

Additive Manufacturing Technologies for metals 7,5 hp

Additiv Tillverkning för metaller, 7,5 hp

Course Code/Codes	50MT038
Subject Area	Mechanical Engineering. The course is also given for students in product development, materials and manufacturing engineering at other Swedish Universities.
School/equivalent	School of Science and Technology. The course is also given for students in the national PhD school Production 2030.
Valid from	2015-12-01
Approved	2015-10-30
Revised	First issue
Approved by	Peter Johansson, Head of school.
Translation to English, date and signature	The course is only described in English. <i>Enter the initials of the person who did the translation.</i>

1 Course content

The course covers the processes that today are in focus for academy and industry, i.e. powder bed fusion (SLM, EBM, ..) and directed energy deposition (wire and blown powder, spray forming). It covers both design, inspection and shape aspects of importance for the different processes. It also give future aspects (industrial and scientific).

The course is directed to methods that are used to manufacture metal components directly.

It will not cover indirect methods aimed at green body manufacturing or manufacturing of sand molds for castings.

The course contains the following topics:

- Introduction to metal AM, incl overview of technologies, materials and inspection methods.
- Manufacturing preparation and design for metal AM, incl cost for analysis of competing technologies, standards.
- Typical applications today, e.g. repair, remanufacturing, prototypes, new designs, etc.
- Each technology pro's and con's, i.e. benefits, special considerations, limitations, etc through theory and lab
 - EBM
 - SLM
 - Blown powder (laser based powder nozzle)
 - Wire deposition
 - Spray forming
- Implications on the production system(s), qualifications, control
- Summary, discussions, future for metal AM.

2 Outcomes

2.1 The course in relation to the doctoral programme

- The course is given in collaboration with Mid Sweden University and University West as a course in the PhD school Production 2030.
- The course aims to give an overview of metal based additive manufacturing methods useful for industrial products.
- The course is primarily targeting doctoral students in production and/or product development who want to gain knowledge in current scientific methods and tools for additive manufacturing of metal components.

The course shall primarily refer to the following intended learning outcomes for third-cycle courses and study programmes as described in the Higher Education Ordinance, i.e. the doctoral student shall demonstrate:

Knowledge and understanding

- advanced and up-to-date specialised knowledge in a limited area of this field (part of outcome 1)
- familiarity with the methods of the specific field of research in particular (part of outcome 2)

Competence and skills

- the capacity to review and assess new and complex phenomena, issues and situations autonomously and critically (part of outcome 3)
- the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively (part of outcome 4)
- the ability to review and evaluate research and other qualified tasks (part of outcome 4)
- the ability to identify the need for further knowledge (outcome 7)

Judgement and approach

- intellectual autonomy and disciplinary rectitude (part of outcome 9)

The intended learning outcomes are listed in the same order as in the general syllabus for the programme.

2.2 Intended course learning outcomes

To obtain a passing grade, the doctoral student shall demonstrate:

Knowledge and understanding of:

- When additive manufacturing is an appropriate choice (geometric shape, series size, material, etc.).
- Properties of different AM processes.
- Different manufacturing equipment.
- Tools for manufacturing preparation, building and inspection.

Skill and ability in:

- Describing prerequisites and capabilities for the different methods.
- Discussing when and how to utilise the different methods and restrictions in the possibilities to use the different methods.
- Discussing research needs and development potential for the respective methods.

3 Reading list and other teaching material

The following course readings and teaching material will be used on the course:

Gibson, Rosen, Stucker. Additive Manufacturing Technologies. Rapid prototyping to Direct Digital Manufacturing. Springer, latest issue,
<http://www.bokus.com/bok/9781493921126/additive-manufacturing-technologies/>

The European roadmap for standardization, SASAM <http://www.sasam.eu/>
Relevant scientific papers will be selected during the course

4 Teaching formats

Teaching on the course takes the following format:

Lectures
Seminars and laborative work
Individual work.

5 Examination

The course is assessed through an examination in the format of

Written and oral reflection and argumentation in the research field of the candidate.
The students will be given a task after each of the four sessions and the examination is based on the performance of all the individual tasks. Each one of these have to be approved.

6 Grades

Examinations on third-cycle courses and study programmes are to be assessed according to a two-grade scale with either of the grades 'fail' or 'pass' (local regulations).

The grade shall be determined by a teacher specifically nominated by the higher education institution (the examiner) (Higher Education Ordinance).

To obtain a passing grade on examinations included in the course, the doctoral student is required to demonstrate that he/she attains the intended course learning outcomes as described in section 2.2. Alternatively, if the course consists of multiple examinations generating credit, the doctoral student is required to demonstrate that he/she attains the outcomes that the examination in question refers to in accordance with section 5.

A student who has failed an examination is entitled to a retake.

If an examination consists of several examination components, and a student fails an examination component, the examiner may, as an alternative to a retake, set a make-up assignment with regard to the examination component in question.

A doctoral student who has failed an examination twice for a specific course or course element is entitled, upon his/her request, to have another examiner appointed to determine the grade.

7 Admission to the course

7.1 Admission requirements

To gain access to the course and complete the examinations included in the course, the applicant must be admitted to a doctoral programme at Örebro University.

The applicant shall be admitted to a doctoral program in Mechanical Engineering.

7.2 Selection

Selection between applicants who have been admitted to doctoral programmes at Örebro University and who otherwise meet the admission requirements as listed above is made according to the following order of precedence:

If no other selection criteria are specified in this section, priority shall be given to applicants with a lower number of course credits left before the award of their degree over applicants with a higher number of remaining course credits. Should two or more students have equal number of credits, selection will be done through the drawing of lots. This also applies within any selection groups listed unless otherwise stated.

7.3 Other applicants than doctoral students admitted at Örebro University

Other applicants than doctoral students admitted at Örebro University may be given access to the course on the grounds of provisions for and/or agreements regarding contracted courses, joint degrees, national graduate schools or cooperation in other respects with other universities.

Any decisions on what such other applicants may be given access to the course are made separately and on the basis of the provisions and/or agreements that occasion the student to apply for the course.

For participation in the course in other respects, the same provisions shall apply as for doctoral students admitted to Örebro University.

8 Transfer of credits for courses, study programmes and other experience

Provisions on the transfer of credits can be found in the Higher Education Ordinance and on the university's webpage.

9 Other information

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In this section, any other information on the course should be provided, e.g.

- if the course or certain course elements will be undertaken at a different location than Örebro,
- if the language of instruction on the course is other than Swedish, or
- if the course is of such a nature that it requires a certain rate of study, e.g. full-time/part-time.

If applicable, enter text here. Otherwise delete by clicking the tab and pressing the delete key three times.

Transitional provisions