

Engineering Tripos Part IIB, 4F1: Control System Design, 2021-22

Module Leader

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Lecturer

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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).

Coursework	Format	Due date & marks
Coursework activity #2 Final Coursework 2 brief description <u>Learning objective:</u> • •	Individual Report anonymously marked	Fri week 9 [15/60]

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](#) [2].

UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [3] 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](#) [4] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [5] 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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Links

[1] <mailto:mcs1000@cam.ac.uk>

[2] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[3] <http://www.engc.org.uk/ukspec.aspx>

[4] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>

[5] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>