TRC3500
Sensors and Artificial Perception

The unit provides an introduction to transducer principles and the background to classify them in terms of performance and characteristics. A range of commonly available sensors are considered. Electronic components and data acquisition/digital signal processing software used in sensor systems are examined. Advanced sensory systems and associated programming techniques are introduced using robotic systems as an example domain.

Mode of Delivery	**On campus**
Workload requirements	3 hours lectures, 2 hours laboratory/practice classes and 7 hours of private study per week.
Unit Relationships	**Prerequisites:** TRC2500, ECE2061 **Co-requisites:** TRC3300 or ECE3073 **Prohibitions:** ECE4306, GSE3801
Chief Examiner	**Prof Jamie Evans**
Unit Coordinator	**Dr Jonathan Li**
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http://www.monash.edu.au/pubs/2014handbooks/units/TRC3500.html

Your Feedback to Us

Monash is committed to excellence in education and regularly seeks feedback from students, employers and staff. One of the key formal ways students have to provide feedback is through the Student Evaluation of Teaching and Units (SETU) survey. The University's student evaluation policy requires that every unit is evaluated each year. Students are strongly encouraged to complete the surveys. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied and areas for improvement.

For more information on Monash's educational strategy, see: www.monash.edu.au/about/monash-directions/directions.html and on student evaluations, see: www.policy.monash.edu/policy-bank/academic/education/quality/student-evaluation-policy.html

Previous Student Evaluations of this Unit

In response to the last SETU of this unit, the following changes have been made:

- The order of laboratory sessions has been revised

Student feedback has highlighted the following strength(s) in this unit:

- Lectures and laboratory classes were a useful resource for learning

If you wish to view how previous students rated this unit, please go to https://emuapps.monash.edu.au/unitevaluations/index.jsp

ACADEMIC OVERVIEW

Engineers Australia stage 1 competencies

The Engineers Australia Policy on Accreditation of Professional Engineering Programs – requires that all programs ensure that their engineering graduates develop to a substantial degree the stage 1 competencies. Listed below are the activities in this unit that will help you to achieve these competencies.

Note: that not all stage 1 competencies are relevant to each unit.

Stage 1 competencies	**Activities used in this unit to develop stage 1 competencies**
PE1.1 Knowledge of science and engineering fundamentals	Basic physical principles underpin the operation of all transducers. We will develop an understanding of the operation and limitations of a number of sensors based on a study of the appropriate fundamental physical principles.
PE1.2 In-depth technical competence in at least one engineering discipline	Understand the principles of operation of sensors in general and specific examples of commonly available devices. Recognise the importance of appropriate signal conditioning for sensor signals.
PE1.3 Techniques and resources	
PE1.4 General knowledge	Appreciation of the pervasiveness of sensors in the modern society.
PE2.1 Ability to undertake problem identification, formulation, and solution	All laboratory projects involve aspects of sensor signal conditioning and require the student to consider the signal available from the sensor, the signal required by the data processing system and to design appropriate signal amplification and filtering circuits.
PE2.2 Understanding of social, cultural, global, and environmental responsibilities and the need to employ principles of sustainable development	
PE2.3 Ability to utilise a systems approach to complex problems and to design and operational performance	To provide effective mechatronics solutions, a systems approach is required and this is emphasized in this unit.
PE2.4 Proficiency in engineering design	

PE2.5 Ability to conduct an engineering project	
PE2.6 Understanding of the business environment	Appreciation of trade-offs between cost and sensor performance in commercial applications.
PE3.1 Ability to communicate effectively, with the engineering team and with the community at large	Written reports and team work
PE3.2 Ability to manage information and documentation	
PE3.3 Capacity for creativity and innovation	Laboratory projects require creative solutions to practical problems.
PE3.4 Understanding of professional and ethical responsibilities, and commitment to them	Potential applications of RFID devices raise a number of ethical questions which are explored in the lectures.
PE3.5 Ability to function effectively as an individual and in multidisciplinary and multicultural teams, as a team leader or manager as well as an effective team member	Laboratory projects will be undertaken as part of a team.
PE3.6 Capacity for lifelong learning and professional development PE3.7 Professional attitudes	It is expected that students will perform some background study as part of the laboratory projects. Developing this form of self reliance will help facilitate lifelong learning.

Learning Outcomes

The student is expected to acquire an understanding of transducer principles and to be able to evaluate sensors in terms of their performance and characteristics. They should be able to develop a complete sensory system including specifying the electronic components required and programming data acquisition and signal processing functions. Students should gather an appreciation of advanced sensory techniques used in robotics and be familiar with their implementation and programming requirements.

UNIT SCHEDULE

Week	Lecture	Laboratory	Assessment
1 **3 Mar**	**Section 1: Introduction** Sensors and mechatronic systems **Section 2: Sensor technology** Sensors and information Transducer effects Sensor taxonomy Sensor initialization	None	None
2 **10 Mar**	Sensor performance Smart sensors Silicon sensors **Section 3: Sensor examples** Potentiometer	Laboratory Exercise 1: Inductive Sensor	
3 **17 Mar**	Optical encoder Strain gauges Hall effect Photoelectric Capacitive Inductive Ultrasonic		Laboratory Report 1: due 21 Mar, 2013
4 **24 Mar**	**Section 4: Robotic sensors** Ultrasonic Tactile Odour	Laboratory Exercise 2: Strain Gauge Load Cell	
5 **31 Mar**	**Section 5: Noise and loading** Johnson noise Shot noise Flicker noise External noise Loading effects		Laboratory Report 2: due 11 Apr, 2013
6 **7 Apr**	**Section 6: Operational amplifier and filter revision** Different amplifier configurations Low-pass filter	Laboratory Exercise 3: Heart-rate Monitor	
7 **14 Apr**	**Section 7: Binary image processing** Scene lighting Thresholding and connectivity analysis Moments of area Image classification		Mid Semester Test: 17 Apr, 2013 Laboratory Report 3: due 18 Apr, 2013
Mid Semester Break 21 Apr – 25 Apr			
8 **28 Apr**	**Section 8: Bar codes** The UPC bar code Modulo check character	Laboratory Exercise 4: Calculating Blob Statistics	
9 **5 May**	**Section 9: Dedicated short-range communications systems** Security tags RFID tags Coding and accommodating collisions Privacy concerns		Laboratory Report 4: due 9 May, 2013
10 **12 May**	**Section 10: Analogue <> Digital conversion** Digital to analogue converters DAC examples ADC support circuits Bipolar coding Analogue to digital conversion ADC examples	Laboratory Exercise 5: Decoding an EAN-13 Barcode	
11 **19 May**	**Section 11: Digital Signal Processing** Nyquist sampling rate		Laboratory Report 5: due 23 May, 2013
12 **26 May**	Moving average FIR filter Median filter **REVISION**	None	

Teaching and Learning Method

This unit consists of lectures, problem solving classes and laboratory classes. Learning in this unit is primarily through the process of applying material introduced in lectures to problems and lab experiments.

Tutorial/Laboratory Class allocation

There are **2-hours of laboratory classes from weeks 2-12**.

Students must enrol in a Laboratory time using Allocate Plus. Students not allocated to a particular laboratory class will not be accepted into that session without the written consent of the unit coordinator.

There are no tutorials in this unit.

Communication, participation and feedback

Monash aims to provide a learning environment in which students receive a range of ongoing feedback throughout their studies. In this unit it will take the form of group feedback via practice classes, individual feedback, peer feedback, self-comparison, verbal and written feedback, discussions in class, as well as more formal feedback related to assignment marks and grades. Students/You are encouraged to draw on a variety of feedback to enhance their/your learning

You can also find information on inclusive teaching practices for students with learning disabilities or mental health conditions at: www.monash.edu.au/lls/inclusivity/

Assessment Summary

Assessment Task	Value	Due Date
1. Laboratory – Inductive sensor	4%	21 Mar 2013
2. Laboratory – Strain gauge sensor	4%	4 Apr 2013
3. Laboratory – Heart rate monitor	4%	18 Apr 2013
4. Laboratory – Calculating blob statistics	4%	9 May 2013
5. Laboratory – Decoding EAN13 barcode	4%	23 May 2013
6. Mid-semester test	10%	17 Apr 2013
7. Examination	70%	

Total continuous assessment: **30 %**
Examination (3 hours) **70 %**
Total assessment **100%**

Students are required to achieve at least 45% in the total continuous assessment component (assignments, tests, mid-semester exams, laboratory reports) and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.

The unit coordinator reserves the right to moderate the assessments. This process will occur at the end of the semester.

ASSESSMENT REQUIREMENTS

Assessment Tasks

Assessment Task 1: Inductive Sensor
Details of task: See detailed laboratory notes
Value: 4%
Criteria for Marking:
Each of the laboratory projects will be assessed on three criteria as detailed in the detailed laboratory notes. These criteria are attendance, demonstration of completed project in functional condition and the laboratory report.

The essential components of the report are as follows:
1) The report should contain a title, and brief description of the aims of the project. In particular, the expected deliverables should be highlighted.
2) For the first three projects the sensor should be evaluated to identify its characteristics. The results of this process must be documented in your report.
3) Your circuit design for processing the sensor signal should then be documented.
4) Results demonstrating the capabilities of your sensor system should be documented and analysed.
5) The report should conclude with a suitable conclusion.
In addition to the above components your report should be well laid out and written in clear English without spelling and grammatical errors. To gain full marks you must go beyond the basic minimum and provide something extra. This may include extending the capabilities of your circuit or program, performing additional testing and data evaluation, etc.

High Distinction
All requirements of the design specification have been met and reliably demonstrated to the lab demonstrator. The written report should be clear, concise and well formulated. The design should go "above and beyond" the basic functionality required in the assignment.

Distinction
All requirements of the design specification have been met and reliably demonstrated to the lab demonstrator. The written report should be clear and concise and well formulated.

Credit
Some requirements of the design specification have been met, and demonstrated to the lab demonstrator. The written report should be clear and concise and well formulated.

Pass
Few requirements of the design specification have been met. The written report should give a detailed analysis of why the design does not work correctly.

Assessment Task 2: Strain Gauge Load Cell
Details of task: See detailed laboratory notes
Value: 4%
Criteria for Marking: As for Task 1

Assessment Task 3: Heart Rate Monitor
Details of task: See detailed laboratory notes
Value: 4%
Criteria for Marking: As for Task 1

Assessment Task 4: Calculating Blob Statistics
Details of task: See detailed laboratory notes
Value: 4%
Criteria for Marking: As for Task 1

Assessment Task 2: Decoding and EAN-13 Bar Code
Details of task: See detailed laboratory notes
Value: 4%
Criteria for Marking: As for Task 1

Assessment Task 6: Mid-semester test
Due Date: 24 Apr, 2013
Details of task: A one hour test will be held during class time in week 7, covering all material presented in previous lectures.
Value: 10%
Criteria for Marking: Students will be awarded marks for correct answers.

Examination(s)

This unit includes a formal 3 hour examination.

Learning resources

Monash Library Unit Reading List (if applicable to the unit)
http://readinglists.lib.monash.edu/index.html

Available on the library website:

(Section 2, 3 & 4) R. Andrew Russell, Robot Tactile Sensing, Prentice Hall, 1990, pp. 13-47, 58 - 78.

(Section 4) L Kleeman and R Kuc, “An optimal sonar array for target localisation and classification”, IEEE International Conference on Robotics and Automation, 1994, pp. 3130-3135.

(Section 4) R.A. Russell, Odour Detection by Mobile Robots, World Scientific, 1999. pp.33-47.

(Section 5) Paul Horowitz and Winfield Hill, The Art of Electronics - 2nd Edition, Cambridge University Press, 1998. pp.428-435.

(Section 7) Patrick Winston and Berthold Horn, Lisp - Second Edition, Addison-Wesley, 1984. pp. 151-167

(Section 8) Savir, D. and Laurer, G.J., „The characteristics and decodability of the Universal Product Code symbol“, IBM Systems Journal, Vol. 14, No. 1, 1975, pp16-34.

(Section 10) Jager, R.C., Tutorial - Analog Data Acquisition Technology, IEEE Micro, May, August, November 1982 and February 1983.

(Section 11) Marven, C. and Ewers, G., A Simple Approach to Digital Signal Processing, John Wiley & Sons, Inc., 1996, pp.35-41 and 89-99.

Feedback to you

This unit has been structured to make the learning outcomes clearer; to make the unit more stimulating; to improve resources and to improve the level of tutoring and feedback. Feedback is always welcome at any time throughout the semester. Please use email to send it to the unit co-ordinator, or in person.

You may wish to use the open ended questions in the unit evaluation to provide written feedback on your experience of this and whether it has been helpful to you during this semester.

Extensions and penalties

The due dates for the submission of assignments are given in the previous section. Please make every effort to submit work by the due dates. Students are advised to NOT assume that granting of an extension is a matter of course.

If you need an extension for any of the assignments, you must submit a written request 48-hours *before* the due time and date, and attach supportive evidence such as medical certificate.

Required Resources

Students generally must be able to complete the requirements of their course without the imposition of fees that are additional to the student contribution amount or tuition fees. However, students may be charged certain incidental fees or be expected to make certain purchases to support their study. For more information about this, go to Administrative Information for Higher Education Providers: Student Support, Chapter 21, Incidental Fees at:
http://www.innovation.gov.au/HigherEducation/TertiaryEducation/ResourcesAndPublications/Pages/default.aspx

Technological Requirements

Students must regularly check Moodle for announcements.

Recommended Resources

Recommended texts

Bolton, W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 4th Edition, Pearson, 2008.

Additional subject costs

Required Hardware

Safety goggles: As part Occupational Health and Safety requirements, students will be required to supply their own safety goggles before they can commence lab work.

Examination material or equipment

A faculty approved calculator is permitted (meaning only scientific calculators that are not programmable and detailed in the list below will be permitted in the examination. These calculators must be checked by the faculty and have either a Faculty of Engineering or a Faculty of Science approved sticker)

A list of the Faculty of Engineering approved calculators and the process for obtaining a sticker is available online at:

www.eng.monash.edu.au/current-students/calculators.html

IMPORTANT: Only these listed calculators with the **authorised "Monash University-Science" or "Monash University-Engineering" STICKER** will be allowed into the examination by the invigilators.

OTHER INFORMATION

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University's academic standards, and to provide advice on how they might uphold them. You can find Monash's Education Policies at: www.policy.monash.edu.au/policy-bank/academic/education/index.html

Key educational policies include:

- Student Academic Integrity Policy and Student Academic Integrity: Managing Plagiarism and Collusion Procedures ;
- Assessment in Coursework Programs;
- Special Consideration;
- Grading Scale;
- Discipline: Student Policy;
- Academic Calendar and Semesters;
- Orientation and Transition; and
- Academic and Administrative Complaints and Grievances Policy.

Graduate Attributes Policy

http://www.policy.monash.edu/policy-bank/academic/education/management/monash-graduate-attributes-policy.html

Student Services

The University provides many different kinds of services to help you gain the most from your studies.Contact your tutor if you need advice and see the range of services available at www.monash.edu.au/students

Monash University Library

The Monash University Library provides a range of services, resources and programs that enable you to save time and be more effective in your learning and research. Go to www.lib.monash.edu.au or the library tab in my.monash portal for more information.

Disability Liaison Unit

Students who have a disability or medical condition are welcome to contact the Disability Liaison Unit to discuss academic support services. Disability Liaison Officers (DLOs) visit all Victorian campuses on a regular basis.

- Website: www.monash.edu/equity-diversity/disability/index.html
- Telephone: 03 9905 5704 to book an appointment with a DLO
- Email: dlu@monash.edu
- Drop In: Equity and Diversity Centre, Level 1, Building 55, Clayton Campus.