Introduction to additive manufacturing

September 9, 2024

Course overview

General

- Teachers and teaching assisants
- Content, motivations and objectives
- Program by chapters

Organization of the course and of the exercises

- General organization, organization of exercises
- Organization of the exam
- Organization of student project
- Agenda

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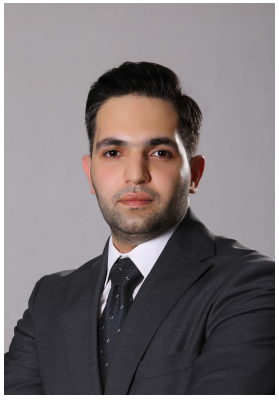

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Introduction to additive manufacturing

Topic: This course is about production processes.

- *It relates specifically to additive production processes also called 3d printing processes.*

Motivations: Additive processes are emerging processes

- *They must be a part of the knowledge of any engineer in **production and development** in particular because they bring innovative solutions to:*
  - *speed up the development phase of a product (time to market),*
  - *manufacture user fitted parts (jewelry, sports, dentures)*
  - *produce innovative designs or improved tools (with additional features)*

Goals: At the end of the course, students

- *will know the principle and applications of standard additive processes,*
- *will understand the nature of their main limitations (low resistance, poor resolution ...) and will assess their consequences,*
- *will have technological skills (management of information, physical understanding of the consolidation principle ...) to master the most common additive processes.*

Introduction to additive manufacturing

Overview:

- ***Part 1****: Overview of additive processes.*
- ***Part 2****: Photopolymer based processes.*
- ***Part 3****: Extrusion processes (FDM, LOM).*
- ***Part 4****: Powder based processes (3dP, SLS).*
- ***Part 5****: Computational aspects of additive processes.*
- ***Part 6****: Energetic aspects of additive processes (laser).*

Organization of the lecture and exercises

Progress

- *The course is divided in* 39 *periods (*13 *weeks,* 3 *periods per week)*
  - 26 — 29 *periods for ex cathedra teaching,* 10 — 13 *periods for personal work (student projects).*
- *The ex cathedra teaching is based on .pdf presentations. The booklet "Introduction to Additive Manufacturing" Nr.149 at vente des cours contains copies of the handouts.*

Exercises

- *Some series of exercises will be placed on the* `moodle` *website. The course number is* `ME-413`*. "Introduction to additive manufacturing".*
- *The exercises will not be solved in class. It is expected that students solve the exercises alone and that they perform a self-correction with the detailed solutions distributed next week. In case of doubt, the contact the TA's or the teachers to roganize a meeting.*
- *The purpose of most of these exercises is to help the students in controlling that they have correctly acquired the course content. They also serve as* ***base material*** *for the exam.*

Organization of the exam

Progress

- *The exam is a written examination, the duration and the rules of this exam will be communicated later on.*

Content

- *The exam will be based on the ex cathedra teaching and on the exercices.*

Mark

- *The mark obtained at the written exam counts for 60% of the final mark.*

N.B. *The other 40% is the mark obtained for the **project**.*

Organization of student projects

Content

- *A project is planned in the program and counts for 40% in the final mark.*
- *This project consists (in principle) of a literature review or of an industry survey.*
- *Typical project topics can be found in the appendices.*

Progress

- *The projects are carried out in groups (maximum of* 18 *groups):*

number of enrolled students:	≤ 72	$73 - 90$	$91 - 108$
number of students per group:	≤ 4	$4 - 5$	$5 - 6$

- *The project will result in*
  1) *an **oral presentation** in front of about one third of the class and one of the three teachers (J.Brügger, C.Moser or E.Boillat) scheduled from beginning of November (three parallel sessions each Monday).*
  2) *a **written report** due at least one week before the presentation.*

(see App. 1, 2, 3, 4)

Organization of student projects - cnt'd

Organization of the presentation

- *The **size of the report** is expected to be around twenty pages (4-5 pages per student),*
- *The **duration of the presentation** will typically be of about 60min (10-15min. for each student). It will be followed by a question session moderated by the teacher of about 15min for a total of 75min.*

Mark

- *The mark of the project will be obtained as the average between a mark for the report and a mark for the presentation.*
- *The mark are individual, in principle*
  - *The subject must be divided and distributed in subtopics among all group members*
  - *In the report the contribution of each member has to be clearly identified in the chapter title:*

`Chapter X written by student Y`

Organization of student projects - end

What you have to do in the followuing weeks

- *Start building groups according to your interest for a subject.*
- *The **deadline** for finalizing the groups, the subjects and the date is 30.09.*
- *Once your group is built (defined subject+defined date) **send an e-mail to***

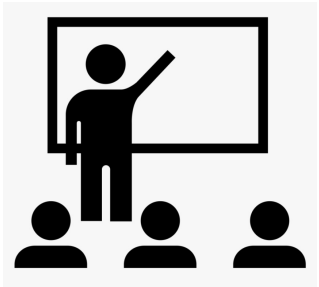
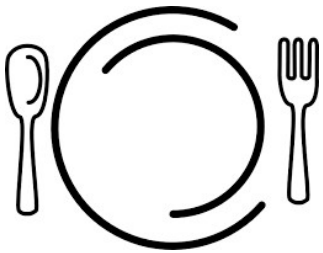
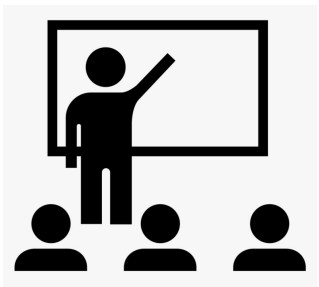
  `eric.boillat@epfl.ch`

  with these informations (people+subject+date).
  - ***One e-mail** per group please with all students in copy,*
  - *Do not register groups of more then **five** students.*
  - *If you are **less then four**, you can already register but, in the meantime, you will have to find one or two additional colleagues and to inform me.*
- ***Be fast:** in principle, each subject can be chosen by only one group and it will be first come first served! A **date** can only be choosen by three groups not more (only three parallel sessions will be organized each Monday).*

Participation to the parallel sessions

- *If you are not presenting, you are nevertheless **expected** to attend one of the parallel sessions according to your interest.*
  It is an opportunity to benefit from your colleagues excellent work and to learn things that can help you in the future (for instance at the exam!).

Proposition for the Monday morning agenda

10h15-11h30		75 *min*
11h30-12h00		30 *min*
12h00-13h00		60 *min*
Total		165 *min*

APPENDICES

A 1: Possible project topics

Overview of additive processes.

GE 1) *History of the additive manufacturing processes.*

GE 2) *Positioning of additive processes with respect to traditional production processes (HSM, EDM).*

GE 3) *New developments in the field of additive processes (new technologies).*

GE 4) *Additive manufacturing processes from the economic and sustainability point of view.*

GE 5) *Energy consumption in additive manufacturing.*

GE 6) *Consumer additive processes: towards domestic 3d-printers.*

GE 7) *Design for additive processes, rules to follow.*

GE 8) *Process optimization by computer and numerical simulation.*

GE 9) *Post-processing (thermal treatment, surface treatment, machining) adapted to additive manufacturing.*

GE 10) *The role of additive manufacturing in industrie 4.0.*

GE 11) *Design for additive manufacturing, topology optimization.*

GE 12) *The use of additive manufacturing in the Swiss industry.*

GE 13) *Drop on demand technologies.*

A 2: Possible project topics - cnt'd

Applications.

PP 1) *Application of additive processes in the medical domain (bio-printing).*

PP 2) *Application of additive processes in surgery.*

PP 3) *Application of additive processes in the dental field.*

PP 4) *Application of additive processes in consumer good manufacturing.*

PP 5) *Application of additive processes for mass manufacturing.*

PP 6) *Application of additive processes in tooling.*

PP 7) *Application of additive processes in micro-technics.*

PP 8) *Application of additive processes in the aerospace domain.*

PP 9) *Additive processes at the (sub)micrometer scale*

Parts certification, standardization, legal aspects

CE-St-L1 1) *Possible diagnoses applicable to additively manufactured parts.*

CE-St-L2 2) *Standardization and norms.*

CE-St-L3 3) *Intellectual property in additive manufacturing, how to avoid piracy and counterfeits?*

A 3: Possible project topics - end

Materials

M 1) *Powder technology (fabrication, characterization, deposition, projection).*

M 2) *Additive processes for metallic materials.*

M 3) *Additive processes for polymer materials.*

M 4) *Additive processes for ceramic materials.*

M 5) *Additive processes for more than one material.*

M 6) *Additive processes for glass materials.*

M 7) *Sustainable materials and processes in AM.*

M 8) *Additive processes using biodegradable materials*

Other projects

- . . .

A 4: Schedule and rooms

(Almost) definitive version

Week	*Date*	*Activity*	*Room*
1)	*09.09*	*Lecture*	*CM1 105*
2)	*16.09*	*lundi du jeûne*	
3)	*23.09*	*Lecture*	*CM1 105*
4)	*30.09*	*Lecture*	*CM1 105*
5)	*07.10*	*Lecture*	*CM1 105*
6)	*14.10*	*Lecture*	*CM1 105*
7)	*28.10*	*Lecture*	*CM1 105*
8)	*04.11*	*Lecture*	*CM1 105*
9)	*11.11*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*
10)	*18.11*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*
11)	*25.11*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*
12)	*02.12*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*
13)	*09.12*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*
14)	*16.12*	*Project+Lecture*	*CM1 105, GR B3 30, GR A 331*