Course guide
820426 - FAB - Manufacturing

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

Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

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

LECTURER

Coordinating lecturer: JOSE ANTONIO TRAVIESO RODRIGUEZ - RAMON JEREZ MESA

Others:

Primer quadrimestre:
MOHAMMAD TALHA SHARIF RAFIQUE - Grup: T11, Grup: T12, Grup: T13
ADRIAN ALBERTO TRAVIESO DISOTUAR - Grup: T11, Grup: T12, Grup: T13
JOSE ANTONIO TRAVIESO RODRIGUEZ - Grup: M11, Grup: M12, Grup: M13, Grup: M14
RODOLPHO FERNANDO VAZ - Grup: M11, Grup: M12, Grup: M13, Grup: M14

Segon quadrimestre:
RAMON JEREZ MESA - Grup: T11, Grup: T12, Grup: T13, Grup: T14
MOHAMMAD TALHA SHARIF RAFIQUE - Grup: T11, Grup: T12, Grup: T13, Grup: T14
JOSE ANTONIO TRAVIESO RODRIGUEZ - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15
RODOLPHO FERNANDO VAZ - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: M15

PRIOR SKILLS

Standardised graphic representation of different machine elements in assembly drawings.
Knowledge of the different groups of engineering materials that can be used to manufacture parts in industry or other related sectors.

REQUIREMENTS

AMPLIACIÓ D'EXPRESSIÓ GRÀFICA. DISSENY MECÀNIC - Prerequisit
CIÈNCIA I ENGINYERIA DE MATERIALS - Precorequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMEC-26. Understand manufacturing, metrology and quality assurance systems and processes.
CEMEC-19. Understand and apply graphic engineering techniques.

Transversal:
1. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

This course is largely based on classroom attendance, where the teacher will explain the course syllabus and solve problems and exercises.
Self-study of the topics by solving exercises independently and carrying out teamwork.
Use of specialised software for CNC composition, testing and simulation.

LEARNING OBJECTIVES OF THE SUBJECT

General Objectives
1 .- Knowledge of parts manufacturing.
2 .- Create the ability to control and verificate products.
3 .- Develope the ability to solve problems of metrology and manufacturing processes.
4 .- To know the rules to make the parts.
5 .- Ability to select the optimal manufacturing process of a piece.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Course Introduction

Description:
a) Structure of the module.
b) Prerequisites. Basic elements in manufacturing engineering.
c) Material families used for part manufacturing.
d) Historical background of part manufacturing processes.
e) Overview of part manufacturing processes.
f) Classification of manufacturing processes according to Groover.

Full-or-part-time: 1h 30m
Theory classes: 1h 30m

Solidification processes

Description:
a) Foundry principles and equipment: Historical background, analysis of material fusibility and types of furnaces used.
b) Moulding technology: Stages of the process, types of moulds (sand, permanent, lost-wax, etc.) and defining tolerances on patterns.
c) Process physics and operations: Design of casting systems and compensation, solidification analysis (Chebyshev) and finishing operations (sprue cutting and cleaning).
d) Powder Metallurgy and Sintering: Powder manufacturing processes, technological execution and design criteria for sintered parts.

Specific objectives:
Analyse the historical evolution of casting and explain the general characteristics of the process and its industrial relevance.
Assess the castability of different metallic materials and relate it to their behaviour during casting.
Identify and compare the different types of furnaces used in casting, selecting the most suitable one for each application.
Describe the stages of the moulding process according to the type of mould and distinguish the operational differences between disposable and permanent moulds.
Interpret and compare the main casting processes (sand, permanent mould, pressure, lost wax, gravity, low pressure) and determine their suitability according to geometry, material and functional requirements.
Apply tolerance and shrinkage criteria to patterns to ensure the dimensional accuracy of castings.
Design casting and compensation systems (sprues and runners) using casting technology principles and justify their effects on final quality.
Analyse the phenomena of cooling and solidification in casting processes, using the Chvorinov equation (sometimes referred to as Chebyshev in non-standardised literature) to estimate solidification times.
Explain demoulding and cleaning operations and evaluate their influence on the surface and dimensional quality of the part.
Describe the main methods of manufacturing metal powders and assess their impact on microstructure and properties.
Explain the technological fundamentals of the powder sintering process and relate its parameters to densification and final properties.
Apply specific design recommendations for sintering processes, integrating criteria of geometry, materials, and behaviour during the thermal cycle.

Full-or-part-time: 20h
Theory classes: 6h
Self study : 14h

Joining and Assembly Processes

Description:
a) Welded Joints. Classification.
b) Distinction between heterogeneous and homogeneous welding. Electrode welding.
c) Homogeneous welding processes: oxy-acetylene welding. Oxy-cutting.
d) Heterogeneous welding processes: TIG, MIG and MAG systems.

Specific objectives:
Classify the different types of welded joints and characterise their main industrial applications.
Distinguish between homogeneous and heterogeneous welding, explaining their metallurgical and operational fundamentals.
Describe the shielded metal arc welding (SMAW) process and analyse its advantages, limitations and critical parameters.
Explain the principles of oxyacetylene welding and apply its fundamentals to the oxyfuel cutting process.
Compare TIG, MIG and MAG heterogeneous welding systems, evaluating their suitability based on material, thickness and quality requirements.
Relate the parameters of each process (intensity, voltage, feed rate, gas flow, material input) to the quality of the weld and the integrity of the joint.
Identify the main defects in welding processes and propose prevention and correction measures according to the method used.

Full-or-part-time: 12h 30m
Theory classes: 4h 30m
Self study : 8h

Metrology and quality

Description:
a) Standardisation in manufacturing processes. Basic concepts.
b) Artisanal and mass production. Characteristics.
c) Standardisation in manufacturing. Manufacturing tolerances.
d) Geometric tolerances according to ISO 1101:2017. IT and tolerance classes. ISO coding and representation on manufacturing drawings.
e) Surface tolerances according to ISO 21920:2021. Surface roughness. Roughness classes. Symbolism on manufacturing drawings.
f) Dimensional tolerances according to ISO 22081:2021.
g) Standardised fits. Definition and types.
h) Calculation of clearance and interference fit descriptors.
i) Tolerances of a fit.
j) Effect of temperature on mechanical fits. Design considerations.

Specific objectives:
Interpret the basic concepts of standardisation in manufacturing processes and explain its impact on the quality and interchangeability of components.
Compare the models of artisanal and mass production, identifying the characteristics, advantages and limitations of each approach.
Apply manufacturing standardisation principles to determine appropriate dimensional tolerances based on functional requirements.
Analyse geometric tolerances according to the ISO 1101:2017 standard, interpreting their symbology and representing them correctly on manufacturing drawings.
Characterise surface roughness parameters according to ISO 21920:2021, select roughness classes and use the standardised symbology in technical documentation.
Apply the dimensional tolerance criteria established in ISO 22081:2021 to assess the permissible variability in machined or other manufactured parts.
Define and classify standard fits, distinguishing between loose, interference and serrated fits.
Perform the calculations for the descriptors (clearance, interference, shaft and bore tolerances, zero lines) for clearance and interference fits.
Determine the tolerances of a fit from the tolerance classes and the basic hole and shaft systems.
Assess the influence of temperature on the behaviour of mechanical fits and integrate these considerations into the design and selection of components.

Full-or-part-time: 30h 30m
Theory classes: 7h 30m
Laboratory classes: 6h
Self study : 17h

Material removal processes

Description:
a) Fundamentals and theory of cutting: General principles, machinability, tool geometry and materials, basic movements and functions.
b) Physics of the cutting process: Merchant model (scalping), force analysis, power, generated temperatures and the use of coolants.
c) The Turning Process: Description of lathes, clamping systems, types of operations and calculation of fundamental and quality parameters.
d) The Milling Process: Types of milling machines, clamping methods (workpiece and tool), operations and calculation of cutting parameters.
e) The Drilling Process: Machines, specific fixtures and cutting regime parameters.
f) Tool Life and Economics: Wear mechanisms (Taylor Model) and selection of the optimal speed (minimum cost vs. maximum productivity).
g) Grinding and Superfinishing: Overview of finishing processes, types of grinding machines, fixtures and abrasive wheel selection.

Specific objectives:
Analyse the general principles of chip-removal machining and their influence on the quality and efficiency of the process.
Evaluate the machinability of materials and select suitable tools and cutting parameters.
Identify cutting operations and movements and characterise tool geometry and materials.
Apply the Merchant model to understand chip formation, the stresses, power and energy involved.
Analyse the generated temperatures and justify the use of lubricating and cooling fluids.
Describe turning operations, the operation of the lathe and workpiece and tool holding systems.
Calculate fundamental turning parameters and relate them to the quality and productivity of the process.
Classify milling machines and holding systems and analyse milling operations, calculating optimal parameters.
Explain the drilling process, the operation of the machines and the selection of cutting regimes.
Analyse tool wear mechanisms and apply the Taylor model to predict cutting life.
Determine the optimal cutting speed according to economic or productivity criteria.
Recognise superfinishing processes and describe grinding, the machines, fixtures and the selection of the appropriate grinding wheel.
Identify other superfinishing operations and their industrial application.

Full-or-part-time: 40h 30m
Theory classes: 10h 30m
Laboratory classes: 4h
Self study : 26h

Numerical control and flexible manufacturing

Description:
a) Introduction to working with Numerical Control machines.
b) Comparison of conventional and CNC machines.
c) Historical references. Evolution of CNC and concepts. CNC machine axes.
d) Preliminary operations for CNC machining: machine origin, part origin, tool origin, tool offsets, origin offsets.
e) Basic M, G, T, D, S and F functions according to ISO 6983-1:2009
f) Differences in the ISO code for turning and milling on CNC machines.
g) High-level programming functions according to ISO 6983-1:2009: FOTO, RPT, IF, ELSE, FOR, WHILE functions.
h) Fixed machining cycles.

Specific objectives:
Understand the architecture and operation of CNC machines and analyse the technological and operational differences between conventional and numerically controlled machines, identifying the historical evolution and, above all, the nomenclature and layout of the working axes. Manage the fine-tuning and reference systems. Define and correctly establish the coordinate origins (machine, workpiece and tool), as well as apply the necessary tool correctors and offsets to ensure dimensional accuracy before machining begins.
Programme machining operations in standard ISO code. Develop numerical control programmes by interpreting and applying ISO 6983-1:2009 (G, M, T, S, F functions), distinguishing the syntactic and operational peculiarities between turning and milling processes.
Optimise the code using parametric programming and fixed cycles. Develop advanced and efficient programmes using high-level programming structures (loops, conditionals, subroutines) and fixed machining cycles to reduce programming time and code length.

Full-or-part-time: 17h
Theory classes: 6h
Laboratory classes: 2h
Self study : 9h

Forming based on plastic deformation

Description:
a) Fundamentals of plastic deformation: Cold and hot deformation, stress-strain relationship, flow criteria and material properties for forming.
b) Continuous bulk forming processes (rolling, extrusion and drawing): Machine selection, process parameter calculation and characteristics of the resulting parts.
c) The forging process: Hot cycle, energy and power calculations, machine selection and analysis of common defects.

Specific objectives:
Analyse the mechanical behaviour of materials under plastic deformation loads, applying the flow criteria and distinguishing the technological implications of cold and hot working.
Dimension bulk forming processes (forging, rolling, extrusion and drawing) by calculating energy requirements and selecting the appropriate machinery to ensure the part's geometry and structural quality.
Design sheet metal forming operations (cutting, bending and deep drawing), determining the necessary process parameters to prevent defects and achieve the required final shape.

Full-or-part-time: 21h
Theory classes: 6h
Laboratory classes: 2h
Self study : 13h

Manufacturing of plastics

Description:
a) Properties of plastic materials. Polymerisation reactions.
b) Industrial plastics according to DIN 7728.
c) Manufacturing processes for plastics. Injection moulding, compression moulding, extrusion, blow moulding, thermoforming. Rapid prototyping.

Specific objectives:
Characterise and classify polymeric materials. Relate the chemical structure and polymerisation reactions to the final properties of the material, and apply industrial standards (DIN 7728) for the correct identification and designation of engineering plastics.
Assess the technical feasibility of the different plastic manufacturing processes (injection moulding, extrusion, blow moulding, thermoforming and rapid prototyping) to determine the most suitable method according to the part's geometry and production volume.

Full-or-part-time: 7h
Theory classes: 3h
Self study : 4h

GRADING SYSTEM

First midterm test: 25 % / Team-work: 15 % / Individual homework: 15% / Laboratories: 15 % / Second midterm test: 30 %
There is no resit examination for this course.

EXAMINATION RULES.

The first midterm examination will be held after topic 4. The second midterm examination will cover all topics in the course. Both examinations will last 1.5 hours. There is no resit examination for this course.

BIBLIOGRAPHY

Basic:
- Kalpakjian, Serope; Schmid, Steven R; Espinosa Limón, Jaime. Manufactura, ingeniería y tecnología . 5ª ed. México [etc.] : Pearson Educación, 2008. ISBN 9789702610267.
- Groover, Mikell P. Fundamentos de manufactura moderna : materiales, procesos y sistemas . 3a ed. México [etc.] : Prentice-Hall Hispanoamericana, cop. 2007. ISBN 978-970-10-6240-1.
- Arias Sanvicente, Héctor; Lasheras Esteban, José Mª. Tecnologia mecánica y metrotecnia. 7ª ed. San Sebastián: Editorial donostiarra, 1978. ISBN 8470630873.

Complementary:
- Larburu Arrizabalaga, Nicolás. Máquinas : prontuario : técnicas, máquinas, herramientas. 4a ed. Madrid: Paraninfo, 1992. ISBN 8428319685.
- Coca Rebollero, Pedro; Rosique Jiménez, Juan. Tecnología mecánica y metrotecnia. Madrid: Pirámide, 1996. ISBN 8436816633.

RESOURCES

Hyperlink:
- Advances in manufacturing [en línia]. Springer. ISSN 2195-3597. http://link.springer.com/journal/volumesAndIssues/40436- CIRP journal of manufacturing science and technology [en línia]. New York, N.Y.: Elsevier Science. ISSN 1755-5817.. http://www.sciencedirect.com/science//journal/17555817- Modern machine shop [en línia]. Cincinnati, OH: Gardner Publications. ISSN 0026-8003. http://search.proquest.com/publication/40497