4B9 Control Engineering 1 [5 credits]

Lecturer(s): Asst. Professor. Dermot Geraghty (tgerghty@tcd.ie)

Module organisation
The module runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week, starting in week 2. Total contact time is 44 hours.

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<th>Semester</th>
<th>Start Week</th>
<th>End Week</th>
<th>Lectures per week</th>
<th>Lectures total</th>
<th>Tutorials per week</th>
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<tbody>
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<td>2</td>
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<td>12</td>
<td>3</td>
<td>33</td>
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Module description, aims and contribution to programme
This module introduces the student to various systems of continuous control of electrical, electronic, mechanical and combined systems. First and Second order systems are studied, with extensions to higher order systems using approximate methods and computer modelling (using Matlab). Aspects of control systems which are discussed include stability, steady state error and frequency response. Techniques covered include transfer functions, block diagram algebra, the root-locus method and frequency response design methods.

Learning outcomes
On successful completion of this module, students will (be able to):
1. Develop transfer functions for electro-mechanical systems
2. Use the Laplace Transform to transform between the time domain and frequency domain and find the time domain responses of 1st and 2nd order systems to standard test inputs e.g. the step input
3. Use s-plane analysis to determine the performance characteristics of systems e.g. settling time, peak time, find lines of constant damping
4. Draw a block diagram for a control system starting with a schematic of the system and find the overall transfer function for the system
5. Determine if a system is stable, marginally stable or unstable using a Routh table or using Matlab
6. Find the steady state error in a system due to a standard test input e.g. a step input. Understand how to reduce or remove this error. Understand steady-state error behaviour of P, PI and PID controlled systems
7. Use the root-locus as a means of assessing the performance of a system including its stability and its behaviour as the gain is changed
8. Use the root locus as a design tool to alter the response of a control system/plant by introducing a compensator
9. Apply frequency response methods to the analysis of control systems including stability analysis
10. Use Matlab Control Systems Toolbox to analyse control systems and design
Module content

1. Introduction to control systems
2. Transfer functions
3. Time response of 1st and 2nd order systems
4. Modelling in the frequency domain
5. Block diagram algebra
6. Stability and the Routh-Hurwitz criterion
7. Steady state errors
8. Root locus techniques – analysis and design of compensators
9. Frequency response techniques; Bode plots and Nyquist criterion
10. Use of Matlab and Control Systems Toolbox in Analysis and Design of Control Systems

Teaching strategies

The module is taught using a combination of lectures, laboratories and tutorials. During the tutorials the students work in groups, thereby encouraging teamwork and cooperation. The tutorials are overseen by a Teaching Assistant. The use of Matlab (Control Systems Toolbox) as a design tool for control systems is introduced via a combination of lecture demonstrations and tutorial sessions. At the end of the module the students are given a design assignment to work on. The exam contains a compulsory question based on the material in the design assignment. No solution to the assignment is provided.

Assessment

The assessment is by a 2 hour examination which is held at the end of the Trinity term and by a laboratory exercise on DC Motor Control. The breakdown of the marks is: Written Exam (85%), lab report (15%).

Required textbook

The module will use the following text:

*Control Systems Engineering by Norman S Nise, Wiley, Any Edition*

Further information

Further information will be provided as the module progresses.