will be the Blackboard site and the ECEN 421 Forum. The forum is a web-based bulletin board system. Questions and comments can be posted to the forum, and staff will read these posts and frequently respond to them.

Assessment

Your grade for ECEN 421 will be determined based on the following assessment weightings:

Item	Weight
Assignments (4)	20%
Labs / In class test	20%
Final Examination	60%

Plagiarism

Working Together and Plagiarism

We encourage you to discuss the principles of the course and assignments with other students, to help and seek help with programming details, problems involving the lab machines. However, any work you hand in must be your own work.

The School policy on Plagiarism (claiming other people's work as your own) is available from the course home page. Please read it. We will penalise anyone we find plagiarising, whether from students currently doing the course, or from other sources. Students who knowingly allow other students to copy their work may also be penalised. If you have had help from someone else (other than a tutor), it is always safe to state the help that you got. For example, if you had help from someone else in writing a component of your code, it is not plagiarism as long as you state (eg, as a comment in the code) who helped you in writing the method.

Mandatory Requirements

It is expected that all work will be completed and submitted for assessment. An incomplete or fail grade will be issued to any student who satisfies *any* of the following conditions:

1. does not sit the test.
2. does not submit at least three (of the four) assignments.
3. is caught cheating in any form (this includes laboratory work).

Passing ECEN 421

To pass ECEN 421, a student must satisfy mandatory requirements and gain at least a **C** grade overall.

Withdrawal

The last date for withdrawal from ECEN 421 with entitlement to a refund of tuition fees is Friday *date* 2010. The last date for withdrawal without being regarded as having failed the course is Friday, *date* 2010 -- though later withdrawals may be approved by the Dean in special circumstances.

Rules & Policies

Find key dates, explanations of grades and other useful information at http://www.victoria.ac.nz/home/study.

Find out about academic progress and restricted enrolment at http://www.victoria.ac.nz/home/study/academic-progress.

The University's statutes and policies are available at http://www.victoria.ac.nz/home/about/policy, except qualification statutes, which are available via the Calendar webpage at http://www.victoria.ac.nz/home/study/calendar (See Section C).

Further information about the University's academic processes can be found on the website of the Assistant Vice-Chancellor (Academic) at http://www.victoria.ac.nz/home/about/avcacademic

All students are expected to be familiar with the following regulations and policies, which are available from the school web site:

Grievances
Student and Staff Conduct
Meeting the Needs of Students with Disabilities
Student Support
Academic Integrity and Plagiarism
Dates and Deadlines including Withdrawal dates
School Laboratory Hours and Rules
Printing Allocations
Expectations of Students in ECS courses

The School of Engineering and Computer Science strives to anticipate all problems associated with its courses, laboratories and equipment. We hope you will find that your courses meet your expectations of a quality learning experience.

If you think we have overlooked something or would like to make a suggestion feel free to talk to your course organiser or lecturer.
