Description: Computer Controlled Systems

<table>
<thead>
<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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<tr>
<td>ELE</td>
<td>3105</td>
<td>30505</td>
<td>1, 2004</td>
<td>ONC</td>
<td>1.00</td>
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Academic group: FOENS
Academic org: FOES04
Student contribution band: 2
ASCED code: 031399

STAFFING
Examiner: Paul Wen
Moderator: John Leis

REQUISITES
Pre-requisite: ELE2103

SYNOPSIS
To apply control to any 'real' problem, it is first necessary to express the system to be controlled in mathematical terms. The 'state space' approach is taught both for expressing the system dynamics and for analysing stability both before and after feedback is applied. These concepts involve revision and extension of matrix manipulation and the solution of differential equations. By defining a time-step to be small, these state equations give a means of simulating the system and its controller for both linear and nonlinear cases. Many of the implementations of on-line control now involve a computer, which applies control actions at discrete intervals of time rather than continuously. It is shown that discrete-time state equations can be derived which have much in common with the continuous ones. Simulation does not then rely on a very small time step. The operator 'z' is first introduced with the meaning of 'next', resulting in a higher order difference equation to represent the system, then shown to be a parameter in the infinite series which is summed to form a 'z-transform'. It is shown that the discrete-time transfer function in z can be derived from the Laplace transform of the continuous system, with additional terms to represent the zero order hold of the DAC. Analysis of stability in terms of the roots of a characteristic equation are seen to parallel the continuous methods and techniques of pole assignment and root locus are also seen to correspond. Techniques are presented for synthesising transfer functions by means of a few lines of computer code, to make stable control possible for systems which would be unstable with simple feedback.
OBJECTIVES

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

- design of a computer control feedback loop, including algorithms in software;
- analysis and simulation of control systems using state space methods;
- design of systems in which the controllers have dynamics implemented in software.

TOPICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting (%)</th>
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<tbody>
<tr>
<td>1. Use of the Z-transform for analysis and design of computer control loops</td>
<td>15.00</td>
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<tr>
<td>2. Representation of discrete time dynamics in software</td>
<td>10.00</td>
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<tr>
<td>3. Discrete time state equations and stability analysis</td>
<td>10.00</td>
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<tr>
<td>4. Controller design and 'tuning' with controller dynamics, PID</td>
<td>15.00</td>
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<td>5. Pole assignment, root locus and other methods in the complex plane</td>
<td>10.00</td>
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<td>6. Derivation of state equations</td>
<td>10.00</td>
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<td>7. Modelling and simulation by computer</td>
<td>10.00</td>
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<tr>
<td>8. Matrix analysis of continuous linear systems and controllers</td>
<td>15.00</td>
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<tr>
<td>9. Concepts of controllability and observability</td>
<td>5.00</td>
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</table>

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).


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.

Dorf, R. C 2001, *Modern Control Systems*, Prentice Hall,

**STUDENT WORKLOAD REQUIREMENTS:**

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>HOURS</th>
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<tbody>
<tr>
<td>Assessment</td>
<td>36.00</td>
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<tr>
<td>Examinations</td>
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</tr>
<tr>
<td>Lectures</td>
<td>26.00</td>
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<tr>
<td>Private Study</td>
<td>64.00</td>
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<tr>
<td>Tutorial</td>
<td>26.00</td>
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**ASSESSMENT DETAILS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks out of</th>
<th>Wtg(%)</th>
<th>Due date</th>
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<tbody>
<tr>
<td>ASSIGNMENT 1</td>
<td>200.00</td>
<td>20.00</td>
<td>05 Apr 2004</td>
</tr>
<tr>
<td>ASSIGNMENT 2</td>
<td>200.00</td>
<td>20.00</td>
<td>31 May 2004</td>
</tr>
<tr>
<td>3 HOUR RESTRICTED EXAMINATION</td>
<td>600.00</td>
<td>60.00</td>
<td>END S1 (see note 1)</td>
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**NOTES:**
1. Students will be advised of the due date when each assessment item is issued.

**IMPORTANT ASSESSMENT INFORMATION**

1. Attendance requirements:
   It is the students’ responsibility to attend and participate appropriately in all activities (such as lectures, tutorials, laboratories and practical work) scheduled for them, and 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:
   To complete each of the assessment items satisfactorily, students must obtain at least 50% of the marks available (or at least a grade of C-) for each assessment item.

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 available for the assignment will apply for each working day late.

4. Requirements for student to be awarded a passing grade in the course:
(i) 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 satisfactorily completing all summative assessment items (the examination and assignments), as stated in 2 above. (ii) Students who do not qualify for a Passing grade may, at the discretion of the Examiner, be assigned additional work to demonstrate to the Examiner that they have achieved the required standard. It is expected that such students will have gained at least 45% of the total 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 Restricted Examination, candidates are allowed access to specific materials during the examination. The only materials that candidates may use in the restricted examination for this course are: writing materials (non-electronic and free from material which could give the student an unfair advantage in the examination); a hand-held, battery-operated, non-programmable calculator (students must indicate on their examination paper the make and model of any calculator(s) they use during 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/corporateservices/calendar/part5.htm or in 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 one of the temporary grades: IM (Incomplete - Make up), IS (Incomplete - Supplementary Examination) or ISM (Incomplete -Supplementary Examination and Make up). A temporary 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).

OTHER REQUIREMENTS

1 A basic familiarity with a programming language or MATLAB is assumed.