DIM-MIC-524 Digital Manufacturing

SEMESTER: Spring

CREDITS: 3 ECTS (2 hr. per week)

LANGUAGE: English

DEGREES: Master in Smart Industry

Course overview

This subject concentrates on providing the fundamental theoretical and practical knowledge to understand the additive manufacturing concept, a range of technologies that are capable of joining materials to make objects from 3D model data, usually layer upon layer, in a quick and easy process. The additive, freeform nature of the technology, coupled with improvements in materials, processing speed, accuracy and surface finish, open up an array of manufacturing options that before were impossible with conventional technologies.

An overview of conception and development of products will be provided while special focus will be put to computer aided design for additive manufacturing, validation and optimization of printable models using simulation, and finally to the scope and connection between reverse engineering and additive manufacturing processes.

Prerequisites

Knowledge of engineering drawings fundamentals and basic 3D modeling.

Course contents

Theory:

1. **Conception and development of products.** Design processes and methods. CAD/CAM/CAE technologies and product lifecycle management (PLM). Concepts generation and embodiment. Expression of product design ideas using 2D sketches.

2. **Computer Aided Design (CAD).** 3D modeling. Parametric design. Assembly modeling. Render the appearance of a product. CAD and Additive Manufacturing.

3. **Computer Aided Engineering (CAE).** Finite Element Analysis (FEA) to validate functional performance: general stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints…), post-processing, results and verifications. Topology optimization in Additive Manufacturing.

4. **Reverse Engineering.** General methodology: point clouds, meshes (.stl), NURBS surface models and parametric CAD models. Digitizing methods and main technologies: applications and selection of reverse engineering systems. Hardware and software involved. Reverse engineering and Additive Manufacturing.

5. **Additive Manufacturing.** General methodology, stages and components of the process. Main technologies, principles and applications. Strengths, weaknesses, challenges and limitations of AM technologies. Main brands and suppliers available. Design for Additive Manufacturing (DFAM). Design for functionality and 3D printability. Planning and slicing AM software.

Laboratory:

Each unit described previously has at least one associated lab practice (2 hours).

1. **2D sketching of product design ideas.**
2. **3D modeling and assembling.**
3. **3D rendering of products.**
4. **Optimization of parts and assemblies.**
5. **Use of 3D digitalization scanners.**
6. **Use of point clouds/meshes editing software.**
7. **Preparation of 3D CAD models and use of planning/slicing AM software.**
8. **Use of FDM, SLA, DLP and SLS machines to produce 3D physical models.**

Textbook

- *Product Design. Techniques in Reverse Engineering and New Product Development*. K. Otto, K. Wood. Pearson.
- *Product Design and Development.* K.T. Ulrich, S.D. Eppinger. McGraw-Hill.
- *Reverse Engineering. An Industrial Perspective.* V. Raja, K.J. Fernandes. Springer.
- *Simulation using Creo Parametric.* Parametric Technology Corporation (PTC) user guides.
- *Fundamentals of Digital Manufacturing Science*. Z. Zhou, S. Xie, D. Chen. Springer.
- *Rapid Manufacturing. An Industrial Revolution for the Digital Age*. N. Hopkinson, R.J.M. Hague, P.M. Dickens. John Wiley & Sons.
- *Additive Manufacturing Technologies.* I. Gibson, D.W. Rosen, B. Stucker. Springer.
- *Rapid Prototyping: Principles and Applications*. C.K. Chua, K.F. Leong, C.S. Lim. World Scientific.

Grading

Standard evaluation at the end of the term:

- 30% Lab reports (practical and theoretical sessions).
- 10% Homework.
- 60% End of term exam (paper + computer).
- Attendance: minimum 85% to be allowed to take the exam.

Additional evaluation during June (for those who do not pass at the end of the term):

- 30% Lab reports (practical and theoretical sessions).
- 70% June exam (paper + computer).