Description: Measurement Science and Instrument Engineering

<table>
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<tr>
<th>Subject</th>
<th>Cat-Nbr</th>
<th>Class</th>
<th>Term</th>
<th>Mode</th>
<th>Units</th>
<th>Campus</th>
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<td>ELE</td>
<td>4109</td>
<td>10610</td>
<td>1, 2002</td>
<td>EXT</td>
<td>1.00</td>
<td>TW MBA</td>
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Academic Group: FOENS
Academic Org: FOES04
HECS Band: 2
ASCED Code: 031399

STAFFING
Examiner: Nigel Hancock
Moderator: David Parsons

PRE-REQUISITES
Pre-requisite: ELE 3506

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 and classification of sensors and transducers; theory of scales and standards; signals, systems and modelling techniques; evaluation of available technologies; manufacturing; economic and management implications. This course is appropriate for students with a range of backgrounds in the senior or honours years of an engineering or science degree. Case study and design work may be tailored accordingly. 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.
OBJECTIVES

On successful completion of this unit students will be able to:

- Analyse general measurement problems in terms of referents and measurands by means of the Measurement Process Algorithm.
- Analyse and model instrumentation systems in terms of information flow.
- Define and explain common instrument performance parameters including static and dynamic response.
- Analyse and model transducer performance.
- Evaluate alternative technologies that might be applied in the realisation of an instrument.
- Describe and implement major signal recovery methods and strategies for signal-to-noise improvement.
- Draw up specifications and plans for the development and management of an instrumentation system.
- Describe current transducer and general instrumentation system practice and make appropriate choices in the broad areas of temperature measurement and flow measurement.
- Discuss current developments and future directions in sensing techniques and measurement system design.

TOPICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting (%)</th>
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<tbody>
<tr>
<td>1. INSTRUMENTS AS INFORMATION MACHINES The scope of measurement science and instrumentation engineering; measurement system architecture; the differing roles of measurement - knowledge/calibration/control</td>
<td>5.00</td>
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<tr>
<td>2. IDENTIFICATION OF THE MEASUREMENT REQUIREMENT The Measurement Process Algorithm - attributes, referents and measurands.</td>
<td>5.00</td>
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<td>3. OVERVIEW OF SENSORS AND TRANSDUCERS Energy conversion, impedances; the information machine versus the energy machine; multi-sensitivity, influence variables; &quot;Latent Information&quot;; sensor individuality; sensor classification - self-generating and modulating; energy domains; 2D, 3D and 4D sensor space.</td>
<td>10.00</td>
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<td>4. TRANSDUCER MODELLING Reasons for modelling and types of model; energy flow modelling and terminal relations; overview of mathematical techniques, FDM, FEM, applications and examples; models as functional parts of instruments.</td>
<td>10.00</td>
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<td>5. DESIGN OF MEASUREMENT SYSTEMS Philosophy, approaches, engineering design versus industrial design; specifications, the CAD and CAE of instruments.</td>
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<td>6. ENABLING TECHNOLOGIES Electrical; mechanical/kinematic; fluid/thermal; radiative /acoustic/ optical.</td>
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7. SIGNAL RECOVERY TECHNIQUES Noise in measurement systems, white, 1/f, drift, offset; theory of averaging, the Boxcar, the Multipoint Averager; autocorrelation and crosscorrelation in instruments; modulation-based techniques, synchronous detection and "lock-in" techniques.

8. TRANSDUCER PRACTICE Temperature and flow measurement

9. MANAGEMENT OF INSTRUMENT SYSTEMS

10. CURRENT AND FUTURE DIRECTIONS distributed measurement systems, field bus options; smart sensors, concepts, examples; fibre optic sensing, fibre optic fundamentals, sensing capabilities, options, examples; sensing for robotics, requirements, tactile sensing and imaging; distributed sensing; sensor fusion, concepts and requirements, introduction to fuzzy processing, robotic applications.

TEXT and MATERIALS required to be PURCHASED or ACCESSED:
Books can be ordered by fax or telephone. For costs and further details use the 'Book Search' facility at http://bookshop.usq.edu.au by entering the author or title of the text.


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.


STUDENT WORKLOAD REQUIREMENTS

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>HOURS</th>
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<tbody>
<tr>
<td>Directed Study</td>
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<tr>
<td>Examinations</td>
<td>3</td>
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<tr>
<td>Private Study</td>
<td>42</td>
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<tr>
<td>Project Work</td>
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<tr>
<td>Report Writing</td>
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ASSESSMENT DETAILS

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<tr>
<th>Description</th>
<th>Marks Out of</th>
<th>Wtg(%)</th>
<th>Required</th>
<th>Due Date</th>
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<tr>
<td>INSTRUMENT DESIGN ASS - OUTLIN</td>
<td>999.00</td>
<td>10.00</td>
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<td>04 Mar 2002</td>
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<tr>
<td>INSTRUMENT DESIGN ASS - FINAL</td>
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<td>3 HOUR CLOSED EXAMINATION</td>
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<td>60.00</td>
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NOTES:
1. Further details about the due dates are detailed in the assessment section of the Course Specifications.
2. Further details about the due dates are detailed in the assessment section of the Course Specifications.
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OTHER REQUIREMENTS

1. Students will normally be expected to achieve at least half marks in both the aggregate assignment and the examination to complete the course.
2. Students are to retain a verbatim copy of all assignment work submitted, for submission in the event that the original is lost or damaged.
3. If students submit assignments after the due date without prior approval then a penalty of up to 20% of the assignment total marks will apply for each working day late.
4. The due date for an assignment is the date by which a student must submit the assignment to the USQ. The onus is on the student to provide proof of the submit date, if requested by the Examiner.
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.

The Faculty of Engineering and Surveying will NOT accept submission of handwritten or typed assignments by facsimile, email or computer diskette. Students in remote locations who do not have regular access to postal services may be given special consideration.

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 Course Leader's convenience.

A closed examination is an examination where the candidates are allowed to bring only writing and drawing instruments into the examination.

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

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.

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; IDSM (Incomplete Deferred Examination and Make-up).

A minimum standard of communication skills must be demonstrated in order for a passing grade to be achieved.