## 7.7 Automation

<table>
<tr><td colspan="3">Module Name<br>Automation</td><td>Module Code<br>CO-543</td><td>Level (type)<br>Year 2 (CORE)</td><td>CP<br>5</td></tr>
<tr><td colspan="6">Module Components<br><br>Number | Name | Type | CP<br>CO-543-A | Automation | Lecture | 5</td></tr>
<tr><td colspan="2">Module Coordinator<br><br>Dr. Szymon Krupinski</td><td colspan="2">Program Affiliation<br><br>• Intelligent Mobile Systems (IMS)</td><td colspan="2">Mandatory Status<br><br>Mandatory elective for IMS</td></tr>
<tr><td colspan="3">Entry Requirements<br><br>Pre-requisites<br>☒ Programming C/C++<br>☒ Introduction to RIS<br><br>Co-requisites<br>☒ None<br><br>Knowledge, Abilities, or Skills<br>• Understanding of the basics of electronics<br>• Calculus<br>• basic C/C++/Python<br>• basic MATLAB/Simulink or SciLab</td><td>Frequency<br><br>Annually<br><br>Duration<br><br>1 semester</td><td colspan="2">Forms of Learning and Teaching<br><br>• Lectures (30 hours)<br>• Lab (5 hours)<br>• Private study (70 hours)<br>• Exam preparation (20 hours)<br><br>Workload<br><br>125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation<br><br>Review material of Embedded Systems Lab.</td></tr>
<tr><td colspan="6">Content and Educational Aims<br><br>Automation is the application of science and technology to control mechanical systems, including situations in which this proposed solution duplicates the skills of a human operator or even exceeds them. Industrial automation concentrates on solutions in the production and delivery of products and services.<br>The field of automation has considerable overlap with the fields of Control and Robotics. However, the distinguishing aspect is the emphasis on an industrial performance and setting, along with the concomitant focus on robustness and efficiency under factory conditions.<br>The topics covered in this course include: an introduction to sensors and their scientific principles; filtering, data fusion and estimation; types of actuators and details about the operation of industrial motors and drives; an introduction to programmable logic controllers (PLCs); their hierarchy and different PLC programming paradigms; and artificial intelligence (AI) concepts used in automation, such as state machines and sensor data processing.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes<br><br>By the end of this module, students should be able to<br>• explain the characteristics and principles of a number of industrial sensors and electric motors, comment on their overall parameters such as accuracy and precision, and outline the reasons for the calibration process;<br>• apply this knowledge to translate simple machine specifications into an automation problem in terms of sensing, actuation, and processing strategy at the conceptual level, including an educated selection of sensors and drives;<br>• apply a family of filtering and estimation techniques covered in the lectures to systems similar to those used in the examples; recall the analysis of their stability and duplicate it in the case of the presented system;<br>• apply the state machine concept to simple processes and routines;<br>• explain the strengths, principles, and programming paradigms of PLCs;<br>• recall the currently used concept in organizing a factory-wide automation pyramid and understand the working of at least one automation communication protocol in detail;<br>• combine the skills mentioned above in proposing solutions to simple industrial problem examples.</td></tr>
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## 7.23.2 Big Questions Modules

### 7.23.2.1 Digitalization: Challenges and Opportunities for Business and Society

| ***Module Name*** | | ***Module Code*** | ***Level (type)*** | ***CP*** |
|---|---|---|---|---|
| Big Questions: Digitalization: Challenges and Opportunities for Business and Society | | JTBQ-01 | Year 3 (Jacobs Track) | 5 |
| ***Module Components*** | | | | |
| *Number* | | | *Type* | *CP* |
| JTBQ-01 | Digitalization: challenges and opportunities for business and society | | Lecture/Projects | 5 |
| ***Module Coordinator*** | ***Program Affiliation*** | | ***Mandatory Status*** | |
| Adalbert Wilhelm | • Big Questions Area: All undergraduate study programs, except IEM | | • Mandatory elective for students of all undergraduate study programs except IEM | |
| ***Entry Requirements*** | | ***Frequency*** | ***Forms of Learning and Teaching*** | |
| *Pre-requisites*: ☒ None | *Co-requisites*: ☒ None | Annually | • Lectures (17.5 hours)<br>• Project work (90 hours)<br>• Private Study (17.5 hours) | |
| *Knowledge, Abilities, or Skills*<br>• the ability and openness to engage in interdisciplinary issues of global relevance<br>• media literacy, critical thinking, and a proficient handling of data sources | | ***Duration***<br>1 semester | ***Workload***<br>125 hours | |

***Recommendations for Preparation***

Critically following media coverage on the module's topics in question.

***Content and Educational Aims***

All "Big Questions" (BQ) modules deal with the economic, technological, societal, and environmental contexts of the global issues and challenges of the coming decades. BQ modules intend to raise awareness of those challenges and broaden students' horizons with applied problem solving beyond the borders of their own disciplines. Knowledge and skills offered in the interdisciplinary BQ modules support students in their development to become informed and responsible citizens in a global society.

Digitalization is currently one of the major drivers of change in our globalized world, affecting all aspects of our lives from private aspects, such as the way we find and select friends and partners, to economic principles, such as the replacement of human labor by robots and artificial intelligence. Furthermore, big data is a buzz word for the digitalization process: the massive storage and analysis of the comprehensive information of customers and citizens instill both hope and fear in the public. From a business perspective, digitalization is often portrayed as a sea of big opportunities, while at the same time many companies are under pressure to comply and adapt to rapidly changing processes and business approaches. The public debate on digitalization, particularly on big data, is torn between the two poles portrayed by the writers George Orwell and Aldous Huxley: complete surveillance and oppression on one end, and irrelevance and narcissism on the other. Technological research quite naturally is mostly concerned with the technical feasibility of different approaches, the

## 7.8 Automata, Computability, and Complexity

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<tr><td colspan="2">Module Name<br>Automata, Computability, and Complexity</td><td>Module Code<br>CO-563</td><td>Level (type)<br>Year 2 (CORE)</td><td>CP<br>7.5</td></tr>
<tr><td colspan="5">Module Components<br><br>Number | Name | Type | CP<br>CO-563-A | Automata, Computability, and Complexity | Lecture | 7.5</td></tr>
<tr><td>Module Coordinator<br><br>Peter Zaspel</td><td colspan="2">Program Affiliation<br><br>• Computer Science (CS)</td><td colspan="2">Mandatory Status<br><br>Mandatory for CS</td></tr>
<tr><td colspan="2">Entry Requirements<br><br>Pre-requisites<br>☒ Introduction to Computer Science<br><br>Co-requisites<br>☒ None<br><br>Knowledge, Abilities, or Skills</td><td>Frequency<br><br>Annually<br><br>Duration<br><br>1 semester</td><td colspan="2">Forms of Learning and Teaching<br><br>• Class attendance (35 hours)<br>• Tutorial attendance (17.5 hours)<br>• Independent study (115 hours)<br>• Exam preparation (20 hours)<br><br>Workload<br><br>187.5 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation<br><br>None</td></tr>
<tr><td colspan="5">Content and Educational Aims<br><br>This module introduces the mathematical theory of computation. Several types of abstract computational machines (called automata) are introduced together with the associated theory of formal languages. A formal language is a set of words over a defined alphabet that are well-formed according to a specific set of rules, called the grammar of the language. After studying the relationship between automata models and classes of formal languages, this course addresses the fundamental question "What problems can a computer possibly solve?" by characterizing those solvable problems, equivalently, through Turing machines, random access machines, recursive functions and lambda calculus. A full answer to the related question, "How many computational resources are needed for solving a given problem?" is not known today. However, the basic outlines of today's theory of computational complexity will be presented up to the most famous open problem in computer science, namely the "P = NP" question: if a computer could guess the right answer to a computational problem (and only needs to check its correctness), would that computer be faster than another one that cannot guess the right solution? This may seem to be a ridiculously obvious case of a clear YES answer, but in fact it is considered by many to be the deepest open question in contemporary mathematics (and computer science, of course).<br><br>This module provides the core education in theoretical computer science. The material covered in this module gives students access to any field in computer science, which is based on discrete-mathematical formal foundations, such as the theory of automata and formal languages or compiler design.</td></tr>
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