Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

Efficient Process Chains 5 ECTS

Lecturers: **A. Schubert**

Lectures: 30h | Tutorials: 30h | Labs: 0h | Project: 0h | Autonomy : 90h | Lang. :

Objectives

The objectives of this course are to provide the students with an understanding of the fundamentals and approaches in the development of resource efficient processes and process chains. After giving an overview of methods for the structuring of manufacturing processes as well for technology planning and manufacturing planning, the course will explore select cutting, abrasive and forming processes with examples from threading, hard and non-circular turning, deep hole drilling, dry machining, and deburring. These manufacturing processes will be analysed and compared regarding their efficiency in the context of the whole process chain. Furthermore, the process chains and operating materials for the manufacturing of rotationally symmetric and prismatic workpiece especially in mechanical engineering and automotive are explained and detailed based on specific examples.

Keywords: manufacturing, process chains, efficiency

Programme

The module comprises detailed information concerning:

1. Basics of process chains
2. Resource efficiency and sustainability in manufacturing processes
3. Development of process chains
4. Efficient technologies / efficiency influence
5. Examples of efficient process chains
6. Trends in manufacturing technology

Prerequisites

In order to successfully achieve this course, the students must have:

- good knowledge in manufacturing processes and manufacturing technology

Learning outcomes

After attending this course, the student will:

- Be able to explain the need for improving the efficiency of process chains
- Be able to explain the fundamental structure of process chains from raw stock to workpiece for manufacturing rotationally symmetric and prismatic workpieces by means of workflow charts
- Be able to analyse existing process chains with regard to their potential for optimization
- Be able to develop solutions for increasing the efficiency of a process chain

Assessment

2h written examination

References

H. K. Toenshoff, B. Denkena: Basics of Cutting and Abrasive Processes. Berlin Heidelberg: Springer-Verlag, 2013 (1. Edition)

G. Schuh, R. Neugebauer, E. Uhlmann: Future Trends in Production Engineering - Proceedings of the First Conference of the German Academic Society for Production Engineering (WGP) Berlin, Germany, 8th-9th June 2011. Berlin Heidelberg: Springer-Verlag, 2013 (1. Edition)

C. Schmidt: Planning of Eco-efficient Process Chains for Automotive Component Manufacturing. Cham: Springer-Verlag, 2021 (1. Edition)

Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

Instrumentation 5 ECTS

Lecturers: **S. Odenwald**

Lectures: 15h | Tutorials: 0h | Labs: 30h | Project: 40h | Autonomy : 65h | Lang. :

Objectives

The Objective of this course is to enable students to analyse the interaction of moving humans and artificial agents (e.g. in collaborations with robots) or objects (e.g. exoskeletons). This covers the needs of future manufacturing, which is characterized by hybrid teams of humans and technology of various kinds. To design the technology to really be a supportive, the interfacing motions, forces, pressures etc. must be recorded in real situations with appropriate equipment and methods for least influence on the natural interaction. The course will therefore cover:

- Available sensor technologies and their fitness for measuring human-technology interaction
- Selection process for the components (hardware and software) to solve specific measurement tasks
- Mathematical methods for data analysis and representation of contained information
- Hands-on experience with latest measurement systems for motion, force, vibration etc
- Virtual Testing – how to move subject-testing in the virtual realm

Keywords: manufacturing, sensors, measurement, data analysis

Programme

1. Introduction to sensor technologies – working principles and application
2. Sensor set-up and data recording with human subjects
3. Experimental methods for force and pressure measurement
4. Experimental methods for motion analysis
5. Introduction to virtual testing and related opportunities

Prerequisites

None

Learning outcomes

After attending this course, the student will:

- Be aware of the basic principles for the selection of sensors and data acquisition systems to measure physical and mechanical parameters of human motion
- Know and be able to use relevant analysis methods and corresponding software
- Be aware of the specific requirements for designing a measurement system be able to apply them to solve an individual measuring task

Assessment

Scientific poster on one of the module topics (size: A0, processing time 4 weeks) with 30-minute defense (5-minute presentation and 25-minute discussion)

References

D. Powell, Y. Celik, D. Trojaniello, F. Young, J. Moore, S. Stuart, A. Godfrey, (29219 Digital Health, Chapter 2 - Instrumenting traditional approaches to physical assessment, Editor(s): A. Godfrey, S. Stuart, Academic Press, Pages 27-42, ISBN 9780128189146

F. K. Fuss, A. Subic, M. Strangwood, R. Metha (2015) Routledge Handbook of Sports Technology and Engineering, Routledge International Handbooks, Pages 43-58, ISBN 978-0-415-58045-8

Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

IT-supported Evaluation of Material Flows and Process Chains — 5 ECTS

Lecturers: **A. Schmidt**

Lectures: 0h | Tutorials: 0h | Labs: 0h | Project: 30h | Autonomy : 120h | Lang. :

Objectives

Interdisciplinary case studies to be worked on in small groups, in which application and consolidation of the acquired knowledge regarding the evaluation of material flows and process chains takes place and the problem-related knowledge and skills as well as the use of suitable software tools are deepened independently.

Keywords: material flows, process chains, evaluation, software tools

Programme

1. Introduction
2. Case Studies in groups
3. Presentations and discussions

Prerequisites

Basic knowledge of material flows and process chains

Learning outcomes

After attending this course, the student will:

- Be able to apply theoretical knowledge of material flows and process chains to real scenarios
- Be able to evaluate material flows and process chains using suitable software tools
- Be able to present and discuss research findings as well as to moderate discussions

Assessment

Written paper (10 to 15 pages) and 15 minute presentation of the case study

References

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Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

Digital Manufacturing 5 ECTS

Lecturers: **P. Klimant, M. Lorenz, M. Putz**

Lectures: 30h | Tutorials: 0h | Labs: 30h | Project: 0h | Autonomy : 90h | Lang. :

Objectives

One of the characteristics of modern industrial production is the intensive use of information and communication technology based on intelligent and digitally connected systems. This course provides students with fundamental knowledge of a digitalized and connected production as part of the value chain and illustrates corresponding fields of application. Essential components of digital production and their usage in the context of Industry 4.0 covered in this course include

- the machine (NC/CNC as well as CAD/CNC process chain, production systems as cyber-physical systems, control types, MDE and DNC systems),
- the use of virtual and augmented reality in development and production, and
- models and methods of digital factories and virtual commissioning.

Lab work complements the lectures in individual areas and field trips to selected companies provide additional insight into the practical application of digital and connected production.

Keywords: smart manufacturing, XR, virtual commissioning, digital factory, CAD, CNC, CPS

Programme

1. Introduction to the context of Digital Manufacturing
2. Methods for smart manufacturing processes
3. Overview of Digital Factory concept focusing the human-factor and data
4. Modern CAx technologies focusing CAD to CNC process chain
5. Virtual commissioning for a better product design process
6. XR (Extended Reality) Technologies for manufacturing

Prerequisites

In order to successfully achieve this course, the students must have:

- Good knowledge in manufacturing processes
- Good knowledge in control engineering
- Good knowledge in CAD

Learning outcomes

After attending this course, the student will:

- Be able to describe the functioning of a NC axis and the reference points within the operating range of a machine tool
- Be able to manually develop NC programs for geometrically simple parts
- Be able to explain realistic CAD/CAM(NC) process chains
- Be able to adapt CAD models for use in XR applications
- Be able to differentiate methods and aspects of the digital factory
- Be able to apply virtual commissioning to a product development process

Assessment

90 minutes written examination

References

“Machining - Fundamental and recent advances” - Springer - J. Paulo Davim
“Practical Guide to Digital Manufacturing “ - Springer - Zhuming Bi
“Digital Twin For Smart Manufacturing” - Academic Press - Rajesh Dhanaraj et al.

Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

Machining Technologies 5 ECTS

Lecturers: **M. Dix**

Lectures: 15h | Tutorials: 15h | Labs: 30h | Project: 0h | Autonomy : 90h | Lang. :

Objectives

The objective of the course is to transfer advanced knowledge of machining to the students. Based on the fundamentals of the processes, the design of efficient processes is focused on the target-oriented selection of the critical system variables and the determination of the process parameters. Tool selection and the specific determination of cutting parameters are the key aspects. The knowledge transfer into practice takes place on specific process examples of CNC machining. Students will be able to independently design and implement turning, milling and processes. Finally, the trends in machining are discussed.

Keywords: cutting process design, milling, turning, water jet cutting, CNC machining

Programme

1. Introduction to process principles of machining
2. Design of efficient processes based on critical variables and process parameters
3. Target-oriented selection of critical system variables (e.g. tool selection) and determination of process settings (e.g. cutting parameters)
4. Experimental methods for design and implementation of turning, milling, waterjet cutting
5. Methods for cost and quality optimization of milling processes

Prerequisites

In order to successfully achieve this course, the students must have:

- Good knowledge in manufacturing processes

Learning outcomes

After attending this course, the student will:

- Be able to select machining procedures and parameters for efficient machining,Be able to manually develop NC programs for geometrically simple parts
- Be able to select system variables such as tools and clamping devices in relation to the defined machining element workpiece properties,
- Be able to determine process parameters in a targeting manner,
- Be able to calculate relevant in-process parameters and also to control the process results,
- Be able to optimize milling processes in terms of cost and quality criteria,
- Be able to discuss the current trends in machining.

Assessment

2h written examination

References

“Machining - Fundamental and recent advances” - Springer - J. Paulo Davim
“Applied Machining Technology” – Springer – Heinz Tschätsch

Semester 3

TECHNISCHE UNIVERSITÄT CHEMNITZ

Composite-based Hybrid Technologies — 5 ECTS

Lecturers: **D. Nestler, K. Roder, J. Stiller, S. Pieper, J. Winhard, K. Jahn**

Lectures: 30h | Tutorials: 15h | Labs: 0h | Project: 0h | Autonomy : 105h | Lang. :

Objectives

Cost efficient large-scale technologies for manufacturing hybrid composite components are essential for the industrial use of lightweight materials. The course will therefore focus on

- the categorization, structure and manufacturing of composite materials
- how to incorporate fibers, textile structures and polymer matrices in fiber-reinforced plastics based on their reinforcing effect, strength behavior, and utilization of fiber substance
- efficient technologies for manufacturing preforms and components made from thermosetting and thermoplastic polymer matrix composites
- the processing of polymer matrix composites in mixed constructions and hybrid structures
- the recycling of composites and compounds
- the testing methods of composites and the micromechanical calculations

The course also includes the manufacturing and testing of a textile reinforced thermosetting preform and the Demonstration of technologies for textile-reinforced thermoplastic components.

Keywords: Light weight structures, Textile Preforms, Polymer Matrices, Composites, Mixed Constructions, Hybrid Compounds

Programme

1. Introduction to composite-based hybrid technologies
2. Lightweight Structures
3. Fibers
4. Textile Preforms
5. Polymer Matrices
6. Fiber reinforced Thermosets
7. Fiber reinforced Thermoplastics
8. Mixed Constructions and Hybrid Compounds
9. Characterization and tests

Prerequisites

None

Learning outcomes

After attending this course, the student will:

- Be able to explain the structure and use of composites and hybrid compounds
- Be able to explain the technologies for manufacturing and processing composites and hybrid compounds including the resulting component properties
- Be able to develop high-performance lightweight components

Assessment

90 minute written examination. In order to be able to attend the examination, the student will have to successfully complete 2 assignments in the tutorials

References

Åström, B.T., Manufacturing of Polymer Composites, Chapman & Hall, London 1997
Gutowski, T.G., Advanced Composites Manufacturing, John Wiley & Sons, Inc. New York 1997
D. Hull, T. W. Clyne:, An Introduction to Composite Materials, Cambridge University Press
Jones, F. R., Handbook of polymer-fibre composites. Harlow: Longman Scientific & Technical.