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Welcome to: Automation in Complex Systems



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Overview of the course

- Lectures Including exercises
- Simulation/computer exercises
 - Dynamic systems (stiff solvers and DAE solutions)
 - Process monitoring (multivariate processes)
- Project
 - The conveyer process

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Lectures

- Dynamic systems, Queuing theory
 - Ulf Jeppsson
- Process monitoring and operator support
 - Christian Rosén
- Plant wide control
 - Christian Rosen

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Lectures (cont.)

- Complexity in automation
 - Gustaf Olsson
- Data bases and human machine interface
 - Gunnar Lindstedt

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Lectures (cont.)

- Guest lectures:
 - Thomas Gillblad (communication and complexity)
 - Charlotta Johnsson (Batch & Industry 4.0)
 - Tobias Antius (Digitalization)

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Simulation exercises

- Available on the web site www.iea.lth.se/aks
- Deadlines Friday 8/4 (#1) and Wednesday 4/5 (#2)
 - Keep the deadlines!
 - If not, maybe not until next year!
- Supervisor: Ulf Jeppsson

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Project

- Start up lecture Wednesday 23/3
- Groups of four (end goal: demonstrate solution + written report)
- Project based on the conveyer system
- Present plan for the project
 - Time and resource plan
 - Structure of the solution
- Presentation on Wednesday week 20
- Project supervisor: Ramesh Saagi

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Literature

- Olsson and Rosen (same as for Automation)
- Scientific papers (will be downloadable and handed out)
- Lab manual (will be downloadable and handed out)

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Finally

- This is an advanced course:
 - Try to take active part in the lectures!
 - We will try to make room for discussions
 - Be prepared
 - Lectures often complementary to literature

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Course goals

Knowledge/understanding about:

- Characterizing industrial processes based on complexity and realize how complexity affects the application of automation
- Account for how to use mathematical models to solve typical automation problems
- Understand and use terms like stability, real-time demand, capacity, stationarity, dynamical stiffness, etc

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Course goals

Skills and ability of how to:

- Formulate and structure a mathematical model of a larger industrial process based on given information of processes and how they interact
- Use this model to analyze important characteristics of the process
- Structure a control system for an industrial process made up of several sub-processes
- Use PLC programming to solve control problems when several parallel processes take place at the same time

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What is complexity?

Complicated versus Complex

Complex engineering systems
Complex dynamical systems

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Automation challenges

- 1000s of control loops - how to handle many loops
- 100000s input and output signals – how to organize and extract relevant information
- Time scales from ms to weeks within same system – stiff systems, hard to simulate and harder to control
- Significant interactions between sub-systems – requires a holistic view
- Uncertainty, estimation, prediction, identification etc.

If you can grasp it – it is not complex!

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Dealing with complexity

- Brute force (i.e. supercomputing) using conventional tools. Combinatorial explosion!
- Approximation (i.e. linearization)
- Divide and conquer (e.g. modularization)
- Change of view – new tools

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Coming up

- Lecture Wednesday Start of project.
Highly recommended that you join the session! Group configuration!
- Lectures this and next week – Ulf Jeppsson
Simulators and queuing theory.

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