CONTROL 4/M – Digital Control

Last update: 14 September 2020

Course Co-ordinator: Dr Henrik Gollee

Lecturer: Dr Matteo Ceriotti

Level of course: 4, MSc **Credits:** 10 **Course code:** ENG4042, ENG5022

Total notional learning hours: Contact hours: 25. Private study: 75

When taught: First semester

Total scheduled teaching hours for the course, specifying the methods used: 20 sixty minute lectures using blackboard, OHP, including sessions for problem solving and discussion.

Laboratory / Practical Work: There are two hours of laboratories for MSc students.

Prerequisites: None **Co-requisites:** None **Excluded combinations:** None

Summative assessment: ENG4042: Final examination only 100%
ENG5022: Final examination 90%; Coursework 10%

Formative assessment: Tutorial work throughout course.

Exam diet: December. Examination duration two hours

COURSE DESCRIPTION

(Optional topics in *italic*)

Syllabus:

- **Dynamical Systems**: Review of basic control theory. Digital signal: digitization and quantization. Digital control: introduction and main differences with continuous control, advantages and disadvantages.
- **Difference equations:** definition, from differential to difference equations using derivation rules. Linear difference equations: definition, stability. Numerical integration with difference equations. Laplace transform, transfer function, zeros and poles. Block diagrams. Pulse response and transfer function. Convolution. BIBO stability.
- **Discrete models of sampled-data systems:** Zero-order hold: transfer function of a system preceded by it. *Review of state-space form. Computation through state-space form.*
- **Signal analysis and dynamic response:** Time domain and transfer functions of: pulse, step, exponential, sinusoid. Frequency, poles, pole mapping between continuous and discrete domains. Correspondence between s-plane and z-plane. Natural frequency and damping. Relationship between frequency response and transfer function. Aliasing.
- **Sampled-data systems:** Sample and hold. Transfer functions. Spectrum of a sampled signal. Sidebands and aliasing. Sampling (Nyquist) theorem. Data extrapolation from a sampled signal.
- **Design of discrete equivalents:** Design by emulation. Numerical integration. Forward, backward and trapezoid (Tustin) rules. Mapping of the poles and consequences on stability of digital equivalents. Pre-warping. Pole-zero matching method. Hold equivalents.

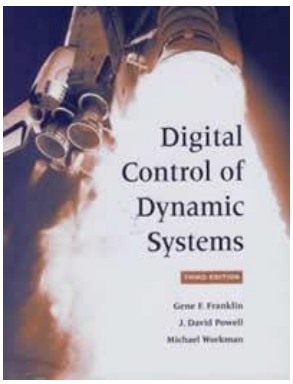
Intended Learning Outcomes:

By the end of this course students will be able to:

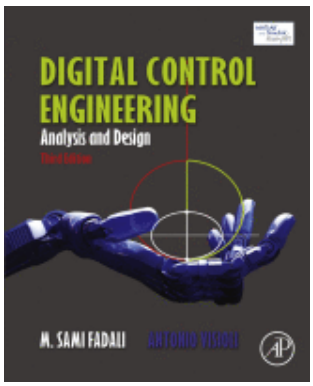
- Represent continuous and discrete dynamic systems in state space form
- implement multi-variable control strategies;
- explain the basic concepts of digital control;
- use the z-transform, perform signal analysis and identify the dynamic response of discrete signals;
- understand the phenomenon of aliasing in sampled data systems, its effects and how to avoid it;
- design discrete equivalent of continuous controllers by emulation, using different techniques.

TEXTBOOKS

Recommended Textbooks:



Title: Digital Control of Dynamic Systems, 3rd Edition
Author: Gene F. Franklin, J. David Powell, and Michael Workman
Publisher: Ellis-Kagle Press (2006)
ISBN: 978-0-9791226-1-3
Library: Engineering LA400 1990-F
Website: http://digitalcontroldynsys.com/



Title: Digital Control Engineering - Analysis and Design (3rd ed)
Author: M. Sami Fadali, Antonio Visioli
Publisher: Elsevier Academic Press (2020)
ISBN: 978-0-12-814433-6
Library: http://tinyurl.com/y5xbeavy
DOI: https://doi.org/10.1016/C2017-0-01563-X