Unit Title: Signal Conditioning, Data Acquisition and Data Analysis

Unit Code: JEE508

Semester: Summer Year: 2011

National Centre: Maritime Engineering and Hydrodynamics

Department: Postgraduate

Campus: Launceston/Distance

CRICOS Provider Code: 00586B
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Unit description*

JEE508

Signal Conditioning, Data Acquisition and Data Analysis

Offered: Ltn Summer Sem 5

This unit is specifically designed for science and engineering graduates requiring a rigorous yet still applied and functional knowledge of signal conditioning and data acquisition appropriate for experiments carried out in the maritime field. The subject matter has been designed around the specific problems encountered using the suite of testing facilities of the National Centre for Maritime Engineering and Hydrodynamics for engineering research and development. However, upon successful completion and retention of the knowledge gained within this unit the student will be able to transfer the methods to other testing environments.

The intensive learning sessions begin with learning activities on transducer technologies for pressure, force, strain, acceleration and flow measurements. Topics on signal conditioning and data acquisition then lead on to filter design. Post-processing of data is covered in the final 2.5 days with specific reference to the hardware already introduced. For all aspects of the course students are introduced to global resources available for such work from the lecturer’s experience of conducting experiments in a number of world renowned facilities.

Although this unit is highly technical, the students are also introduced to the ideas of ethical research, and the need for formal ethical approval. This unit will not cover the formal approval process, students MUST conduct further self driven research on this topic if they require it.

In essence the unit is designed to plug the gaps in modern undergraduate engineering education to allow students to progress research and development based on experimental approaches.

Learning outcomes*

The following learning outcomes have been constructed; the links to the Generic Graduate Attributes are shown in brackets. On completion of this unit, you should be able to:

1. List 5 probabilistic and 5 deterministic methods of analysing time series data (a, c, d, g)
2. Design and test a combined analog and digital filter system for an expected set of experimental data (a, b, c, d, e, f, h)
3. Specify a temperature, a pressure, a strain, a force, a flow and a level transducer for a given set of data acquisition requirements using global and local resources (a, c, e, i)
4. Report the details of an experimental setup for a specialist experimentalist and a generalist scientist (d, e)
5. Differentiate between an impulse signal and a periodic signal and apply analysis methods appropriate to each form of data (a, b, c, f)
6. Determine if a particular study requires formal ethical approval, if not then identify what ethical considerations are required (j)

Generic graduate attributes

The University has defined a set of generic graduate attributes (GGAs) that can be expected of all graduates (see http://www.utas.edu.au/policy/attributes_grads.pdf). This set has been further refined to apply specifically to the Graduate Certificate in Research. By undertaking this unit you should make progress in attaining the following attributes:
**Knowledge:**

a) Understand the limitation of, and have the capacity to evaluate their current knowledge
b) Identify, evaluate and implement personal learning strategies
c) Find, acquire, evaluate, manage and use relevant information in a range of media

**Communication skills:**

d) Present well-reasoned arguments and ideas, using technology as appropriate
e) Access, organise and present information clearly and purposefully for a specific audience

**Problem-solving skills:**

f) Identify critical issues or problems and analyse them in ways relevant to their professional field
g) Formulate a range of solutions drawing on evidence
h) Implement and evaluate strategies to address problems

**Global perspective:**

i) Students will gain the ability to source experimental equipment from the global market

**Social responsibility:**

j) Candidates will be briefed on the social and ethical implications of the actions of researchers. Some studies may require actual Ethical approval, all studies must consider the wider ethical implications of their conclusions.

**Alterations to the unit as a result of student feedback**

This unit has been created by canvassing post graduate students and supervisors at NCMEH. It will continue to be modified to address the needs of students and supervisors

**Prior knowledge &/or skills**

Students must have completed a minimum of a 3 year science based degree, ideally a 4 year engineering degree would have been completed

**Learning resources required**

**Requisite texts**

See [https://www.omega.com/literature/international.html](https://www.omega.com/literature/international.html) for ordering instructions:

Omega Engineering, 2010a, *Omega Complete Data Acquisition and Computer Interface Handbook and Encyclopedia*


The following can be ordered or downloaded online at [http://www.dspguide.com/](http://www.dspguide.com/)

**Recommended reading**


**E- (electronic) resources**

**Library**

The subject guides for Maritime Engineering and Naval Architecture ([http://utas.libguides.com/marine_engineering](http://utas.libguides.com/marine_engineering)) and Mechanical Engineering ([http://utas.libguides.com/mechanical_engineering](http://utas.libguides.com/mechanical_engineering)) are a great starting place to source further information on the topics covered within this unit.

**MyLO**

MyLO: Subject is presented on MyLO for:

Lecture and tutorial notes

Submission of assignments

Distribution of data, between lecturer and students and from students to students

Additional information

**Equipment & materials**

Experimental equipment to be supplied by the student’s project.

**Computer hardware & software**

Unit-specific software

MATLAB

Excel

**For Blackboard Vista MyLO**

To access MyLO from your own computer you will need the appropriate software, and hardware to run that software. See Learning Online at [http://uconnect.utas.edu.au/](http://uconnect.utas.edu.au/) for computer software you will need.

**Note:** Older computers may not have the hardware to run some of the required software applications. Contact your local IT support person or the Service Desk on 1818 if you experience difficulties.

# Details of teaching arrangements*

## Lectures/Intensive sessions

<table>
<thead>
<tr>
<th>Day/Date</th>
<th>Time</th>
<th>Topic</th>
<th>Readings / Resources</th>
<th>Link to Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 (Tue 15/11)</td>
<td>9.30 – 11.30</td>
<td>Pressure/load/strain transducers</td>
<td>Omega Engineering (1998b)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>12.00-1.00</td>
<td>Accelerometers</td>
<td>Omega Engineering (1998b)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2.00-4.30</td>
<td>Flow measurements</td>
<td>Omega Engineering (1998c)</td>
<td>3</td>
</tr>
<tr>
<td>Day 2 (Wed 16/11)</td>
<td>9.30 – 11.30</td>
<td>Data-acquisition – Digital/Analog I/O</td>
<td>Omega Engineering (1998a)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12.00-1.00</td>
<td>Analog signal transmission</td>
<td>Omega Engineering (1998a)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.00-4.30</td>
<td>Aliasing</td>
<td>Omega Engineering (1998a)</td>
<td>2</td>
</tr>
<tr>
<td>Day 3 (Thu 17/11)</td>
<td>9.30 – 11.30</td>
<td>Data acquisition hardware</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.00-1.00</td>
<td>Presenting data</td>
<td>1, 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00-4.30</td>
<td>Deterministic or Probabilistic?</td>
<td>1, 5</td>
<td></td>
</tr>
<tr>
<td>Day 4 (Fri 18/11)</td>
<td>9.30 – 11.30</td>
<td>Statistical methods of great use – ANOVA, Monte Carlo, bootstrap</td>
<td>1, 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.00-1.00</td>
<td>Periodic signals and spectrum</td>
<td>Omega Engineering (1998a)</td>
<td>1, 2</td>
</tr>
<tr>
<td></td>
<td>2.00-4.30</td>
<td>Designing an analog filter</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Day 5 (Mon 21/11)</td>
<td>9.30 – 11.30</td>
<td>Designing a digital filter and matching to an analog filter</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.00-1.00</td>
<td>Bringing it all together - I</td>
<td>Omega Engineering (2010a, b, c)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2.00-4.30</td>
<td>Bringing it all together – II</td>
<td>Omega Engineering (2010a, b, c)</td>
<td>6</td>
</tr>
</tbody>
</table>

*Students MUST do more personal research if they require Ethics approval.*
Videoconference activities
The above intensive learning program will be conducted via web conference when required.

For information about videoconferencing at UTAS and how to participate effectively, see the Students’ guide to Videoconferencing available at: http://www.utas.edu.au/itr/videoconf/StudentGuide2004.pdf or follow the Service desk link from the Current Students homepage > Videoconferencing.

Practical/laboratory sessions
Each student must conduct their own experiment and report on it for Assignment Two.

Occupational health and safety (OH&S)
The University is committed to providing a safe and secure teaching and learning environment. In addition to specific requirements of AMC and this unit you should refer to the University’s policy at: http://www.admin.utas.edu.au/hr/ohs/pol_proc/ohs.pdf

Unit schedule (for the Summer Session)

<table>
<thead>
<tr>
<th>Week Beginning Date</th>
<th>Activity</th>
<th>Assessment Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th-18th Nov</td>
<td>4 day face to face teaching block</td>
<td></td>
</tr>
<tr>
<td>21st Nov</td>
<td>1 day, lecture, lab and class test</td>
<td>10 question quiz</td>
</tr>
<tr>
<td></td>
<td>Christmas and New Year break</td>
<td></td>
</tr>
<tr>
<td>13th Feb 2012c</td>
<td></td>
<td>Assignment One</td>
</tr>
<tr>
<td>27th Feb 2012</td>
<td>Semester 1 starts</td>
<td></td>
</tr>
<tr>
<td>26th Mar 2012</td>
<td>Semester 1 starts</td>
<td>Assignment Two</td>
</tr>
<tr>
<td>1st Jun 2012</td>
<td>Semester 1 ends</td>
<td></td>
</tr>
</tbody>
</table>

Learning expectations and strategies

Expectations
The University is committed to high standards of professional conduct in all activities, and holds its commitment and responsibilities to its students as being of paramount importance. Likewise, it holds expectations about the responsibilities students have as they pursue their studies within the special environment the University offers.

The University’s Code of Conduct for Teaching and Learning states:

Students are expected to participate actively and positively in the teaching/learning environment. They must attend classes when and as required, strive to maintain steady progress within the subject or unit framework, comply with workload expectations, and submit required work on time.

Learning strategies
As is typical of engineering education, a problem based method of explanation will be used throughout this unit by utilising the experimental data and equipment from the Australian Maritime Hydrodynamics Research Centre.
Specific attendance/performance requirements*

All students must attend all of the intensive learning sessions. Failure to attend these sessions will require repeat attendance at a later course.

Assessment*

Assessment schedule*

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Date due</th>
<th>Percent weighting</th>
<th>Links to Intended Learning Outcomes</th>
<th>Links to Generic Graduate Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Question Quiz</td>
<td>21st Nov</td>
<td>10%</td>
<td>1, 2, 3, 5</td>
<td>a, b, f, g</td>
</tr>
<tr>
<td>Assignment 1:</td>
<td>13th Feb</td>
<td>40%</td>
<td>1, 3, 4, 5</td>
<td>a, b, c, d, f</td>
</tr>
<tr>
<td>Assignment 2:</td>
<td>26th Mar</td>
<td>50%</td>
<td>1, 2, 3, 4, 5, 6</td>
<td>a, b, c, d, e, f, g, h, i, j</td>
</tr>
</tbody>
</table>

Assessment details*

10 Question Quiz

Task description

A short answer 10 question quiz will be issued on the third day of the intensive session.

Task length

10 short answers

Links to unit’s learning outcomes

1, 2, 3, 5

Assessment criteria / guidelines

Succinct correct answers specifically addressing the question will attain the most marks

Date due

To be conducted under class test conditions
Assessment task 1 – Lecturer Driven

Task description

Analyse a provided data set and:

1. Determine if any of the experiments should be repeated, explaining why

2. Determine which instrument could be replaced resulting in a decrease in error for the results

3. Specify a replacement model for the instrument determined in step 2

Task length

Sufficient to describe the experiment, the fundamentals of the analysis method, the results and the meaning of the results. Typically this will be a report of approximately 5-10 pages.

Links to unit’s learning outcomes

1, 3, 4, 5

Assessment criteria / guidelines

The extent to which the three elements listed above are defined

Date due

13th February
Assessment task 2 – Student Driven

Task description
Conduct an experiment and analyse the results using one method or derivative of a method explained during the intensive learning session. For the experiment conducted:

1. Determine if any of the experiments should be repeated, explaining why
2. Determine which instrument could be replaced resulting in a decrease in error for the results
3. Design an analog/digital filter system appropriate for use in your experiment
4. Specify a replacement model for the instrument determined in step 2
5. Determine and report on any ethical implications of the experiment conducted. If there is no requirement for formal ethical approval explain why.

Task length
Sufficient to describe the experiment, the fundamentals of the analysis method, the results and the meaning of the results. Typically this will be a report of approximately 5-10 pages.

Links to unit’s learning outcomes
1, 2, 3, 4, 5, 6

Assessment criteria / guidelines
The extent to which the five elements listed above are defined

Date due
26th March

How your final result is determined*
The grade that you receive for this unit will be determined by a committee of examiners. The raw marks that you receive from each piece of assessable material will be combined in order to determine a letter grade for the unit (see Assessment Schedule for percent weighting). The raw marks may undergo a scaling process.

Submission of assignments*
All assignments and reports must be accompanied by a completed cover sheet. Group reports must be signed by all participants.

Assignments and reports with cover sheet must be submitted via MyLO and/or email.

Electronic submissions by any other means are not acceptable. The assessed work will be returned in person or via internal mail.
Requests for extensions

Requests for extensions must be made in writing to the lecturer in charge and must be accompanied by appropriate paperwork proving the necessity for the extension.

Penalties*

Non-attendance or Non-participation of the laboratory sessions will result in a fail grade for the unit.

All late submissions will have marks deducted at a rate of 5% per day. An assessment with 100% of the marks deducted due to late submission will not be marked.

Review of results and appeals

If you have questions or problems with your assessment, you should discuss this with the following people/resources:

(1) The person who marked the assessment.
(2) Unit Coordinator.
(3) Head, Maritime Engineering.
(4) Director, National Centre for Maritime Engineering and Hydrodynamics.
(5) See http://acserv.admin.utas.edu.au/Complaints_FAQs.html for a complete guide

Academic referencing*

In your written work you will need to support your ideas by referring to scholarly literature, works of art and/or inventions. It is important that you understand how to correctly refer to the work of others and maintain academic integrity.

Failure to appropriately acknowledge the ideas of others constitutes academic dishonesty (plagiarism), a matter considered by the University of Tasmania as a serious offence.

The appropriate referencing style for this unit is the Havard System

For information on presentation of assignments, including referencing styles:
http://utas.libguides.com/content.php?pid=27520&sid=329009

Please read the following statement on plagiarism. Should you require clarification please see your unit coordinator or lecturer.

Academic misconduct*

Academic misconduct includes cheating, plagiarism, allowing another student to copy work for an assignment or an examination and any other conduct by which a student:

(a) seeks to gain, for themselves or for any other person, any academic advantage or advancement to which they or that other person are not entitled; or
Students engaging in any form of academic misconduct may be dealt with under the Ordinance of Student Discipline, and this can include imposition of penalties that range from a deduction/cancellation of marks to exclusion from a unit or the University. Details of penalties that can be imposed are available in the Ordinance of Student Discipline – Part 3 Academic Misconduct, see http://www.utas.edu.au/universitycouncil/legislation/

Plagiarism is a form of cheating. It is taking and using someone else’s thoughts, writings or inventions and representing them as your own; for example, using an author’s words without putting them in quotation marks and citing the source, using an author’s ideas without proper acknowledgment and citation, copying another student's work. If you have any doubts about how to refer to the work of others in your assignments, please consult your lecturer or tutor for relevant referencing guidelines, and the academic integrity resources on the web at: http://www.academicintegrity.utas.edu.au/

The intentional copying of someone else’s work as one’s own is a serious offence punishable by penalties that may range from a fine or deduction/cancellation of marks and, in the most serious of cases, to exclusion from a unit, a course or the University.

The University and any persons authorised by the University may submit your assessable works to a plagiarism checking service, to obtain a report on possible instances of plagiarism. Assessable works may also be included in a reference database. It is a condition of this arrangement that the original author’s permission is required before a work within the database can be viewed.

For further information on this statement and general referencing guidelines, see http://www.utas.edu.au/plagiarism/ or follow the link under ‘Policy, Procedures and Feedback’ on the Current Students homepage.

Further information and assistance

If you are experiencing difficulties with your studies or assignments, have personal or life planning issues, disability or illness which may affect your course of study, you are advised to raise these with your lecturer in the first instance.

There is a range of University-wide support services available to you including Teaching & Learning, Student Services, and International Services. Please refer to the Current Students homepage at: http://www.utas.edu.au/students/

Should you require assistance in accessing the Library visit their website for more information at http://www.library.utas.edu.au/
Unit Justification

This unit has been designed to be an elective within the newly proposed Graduate Certificate in Research (GradCertRes) (Board of Graduate Research, 2010a). The stated aim of the new GradCertRes is to equip Higher Degree by Research (HDR) students with generic and transferable skills, thus improving their employment prospects outside of academia whilst encouraging enhanced social and ethical responsibility (Board of Graduate Research, 2010b). In addition to this esoteric goal, it is a stated aim of the GradCertRes to help in bringing HDR completion times down. Therefore, any elective must address both goals.

The first approximation on future HDR students at the National Centre for Maritime Engineering and Hydrodynamics (NCMEH) and their generic skill set would be to assume that they will be the same as the graduates from the Bachelor of Engineering programs delivered at the NCMEH. Once established, gaps in the skill set which commonly need to be filled during HDR projects can be identified and addressed by the proposed unit. Formulated in this way, the new unit will achieve both goals of the GradCertRes.

The simplest way of establishing a gap is to examine the course flow charts (NCMEH T&L Committee, 2010b). The initial subject in the area proposed by this unit is the subject JEE114-Electrical Fundamentals delivered in the first year. This subject is very basic and as such has little useful applied content, rather it sets the foundation for further education in the field. To gain a quick appreciation for where this subject leads to the course flow chart for Marine and Offshore Systems can be followed to the most advanced subject JEE344 – Applied Control Engineering (NCMEH T&L Committee, 2010a). From the unit outline of this subject it can be readily seen where the electrical education of maritime engineering heads, that is toward highly applied instrumentation and process control. Although this area is significant to a practicing engineer who is required to control complex systems, it does not encompass the specific skills required to carry out and analyse a sophisticated hydrodynamic experiment to the level of rigour demanded by HDR projects.

In addition, the author has carried out a brief investigation of HDR skill sets at the NCMEH by asking simple questions concerning aliasing and fast Fourier transforms (Beckwith, Marangoni, & Lienhard, 2006) and by canvassing interest in a similar subject run in Hobart (QMS517). The two students asked simple questions were not able to answer them and three out of four students canvassed expressed a desire to find out more on the subject QMS517. Upon further investigation, however, the students’ supervisors were opposed to them attending QMS517 as its basis is too probabilistic. As an engineering school NCMEH requires far more deterministic concepts to be taught, such as those proposed within this unit.