Course Descriptions

of our English-taught classes in **Mechanical and Plastics Engineering**

Overview:

- Adaptive Control, Modeling and Identification (lecture & lab/practical class)
- Computer Vision (lecture & lab/practical class)
- Eco Design & Life Cycle Assessment (lecture & project work)*
- Failure Analysis (lecture & lab/practical class)*
- Fracture Mechanics (lecture & lab/practical class)*
- Safety in Industrial Automation (lecture)
- Safety in Industrial Automation (lab/practical class)
- Individual research projects

*these classes are available in spring semesters only; they're not available during winter semesters

Adaptive Control, Modeling and Identification (lecture & lab/practical class)*

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Content:

- Introduction to and classification of Adaptive Control Systems
- Adaptation of Optimal Controllers and Controller Design by Pole Placement
- Dynamic Behavior of Adaptive Control Loops and Configuration Issues
- Modeling of Linear and Non-linear Time-invariant and -variant Dynamic Systems
- Algorithms and Filters for Online Process Identification
- Neural Networks as Memory Blocks for Controller and Process Model in Learning Control Loops
- Computer based applications using Matlab/Simulin
- Understanding the basic applications, concepts, components and challenges of adaptive control loops
- Understanding the basic principles for modeling and identification of complex dynamic system
- Classifying a control application and select an appropriate approach for adaptive control
- applying knowledge of the advantages and disadvantages of modeling and identification algorithms and structures
- implementing and simulating the components of an adaptive control loop
- transfer of the design process of adaptive control systems to problems from various domains in automation

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Credits and Workload:

2 course types:

- lecture
- lab class

5 credits for both lecture and lab class

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Forms of examination/assessment:
Written exam (90 minutes) covering the complete content of the module at the end of the semester. A make-up exam will be offered during the following semester.

Computer Vision (lecture & lab/practical class)*

Content:

- Image Sensors
- Image formation and digital images
- 3D Sensors and point clouds
- Image enhancement
- Object recognition techniques
- Pattern classification
- Camera calibration
- Stereo vision techniques and algorithms
- Case studies of selected imaging solutions for Automation, Robotics and Industrial Image Processing
- Understanding the mathematical and theoretical foundations of image processing and computer vision
- Understanding the basic components and working principles of 2D- and 3D-Machine Vision Systems
- Understanding the difference between image and point cloud based approaches to vision problems and their areas of application
- Understanding the uses and limitations of computer vision through practical case studies
- knowing the advantages and disadvantages of different imaging sensors
- knowing how to select appropriate hardware components for a given imaging scenario
- knowing how to identify a suitable chain of algorithms for a given imaging problems transfer of the knowledge acquired in the lectures to new vision problems in Robotics, Automation and Production

Credits and Workload:
2 course types:

- lecture
- lab class

5 credits for both lecture and lab class

Forms of examination/assessment:
Written exam (90 minutes) covering the complete content of the module at the end of the semester. A make-up exam will be offered during the following semester.

* The classes are offered by the department of Electrical Engineering and Information Technology, but are open to students of Mechanical and Plastics Engineering, too.

Eco-Design & Life Cycle Assessment (lecture & project work)*

Content: Environmental impact of technical products, terms and examples; role of the engineer. Environmental impact of resource use and sustainable development goals. Product development, roles, tasks and requirements from a company perspective and as the responsible engineer: management and operational perspective. Environmentally conscious design: product life cycle, life cycle thinking, risk, consideration and product safety, LCA, material and energy efficiency, lifetime, upgrade, repair, product and material consistency. Methods for finding ideas and solutions: Method selection, examples. Methods for evaluation in environmentally conscious design: method selection, examples.
Credits and Workload: 4 credits for both the lecture and project work (4 weekly hours in total)
Forms of examination/assessment: will be communicated at the start of the class

*available during spring semesters only; **not** available during winter semesters

Failure Analysis (lecture & lab/practical class)*

Content of the lecture: • Introduction to failure analysis • Fundamentals and performance of failure analysis • Examination methods • Failure caused by mechanical working conditions • Failure caused by thermal loading • Further failure causes **Content of the lab class**: • Documentation of failures in selected components • Translation of important technical terms English-German • Performance of first steps of a failure analysis in selected components • Presentation of failure cases from international literature • Fracture surface investigation with the scanning electron microscope
Credits and Workload: 5 credits for both the lecture (3 weekly hours) and the lab class (1 weekly hour)
Forms of examination/assessment: **Lecture**: Written exam (90 minutes) covering the complete content of the lecture at the end of the semester. **Lab class**: reports for the lab class.

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Fracture Mechanics (lecture & lab/practical class)*

Content of the lecture: • Introduction to safety systems in industrial automation Basics of linear elastic fracture mechanics • Basics of elastic plastic fracture mechanics • Input quantities – defect state, loading state, material state • Modelling and fracture mechanics calculation at static and cyclic loading • Consideration of mixed mode loading, dynamic loading, stress corrosion cracking, welded joints, probabilistic calculation • Worked examples from mechanical engineering **Content of the lab class**: • Documentation of cracks and fractures • Translation of important technical terms English-German • Calculation of crack tip loading and parameters of linear elastic and elastic plastic fracture mechanics • Proof of strength for simple components under static and cyclic loading • numerical investigation of a cracked component with Franc2D and IWM verb • experimental determination of fracture mechanics material properties under cyclic loading
Credits and Workload: 5 credits for both the lecture (3 weekly hours) and the lab class (1 weekly hour)
Forms of examination/assessment: **Lecture**: Written exam (120 minutes) covering the complete content of the lecture at the end of the semester. **Lab class**: Lab reports for the lab class.

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Safety in Industrial Automation (lecture)

Content: Participants will be exposed to and gain working experience to design, implement, verify and validate safe systems in industrial automation. The course will cover: • Introduction to safety systems in industrial automation • Basic terminology and standards concerning safety in industrial automation • Design of safe control systems • Measures to achieve safe processes and safe products incl. overview of safety devices • Development of safety related software using safety PLCs: configuration & programming of safety PLCs • Verification & validation of safety measures in accordance to a standard, e.g. EN ISO 13849

Credits and Workload: 5 credits
Forms of examination/assessment: Written exam (90 minutes) covering the complete content of the module at the end of the semester. A make-up exam will be offered during the following semester.

Safety in Industrial Automation (lab/practical class)

Content: Practical design and programming of safety programs using safety PLCs and practical verification of safety in accordance to a standard are part of this course: • Hardware configuration of safety PLC • Design, implementation, testing and debugging of a safety program using a safety PLC
• Calculating the safety level required, e.g. performance level required in accordance to EN ISO 13849 • Verification of safety systems e.g. by calculating the performance level achieved in accordance to EN ISO 1384 • understanding the basics of safety in industrial automation • understanding the basic standards and the terminology for safe systems in industrial automation • understanding the different concepts to achieve safe systems • understanding the structure of safety systems • understanding the verification and validation process for safe systems • applying the knowledge of how to design safe control systems, i.e. to design the safety concept, to select meaningful safety devices, to implement the hardware of the system including where to place the safety devices and the electrical connection • knowing how to develop safety related software using safety PLCs including the hardware configuration, the programming, the testing and the debuggig • knowing how to verify and validate safe systems in industrial automation in accordance to a standard, e.g. EN ISO 13849 • transfer of the acquired knowledge to create, verify and validate safe systems in industrial automation.
Credits and Workload: 2.5 credits
Forms of examination/assessment: Written exam (90 minutes) covering the complete content of the module at the end of the semester. A make-up exam will be offered during the following semester.

Individual research projects

in:

- mechanical engineering (numerical or experimental design)
- plastics engineering (numerical or experimental design)
- mechatronics (numerical or experimental design)

Content:
The exact topic will be discussed individually. Overall, our research projects aim at teaching the following skills:

- Introduction into research methodologies
- Working on state of the art research questions
- Coming up with a research strategy
- Carrying out research work
- Presenting the results
- Understanding the project roles, phases and workflows
- applying the work package definition and assignment
- applying modern methods of project management and engineering
- applying professional team communication techniques
- transfer of the project management and engineering techniques into new project scenarios

Credits and Workload: up to 10 credits, project work includes regular meetings with the instructors
Examination/Assessment types: • project presentation (30 minutes) and report • milestone review • regular attendance

For questions about the classes and research projects, please turn to Professor Brita Pyttel: brita.pyttel@h-da.de.