ELEC3104: Digital Signal Processing

COURSE INTRODUCTION – Semester 1, 2011

Course Staff

Course convener: Prof. E. Ambikairajah, room G6, ambi@ee.unsw.edu.au
Tutor: Dr. A. Tabatabaei Balaei, room 340, asghart@unsw.edu.au
Laboratory Coordinator: Dr. T. Thiruvaran, t.thiruvaran@unsw.edu.au
Mr. Phu Le, phule@unsw.edu.au

Course details

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

Contact hours
The course consists of 3 hours of lectures, a 1-hour tutorial, and a 2-hour laboratory session each week. These face-to-face hours are supplemented by pre-recorded lectures, which can be downloaded online, that students are required to watch at their own pace each week.

Lectures: Tuesday 12 – 2 pm, Room: ElecEngG24
Thursday 11am – 12 noon, Room: ElecEngG24

Tutorials: Monday 5 – 6 pm ElecEng225
Tuesday 11-12 noon RedC 1041
Wednesday 12 – 1 pm RedC 2060

Consultations: You are encouraged to ask questions on the course material after the lecture class times in the first instance, rather than via email.

Course Information

Context and aims
Signal Processing is the process of measuring, manipulating or analysing information. Signals of interest include biomedical data, audio, still or moving images, radar, and even DNA. Filtering techniques can be crucial in revealing and interpreting information present in a signal. ELEC3104 Digital Signal Processing is an introductory signal processing course which takes students through the steps necessary to design and implement filters for a range of signals.
Aims
The course aims to equip the student to do the following:

- Deduce and understand the behaviour of a system in terms of both its time domain and frequency domain representations.
- Identify the correct type of filter required for a given problem and be able to demonstrate the design and implementation of such a digital filter.
- Explain the concept of aliasing and its effect on the design and use of practical systems.

Relation to other courses
The course is a third year subject in the school of Electrical Engineering and Telecommunications at the University of New South Wales. It is a core subject for students following a BE (Electrical) or (Telecommunications) program, and an elective for Computer Engineering students.

Pre-requisites
The pre-requisites for this course is ELEC2134, Circuits and Signals. It is essential that students are familiar with basic circuit theory and signal analysis.

Assumed knowledge
It is further assumed that the students are familiar with the MATLAB environment, and have good computer literacy.

Following courses
The course is a pre-requisite for all professional electives in the Signal Processing group, including ELEC4621 Advanced Digital Signal Processing, ELEC4622 Multimedia Signal Processing, and ELEC4623 Biomedical Instrumentation, Measurement and Design.

Learning outcomes
At the end of the course you should:

- Be able to apply transform methods to the analysis of analogue and digital linear time-invariant systems
- Be able to convert between time and frequency domain representations of signals and systems
- Understand the practical aspects of sampling and reconstruction and be able to select a suitable sampling rate for a given signal processing problem
- Be capable of designing and analysing analogue and digital filters for a given specification
- Be able to demonstrate an understanding of the use and applications of the discrete Fourier transform
- Have gained practical experience with the implementation of digital filters

The course delivery methods and course content address a number of core UNSW graduate attributes; these include:
• Analytical skills, critical thinking and creative problem solving will be developed by the laboratory experiments and interactive checkpoint assessments during the labs.

• Self-assessment of independent and reflective learning is made available through a series of tutorials spanning the duration of the course together with the video-based learning material. The laboratory program fosters independent learning.

• Demonstration of the understanding of principles, and the effective use and communication of relevant information will be tested in depth in the mid-semester examination and the final examination.

Syllabus

Teaching strategies

Delivery Mode
This entire course will be delivered via live lectures and pre-recorded electronic whiteboard based lecture presentations. The live lectures will be supported by these pre-recorded lectures and you can watch these in your own time before the weekly lecture/discussion class. The advantages of the pre-recorded lectures:

• You will be able to watch them at your own pace

• You can revisit the lecture content as many times as you like

• Things that you might miss in a normal live lecture (e.g. difficult mathematical concepts) are available on the video lectures via the discussion classes

This mode of delivery was used from 2006 for this course, and it was popular with both undergraduate and postgraduate students in other courses who said that it helped them gain a deeper understanding of the course material.

Note that the laboratory material and the lecture material may not be entirely synchronised. The pre-recorded lectures on video provide you with an opportunity to cover material not yet covered in class. You should look through the laboratory notes to decide what material you need to look over.

Teaching Methods
Lectures = 3 hrs/week (mandatory)   Tutorials = 1 hr/week (mandatory)
Labs = 2 hrs/week (mandatory)

The rationale behind the teaching methods for this course:

• The course is structured such that the pre-recorded lectures provide details of course material so that you can understand each concept presented and re-visit any difficult sections in detail.
• The tutorials help to develop the required level of analytical skills that will be used in this course.
• Your class exam and the final exam will test your problem solving skills and give you the opportunity to effectively communicate and demonstrate your understanding of the principles in the course.
• The lab quizzes/checkpoints will test your weekly preparation methods for the lab work and ensure that you are sufficiently prepared to take the lab.

Learning in this course
You are expected to attend all lectures, tutorials, labs, lab quizzes and class exams in order to maximise learning. You should prepare your tutorial questions in advance of attending the tutorial classes. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional text would further enhance your learning experience. Group learning is also encouraged.

Laboratory program
The laboratory program is the centre of this course. Through the laboratory component, you will progressively encounter the elements of the syllabus. The aim of the laboratory component is to ground the analytical subject material in a real-world problem, meaning that the skills and knowledge you learn throughout the course will be applied in real engineering design work. Throughout the semester you will focus on:
• Sampling and reconstruction
• Impulse and frequency response of systems
• Description of filter types using poles and zeroes
• Digital filter design
• Frequency domain analysis
• Multi-rate processing

Laboratory Exemption
There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course for Semester 1, 2011 must take the labs.
If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, you will need to apply for a catch-up lab during another lab time, as agreed by the laboratory co-ordinator.

Pre-requisite to pass the course
A satisfactory performance (50% or greater) in each of the following, is a necessary requirement to pass this course:
• Ongoing laboratory assessment
• Final Exam
Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through the lab checkpoints and the semester tests.

Mid - Semester Exam (19 April: 1.5 hours) = 20%
Ongoing Lab Assessment = 30%
Final Exam (3 hours) = 50%

Mid - Semester Examinations (20% total)
There will be one mid semester examination, testing your understanding of the principles and your analytical skills through a number of set problems.

- Tuesday, 19th April, 12.15 – 1.45pm, Room: ElecEngG24.
- Covers material from Modules 1 to 18

If for medical reasons (note that a valid medical certificate must be provided) or any other reasons, you are unable to attend the mid-semester exam, you will be given an oral examination of approximately 1 hour.

Laboratory Assessment (30%)
Throughout the semester your progress in the laboratory will be assessed by your lab tutor at a series of checkpoints. At these checkpoints you will present your work to your tutor, solve analytical problems, write MATLAB code, explain the relevant concepts, and answer questions on your labs. Marks will be assigned according to the broad criteria explained in the Laboratory notes.

Final Exam (50%)
There will be one final examination, testing your understanding of the principles and your analytical skills through a number of set problems. If for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend the mid-semester exam, you will be given another exam (either oral or written, at the discretion of the course convenor).

- The final exam will be 3 hours long
- The final exam consists of 6 questions (with many parts) and all of them must be answered
- The final exam will cover all modules covered in the semester

Resources for Students

Textbooks

Prescribed textbook

Reference book
On-line resources

BlackBoard
As a part of the teaching component, BlackBoard will also be used. Mid-term examination results and lab marks will also be available via BlackBoard.
Course web page http://subjects.ee.unsw.edu.au/elec3104
BlackBoard http://telt.unsw.edu.au/
Video Lectures http://eemedia.ee.unsw.edu.au/ELEC3104_Streaming/index.htm

Mailing list
Announcements concerning course information will be given in the lectures, via the course website http://subjects.ee.unsw.edu.au/elec3104.

Other matters

Academic Honesty and Plagiarism
Plagiarism is the unacknowledged use of other peoples work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply: http://www.icc.unsw.edu.au/plagiarism

Continual Course Improvement
Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

Administrative Matters
On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies: http://scoff.ee.unsw.edu.au/

Important Points

Please note the following:

- During your lab sessions, you will be assigned to a lab demonstrator, who will be able to guide you in your laboratory-based learning.
- You can purchase the lecture notes (hard copy) which contains the course outline, MATLAB exercises, problem sheets and solutions, sample quizzes, final exam papers, references and laboratory manual along with lecture notes. This costs $25 and can be purchased from the School Office.
- A soft copy of the lecture notes is available on the course website: http://subjects.ee.unsw.edu.au/elec3104
- Guidelines on learning that inform teaching at UNSW are available at www.guidelinesonlearning.unsw.edu.au
Course Schedule
Previously there were 6 chapters in this course, however based on student feedback, the 6 chapters have now been divided into 26 smaller modules, which are supported by problem sheets along with solutions, and multiple choice questions. No solutions will be provided by the multiple choice questions – work with your peers to determine the answers or alternatively MATLAB simulations will help you derive the answers.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td>Modules 1 - 18</td>
</tr>
<tr>
<td>8</td>
<td>Mid semester Exam (12.15-1.45pm): Tuesday 19 April (modules 1 - 18)</td>
</tr>
<tr>
<td>9-12</td>
<td>Modules 19-26</td>
</tr>
<tr>
<td>13</td>
<td>Revision</td>
</tr>
<tr>
<td></td>
<td><strong>Final Exam covers all the modules (1 to 26)</strong></td>
</tr>
</tbody>
</table>

Laboratory Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Suggested Lab work</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lab1 - Introduction to TIMS and Matlab</td>
<td>Matlab Exercises, Modules 1 &amp; 2</td>
</tr>
<tr>
<td>2</td>
<td>Lab 2 - Sampling and Reconstruction</td>
<td>Modules 1 &amp; 2</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Modules 1 &amp; 2</td>
</tr>
<tr>
<td>4</td>
<td><strong>Checkpoint 1</strong></td>
<td>Modules 1 &amp; 2</td>
</tr>
<tr>
<td>5</td>
<td>Lab 3 - Impulse and Frequency Response of Systems</td>
<td>Modules 1 to 9</td>
</tr>
<tr>
<td>6</td>
<td>Lab 4 - Poles and Zeros</td>
<td>Modules 1 to 18</td>
</tr>
<tr>
<td>7</td>
<td><strong>Checkpoint 2</strong></td>
<td>Modules 1 to 18</td>
</tr>
<tr>
<td>8</td>
<td>Lab 5 - Digital Filters</td>
<td>Modules 1 to 22</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Modules 1 to 22</td>
</tr>
<tr>
<td>10</td>
<td><strong>Checkpoint 3</strong></td>
<td>Modules 1 to 22</td>
</tr>
<tr>
<td>11</td>
<td>Lab 6 Interpolation and Decimation</td>
<td>Modules 1 to 26</td>
</tr>
<tr>
<td>12</td>
<td><strong>Checkpoint 4</strong></td>
<td>Modules 1 to 26</td>
</tr>
</tbody>
</table>