CENTRALELYON ENISE

Basics of production engineering 3 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: C. Courbon

Lectures: 4h | Tutorials: 0h | Labs: 0h | Project: 14h | Autonomy : 36h | Lang. :

Objectives

The objective of this course is to provide the students a general framework about industrialization, i.e. how to design, optimise and organise all technical solutions (feasibility, capacity, and reliability) and product production methods, according to productivity and quality requirements. After various recalls, a systematic method is presented to identify the manufacturing steps, link them considering the various technical, economical or quality constrains and determine the proper manufacturing sequence.

Keywords: manufacturing, industrialization, metrology and control, technical drawing

Programme

1. Introduction to the notion of industrialization
   a. Presentation of the services involved during the development of a product
   b. Notion of functional specifications
2. Recalls on conventional manufacturing technologies
3. Recalls on dimensional product specification, Geometrical Product Specification (GPS) standard and surface topography (roughness, waviness) (filtering ISO 4288)
4. Analysis of a production scheduling problem (case study)
   a. Reading and analysis of a technical drawing
   b. Identification of the tasks/operations to be conducted
   c. Construction of the link map between the tasks/operations
   d. Identification of precedence constrains
   e. Sequencing of the tasks/operations
   f. Determination of the manufacturing sequence
5. Brief introduction to machining fixtures

Prerequisites

- Basic knowledge of manufacturing processes
- Basic knowledge of metrology

Learning outcomes

- To know the basics of product industrialisation.
- Be able to break down a production process into tasks and sub-tasks
- Be able to schedule tasks according to the associated constrains
- Be able to read a technical drawing and identify the key constraints

Assessment

One written exam on a case study

References

All course materials will be supplied in class

Transverse project in manufacturing 2 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **C. Courbon, alii**

Lectures: 0h | Tutorials: 0h | Labs: 0h | Project: 24h | Autonomy : 24h | Lang. :

Objectives

The objective of this course is to provide the students a practical experience combining various manufacturing technologies, from additive to surface finishing processes including material removal or surface treatment methods. An actual industrial issue will be used as a case study and the students will be able to propose solutions integrating all the available manufacturing techniques, conduct experiments on representative samples as well as advanced analyses such as microstructural, residual stresses or tribological performances. Designed as a project course, it also intends to foster team working abilities by organising and sharing tasks in smaller groups, planning the work and presenting the results.

Keywords: manufacturing technologies, additive manufacturing, surface analysis

Programme

1. Introduction of the case study
2. Identification of the needs and targeted objectives
3. Structure and planning of the work
4. Design of the samples and set of experiments to perform
5. Organisation of the experimental campaigns
6. Analysis of the results and possible iteration
7. Presentation of the work done

Prerequisites

- Basics of Production Engineering S1
- Additive Manufacturing S1
- Metalworking processes S1

Learning outcomes

- To know the basics of product industrialisation.
- Be able to break down a production process into tasks and sub-tasks
- Be able to schedule tasks according to the associated constrains
- Be able to read a technical drawing and identify the key constraints

Assessment

One oral presentation and a summary report answering the industrial need

References

All course materials will be supplied in class

Additive Manufacturing — 5 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **Ph. Bertrand, M. Doubenskaia, E. Cabrol, A. Sova**

Lectures: 36h | Tutorials: 0h | Labs: 0h | Project: 0h | Autonomy : 72h | Lang. :

Objectives

Additive Manufacturing is the most common name given to a host of related technologies which are used to fabricate physical objects layer-by-layer directly from Computer- Aided Design (CAD) data sources. The key to how AM works is that parts are made by adding material in layers; each layer is a thin cross-section of the part derived from the original CAD data. The objective is to explain the scientific and technological background of various AM technologies and the corresponding application fields.

Keywords: additive manufacturing, rapid prototyping, rapid tooling, rapid casting.

Programme

1. Process Categories to be discussed: Vat Photopolymerisation; Material jetting by single and multiple nozzles; Binder jetting; Material extrusion; Powder bed fusion; Sheet lamination; Direct material deposition; Hybrid AM.
2. Scaling-up and scaling-down AM processes.
3. Materials applied in AM, properties of manufactured parts.
4. Basic drives: Design complexity; Personalised products; Supply chain realignment; Parts functionality; Low volume production.
5. Market of AM, growth areas, AM equipment.
6. Integral analysis of Selective laser Melting and Laser Cladding including experimental parametric analysis, optical diagnostics and numerical simulation.
7. Cold Gas dynamic Spraying as AM process.

Prerequisites

- Basic knowledge in material science
- General knowledge of laser processes
- General knowledge of thermal spraying processes
- General knowledge of thermal engineering

Learning outcomes

After attending this course, students will:

- Have basic knowledge of AM including corresponding thermo-physical phenomena, different technologies, eventual applications, materials, etc.
- Be able to select an appropriate AM technology, equipment and material to realise chosen industrial objective.

Assessment

2 hours examination without any technical support: written answers on a few questions based on lectures content.

References

I. Gibson, I. D. W. Rosen, I. B. Stucker // Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2014.

G. Gladush, I. Smurov // Laser Processing of Materials: Theory, Experiment Springer, 2011.

M Doubenskaia, A. Domashenkov, I. Smurov, P. Petrovskiy // Study of Selective Laser Melting of intermetallic TiAl powder using integral analysis, International Journal of Machine Tools and Manufacture, Vol. 129, 2018, pp. 1-14.

D. V. Bedenko, O.V. Kovalev, I. Smurov, A.V. Zaitsev, Numerical simulation of transport phenomena, formation the bead and thermal behavior in application to industrial DMD technology, International Journal of Heat and Mass Transfer, Vol. 95, 2016, 902-912.

CENTRALELYON ENISE

Metalworking processes 5 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **J. Rech, F. Valiorgue, C. Courbon**

Lectures: 28h | Tutorials: 0h | Labs: 12h | Project: 0h | Autonomy : 56h | Lang. :

Objectives

The objectives of this course are to make the students able to control a given manufacturing technology using a systematic approach and to make them aware of the future challenges for some key industrial sectors. The module will be divided in two parts: i) the first one, more technologically oriented, intends to review the basics of metalworking operation especially focusing on machining, present a standard and related instrumentation to control such operations; ii) the second part will provide a scientific insight focused on numerical simulation dealing with the needs of modelling in the whole production chain, the requirements to build a numerical model, the characterisation of the main input data with a special emphasis on material removal and finally how to build a numerical approach to predict the surface integrity of a machined part.

Keywords: manufacturing, cutting, control, numerical simulation, tribology, surface integrity

Programme

1. Control of a metalworking operation (10h + labs)
   a. Basic knowledge on machining, cutting tools, cutting materials, lubrication
   b. Introduction to the methods of instrumentation of machining processes
   c. Methods for the control of machining operations (NFE66-520) – application in labs
   d. Extension to metal forming operation (remote lecture by a partner university)
2. Future challenges in manufacturing (18h)
   a. Introduction to the context and needs of numerical simulation
   b. Experimental methods to investigate a metalworking process
   c. Experimental methods to determine the workmaterial constitutive model
   d. Experimental methods to assess the tribological interaction
   e. Input data and methodology for the numerical prediction of surface integrity

Prerequisites

- Basic knowledge of manufacturing processes
- Basic knowledge of material science

Learning outcomes

- Ability to describe the technological solutions associated with a machining operation
- Ability to put a manufacturing process under control
- Ability to identify the causes of non-quality and to suggest solutions
- Awareness of the benefits and requirements of process modelling
- Ability to select a material and tribological characterization technique
- Be able to develop a simple numerical model to predict residual stresses

Assessment

Part 1: 1 written exam based on lectures content, 1 oral presentation and report of the labs
Part 2: Oral presentation on a research related topic based on journal papers

References

"Machining - Fundamental and recent advances" - Springer - J. Paulo Davim

PJ. Arrazola, T. Ozel, D. Umbrello, M. Davies, IS. Jawahir (2013) Recent Advances in Modelling of Metal Machining Processes. CIRP Annals - Manufacturing Technology 62(1):695–718.

Rech J, Arrazola PJ, Claudin C, Courbon C, Pusavec F, Kopac J (2013) Characterization of Friction and Heat Partition Coefficients at the Tool–workmaterial Interface in Cutting. CIRP Annals — Manufacturing Technology 62(1):78–82

High temperature processes 5 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: M. Doubenskaia, A. Sova

Lectures: 26h | Tutorials: 4h | Labs: 8h | Project: 0h | Autonomy : 60h | Lang. :

Objectives

Introduction to physics and technologies of materials processing by concentrated energy fluxes covering a wide spectrum of applications ranging from the traditional ones to the most modern. Knowledge of typical equipment and application domains. Introduction into Thermal Spraying of thick protective coatings.

Keywords: laser processing, thermal spray technologies, high temperature heat-and mass transfer.

Programme

1. Lectures
   a. Types of laser sources and their applications : cutting, welding, drilling, marking, additive manufacturing;
   b. Industrial Thermal Spraying Technologies: Equipment; physics of coating deposition;
   c. Applied materials and coatings design. Application fields.
   d. Optical diagnostics for modern high temperature technologies.
2. Tutorials:
   a. Different types of effective heat sources used for simulation of materials processing by concentrated energy sources: laser, plasma arc, electron beam;
   b. Calculation of temperature fields in welding and surface heat treatment.
3. Labs: Traditional laser applications: welding, surface hardening, cutting, engraving.

Prerequisites

- General knowledge of industrial manufacturing processes.
- Basics of Heat Transfer and Thermodynamics.
- General knowledge in material science: Typical compositions and microstructures of metals and alloys

Learning outcomes

After attending this course, students will:

- Be able to describe physical phenomena in laser machining and thermal spraying.
- Be able to describe all the technical parameters and materials used in laser or thermal projection processes;
- Be able to implement a control approach for a laser or projection process;
- Master the different modes of heat transfer in solids and apply the results to processes using concentrated energy beams (laser, plasma, electron beam, etc.)

Assessment

One 2 hour exam on the lectures' and tutorials' content and report of the labs

References

William M. Steen, Jyotirmoy Mazumder, Laser Material Processing, 4th Edition, Springer-Verlag London, 2010.

John Ion, Laser Processing of Engineering Materials: Principles, Procedure and Industrial Applications, Elsevier, 2005.

G. Gladush, I. Smurov. Laser Processing of Materials: Theory, Experiment, Springer-Verlag, Berlin Heidelberg, 2011

Physical measurement 5 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **Ph. Bertrand, F. Cabanettes**

Lectures: 36h | Tutorials: 0h | Labs: 0h | Project: 0h | Autonomy : 72h | Lang. :

Objectives

The aim of the course is to provide an understanding of the building mechanisms of volumes and surfaces during laser/matter interaction, ii) an ability to select the proper temperature measuring instrument to control laser/matter interaction based on optical diagnosis and iii) the ability to propose a complete surface characterization workflow (measuring equipment and strategy, filtering technique, roughness parameters) adapted to an industrial application.

Keywords: Radiation, laser/matter interaction, temperature measurement, surface topography, acquisition, filtering techniques and roughness parameters

Programme

1. Radiation (4h) : Basics, Definitions, Quantities, Theories
2. Laser based processes to build objects (and surfaces) (8h)
   a. Laser technologies
   b. Study and understanding of laser/matter interaction
   c. Link between structure and material properties, including the laser effects
   d. Temperature fields at the laser/matter interaction and measurements
3. Temperature measurements to control the building process by laser (8h)
   a. Infrared pyrometry
   b. CCD camera
4. Surface topography acquisition and data treatment (8h): Introduction
   a. Surface topography acquisition: measuring equipment principles and limits
   b. Filtering techniques
   c. Roughness parameters and areal parameters
   d. Case study: analysis of research data

Prerequisites

- Basic knowledge of heat transfer
- Basic knowledge of manufacturing processes
- Basic knowledge of mathematics and statistics

Learning outcomes

- Knowledge on the physical phenomena governing the laser/matter interaction leading to volume and functional surfaces generation
- Understanding the temperature measuring principles by optical means
- Understanding the measuring principles of instruments for surface topography acquisition. Knowledge about the limits of the instruments.
- Understanding the filtering techniques and roughness parameters

Assessment

Home exam on chapter 1 to 3; Case study (per group of max. 5 students) on chapter 4.

References

CENGEL Y., TURNER R., CIMBALA J., Fundamental of thermal-fluid science, 2016
Laser and Electron Beam Material Processing, Handbook, MIR Publisher Moscow
THOMAS Tom R., Rough surfaces. World Scientific, 1998.
BLUNT L., JIANG X., Advanced techniques for assessment surface topography: development of a basis for 3D surface texture standards" surfstand". Elsevier, 2003.

French for beginners 2 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **M. Leplat**

Lectures: 0h | Tutorials: 30h | Labs: 0h | Project: 0h | Autonomy : 10h | Lang. :

Objectives

This course will provide students with an introduction to the French language. Course sessions will include: Reading comprehension, Written expression, Oral expression, Listening comprehension, Vocabulary and Grammar.

Keywords: French language

Programme

Dependent on student level, the educational method focuses on practical work:

1. Grammatical exercises with multiple examples and oral practice,
2. Listening to oral materials with increasingly difficult characteristics,
3. Discussions, presentations and debates, role-plays, writing short essays and summaries.

Prerequisites

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Learning outcomes

After attending this course, students will:

- Express themselves through a short series of expressions or easy sentences (daily life, asking questions);
- Understand and use common expressions;
- Categorize the key information taken in a written document to be able to use it;

Assessment

Continuous assessment and oral presentations

References

All course materials will be supplied in class

Research methods 3 ECTS

Draft version undergoing final validation and provided for information only

Lecturers: **To be defined – Remote course by TUC and NTNU**

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

Objectives

This module conveys the basic principles of scientific work in the field of Engineering Sciences. The students acquire the key aspects (e.g. philosophy of science, scientific ethics) and deploy them to write their own scientific work. Handling of literature sources, collection and analysis of experimental data as well as guidelines for the publication of scientific findings will be treated.

Keywords: French language

Programme

1. Fundamentals of Science
2. History of Science
3. Ethics in Science
4. Finding Literature
5. Reading Literature
6. Citing Literature
7. Writing and Publishing an article
8. Peer Review

Prerequisites

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Learning outcomes

After attending this course, students will:

- Be familiar with research based learning and working;
- Be familiar with aims, methods, ethics of science ;
- Be able to structure a scientific article or their final thesis independently;
- Be able to participate in science community after graduation.

Assessment

One written scientific paper and associated oral presentation

References

All course materials will be supplied in class