TITLE: CONTROL OF LINEAR SYSTEMS

SI MODULE CODE: 55-7963

CREDITS: 15

LEVEL: 7

JACS CODE: H660

SUBJECT GROUP: Automation and Operations Engineering

DEPARTMENT: Engineering and Mathematics

MODULE LEADER: Hongwei Zhang

MODULE STUDY HOURS (based on 10 hours per credit)*

<table>
<thead>
<tr>
<th>Scheduled Learning and Teaching Activities</th>
<th>Placement (if applicable)</th>
<th>Independent Guided Study</th>
<th>Total Number of Study Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>114</td>
<td></td>
<td>150</td>
</tr>
</tbody>
</table>

*To be used for Key Information Sets - see Module Descriptor guidance notes

MODULE AIM

This module aims to impart knowledge of modelling, analysing and designing of linear control systems in time and frequency domains as well as digital systems, and, at the same time, encourage students to bear in mind the practical limitations of real-world devices and signals when using simulation studies.

MODULE LEARNING OUTCOMES (up to 4 LOs max)

By engaging successfully with this module a student will be able to

(i) Develop frequency-domain (Laplace transfer function) and time-domain (state-space) mathematical models of systems and critically compare and analyse their behaviour, both with each other and with the real-world systems they purport to model.

(ii) Critically assess the stability of feedback systems, select and use appropriate design techniques to develop feedback control schemes, taking into account the characteristics and uncertainties of the chosen plant model and of the real-world plant itself.

(iii) Describe and develop digital computer implementations of controllers originally designed in continuous-time, and purely digital controllers with no analogue counterpart, critically compare such design approaches.

(iv) Critically evaluate the conditions in which controllers designed using CACSD software and simulation are likely to be practicable.

INDICATIVE CONTENT

System modelling – lumped-parameter models, differential equations, state-space models, Laplace transfer functions, ARMAX-type and, z-transform models.

System identification – models from step- and frequency-response tests.

System responses – time and/or frequency responses from state-space models, Laplace transfer functions and discrete-time models.

System stability – poles, eigenvalues, Routh and Nyquist criteria.

Frequency response methods – Bode plot, s-plane plots and compensator design. PID controllers. Transport lags.
Digital systems – digital implementation of continuous-time designs (e.g. PID). Truly digital controllers (dead-beat, Kalman, Dahlin).

**LEARNING, TEACHING AND ASSESSMENT - STRATEGY AND METHODS**

Students will be supported in their learning, to achieve the above outcomes, in the following ways:

The course material is delivered by traditional lectures (some of which use data projection for examples and simulation studies) supported, as appropriate, by tutorials, laboratory sessions, the module Blackboard site on the intranet, handouts and the recommended module text (currently Dutton, Thompson and Barraclough, “The Art of Control Engineering”, Addison Wesley-Longman, 1997). Lectures are interactive in the sense that dialogue is encouraged. Guided reading around the lecture topics will be necessary, as there is insufficient lecture time to cover all the material. Sometimes, the guided reading may be linked to assignments.

If you do not have prior knowledge of Laplace transforms, then some initial reading will be indicated.

The coursework component of assessment is typically by control system analysis and design exercises, which are paper-based, but assisted by CACSD software such as MATLAB and SIMULINK. Laboratory reports may also be assessed in a summative manner.

Whereas the coursework allows time for students to reflect upon their learning and undertake self study to further their learning, the examination provides the opportunity for students to carry out independent work on the principles and concepts of the subject under controlled and time-constrained conditions. The examination is a two-hour unseen paper.

**ASSESSMENT TASK INFORMATION**

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Short Description of Task</th>
<th>SI Code EX/CW/PR</th>
<th>Task Weighting %</th>
<th>Word Count or Exam Duration*</th>
<th>In-module retrieval available</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assignment.</td>
<td>CW</td>
<td>50%</td>
<td>2000 words or equivalent</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>Examination closed book.</td>
<td>EX</td>
<td>50%</td>
<td>2 hours</td>
<td>N</td>
</tr>
</tbody>
</table>

“NB to achieve a pass in this module students must achieve a minimum of 40% in every assessment task.”

**FEEDBACK**

The students will undertake formative tasks during each tutorial session, and receive direct feedback from the tutor. The feedback from the summative assignments will consist of comments on the assignment and assignment cover sheet.

**LEARNING RESOURCES FOR THIS MODULE (INCLUDING READING LISTS)**

These are examples of the key learning resources a student will use:

- Handouts.
- Online Learning Environment (e.g. Blackboard).
- Computer-aided control system design software, typically MATLAB / SIMULINK.
• Real-time control equipment and experimental rigs (control systems laboratory), including both analogue and digital control capabilities.

• SHU Learning Centre literature resources, databases, link to gateways.

Reading List

Recommended Text


Other Control Texts


REVISIONS

<table>
<thead>
<tr>
<th>Date</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2014</td>
<td>Confirmed in PG Engineering Re/approval</td>
</tr>
<tr>
<td>August 2014</td>
<td>Assessment Model approved by UEP</td>
</tr>
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SECTION 2  MODULE INFORMATION FOR STAFF ONLY

MODULE DELIVERY AND ASSESSMENT MANAGEMENT INFORMATION

NEW MODULE               | N
EXISTING MODULE - NO CHANGE | Y
Title Change              | N
Level Change              | N
Credit Change             | N
Assessment Pattern Change | N
Change to Delivery Pattern | N
Date the changes (or new module) will be implemented  | 09/2014

MODULE DELIVERY PATTERN - Give details of the start and end dates for each module. If the course has more than one intake, for example, September and January, please give details of the module start and end dates for each intake.

<table>
<thead>
<tr>
<th>Course Intake</th>
<th>Module Begins</th>
<th>Module Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Intake 1</td>
<td>29/09/2014</td>
<td>23/01/2015</td>
</tr>
<tr>
<td>Course Intake 2</td>
<td>DD/MM/YYYY</td>
<td>DD/MM/YYYY</td>
</tr>
<tr>
<td>Course Intake 3</td>
<td>DD/MM/YYYY</td>
<td>DD/MM/YYYY</td>
</tr>
</tbody>
</table>

Is timetabled contact time required for this module? | Y

Are any staff teaching on this module non-SHU employees? | N

If yes, please give details of the employer institution(s) below

What proportion of the module is taught by these non-SHU staff, expressed as a percentage?

MODULE ASSESSMENT INFORMATION

Indicate how the module will be marked

*Overall PERCENTAGE Mark of 40% | Y
*Overall PASS / FAIL Grade     | N

*Choose one only – module cannot include both percentage mark and pass/fail graded tasks

SUB-TASKS

Will any sub-tasks (activities) be used as part of the assessment strategy for this module? | N

If sub-tasks / activities are to be used this must be approved within the Faculty prior to approval. Sub-task / activity marks will be recorded locally and extenuating circumstances, extensions, referrals and deferrals will not apply to sub-tasks / activities.

FINAL TASK

According to the Assessment Information shown in the Module Descriptor, which task will be the LAST TASK to be taken or handed-in? (Give task number as shown in the Assessment Information Grid in Section 1 of the Descriptor) | Task No. 2

NON-STANDARD ASSESSMENT PATTERNS

MARK ‘X’ IN BOX IF MODULE ASSESSMENT PATTERN IS NON STANDARD, eg MODEL B, ALL TASKS MUST BE PASSED AT 40%.

NB: Non-standard assessment patterns are subject to faculty agreement and approval by Registry Services - see guidance. notes. | X