



The University of Southern Queensland

Course specification

The current and official versions of the course specifications are available on the web at <http://www.usq.edu.au/coursespecification/current>.
Please consult the web for updates that may occur during the year.

Description: Measurement Science and Instrument Engineering

Subject	Cat-nbr	Class	Term	Mode	Units	Campus
ELE	4109	87219	1, 2009	EXT	1.00	Toowoomba

Academic group:	FOENS
Academic org:	FOES04
Student contribution band:	2
ASCED code:	031399

STAFFING

Examiner: Nigel Hancock
Moderator: Andrew Maxwell

REQUISITES

Pre-requisite: ELE3506

SYNOPSIS

An instrument is an Information processing machine involving: sensing (usually analogue); signal processing (analogue and digital); reference to a scale of measurement or a standard; and, display or actuation. Although modern instruments are mostly implemented using electronic technology, their functionality is determined largely by embedded software. The physics of the sensing interface remains fundamental. Design of an optimal instrument (or instrumentation system) to meet a new measurement requirement involves the formal design methodology of measurement science: it is not adequate to rely on experience alone and an "off-the-shelf" solution will usually not be available. Hence this course does NOT present a traditional catalogue of standard techniques. In consequence this is a design-oriented course which seeks to develop cross-disciplinary skills in fundamental areas including the use of the Measurement Process Algorithm; the physics, classification and selection of sensors and transducers; theory of scales and standards; signals, systems and modelling techniques; evaluation of available technologies; manufacturing; economic and management implications. Advanced topics will be drawn from: fibre optic and silicon sensors; distributed sensing; rule based and fuzzy sensing; multisensor systems and sensor fusion; intelligence and mechatronics in instruments; and tactile sensing. This course is appropriate for students with a range of backgrounds in the senior or honours years of an engineering or science degree with an appropriate electronics background.

OBJECTIVES

On completion of this course, student should be able to:

1. analyse general measurement problems in terms of referents and measurands by means of the Measurement Process Algorithm;
2. analyse and model instrumentation systems in terms of information flow;

3. define and explain common instrument performance parameters including static and dynamic response;
4. analyse and model transducer performance;
5. evaluate alternative technologies that might be applied in the realisation of an instrument;
6. select and implement major signal recovery methods and strategies for signal-to-noise improvement;
7. draw up specifications and plans for the development and management of an instrumentation system;
8. choose appropriate transducers and instrumentation system components in the broad areas of temperature measurement and flow measurement;
9. evaluate current developments and potential future directions in sensing techniques and measurement system design.

TOPICS

Description	Weighting (%)
1. Instruments as Information Machines	5.00
1.1. The scope of measurement science and instrumentation engineering.	
1.2. Measurement system architecture.	
1.3. The differing roles of measurement - knowledge/calibration/control.	
2. Identification of the Measurement Requirement	5.00
2.1. The Measurement Process Algorithm - attributes, referents and measurands.	
3. Overview of Sensors and Transducers	10.00
3.1. Energy conversion, impedances	
3.2. The information machine versus the energy machine.	
3.3. Multi- sensitivity, influence variables.	
3.4. "Latent Information".	
3.5. Sensor individuality.	
3.6. Sensor classification - self-generating and modulating.	
3.7. Energy domains.	
3.8. 2D, 3D and 4D sensor space.	

4.	Transducer Modelling	10.00
	4.1. Reasons for modelling and types of model.	
	4.2. Energy flow modelling and terminal relations.	
	4.3. Overview of mathematical techniques, FDM, FEM, applications and examples.	
	4.4. Models as functional parts of instruments.	
5.	Design of Measurement Systems	5.00
	5.1. Philosophy, approaches, engineering design versus industrial design.	
	5.2. Specifications, the CAD and CAE of instruments.	
6.	Enabling Technologies	10.00
	6.1. Electrical.	
	6.2. Mechanical/kinematic.	
	6.3. Fluid/thermal.	
	6.4. Radiative/acoustic/ optical.	
7.	Signal Recovery Techniques	10.00
	7.1. Noise in measurement systems, white, 1/f, drift, offset.	
	7.2. Theory of averaging, the Boxcar, the Multipoint Averager.	
	7.3. Autocorrelation and crosscorrelation in instruments.	
	7.4. Modulation-based techniques, synchronous detection and "lock-in" techniques.	
8.	Transducer Practice	10.00
	8.1. Temperature and flow measurement.	
9.	Management of Instrument Systems	5.00

10. Current and Future Directions 30.00
- 10.1. Distributed measurement systems, field bus options.
- 10.2. Smart sensors, concepts, examples.
- 10.3. Fibre optic sensing, fibre optic fundamentals, sensing capabilities, options, examples.
- 10.4. Sensing for robotics, requirements, tactile sensing and imaging.
- 10.5. Distributed sensing; sensor fusion, concepts and requirements, introduction to fuzzy processing, robotic applications.

TEXT and MATERIALS required to be PURCHASED or ACCESSED

ALL textbooks and materials are available for purchase from USQ BOOKSHOP (unless otherwise stated). Orders may be placed via secure internet, free fax 1800642453, phone 07 46312742 (within Australia), or mail. Overseas students should fax +61 7 46311743, or phone +61 7 46312742. For costs, further details, and internet ordering, use the 'Textbook Search' facility at <http://bookshop.usq.edu.au> click 'Semester', then enter your 'Course Code' (no spaces).

Bentley, JP 2004, *Principles of Measurement Systems*, 4th edn, Longman,

REFERENCE MATERIALS

Reference materials are materials that, if accessed by students, may improve their knowledge and understanding of the material in the course and enrich their learning experience.

Doebelin, EO 1990, *Measurement Systems, Application and Design*, 4th edn, McGraw Hill,

Jones, BE (Ed) *Instrument Science and Technology*, Adam Hilger, UK, Vol 1-3.

Jones, BE (Ed) 1987, *Current Advances in Sensors*, Adam Hilger, UK.

Lang, TT 1987, *Electronics of Measuring Systems. Practical Implementation of Analogue and Digital Techniques*, John Wiley,

Lang, TT 1991, *Computerised Instrumentation*, John Wiley,

Stein, PK 1991, *The Unified Approach to the Engineering of Measurement Systems*, Stein Engineering Services Inc, Phoenix, AZ, USA.

Sydenham, PH, Hancock, NH & Thorn, R 1989, *Introduction to Measurement Science and Engineering*, John Wiley,

Sydenham, PH (Ed) 1982, *Handbook of Measurement Science: Theoretical Fundamentals*, John Wiley, Vol 1.

Sydenham, PH (Ed) 1983, *Handbook of Measurement Science: Practical Fundamentals*, John Wiley, Vol 2.

Sydenham, PH & Thorn, R 2005, *Handbook of measurement system design*, John Wiley,

Sydenham, PH & Thorn, R (Eds) 1992, *Handbook of Measurement Science: Elements of Change*, John Wiley, Vol 3.

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Directed Study	60.00
Examinations	2.00
Private Study	42.00
Project Work	40.00
Report Writing	10.00

ASSESSMENT DETAILS

Description	Marks out of	Wtg (%)	Due date
ASSIGN 1 - PRELIMINARY DESIGN	100.00	10.00	17 Apr 2009
ASSIGN 2 - FINAL DESIGN	300.00	30.00	05 Jun 2009
2 HOUR CLOSED EXAMINATION	600.00	60.00	END S1 (see note 1)

NOTES

1. Student Administration will advise students of the dates of their examinations during the semester.

IMPORTANT ASSESSMENT INFORMATION

- 1 Attendance requirements:
There are no attendance requirements for this course. However, it is the students' responsibility to study all material provided to them or required to be accessed by them to maximise their chance of meeting the objectives of the course and to be informed of course-related activities and administration.
- 2 Requirements for students to complete each assessment item satisfactorily:
(i) To complete the examination satisfactorily, students must obtain at least 50% of the marks available (or at least a grade of C-) for the examination. (ii) To complete the two assignments satisfactorily, students must obtain at least 50% of the marks available in aggregate.
- 3 Penalties for late submission of required work:
If students submit assignments after the due date without prior approval then a penalty of 10% of the total marks gained by the student for the assignment will apply for each working day late.
- 4 Requirements for student to be awarded a passing grade in the course:
To be assured of a passing grade, students must demonstrate, via the summative assessment items, that they have achieved the required minimum standards in relation to the objectives of the course by: (i) satisfactorily completing the examination and assignments; and (ii)

- obtaining at least 50% of the total weighted marks available for all summative assessment items.
- 5 Method used to combine assessment results to attain final grade:
The final grades for students will be assigned on the basis of the weighted aggregate of the marks (or grades) obtained for each of the summative assessment items in the course.
 - 6 Examination information:
In a Closed Examination, candidates are allowed to bring only writing and drawing instruments into the examination.
 - 7 Examination period when Deferred/Supplementary examinations will be held:
Any Deferred or Supplementary examinations for this course will be held during the examination period at the end of the semester of the next offering of this course.
 - 8 University Regulations:
Students should read USQ Regulations 5.1 Definitions, 5.6. Assessment, and 5.10 Academic Misconduct for further information and to avoid actions which might contravene University Regulations. These regulations can be found at the URL:
<http://www.usq.edu.au/SECARIAT/calendar/Part5/> or in the printed version of the current USQ Handbook.

ASSESSMENT NOTES

- 1 The due date for an assignment is the date by which a student must despatch the assignment to the USQ. The onus is on the student to provide proof of the despatch date, if requested by the Examiner.
- 2 Students must retain a copy of each item submitted for assessment. This must be produced within five days if required by the Examiner.
- 3 In accordance with University's Assignment Extension Policy (Regulation 5.6.1), the examiner of a course may grant an extension of the due date of an assignment in extenuating circumstances.
- 4 The Faculty will normally only accept assessments that have been written, typed or printed on paper-based media.
- 5 The Faculty will NOT accept submission of assignments by facsimile.
- 6 Students who do not have regular access to postal services or who are otherwise disadvantaged by these regulations may be given special consideration. They should contact the examiner of the course to negotiate such special arrangements.
- 7 In the event that a due date for an assignment falls on a local public holiday in their area, such as a Show holiday, the due date for the assignment will be the next day. Students are to note on the assignment cover the date of the public holiday for the Examiner's convenience.
- 8 Students who have undertaken all of the required assessments in a course but who have failed to meet some of the specified objectives of a course within the normally prescribed time may be awarded the temporary grade: IM (Incomplete - Make up). An IM grade will only be awarded when, in the opinion of the examiner, a student will be able to achieve the remaining objectives of the course after a period of non-directed personal study.
- 9 Students who, for medical, family/personal, or employment-related reasons, are unable to complete an assignment or to sit for an examination at the scheduled time may apply to defer an assessment in a course. Such a request must be accompanied by appropriate supporting documentation. One of the following temporary grades may be awarded IDS (Incomplete - Deferred Examination; IDM (Incomplete Deferred Make-up); IDB (Incomplete - Both Deferred Examination and Deferred Make-up).

10 The Faculty of Engineering and Surveying does not offer supplementary examinations.