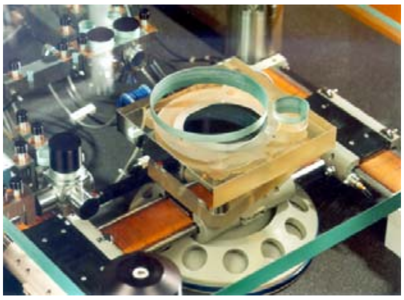
Mechatronic system design

Mechatronic system design wb2414-2013/2014
Course part 1



Introduction

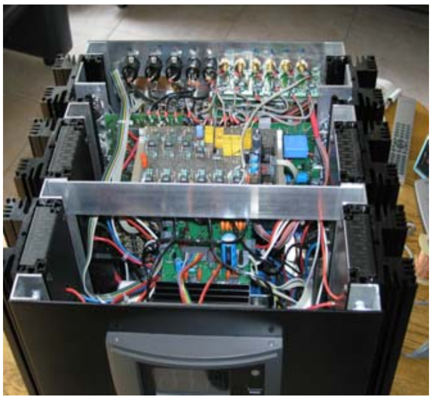
Prof.ir. R.H.Munnig Schmidt
Mechatronic System Design

Contents

- Personal Introduction Teacher
- Structure of the course
- Positioning; What is Mechatronic System Design?

Introduction Rob Munnig Schmidt

It all started with audio, amplifiers and loudspeakers

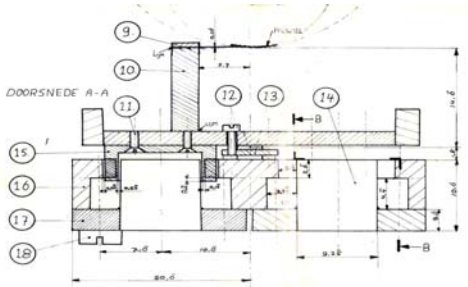


Master thesis work. Portable drive for medical pump.

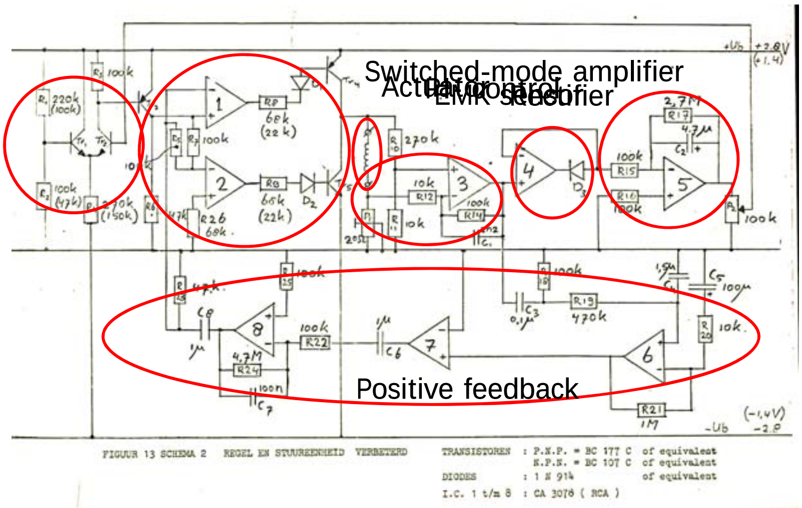
<u>Infusiepompjes.</u>

De groei van kankergezwellen kan soms tot stilstand gebracht worden door de patienten continu te voorzien van een cytostatische vloeistof.
Daarvoor is het noodzakelijk de patienten in het ziekenhuis op te nemen. Er is geprobeerd, een transportabele pomp te ontwerpen, zodat opname overbodig wordt, en de patient een normaal leven kan leiden.

Binnenwerk van de slangepomp.



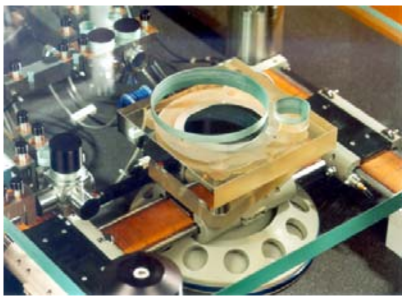
Including the electronics



Design of first electric waferstepper stage @ Philips Research

Starting point of ASML

ASML Wafer Scanner

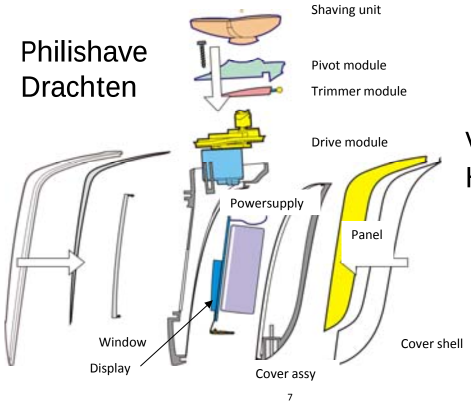


Industrial Career until 2006

D&E Mechatronics ASML

ASML Wafer Scanner

Philishave Drachten



Vacuumcleaners Hoogeveen

Philips triathlon 1400

TUDelft Delft University of Technology

WB2414-Mechatronic System Design 2013-2014

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Presently part-time professor and back to audio.

RMS Acoustics & Mechatronics

TUDelft Delft University of Technology

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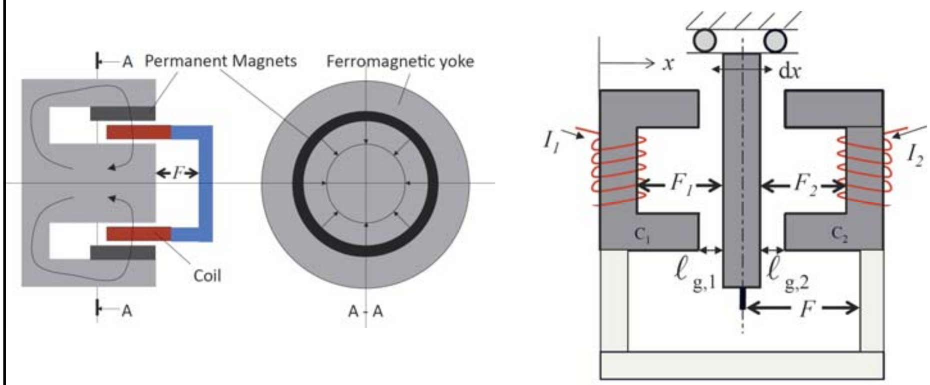
- Personal Introduction Teachers and assistant staff
- Structure of the course
- What is Mechatronic System Design

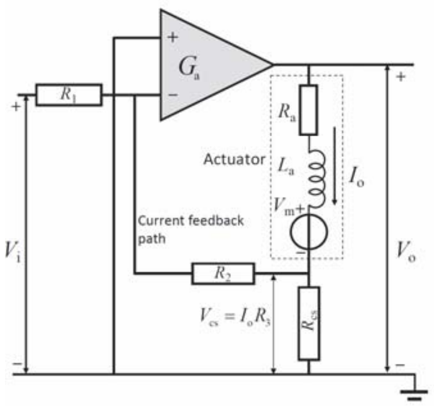
Learning goals. The student:

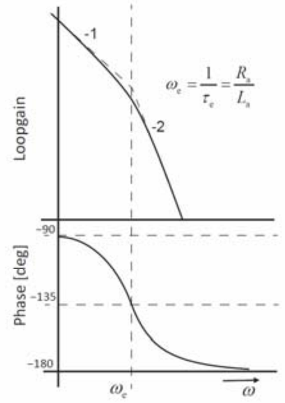
- Can select and calculate a single axis functional electromagnetic actuator for a given specification, working according to the Lorentz or reluctance force generation principle.



Learning goals. The student:

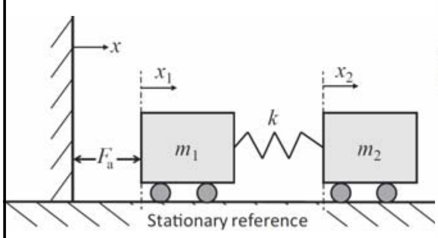
- Can select a suitable circuit and calculate component values for a single channel stable power amplifier intended for a given electromagnetic actuator.

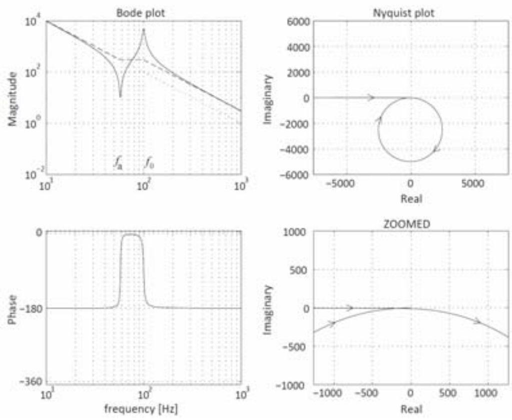




Learning goals. The student:

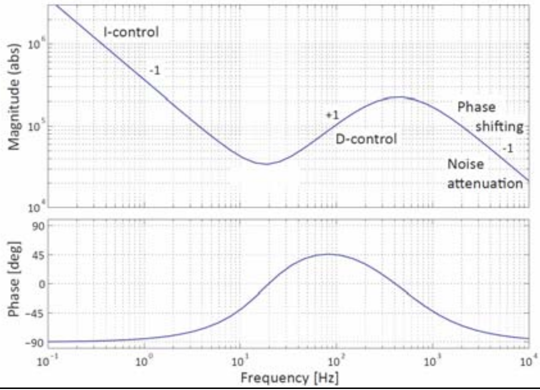
- Can analyse and derive improvements to the dynamic behaviour of an actuator driven mechanical structure with maximum 6th order plant dynamics (incl actuator and amplifier) by means of Bode and Nyquist plots.





Learning goals. The student:

- Can apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor, to achieve a maximum bandwidth or disturbance rejection.



Learning goals. The student:

- Can select and calculate a single axis functional electromagnetic actuator for a given specification, working according to the Lorentz or reluctance force generation principle.
- Can select a suitable circuit and calculate component values for a single channel stable power amplifier intended for a given electromagnetic actuator.
- Can analyse and derive improvements to the dynamic behaviour of an actuator driven mechanical structure with maximum 6th order plant dynamics (incl actuator and amplifier) by means of Bode and Nyquist plots.
- Can identify and apply optimal PID motion controller settings for a given plant, consisting of a dynamically realistic power amplifier, electromagnetic actuator and mechanical structure with an ideal sensor, to achieve a maximum bandwidth or disturbance rejection.

Examination test matrix (toetsmatrijs)

LG/Level	Knowledge	Insight	Application	Analysis	Evaluation	Creation	**Total**
Actuator design		10	10				20
Power amplifier		10	10				20
Dynamic analysis				20	10		30
PID tuning		15	15				30
Total		35	35	20	10		100

Typical aspects of this course

- Continuous matching of physical and mathematical models with practice. Translate a real system into a dynamic model and vice-versa. Get a gut-feel for the right answer before calculating with MATLAB like tools.
- Understand what a position control system really behaves like.
- The use of approximating (scalar) calculations is often sufficient for making important concept design decisions.
- Math is great but only after sufficient understanding of the relevant physics phenomena is obtained.

The book is used in three interconnected lectures

- ME1611-10 Physics for Mechanical Engineers. (Chapter 7, Optics)
- WB2414-09 Mechatronic System Design. (Chapter 2-6)
- WB2303-10 Electronics & Measurement. (Chapter 7,8)
- Used at external professional courses and inside high-tech companies as reference book.
- Cost €30 for the present edition. New edition (€tbd) will come in January when old stock is gone. (No fee for authors on sales to students!, official price €135,-)
- Only the book is allowed to be used with the written examination!

Assignments

- Goal is to gain experience on the subject by exercising.
- 4 assignments total, one for each study goal.
- Each assignment is targeted 6 hours of work
- Assignment published on blackboard
- Answers presented in separate lecture (see program)

- Only PME students following the special Physics, Mechatronics and Measurement course will receive grades.

Program MSD (1)

Week	Date	Time (min)	Topic	Teaching Method
			Term 2	
2.1	Wed 13 NOV	45+45	Introduction Mechatronics	Lecture
2.2	Wed 20 NOV	45+45	Electromechanic actuators I	Lecture
2.2	Thurs 21 NOV	45+45	Assignment discussion Optics (PME)	Class discussion
2.3	Wed 27 NOV	45+45	Electromechanic actuators II	Lecture
2.4	Wed 04 DEC	45+45	Dynamics of Motion Systems I	Lecture
2.4	Thu 05 DEC	45+45	Assignment Discussion Magnetism+Electromechanic actuators (PME+MSD)	Class discussion
2.5	Wed 11 DEC	45+45	Dynamics of Motion Systems II	Lecture
2.6	Wed 18 DEC	45+45	Motion Control I	Lecture
2.6	Thu 19 DEC	45+45	Assignment discussion Dynamics	Class discussion

No lectures in January!

Program MSD (2)

			Term 3	
3.1	Wed 12 FEB	45+45	Motion Control II	Lecture
3.1	Wed 19 FEB	45+45	Motion Control III	Lecture
3.3	Wed 26 FEB	45+45	Power Electronics I	Lecture
3.3	Thu 27 FEB	45+45	Assignment discussion Motion control	Class discussion
3.4	Wed 05 FEB	45+45	Power Electronics II	Lecture
3.5	Wed 12 FEB	45+45	Power Electronics III	Lecture
3.5	Thu 13FEB	45+45	Assignment discussion Low power electronics (MIE)	Class discussion
3.6	Wed 20 MAR	45+45	Dynamic System Control Examples I	Lecture
3.7	Wed 26 MAR	45+45	Dynamic System Control Examples II	Lecture
3.7	Thu 27 MAR	45+45	Assignment discussion Power Electronics	Class discussion

Contents

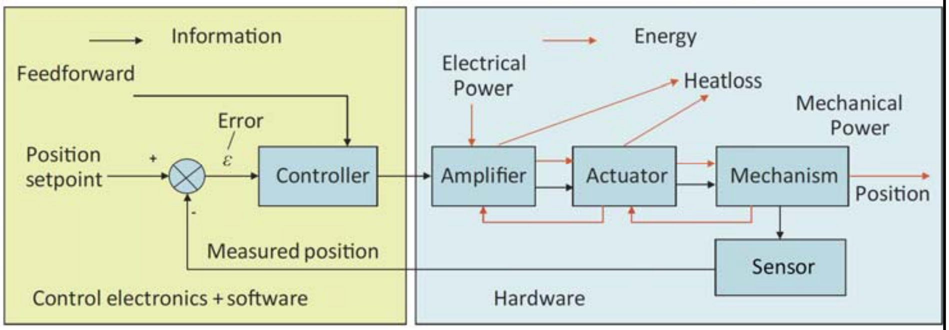
- Personal Introduction Teachers and assistant staff
- Way of Working
- Structure of the course
- What is Mechatronic System Design?

Mechatronic System Design is about:

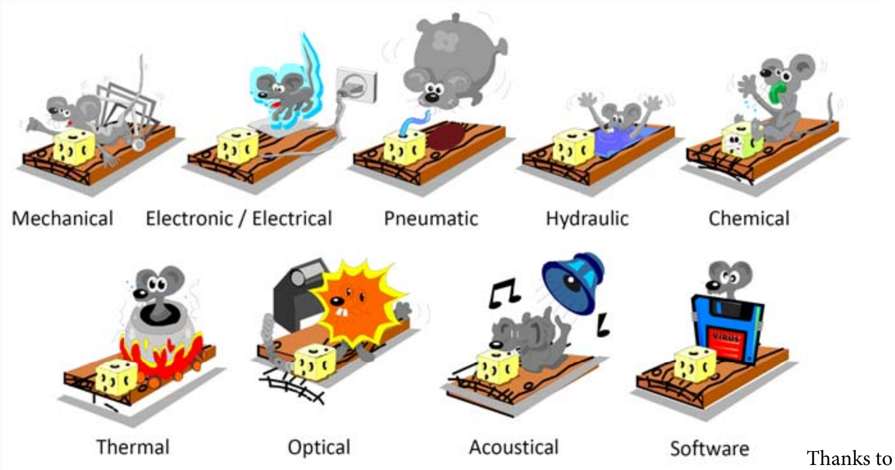
Precision Controlled Positioning systems.

- Controlled by model-based feedforward and feedback.
- Mastering disturbances that determine the precision.
  - Noise
  - Vibrations
- Applied on a real hardware device.
- Where reliable physical and mathematical models are used to determine predictable behaviour.

Mechatronic system overview



Mechatronics is multidisciplinary



Thanks to Mice BV