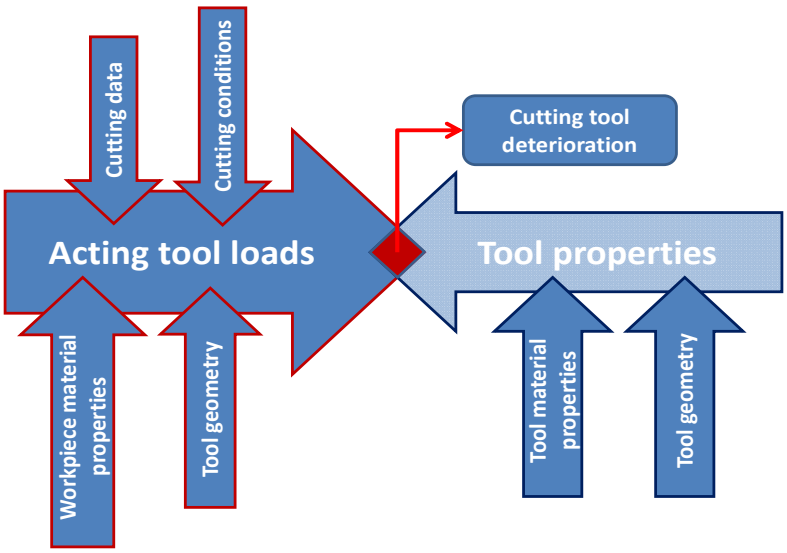
Lund 2014-12-21

National PhD and expert Course in
Production Science a part of Produktion2030

Advanced Metal Cutting – MMT 220

Professor Jan-Eric Ståhl, Lund University

Advanced Metal Cutting – MMT 220, 7.5 hp	
Main content: 1. Introduction to metal cutting 2. Basic principles 3. Mechanical analysis 4. Thermal analysis 5. Tribological analysis 6. Chip formation 7. Machinability 8. Tool materials and tool deterioration 9. Economic aspects in metal cutting operations	
Examiner	Jan-Eric Ståhl, Lund University, jan-eric.stah@iprod.lth.se
More information	Jan-Eric Ståhl jan-eric.stah@iprod.lth.se
Site and dates	Lund, 2015: 28/1-30/1, 16/2-18/2 and 10/3-11/3 or 12/3-13/3
Main teacher and examiner	Jan-Eric Ståhl was appointed as Associate Professor and full professor at the Department of Mechanical Engineering, Lund University, Sweden in 1987 and 1990 respectively. His research has been characterized by an inclusive approach that led into adjacent disciplines such as materials technology, measurement and signal processing, and thermodynamics. Over the past 10 years he has been focusing on quantifying economic values of research and development through the use of engineered techno-economic models that describe the important link between technology and economy. Jan-Eric Ståhl initiated and started up the Swedish Production Academy in 2006 and has been president for two terms.
Pictures of Teachers	 Prof. J-E Ståhl  Doc. V Bushlya  Prof. J Zhou  Dr. F Schultheiss

Lunds universitet

PRODUKTION2030

Target group	The course is targeted at professionals and doctoral students who want to attain a deeper understanding of machining processes.
Overall Course Goal	Through better understanding of today's forefront of machining research the participants will be better suited to both implement and contribute to the continued development of the field of machining processes.
Higher Education	7.5 hp
Ingress Short	The course has a strong affiliation with the research and gives more in-depth knowledge in the field of metal cutting, at a level that touches on the research front.
Summary and aims	Analysis of production and production development of machining systems based on KPI numbers. Basic principles of metal cutting. Mechanical analysis and modeling, cutting resistance, load functions and variation numbers. Cutting force measurement and development of equipment for cutting force measurements. Thermal analysis and modeling. Stress analysis of cutting tools. Tribological analysis of surfaces in contact and contact relations in the cutting process. Archards modified wear equation and Colding equation. Mechanics of chip generation and process dynamics and segment formation. Vibrations and instability as well as process damping. Micro geometries and its influence on cutting process with respect to vibrations and mode-locking. Tool properties for different application areas. Tool material and tool deterioration regarding cracking, chipping, breakage and deformation. New potential high-performance cutting materials are processed in connection with the future challenges in metal cutting are discussed. Micro- and macroeconomic models for evaluation and simulation of the cost outcomes.
Learning out-come	➢ Be able to describe the basic principles in metal cutting. ➢ Be able to evaluate and describe the acting tool-loads with respect to mechanical, thermal and tribological effects. ➢ Understand and be able to do simple calculations that describe the interaction between tool stress conditions, tool geometry and the tool material properties. ➢ Able to design cutting tests for specific purposes such as assessment of the tool life-time, plastic deformation and fracture behavior of cutting tools or assess workpiece materials machinability in one or more applications. ➢ Generally be able to analyze a cutting process and allocate development paths for cutting tool and work materials that allow for increased quality and reduced processing costs. ➢ Have insight on the measurement principles for measuring static and dynamic cutting forces and tool movements. ➢ Have insight on current research issues in the area of metal processing.
Course content in h	**Lectures:** 32 h **Exercises:** 2 h (40 h home work) **Laboratory works:** 8 h (3+3+2) / Total with teacher 42 h. **Home exam:** 15 – 30 h and home work: 40 – 80 h

Expected pre-knowledge	Advanced course or experience in production on master level.
Registration info	**Contact:** Jan-Eric Ståhl jan-eric.stah@iprod.lth.se
Examination	The course will be examined through the completion of **4 assignments** and 3 **laboratory works** including written reports as well as an individual written **home exam** at the end of the course. The participants are compiled to attend 80 % or more of the scheduled time.
Literature	Metal cutting – Theories and models, 2012 Jan- Eric Ståhl in cooperation with Seco Tools ISBN 978-91-637-1336-1
Limiting number of participants	25
Detailed Course Structure/ Class sessions	**First meeting** **Day 1: 2015-01-28** 13:00-15:00 Fundamental introduction to industrial development and the connections between technology and economy. Focus on the machining process technical results that affect manufacturing economy and how these results are analyzed industrially. 15:00-17:00 Overall material classification from a general perspective. Materials technology from a machining perspective, the influence of the material selection on the machinability and the interaction with other method groups such as casting, forging and joining (welding). **Day 2: 2015-01-29** 9:00-10:00 Introduction to metal cutting and basic definitions. 10:00-17:00 Fundamental principles and definitions: - Classification of cutting processes. - Cutting- and process data. - Tool geometries. - Application areas for metal cutting. - Theoretical surface roughness during machining processes. - Deformation zones during machining. - Chip thickness parameters. - Stagnation point and minimum chip thickness. - Maximum chip thickness. **Day 3: 2015-01-30** 09:00-12:00 Mechanical analysis of the machining process: - Static cutting forces and their measurement. - Modeling of cutting forces.

- Cutting resistance and specific cutting force.
- Dynamic cutting forces.

Second meeting

Day 1: 2015-02-16

13:00-15:00
Mechanical analysis of the machining process:
- Intermittent machining processes.
- Dynamic effects during intermittent machining.
- Tool stresses.

15:00-17:00
Thermal analysis of the machining process:
- Energy development during the machining process.
- The adiabatic temperature.
- The temperature of the machining process.
- Introduction to time dependent temperature fields.

Day 2: 2015-02-17

09:00-12:00
Tribological analysis of the machining process:
- Contact conditions during the machining process.
- Built-up edges, layers and TPL-principles.

Tool wear models and tool life models:
- Introduction to Archard's wear model.
- Taylor's equation.
- Colding's equation.

13:00-15:00
The chip forming process:
- Shear plane and deformation velocities.
- Chip types.
- Process frequencies.
- Critical machining.
- Process damping.
- Chip forming.

15:00-17:00
Workpiece materials and their machinability:
- Machining process related classification of materials.
- Machinability of a workpiece material.
- Polar diagrams for describing the potential machinability.
- Machinability of selected workpiece materials.
- Introduction to surface integrity.
- Introduction to burr formation.

Day 3: 2015-02-18

09:00-10:00 Continuation on workpiece materials and their machinability.

	10:00-12:00 Tool materials and tool wear: - Types of tool degradation. - Properties and principal construction of tool materials. - Types of tool materials and their properties. 13:00-15:00 Economic considerations on the machining process and statistical analysis methods: - Analysis of the machining process through using the production performance matrix. - Classical model for calculating the manufacturing cost during machining operations. - Introduction to manufacturing-economic simulation. - Introduction to statistical analysis of production data through the use of Monte-Carlo simulation. **<u>Third meeting</u>** **Day 1: Group A – 2015-03-10, Group B – 2015-03-12** 13:00-17:00 Experiments and demonstrations practically demonstrating important parts of the course: - Determination of the cutting resistance and specific cutting force. - Study of intermittent machining in respect to engagement and exit while using different tool micro geometries. - Measurement of accelerations and dynamic cutting forces. - Measurement and modeling of tool wear. - Measurement of the nano hardness of both workpiece and tool materials and its implications on the machining process. **Day 2: Group A – 2015-03-11, Group B – 2015-03-13** 9:00-12:00 Continuation on previous day experiments followed by a brief summary and discussion on the obtained results.
Costs and payment	The course is free of charge for **Production2030** PhD-students. The cost of the course is 8.000 SEK for university and research institutes employees. The cost of the course is 16.000 SEK for the industry employees. The complementary literature cost corresponds to 800 SEK.
Travelling directions incl. google map and coordinates	**How to get to Lund:** http://www.lth.se/kontakt/besoek-lth/ Accommodation - see links under 'Boende' **How to find us at the Campus:** Ole Römers väg 1, Lund M-huset, LTH Third floor in the Southern part of the building.

Karta + Boende Ideon Gästeri