Course guide
295462 - 295TM113 - Advanced Manufacturing

Last modified: 06/03/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: MASTER'S DEGREE IN MECHANICAL TECHNOLOGIES (Syllabus 2024). (Optional subject).
MASTER'S DEGREE IN ADVANCED BIOMEDICAL TECHNOLOGIES (Syllabus 2025). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: RAMON JEREZ MESA

Others: Segon quadrimestre:
RAMON JEREZ MESA - Grup: T1
ERIC VELÁZQUEZ CORRAL - Grup: T1

PRIOR SKILLS

Interpret and generate standardised manufacturing drawings with tolerances and adjustments.
Select and apply different metrology techniques, surface condition control and quality assurance.
Prepare manufacturing roadmaps for machining, selecting tools and cutting parameters.
Interpret and write simple programmes with ISO code, CAD/CAM/CAE integration and flexible manufacturing systems.
Design metal forming and joining processes (casting, welding) and plastic deformation processes (forging, stamping, extrusion, rolling).
Design polymer forming processes (extrusion, injection).
Plan and execute additive manufacturing processes for the manufacture of prototypes or functional parts.
Select machinery for manufacturing processes based on the mechanical power required.

REQUIREMENTS

Proactive approach to carrying out manufacturing projects.
Aptitude for applying self-directed learning independently.

LEARNING RESULTS

Knowledges:
K1. Relate advanced knowledge of biomechanics, biomaterials, implants and prostheses to the design of medical devices.
K3. Relate advanced knowledge of healthcare products and technological innovation concepts.
K.06. Identify the most appropriate techniques, components and materials for the development of advanced applications in mechanical engineering.
K.04. Correctly interpret technical documentation related to the design of facilities, processes and products in the context of research and development projects in the mechanical engineering field.
K.03. Recognise the process and product design principles and methods that apply to smart manufacturing systems.

Skills:
S1. Develop kinematic and dynamic analyses of biomechanical systems using the finite element method.
S9. Plan the stages, tasks and activities involved in designing and developing biomedical devices and sensors or processing biomedical data.
S2. Appropriately use techniques for manufacturing, analysing and characterising biomaterials to choose them correctly and process them according to their properties and potential application.
S.07. Design flexible production/operation systems to improve the performance of industrial processes.
S.03. Use advanced numerical simulation and virtual prototyping techniques to solve complex mechanical problems.
S.01. Comprehensively apply experimental techniques, calculations, evaluations, appraisals, expert reports, studies, work plans and related tasks in the development of mechanical engineering projects, applying compulsory specifications, regulations and standards at each stage of the process.

Competences:
C3. Identify and analyse problems that require making autonomous, informed and reasoned decisions in order to act with social responsibility following ethical values and principles.
C5. Use scientific and technical information to respond to any demand for modification, innovation or improvement of devices, products and processes linked to biomedical engineering for new scientific or technological applications.
C.02. Work as part of a multidisciplinary team, whether as a team member or in a leadership role, to contribute to the development of projects with pragmatism and a sense of responsibility, undertaking commitments with due regard to the resources available.
C.04. Ensure, within the limits of one's professional competence, compliance with ethical standards, professional guidelines and current legislation regarding fundamental rights, taking into account the goal of reducing inequalities, the gender perspective, and the principles of accessibility, inclusion and non-discrimination in the design of technical solutions and in the management of projects and teams.
C.05. Propose advanced scientific and technological solutions to complex industrial challenges in the field of mechanical engineering.

TEACHING METHODOLOGY

Introductory theory sessions.
Development of a scientific-technical project on topics proposed by the teaching staff.
Laboratory practicals.
Preparation of laboratory practicals for the rest of the students in the group.

LEARNING OBJECTIVES OF THE SUBJECT

LO1. Design multi-material 3D printing processes applying mechanical or biomedical engineering criteria to improve strength, rigidity or emulation of biological tissues.
LO2. Evaluate the mechanical and functional performance of printed parts through experimental testing and comparative analysis with specifications, applying characterisation methodologies (tension, compression, hardness) and validation criteria for industrial or biomedical applications.
LO3. Program manufacturing routines with 2-, 3- and 5-axis CNC machines using CAM software, including the definition of trajectories, optimisation of supports and collision verification to ensure precision and efficiency in machining.
LO4. Implement the ISO codes resulting from these digitally designed routines on the machine.
LO5. Plan vibration-assisted manufacturing processes on lathes and milling machines based on the desired multiscale texture, selecting machining parameters, dynamic conditions and control strategies to ensure the required functionality and surface performance.
LO6. Plan and perform finishing routines on machine tools using plastic deformation to obtain surfaces of excellent surface integrity.
LO7. Apply advanced dimensional and surface verification technologies using coordinate measuring machines (CMMs) and optical systems for 3D texture acquisition, interpreting the data obtained to ensure compliance with technical specifications.
LO8. Plan and manage a scientific-technical project applying methodologies for organisation, resource allocation and time control.
LO9. Carry out laboratory and workshop practices following experimental procedures, recording data and evaluating results with technical rigour.
LO10. Design, prepare and lead a practical session for the group, applying principles of technical communication, organisation and safety in the manufacturing environment.
LO11. Develop autonomous learning and collaborative work, integrating theoretical and practical knowledge in real manufacturing environments.

STUDY LOAD

Type	Hours	Percentage
Guided activities	6,0	4.00
Self study	102,0	68.00
Hours large group	21,0	14.00
Hours small group	21,0	14.00

Total learning time: 150 h

CONTENTS

Multimaterial additive manufacturing

Description:
• Mastery of FFF additive manufacturing technology using a single material, in one or two colours simultaneously.
• Application of knowledge already acquired to printing with two different materials.
• Printing of multi-material parts as part of a project with a goal related to the mechanical and/or biomedical industry.

Specific objectives:
1. To study in depth the challenges associated with multimaterial 3D printing, identifying the risks of this emerging technique.
2. Apply multimaterial printing to generate a part as part of an advanced manufacturing project.
3. Evaluate the resulting part from a functional perspective for a mechanical or biomedical application.

Related activities:
1. Guided practical sessions using multi-head 3D printers to print parts with different pairs of materials, for which a deliverable will be required.
2. Functional evaluation of the parts obtained using mechanical and other techniques.
3. Advanced manufacturing project.

Full-or-part-time: 15h
Theory classes: 1h 30m
Practical classes: 6h
Self study : 7h 30m

Computer-Aided Manufacturing (CAM)

Description:
• Role of CAM within Industry 4.0.
• Requirements to take into account for the design of a manufacturing process with CAM: tool selection, machine programming, part location in the work environment...
• CAM post-processing and ISO code generation for CNC machining.
• Exporting post-processed files to the machines in the workshop at EEBE and execution.

Specific objectives:
1. Deepen knowledge of different automated subtractive manufacturing processes and their role in Industry 4.0.
2. Independently programme CAM routines for lathes and 3- and 5-axis milling machines, independently selecting the cutting parameters and tools to be used based on availability in the workshop.
3. Post-process these routines and implement them on the workshop machines.
4. Apply the above objectives to the development of an advanced manufacturing project to generate functional parts.

Related activities:
1. Guided practical exercises using SolidCAM software, for which a deliverable will be required.
2. Implementation of post-processed files on a real machine.
3. Advanced manufacturing project.

Full-or-part-time: 15h
Theory classes: 1h 30m
Practical classes: 6h
Self study : 7h 30m

Integrated CNC finishing processes

Description:
• Role of automated finishing processes using numerical control in Industry 4.0.
• Application of complex surface finishing procedures using CNC-controlled burnishing.
• Design of finishing routines based on surface requirements.

Specific objectives:
1. Identify scenarios for the application of automated finishing processes using numerical control in the context of Industry 4.0.
2. Apply finishing procedures for complex surfaces using CNC-controlled burnishing.
3. Design finishing routines based on established surface requirements.

Related activities:
1. Guided practical sessions with machine tools equipped with honing tools.
2. Development and execution of honing routines on the machine using code generated with CAM.
3. Advanced manufacturing project.

Full-or-part-time: 15h
Theory classes: 1h 30m
Practical classes: 6h
Self study : 7h 30m

Integrated part verification

Description:
• Application of automated metrology technologies for parts verification: role within Industry 4.0.
• Surface engineering and its importance for controlling the surface integrity of industrial or biomedical parts.
• Measurement of 3D texture on engineered surfaces and functional impact.

Specific objectives:
1. Develop the ability to apply automated metrology technologies for part verification, integrating them into advanced production environments typical of Industry 4.0.
2. Analyse and evaluate surface engineering to ensure surface integrity in industrial and biomedical parts, considering functional and quality criteria.
3. Interpret and perform three-dimensional texture measurements on engineered surfaces, relating the parameters obtained to the functional performance of the component.

Related activities:
1. Guided practical sessions with 3D profilometers and CNC-controlled verification machines.
2. Functional evaluation of the parts obtained using advanced metrology techniques.
3. Advanced manufacturing project.

Full-or-part-time: 15h
Theory classes: 1h 30m
Practical classes: 6h
Self study : 7h 30m

GRADING SYSTEM

The final mark is given out of 10, following a continuous assessment system that includes the following elements:
Completion and presentation of a scientific-technical project: 40%
Attendance and completion of laboratory and workshop practicals (level 1): 35%
Independent preparation of a laboratory and workshop practical session (level 2) for the rest of the group: 15%
Assessment of the functionality of the parts manufactured at the end of the project: 10%

BIBLIOGRAPHY

Basic:
- Burnishing Of EN-31.
- Martín Llorente, Óscar. Problemas resueltos de mecanizado de metales. Valladolid: Ediciones Universidad de Valladolid, [2018]. ISBN 9788484489597.
- Curry, Guy L; Feldman, Richard Martin. Manufacturing systems modeling and analysis [on line]. 2nd ed. Berlin ; Heidelberg: Springer, cop. 2011 [Consultation: 15/04/2020]. Available on: http://dx.doi.org/10.1007/978-3-642-16618-1. ISBN 9783642166181.
- ASM handbook. Vol. 5, Surface engineering. 10th ed. Materials Park, Ohio: ASM International, 1999. ISBN 087170384X.