Additive Manufacturing: Tools, Materials and Methods

Programme course

6 credits

Additiv tillverkning: verktyg, material och metoder

TFYA88

Valid from: 2017 Spring semester

Determined by
Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study
Applied Physics, Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Biomedical Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Biomedical Engineering, Master's programme
- Physics and Nanoscience, Master's programme
- Materials Science and Nanotechnology, Master's programme

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Thermodynamics at the level provided in a basic course in chemistry, physics, or materials science. Familiarity with material physics, as provided in a course such as modern physics, is beneficial but not required, as is familiarity with at least one CAD program. (CAD instruction will be offered as a brief supplemental course for those who lack training/experience.) Basic laboratory skills. This will be a relatively fast-paced course. Students who are unfamiliar with at least one of the pre-requisites (physics/chemistry/materials science or CAD) may struggle.

Intended learning outcomes

This course will provide a general understanding of additive manufacturing (3D-printing), and detailed understanding of:

- the physics and chemistry involved with the various printing methods, including the material requirements,
- the types of materials appropriate for various printing methods,
- various printing methods, their advantages and disadvantages,
- current and future applications of additive manufacturing.

After completing this course, students will be able to:

- describe several types of 3D printers, their mode of operation, and their strengths and limitations,
- determine which type of printer is most suitable for fabricating a part based on the requirements of the desired product (choice of material, tolerances, etc.), or whether 3D printing is at all a viable option,
- prepare 3D CAD models for creating printed devices (including editing for printer limitations, etc.), and
- confidently produce 3D-printed devices with at least two kinds of 3D printers (after hands-on work in the labs).

Course content

Material properties in the solid, liquid, and other (gel, glass) states. Phase-change processes and chemical reactions, including photo-initiated chemistry. Introduction to digital control of mechanical systems (stepper motors, etc.) Introduction to fluid mechanics, as applied to additive manufacturing. Introduction to surface science, as applied to additive manufacturing. Applications, strengths, and weaknesses of various forms of additive manufacturing including: Mechanical applications (prototypes, mechanical components), chemical and life-science applications (prosthetics, artificial organs, lab-on-a-chip devices, etc.). An introduction to 3D CAD. An introduction to planning/slicing software. Hands-on design, fabrication, and evaluation of fabricated parts.

Teaching and working methods

- Most of the course content is delivered via lectures, primarily because the field is so new and advancing so quickly that no suitable textbook is available.
- A brief introduction to CAD (2-4 hours) is provided during the first week of the course for those who lack experience.
- Each student will be scheduled for 2 laboratory sessions (4 hours each) with 2 different types of printers to obtain hands-on experience, particularly in preparation for the project.
- The course includes a (mandatory) field trip to a company using 3D printers in their business.
- Early in the course, a project is to be proposed (by each student or pair of students) for instructor approval. The student(s) will then execute the project using one of the printers available at the university and summarize the results in a report.

Examination

TEN1	Written examination	3 credits	U, 3, 4, 5
LAB1	Laboratory work	1 credits	U, G
UPG1	Industry visit	0.5 credits	U, G
PRA1	Student project and presentation	1.5 credits	U, G

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Johansson

Examiner

Nathaniel D Robinson

Education components

Preliminary scheduled hours: 38 h
Recommended self-study hours: 122 h

Course literature

Additional literature

Websites

Nathaniel Robinson, *TFYA88*
https://liuonline.sharepoint.com/sites/TFYA88/TFYA88-2017HT/Pages/default.aspx
Review articles and notes available for download (password protected) on the course homepage