EMIG SUMMER SCHOOL 2022
Engineers Made in Germany

HS PF

SYLLABUS

COURSE BLOCK B **Emerging Technologies and Innovative Laser-based Production Facilities**

COURSE **Innovative Laser-based Production Facilities**

15 contact hours (as a part of 45 contact hours for the course block B)
3 credits (in total for the course block B)

LECTURER

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OVERVIEW

Innovative Laser-based Production Facilities play a significant and further increasing role in advanced automotive production. This can be explained through their various advantageous properties, such as high processing speeds or low heat inputs to the work pieces. On the other side high path-accuracies are requested for their successful operation in production.

Educational objective is a basic understanding of laser technology, laser materials processes and high-accuracy applications of robot-based production machineries. This will offer the capability to plan and to technologically accompany implementations of innovative laser-based production facilities in production.

Focus will be on: Industrial robots and their path-accuracy properties. Strategies to optimize path-accuracy. Lasers and laser-specific components of innovative laser-based production machinery. Welding and cutting for B-I-W. Welding, cladding, hardening for powertrain parts. Materials processes for the car interior.

The lecture includes the possibility of supplementary practical demonstrations in the lab for the participants.

PREREQUISITES

Basic knowledge in Manufacturing Engineering. Basic knowledge in Optics, as taught in introductive lectures of Physics.

LEARNING OBJECTIVES

By the end of the course students…

- understand the increasingly important role of robots with high path-accuracy properties as a base for innovative production facilities
- understand the strategies to increase and optimize a robots path-accuracy
- understand the fundamental properties of laser beams and their influences on laser materials processes
- understand the technologies and operating modes of important materials processes
- understand the innovative potential of presented innovative application examples
- are able to adapt the knowledge extracted out of the presented application examples in future construction or manufacturing planning and optimizing processes they will face
- are able to accompany or participate in processes of planning, selecting or procurement of innovative laser-based production machineries

COURSE TOPICS

- Fundamentals of production machinery types, with a focus on robot based machinery
- Path accuracy of robots - typical properties and strategies to optimize accuracy
- Fundamentals of lasers and laser materials processes
- Typical setup of innovative laser-based production machinery
- Technologies and application examples of Laser welding, cutting, drilling, marking, deposition welding (cladding), hardening
- Demonstrations in the laser-lab: machinery components, processing results

TEACHING AND LEARNING APPROACH

The teaching and learning concept is divided into **three phases**.

In **Phase I** the students gain important fundamental knowledge concerning innovative production machinery based on robots and path-accuracies of robots as well as of lasers and properties of laser beams. The lecture content is selected and customized on fundamentals which are especially important to understand the need of path accuracy in laser-based production machinery due to the technologies and operating modes of the laser materials processes presented in Phase II.

In **Phase II** technologies and operating modes of the most commonly used and most important laser materials processes are presented. The gained knowledge will lead to the ability to appropriately choose or optimize laser materials processes for an application. The

presented innovative materials processing examples are helpful to potentially create new thoughts and ideas in developments of production processes on new products. Based on that understanding, the construction and operation of laser-based innovative production facilities are presented and can be understood.

With demonstrations in the laser applications laboratory (**Phase III**) the practical side of laser materials processing is presented. Laser machinery components and attainable results of different laser materials processes are shown in real in order to enable students to see, smell, and feel the theoretically learned content and broaden their knowledge in a practical manner.

COURSE MATERIAL

Lecture notes.

FINAL EXAMINATION

There will be two written closed book exams on the course block B. Each of the two subjects will be covered by a 60-minutes exam. The overall grade of Block B is then calculated from the individual scores of the individual results.

Students will be prepared throughout the course on the relevant topics. The exam will be based on the topics discussed in class. Topics that have not been discussed in class although they can be found in the lecture notes are not relevant for the exam. On the other side topics that were discussed in class although they cannot be found in the lecture notes are relevant.

Students who attend the course will be well-prepared for the examination. For this purpose a list of sample questions will be handed out to the participants.

GRADING

Students will be graded on a scale of
A = excellent, B = good, C = average, D = below average, F = fail.

PLANNED SCHEDULE

	Contact hours	Content
Session 1	**1-2**	• Introduction • Fundamentals of production machinery types • Trend of further increased employment of robots • Technological fundamentals of robots
Session 2	**3-4**	• Fundamentals of robots for precision applications • Path accuracies of robots - strategies for improvement
Session 3	**5-6**	• Laser materials processes - Introduction of a challenging field towards accuracy and dynamics of production facilities • Laser fundamentals: laser beam generation, beam focusing quality
Session 4	**7-8**	• Laser beam guidance to the workpiece • Laser beam focusing and monitoring • Types of laser machineries for production • Sensors for path guidance along workpieces
Session 5	**9-10**	• Welding with laser - process variants and innovative applications • Welding with laser - specific knowledge for applications in B-I-W production
Session 6	**11-12**	• Cutting with laser – process and innovative application examples • Cutting with laser - specific knowledge for applications in B-I-W production • Drilling with laser • Marking with laser
Session 7	**13-15**	• Other laser materials processes and applications in production • Demonstrations in the laser applications laboratory

TEACHING PHILOSOPHY

My aim is to establish a fundamental comprehension for the typical topics in high-accuracy robot applications in production facilities and on laser materials processes and machineries.

Comprehension questions and comments with a contribution to the learning effect to all students are always welcome and should be raised immediately. The purpose is that you complete the course successfully. Nevertheless you have to do the essential part of the work and hence your success is down to your own personal responsibility.

Being able to follow the technological arguments and also participating in the discussions on questions which arise within the lectures are fundamental for a clearer understanding of the subject matter.

Large class sizes comprising of foreign students imply a risk of a high noise level, which could have a strong negative influence on work climate, knowledge acquisition and collaboration. A high noise level is predominantly caused by a few group members. These ‘troublemakers’ hinder the other ones from being able to concentrate and therefore won’t be tolerated and will be ejected from the class.