Engineering Tripos Part IIB, 4F1: Control System Design, 2018-19

Module Leader
Prof MC Smith

Lecturer
Prof M Smith

Lab Leader
Prof M Smith

Timing and Structure
Michaelmas term. 12 lectures + 2 examples classes + coursework. Assessment: 75% exam/25% coursework

Prerequisites
3F1 and 3F2 useful

Aims
The aims of the course are to:

- establish for the students a fundamental approach to the design of linear control systems.

Objectives
As specific objectives, by the end of the course students should be able to:

- understand the role and importance of feedback for the control of uncertain dynamical systems.
- demonstrate the information conveyed via root locus diagrams for transient behaviour and basic frequency response analysis using Nyquist (polar) and Bode plots.
- following its basic derivation, illustrate the use of the Nyquist stability criterion with both open loop stable and open loop unstable systems;
- understand factors which limit achievable performance in feedback systems.
- use analytical tools to understand trade-offs (e.g. Bode gain/phase relations, sensitivity integrals).
- translate general requirements for robustness and performance into specifications on the open-loop frequency response.
- use computer software for simple control system design and system simulation
- design simple compensators to achieve such specifications.

Content
Control system design (11L)

- System dynamics, stability and instability, principles and use of root locus plots, derivation of Nyquist
stability criterion, Bode theorems and plots.
  - Design of simple P.I.D. controllers and phase compensators. Sensitivity, complementary sensitivity and
    SISO robustness. Non-minimum phase systems and limitations, bandwidth. Delays in systems.
  - Two degree of freedom design.

Introduction to Coursework (1L)

Case studies and simulation.

Coursework

Case studies and design by simulation and computer software, e.g. use of Matlab. Four hours DPO time plus report
(further four hours).

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<tr>
<th>Coursework</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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<tbody>
<tr>
<td>[Coursework activity #1 title / Interim]</td>
<td>Individual/group Report / Presentation</td>
<td>Thu week 3</td>
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<td>Coursework 1 brief description</td>
<td>[non] anonymously marked</td>
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<td>Learning objective:</td>
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<td>[Coursework activity #2 title / Final]</td>
<td>Individual Report</td>
<td>Wed week 9</td>
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Booklists

Please see the Booklist for Group F Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have
to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has
been developed, and is regularly updated, by panels representing professional engineering institutions, employers
and engineering educators. Of particular relevance here is the Accreditation of Higher Education Programmes’
The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

Last modified: 17/05/2018 14:18

Source URL (modified on 17-05-18): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4f1-control-system-design-2018-19

Links
[1] mailto:mcs1000@cam.ac.uk