Engineering Tripos Part IIB, 4F2: Robust and Nonlinear Control, 2021-22

Module Leader

Prof R Sepulchre [1]

Lecturers

Prof R Sepulchre and Dr F Forni [2]

Timing and Structure

Lent term. 14 lectures + 2 computer lab sessions. Assessment: 100% coursework

Prerequisites

3F2 assumed.

Aims

The aims of the course are to:

- introduce fundamental concepts from nonlinear dynamic systems
- introduce techniques for the analysis and control of nonlinear and multivariable systems.

Objectives

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

- apply standard analysis and design tools to multivariable and nonlinear feedback systems.
- appreciate the diversity of phenomena in nonlinear systems.

Content

Part I. ROBUST CONTROL (7L + 1 Computer Lab session, Prof R. Sepulchre)

1. Uncertainty and Nonlinearity in control systems: simple models.

2. Signal spaces and system gains.

3. The small-gain theorem and the passivity theorem. Phase versus gain uncertainties

4. Dissipativity theory


7. Gap metrics
PART 2: NONLINEAR SYSTEMS (7L + 1 computer lab session, Dr F Forni)


4. Phase portrait analysis.

5. Analysis and design of switches and clocks. Robust differential control.


7. Describing function analysis.

Further notes

ASSESSMENT

Coursework only.

Coursework

<table>
<thead>
<tr>
<th>Coursework activity #1 Robust control of haptic interfaces</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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<tbody>
<tr>
<td>Individual Report</td>
<td>anonymously marked</td>
<td>25 February 2022 [30/60]</td>
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Learning objective:

• Learn how to model uncertainty in an engineering application
• Design a robust controller in Matlab

<table>
<thead>
<tr>
<th>Coursework activity #2 Feedback oscillations control</th>
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<th>Due date &amp; marks</th>
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<tr>
<td>Individual Report</td>
<td>anonymously marked</td>
<td>25 March 2022 [30/60]</td>
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Learning objective:

• Learn how to model and analyse nonlinear oscillations in feedback systems
• Design a nonlinear oscillator in a biologically motivated application

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

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' (AHEP) document [5] which sets out the standard for degree accreditation.

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: 27/09/2021 09:29

**Source URL (modified on 27-09-21):** http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4f2-robust-and-nonlinear-control-2021-22

**Links**

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