Syllabus

BAE4712 Future Oriented Business Concepts

Prof. Dr. Carlo Burkhardt, Prof. Dr. Roland Wahl

Summer Semester 2024

Level	Bachelor	
Credits	3	
Student Contact Hours	2	
Workload	90 hours	
Prerequisites	Fundamental Knowledge in MEN1340 and MEN2360 Manufacturing Technology I and II	
Time	s. LSF / Thursday, 09:45 – 11:15 (Course Part Laser Materials Processing)	
Room	s. LSF / T2.4.10 (Course Part Laser Materials Processing)	
Start Date	s. LSF	
Lecturer(s)	**Name**	Prof. Dr. Carlo Burkhardt Prof. Dr. Roland Wahl
	Office	T1.1.05 (Prof. Burkhardt) T1.3.24 (Prof. Wahl)
	Virtual Office	Virtual Office Prof. Burkhardt Virtual Office Prof. Wahl
	Office Hours	Wednesday, 09:00 – 10:00 (Prof. Burkhardt) Friday, 13:45 – 15:15, alfaview or T1.1.28 (Prof. Wahl)
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Summary

The course consists of 2 parts:
Part "Additive Manufacturing" – Lecturer Prof. Burkhardt (see descriptions below)
Part "Laser Materials Processing" – Lecturer Prof. Wahl (see descriptions below)

Course part: Additive Manufacturing

The course – a combination of lecture, workshops and case studies - provides an advanced knowledge in Additive Manufacuring.

Since the market launch of AM systems in the 1990s, they have been used for the production of single pieces or small series with a steadily increasing tendency. This is mainly due to the fact that the AM does not require any tools or moulds. Since the 3D file serves as a direct template for the component, the manufacturing process can be accelerated considerably. With increasing complexity of the component, through extended form or function, the use of AM becomes even more important. Complex designs, which can only be manufactured with conventional systems with a great deal of effort, can usually be realized many times more easily with AM systems..

Measured by sales figures and media reports, AM of metals is in a phase of hypes. The volume of AM equipment sold for metals in 2016 was an estimated USD 540 million, with growth of 18% predicted for the coming years. The consumables market was 2016 approximately USD 120 million, with further growth of 15% expected here as well. The metal AM market is distributed as follows: 38% in the USA, approx. 20% in Europe with a focus on Germany, followed by China and Japan with approx. 10% each. This distribution clearly shows that the use of additive manufacturing, contrary to the prevailing trend, is shifting production back to economic areas with higher personnel costs.

In addition to the predicted growth rates, current investments of well-known companies show the importance of metallic 3D printing in future production. The US Start Up Desktop Metal, for example, secured a financing of approx. 300 million USD with a participation of Google Ventures and BMW . With the acquisition of Arcam and Concept Laser, General Electric secured access to AM technology and invested approximately USD 1.4 billion. Siemens and Airbus announce that they will continue to focus more intensively on 3D printing in the future. The voestalpine Group is also increasingly concentrating on the research and development of new powder materials and has set up its own research center in Düsseldorf for this purpose.

In this context, the lecture intends to provide a comprehensive guidance to understand existing additive manufacturing methods to identify possible applications, existing boundaries and hindrances as to evaluate where additive manufacturing is a possible, cost effective alternative manufacturing method to existing systems.

Course part: Laser Materials Processing

The course – a combination of lecture and case studies - provides an advanced knowledge in Laser Materials Processing.

Learning objectives are:

Students have knowledge of important properties of laser beams for effective laser materials processing, especially focussability and beam quality.

Students have knowledge of the basic principles of laser beam guidance, forming and focussing under production circumstances.

Students have knowledge of the processing techniques for the most important and common laser materials processes.

Students have knowledge of important and advanced concepts of employing laser technology in very efficient and cost saving ways in production, e.g. beam-splitting, scanning, robot-scanner-combinations.

Way to reach objectives:

The lecture intends to provide a comprehensive guidance to understand existing laser materials processing devices, machinery and processes.

By understanding the ways of beam and material interaction possible applications as well as existing boundaries and hindrances can be identified and clearly understood.

By understanding the setups and properties of laser machineries tendencies of cost situations can be clearly understood.

Outline of the Course

Course part: Additive Manufacturing

- Overview Additive Manufacturing (AM) Methods
- Metal AM
- Comparison of AM methods with respect to tolerances, material properties and cost effectiveness
- AM manufacturing and value chain considerations
- Quality Assurance in AM
- AM Case and design study

Course part: Laser Materials Processing

- Fundamentals: Laser beam sources for materials processing, beam characteristics, beam transport via fibers, focusing.
- Laser materials processes: Welding, brazing, cutting, hardening, cladding, drilling, marking. All laser materials processes are described in their function, attainable results and application examples.
- Machineries for laser materials processing: Laser materials processes often allow high feed rates in manufacturing. To take advantage of this in applications in production often advanced machinery has to be employed. Contemporary advanced machinery is described (e.g. robots with scanners or sensors).

Course Intended Learning Outcomes and their Contribution to Program Intended Learning Outcomes / Program Goals

Program Intended Learning Outcomes		Course Intended Learning Outcomes
	After completion of the program the students will be able…	After completion of the course the students will be able…
1	**Expert Knowledge**	
1.1	...to demonstrate their solid key knowledge in Technical Basics.	...to identify future technologies and production concepts in a holistic view of technical, logistical and business aspects.
1.2	...to demonstrate their solid key knowledge in Mechanical Engineering.	...to identify future technologies and production concepts in a holistic view of technical, logistical and business aspects.
1.3	…to demonstrate their distinguished and sound competencies in General Business Administration.	...to identify future technologies and production concepts in a holistic view of technical, logistical and business aspects.
2	**Digital Skills**	
3	**Critical Thinking and Analytical Competence**	
4	**Ethical Awareness**	
5	**Communication and Collaboration Skills**	
5.1	...to express complex issues effectively in writing.	..to prepare Presentations regarding current and future technologies, as well as production concepts, to present and discuss.
5.2	...to demonstrate their oral communication skills in presentations.	..to prepare Presentations regarding current and future technologies, as well as production concepts, to present and discuss.
5.3	...to work successfully in a team by performing practical tasks.	...to discuss issues in groups; teamwork and project management.
6	**Internationalization**	
6.2	...to articulate themselves in a professional manner in international business.	...to present complex aspects of future oriented Production Conepts in a structured way in English.

Teaching and Learning Approach

Course part: Additive Manufacturing

The teaching and learning approach is based on 3 didactical methods:
The theoretical key knowledge and the basic concepts are thought at the lecture. The students gain the methodology and the guidance to know and to implement the introduced concepts and tools. Questions and comments of the students are welcome during the lecture.
After the lecture the students should reflect and sum up the content of the lecture based on course materials provided.
The theoretical knowledge is enlarged and converted into a practical role by workshops and case studies. An active participation in class is an important part of the teaching and learning approach.
The students can always communicate with the instructor and get support and advice by talking or mailing.

Course part: Laser Materials Processing

The teaching and learning approach is based on 3 didactical methods:
The theoretical key knowledge and realized practical applications in production are taught in the lecture. The students gain the methodology and the guidance to know and to implement the introduced contents. Questions and comments of the students are welcome during the lecture.
After the lecture the students should reflect and sum up the content of the lecture based on course material provided.
The students can always communicate with the instructor and get support and advice by talking or mailing.

Literature and Course Materials

Class handouts will be available in the LMS.

Assessment

There is a written **exam** at the end of the semester.

Grading, based on exam results:
'Sehr gut' represents exceptional work, far above average.
'Gut' represents good work, above average.
'Befriedigend' represents average work.
'Ausreichend' represents below average work with considerable shortcomings.
‚Mangelhaft' is just exceptional work in the wrong direction or with unacceptable shortcomings.

Course part: Additive Manufacturing

Basically, the following requirements will be graded each separately, and on that basis an average grade per person will be built by the professor:
Active general participation during lectures, and especially in brainstormings, workshops, and case studies.
Individual roles prepared and actively performed in group(s) during workshops and case studies, as defined by and agreed with the professor.
Individual or group voluntary activities/ presentations, as required by or agreed with the professor – as far as reasonably possible.
Maximum 2 lectures (90 minutes each) missed during the course. More absence must be agreed with the professor and be compensated.

Course part: Laser Materials Processing

Basically, an individual grade per person will be built by the professor on base of the written answers in the exam, see above.

Schedule

Course part: Additive Manufacturing

Date	Theme
Lecture 1	Topic Introduction
Lecture 2	AM methods for polymeric materials
Lecture 3	AM methods for metals
Lecture 4	AM manufacturing chain/value chain
Lecture 5	AM quality assurance
Lecture 6	Indirect metal AM
Lecture 7	Case Study
Lecture 8	Exam preparation, Q&A

Changes tba

Course part: Laser Materials Processing

Date	Theme
Lecture 1	Topic Introduction. Danger potentials of laser beams.
Lecture 2	Beam quality and focusing of laser beams
Lecture 3	Elements for guidance and focusing of laser beams. Absorption at metals and plastics.
Lecture 4	Laser machinery types for future oriented production concepts
Lecture 5	Laser welding (1)
Lecture 6	Laser Welding (2), Laser cutting
Lecture 7	Laser drilling, marking, deposition welding, hardening

Changes tba

Academic Integrity and Student Responsibility

N/A

Code of Conduct for Students

Link to the Code of Conduct for online Teaching

Teaching Philosophy

Course part: Additive Manufacturing

In the classes we consider the important concepts, models, principles and phases of strategic and operational management and apply them on a real world situation. I will assist you to develop a self-contained strategic thinking, based on the acquired basic skills, and to evaluate the opportunities and the threats of different strategies and management methods. When not understanding a learning step, you should pose a question during the lesson. I want to support every student who is committed to take the required knowledge and to pass the exams successfully.

Course part: Laser Materials Processing

To give an introduction into a new field of High-Tech which was not mentioned before during the candidates study, like here the field of laser materials processing, the presented lesson should always come along with lessons in lecture style. Following this philosophy of mine, my contents of this course are subsequently presented in lectures.

Nevertheless, the successful participation at this lecture should enable the students to use the acquired knowledge in later practical use cases in production as well as in development. Therefore, all lecture contents are presented oriented to typical use cases in the students later business lives.

Additional Information

Language: English

Course part: Additive Manufacturing

Further details to be announced via e-learning (sign in and check regularly)

Course part: Laser Materials Processing

Further details to be announced via e-learning (sign in and check regularly)