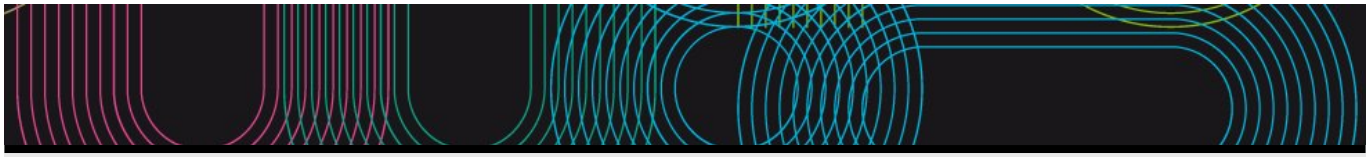

IDENTIFYING DATA				
Graphic engineering				
Subject	Graphic engineering			
Code	P52G381V01304			
Study programme	Grado en Ingeniería Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Puente Luna, Iván			
Lecturers	Pérez Vallejo, Javier Puente Luna, Iván			
E-mail	ipuente@cud.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This subject is part of the module of Specific Mechanical Technology. It links and complements the first-year subject Graphic Expression and aims to encompass all the language of the technical drawing, reinforcing the theoretical basis, the geometric foundations that allow the conception and visualization of shapes and dimensions, while expanding the practice, through the already inescapable computing environments. All of this without forgetting the study of the Standardization, that facilitates the exchange of technical information through the graphic language of current regulations. The aim is the creation and management of graphical information from the mechanical engineer's perspective, focusing on the specific characteristics of the Bachelor Degree taught at the CUD-ENM. It will cover contents on descriptive geometry, computer graphics, the definition of sets and mechanisms unequivocally, the normalized representation of ships, etc., seeking a general training but especially adequate and useful for the future performance of the students.			

Training and Learning Results	
Code	
B1	Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose is, specializing in Mechanics, construction, alteration, repair, maintenance, demolition, manufacturing, installation, assembly or operation of: structures, mechanical equipments, energy facilities, electrical systems and electronic installations and industrial plants, and manufacturing processes and automation.
C19	Knowledge and skills to apply the techniques of graphics engineering.
D2	Problems resolution.
D6	Application of computer science in the field of study.
D9	Apply knowledge.
D10	Self learning and work.
D14	Creativity.
D16	Critical thinking.
D17	Team working.

Expected results from this subject	Training and Learning Results		
To know and to posess well-grounded criteria for the selection and application of standard components.	B1	C19	D2 D9 D10 D16
To know CAD technologies for the geometrical modelling and the generation of technical drawings from it.		C19	D6 D9 D10

Ability to perform analysis on the operation of mechanisms from the specifications contained in technical drawings.	B1	C19	D2 D9 D14
To know how to apply Geometry to the resolution of problems about constructions and industrial installations.		C19	D2 D9 D14
To acquire skills for creating and managing graphic information related to Mechanical Engineering problems.		C19	D10 D14 D16 D17
ENAEE learning outcome: 1. KNOWLEDGE and UNDERSTANDING LO1.2. Knowledge and understanding of engineering disciplines underlying their specialization, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. Level of achievement: Intermediate (2).		C19	
ENAEE learning outcome: 2. ENGINEERING ANALYSIS LO2.1. Ability to analyze complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. Level of achievement: Intermediate (2).	B1		D2 D9
ENAEE learning outcome: 2. ENGINEERING ANALYSIS LO2.2. Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical - societal, health and safety, environmental, economic and industrial- constraints. Level of achievement: Intermediate (2).			D2 D9 D14 D16
ENAEE learning outcome: 3. ENGINEERING DESIGN LO3.1 Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical - societal, health and safety, environmental, economic and industrial- considerations; to select and apply relevant design methodologies. Level of achievement: Advanced (3).		C19	D2 D9
ENAEE learning outcome: 3. ENGINEERING DESIGN LO3.2. Ability to design using some awareness of the forefront of their engineering specialization Level of achievement: Intermediate (2).	B1	C19	D9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.1 Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study. Level of achievement: Intermediate (2).		C19	D9
ENAEE learning outcome: 5. ENGINEERING PRACTICE LO5.2 Practical skills for solving complex problems, realizing complex engineering designs and conducting investigations in their field of study. Level of achievement: Intermediate (2).			D2 D9 D16
ENAEE learning outcome: 7. COMMUNICATION AND TEAM-WORKING LO7.2 Ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers. Level of achievement: Intermediate (2).	B1		D10 D17

Contents

Topic	
THEORETICAL CONTENTS	
Chapter 1. Introduction to graphics in engineering.	1.1. Types of graphics in engineering. Fields of application. Graphics for the design, the visualization and the communication. The graphic language. 1.2. Graphic systems. Types and structure of the graphic files. Information management. Hierarchies. Layers. 1.3. Models. Geometrical model. Information associativity. 1.4. Graphic constructions used in engineering. 1.5. Diagrams and nomograms.
Chapter 2. Mechanical design and use of transmission elements.	2.1 Definition and representation of axles and shafts. 2.2 Definition and representation of gears and cogwheels. Standard representation. 2.3 Definition and representation of bearings and plugs. Standard representation. 2.4 Definition and representation of sealing elements.

Chapter 3. Structural design.	3.1 Study of joints. Typology. Elementary functions. Joining methods. 3.2 Threaded joints. Threads. Joint elements. Design criteria. Representation of threaded joints. 3.3 Permanent joints. Welding. Rivets. Representation of permanent joints.
Chapter 4. Management of the variability; functional impact of tolerances. Analysis and synthesis of tolerances.	4.1 Variability associated to engineering problems. 4.2 Macro- and micro-geometrical variability. 4.3 Size tolerances and fits. Specification. 4.4 References and reference systems. 4.5 Statistical tolerances. Cost functions for tolerances. 4.6 Analysis and synthesis of tolerances. 4.7 Combination of tolerances; consequences of the tolerance cummulation on the operation of mechanisms.
Chapter 5. Geometrical product specifications.	5.1 The geometrical specification concept according to ISO. 5.2 Chains of standards. 5.3 GPS standards matrices.
Chapter 6. Fundamentals of computer graphics.	6.1 Basic geometrical transformations. 6.2 Grafication of lines: basic algorithms. 6.3 Surface modeling: implicit, parametric, poligonal. 6.4 Solid modeling: representation schemes & methods.
Chapter 7. CAD/CAE/CAM systems. Systems for data acquisition from actual geometries. Rapid prototyping.	7.1. Systems CAx (Computer Aided Technologies). 7.2. CAD/CAM tools. 7.3. CAE tools in the context of Design Engineering. 7.4. Virtual reality: characteristics and devices. Applications in the Engineering field. 7.5. Digitalization of forms. Reverse engineering projects. 7.6. Rapid prototyping systems.
Chapter 8. Introduction to industrial design.	8.1 Design. Types. Industrial Design (product, communication and corporate image). 8.2 Design methodologies. 8.3 Stages in the design process. 8.4 Creativity in the design process. 8.5 Assessment of design alternatives. 8.6 DfX (Design for X).
Chapter 9. Introduction to ship design.	9.1 Ship classification. 9.2 Introduction to ship representation techniques. 9.3 Main ship dimensions and characteristics. 9.4 Ship form dimensionless coefficients. 9.5 Structural and constructive elements.
Chapter 10. Ship hull representation.	10.1 Ship construction project. Documentation and plans to develop. 10.2 Hull form and lines drawing. 10.3 Sectional area curve and midship section. 10.4 Draft marks. 10.5 Representation and dimensioning of the ship structure and sections. 10.6 General and detailed plans of the ship structure. Midship frame, shell expansion, typical sections, decks and blocks. 10.7 General layout of the ship. Contours, spaces, tanks, etc... 10.8 Machinery and facility plans.
PRACTICAL CONTENTS	
Practical sessions 1,2 & 3. Solid modeling and assemblies.	In the first laboratory sessions, the student will learn to generate three-dimensional elements using regular modeling tools.
Practical session 4. Preparation of technical documentation (plans, projects,...).	The main objective of this practical session is for the student to learn to use the tools for the production of technical documentation obtained from the models and assemblies made previously.
Practical session 5. Reverse engineering.	The key objective of this practical session is for the student to carry out a three-dimensional reconstruction of an object from photographs. The software can be chosen by the student, suggesting the possibility of using: Meshroom, Eyescloud, ReCap Pro and Agisoft Photoscan (or Metashape). The reconstruction will be made from several photographs, since if a single photograph is used, a faithful reconstruction will not be achieved, but an approximation.
Practical sessions 6 & 7. Design and modeling of a Personal Protective Equipment (PPE).	The main objective of these practical sessions is to design and develop PPE in operator positions (protective masks, goggles, helmets, ear muffs, etc.) for the prevention and protection against occupational accidents and damage to health. The student must generate the 3D model of the assembled set and its drawings.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	20	25	45
Problem solving	8	10	18
Practices through ICT	8	12	20
Collaborative Learning	2	3	5
Project based learning	4	6	10
Seminars	7	7	14
Problem and/or exercise solving	17	10	27
Essay questions exam	9	0	9
Laboratory practice	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Each lecture session will be presented by the lecturer, setting examples for a better understanding of the contents. By raising issues in theoretical contents and examples, the active student participation will be boosted and assessed. Office presentations and the blackboard will be used to convey information such as definitions, graphics, pictures, etc. To the extent possible, copies of the presentations will be provided to the students prior to the lecture, focusing the effort of the lecturer and students on the exhibition and understanding of the knowledge. Printed reproductions of the presentations should never be considered as substitutes for notes taken in class or the texts suggested in the bibliography, but as complementary material.
Problem solving	Activities where problems related to Graphic Engineering are formulated. The student must develop adequate or correct solutions through the practice of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. This methodology constitutes a complement to lecturing.
Practices through ICT	Activities for the application of knowledge to specific situations and for the acquisition of basic and procedural skills related to Graphic Engineering. These practical sessions will take place in computer rooms with specialized equipment.
Collaborative Learning	Implementation of activities that require active participation and collaboration among students.
Project based learning	Throughout the quadmester, different 2D and 3D modeling projects will be carried out on a scheduled basis and during practical classes.
Seminars	Activities to reinforce learning through a supervised group resolution of practical exercises linked to the theoretical and practical contents of the subject. Those exercises in laboratory classes that students were unable to finish, need to be addressed in their study hours and if there is any difficulty or question, they can be resolved in these seminars.

Personalized assistance

Methodologies	Description
Seminars	In addition to group tutorials, individualized seminars can be carried out, in which each student, individually, will be able to consult the lecturer with doubts or difficulties that prevent them from monitoring the theoretical or practical contents of the subject. Complementary exercises will be proposed to reinforce the learning of the contents of the subject, aimed at students who show difficulties to adequately follow the development of the classes. The lecturers will solve the questions of the students both in person, according to the tutoring schedule published on the web page of the CUD-ENM, as well as through telematic means (email,videoconference, MooVi forums, etc.) with previous appointment.

Assessment

	Description	Qualification	Training and Learning Results
Practices through ICT	LABORATORY PRACTICE EXAM (percentage on the final grade: 15%) There will be a practical assessment test based on the problems made in class. ASSESSMENT OF THE PRACTICAL SESSIONS (percentage on the final grade: 15%): During the quadmester, in certain practical sessions, problems or exercises will be raised to be solved by the students and submitted for evaluation when determined by the lecturer. The evaluation of each deliverable will be in accordance with the criteria that have previously been communicated to the students.	30	B1 C19 D2 D6 D9 D14 D16 D17

Problem and/or exercise solving	INTERMEDIATE TESTS OF CONTINUOUS ASSESSMENT: They will be realized during the quadmester and will be of short duration. The execution of both tests will be compulsory and required to pass the subject. The tests will cover the contents taught to date.	30	B1	C19	D9 D10 D16
Essay questions exam	A final exam will be carried out covering all the contents of the subject, both theoretical and practical, and it may include test questions, reasoning questions, problem solving and case study's development. It is required to achieve a minimum score of 4.0 points over 10 possible to pass the subject.	40	B1	C19	D9 D10 D16

Other comments on the Evaluation

Final assessment of students will attend to the sum of the score given to each of the above mentioned parts, being their overall continuous assessment grade (CAG):

*CAG= 0,15 *INTERMEDIATE TEST 1 + 0,15 * INTERMEDIATE TEST 2 + 0,15 *PRACTICAL SESSIONS + 0,15* LABORATORY PRACTICE EXAM + 0,40* FINAL EXAM*

In order to pass the subject, the overall continuous assessment grade (CAG) calculated by the previous formula must be at least 5 points out of 10. However, minimum requirements and conditions will be required in some of the sections, which ensure a balance between all types of competences.

The student must take the ordinary exam of all the contents of the subject, which will represent 100% of the grade, in the following cases:

- If a student fails to take the intermediate tests or does not attend more than one practical session.
- If a student earns a grade below 4 points out of 10 in the final exam of continuous assessment.

In either of these two assumptions, the continuous assessment grade will be the minimum of the continuous assessment grade calculated with the previous formula and 4 points. In any case, students who have passed the continuous assessment, will have the possibility to take the ordinary exam to increase grades.

Both the ordinary and the extraordinary exams will evaluate all the competences of the subject. Therefore, the exams will include a practical assessment test in the computer room.

ACADEMIC INTEGRITY: Students are expected to show adequate ethical behaviour, committing to act honestly. Based on article 42.1 of the *Regulation on the evaluation, qualification and quality of teaching and the student learning process of the University of Vigo*, as well as point 6 of the fifth rule of *Order DEF/711/2022, of July 18th, which establishes the requirements for evaluation, progress, and ongoing enrolment in military educational training centers for incorporation into the ranks of the Armed Forces*, **any violation of academic integrity in the assessment process, as well as the cooperation in it will result in the assignment of a failing grade to the student (zero) for the entire course in the corresponding assessment opportunity**, regardless of the porcentage of importance that the test in question had in the overall continuous assessment and independently of other disciplinary actions that may be applied.

Sources of information

Basic Bibliography

Company, P.; Vergara, M.; Mondragón, S., **Dibujo Industrial**, Publicacions de la Universitat Jaume I, 2007

Félez, J.; Martínez, M.L., **Ingeniería Gráfica y Diseño**, Síntesis, 2008

Complementary Bibliography

Alcaide Marzal, J.; Diego Más, J.A.; Artacho Ramírez, M.A., **Diseño de producto**, Universidad Politécnica de Valencia, 2001

Asociación Española de Normalización (AENOR), **Normas UNE de Dibujo Técnico (Versión en vigor)**, AENOR,

Brusola Simón, F.; Calandín Cervigón, E.; Baixauli Baixauli, J. J.; Hernandis Ortuño, B., **Acotación funcional**, Tébar Flores, 1986

Calandín Cervigón, E.; Brusola Simón, F.; Blanes Pastor, J. G., **Prácticas de acotación funcional**, Tébar Flores,

Dondis, D. A., **La sintaxis de la imagen. Introducción al alfabeto visual**, 10ª, Gustavo Gili, 1992

Félez, J.; Martínez, M.L., **Fundamentos de Ingeniería Gráfica**, Síntesis, 1999

Gómez-Senent, E., **Diseño Industrial**, Universidad de Valencia, 1986

Gomis Martí, J. M., **Dibujo Técnico (I)**, Universidad Politécnica de Valencia, 1990

Guirado Fernández, J. J., **Iniciación a la Expresión Gráfica en la Ingeniería: Los fundamentos proyectivos de la representación**, Gamesal, 2003

Izquierdo Asensi, F., **Geometría Descriptiva I (Sistemas y perspectivas)**, 26ª, Grefol, 2008

Izquierdo Asensi, F., **Geometría Descriptiva II (Líneas y superficies)**, 26ª, Grefol, 2008

Pérez Díaz, J. L.; Palacios Cuenca, S., **Expresión Gráfica en la Ingeniería: Introducción al dibujo industrial**, Prentice Hall, 1998

Sanz Adán, F.; Lafargue Izquierdo, J., **Diseño Industrial: Desarrollo del producto**, Paraninfo, 2002

Recommendations

Subjects that continue the syllabus

Machine design/P52G381V01405
Manufacturing engineering and dimensional quality/P52G381V01407
Technical Office/P52G381V01501

Other comments

The subject of Graphic Engineering has no associated prerequisite. However, in order to successfully complete this course, the student must have:
- Sufficiently developed written and oral comprehension skills.
- Capacity of spatial vision, basic calculation and synthesis of information.
- Teamwork and communication skills.
- At least basic knowledge acquired in the subjects Graphic Expression, Mechanism and machine theory and Physics, taught in previous years.

The most frequent learning difficulties are related to the lack of such knowledge, but it can be saved with a little effort and the resources available of this center.