Engineering Tripos Part IIB, 4F2: Robust & Nonlinear Systems & Control, 2019-20

Module Leader

Prof RJCPM Sepulchre [1]

Lecturers

Prof RJCPM Sepulchre and Dr I Lestas [2]

Timing and Structure

Lent term. 14 lectures + 2 examples classes. Assessment: Exam only

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 1: MULTIVARIABLE FEEDBACK SYSTEMS (7L + 1 example class, Prof R. Sepulchre)

- Performance measures for multi-input/multi-output systems.
- Stabilization: stability conditions, all stabilizing controllers, small gain theorem.
- Models for uncertain systems.
- Robust stability and performance. Loop shaping design.
- Design of multivariable systems.

PART 2: NONLINEAR SYSTEMS (7L + 1 example class, Dr I Lestas)

- Linear and Nonlinear systems; feedback circuits.
- Differential equations and trajectories.
- Multiple equilibria, limit cycles, chaos and other phenomena.
- Examples from biology and mechanics.
State space stability analysis:
- The theorems of Lyapunov, LaSalle invariance principle.
- Stability of nonlinear circuits and neural behaviors.
- State-space tools for robustness analysis.
- Input/output stability analysis:
  - Describing functions
  - Small gain theorems, circle and Popov criteria, passivity.

Further notes

ASSESSMENT

Lecture Syllabus/Written exam (1.5 hours) - Start of Easter Term/100%

Booklists

Please see the Booklist for Group F Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [5] 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 [6] which sets out the standard for degree accreditation.

The Output Standards Matrices [7] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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