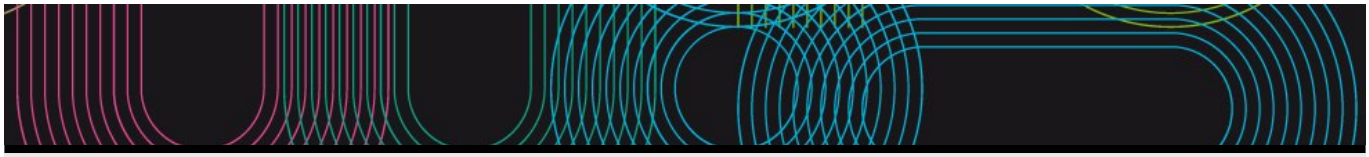

IDENTIFYING DATA				
Graphic Engineering				
Subject	Graphic Engineering			
Code	V12G380V01602			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	English			
Department				
Coordinator	López Pérez, Luis Pérez Vázquez, Manuel			
Lecturers	López Pérez, Luis Pérez Vázquez, Manuel			
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General description	The aim of this course is to provide the student with methods and tools to solve engineering problems graphically. After taking it the student will: Be aware of the criteria used for the selection and use of standard parts. Know about the CAD technologies used in geometrical modelling, and how to use them to produce engineering drawings. Be able to perform analysis on the operation of mechanisms from the specifications in the engineering drawings. Know how to apply geometrical tools to solve problems involving mechanisms, constructions, industrial facilities and installations. Possess skills to create and manage graphical information associated to mechanical engineering problems.			

Competencies	
Code	
B1	CG1 Skills for writing, signing and developing projects in the field of industrial engineering, whose purpose, 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	CE19 Knowledge and skills to apply the techniques of engineering graphics.
D2	CT2 Problems resolution.
D6	CT6 Application of computer science in the field of study.
D9	CT9 Apply knowledge.
D10	CT10 Self learning and work.
D14	CT14 Creativity.
D16	CT16 Critical thinking.
D17	CT17 Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
TM1 Knowledge and abilities to apply graphic engineering techniques.	B1	C19	D2
CT2 Problem solving.		C19	D6
CT6 Application of computing to the field of study.	B1	C19	D16
CS1 Knowledge application.		C19	D2 D9 D14

CS2 Autonomous learning and work.		C19	D10 D14 D16 D17

Contents	
Topic	
1. Introduction to graphics in Engineering.	1.1. Types of graphics in Engineering and their fields of application. Graphics for design, visualization and communication. The graphical language. 1.2. Graphic systems. Types and structure of graphics files. Information management. Hierarchies. Layers. 1.3. Models. Geometrical models.
2. Representation of standard parts and mechanical components.	2.1. Preferred numbers/values. Standard part names. 2.2. Standard representation, annotation and part names for threaded elements, springs, bearings and its accessories, pulleys. Graphics information in gear wheel drawings. Teeth profile curves. 2.3. Other alternatives for the transmission of movement. 2.4. Mechanical couplings. 2.5. Symbolic representation of mechanisms. 2.6. Criteria for selecting and using standard components.
3. Management of variability; functional consequences of tolerancing. Analysis and synthesis of tolerances.	3.1. Variability associated to engineering problems. 3.2. Macro- and micro-geometrical tolerances. 3.3. Dimensional tolerances and fits and their specifications. 3.4. Geometrical tolerances and their specifications. 3.5. References and reference systems. 3.6. Surface roughness tolerances and their specifications. 3.7. Statistical tolerancing. Cost functions of tolerancing. 3.8. Tolerance analysis and tolerance synthesis. 3.9. Combination of tolerances; effects of tolerance cumulation on the operational and assembly conditions of mechanisms.
4. Conception and representation of elementary mechanical forms. Function-oriented, manufacturing-oriented and control-oriented dimensioning.	4.1. Constructive forms for the design of casted, forged, shaped and deep-drawn parts. 4.2. Elementary mechanical functions. 4.3. Analysis of operation conditions in mechanisms. 4.4. Functional dimensioning. Dimension chains. 4.5. Manufacturing-process-oriented dimensioning. 4.6. Compliance-control-oriented dimensioning.
5. Diagrams, nomograms and empirical equations.	5.1. Graphical constructions used in Engineering. 5.2. Scales for graphical constructions. 5.3. Diagrams and nomograms. Volumetric graphs. 5.4. Graphical representation of empirical equations. 5.5. Data analysis functions.
6. Fundamentals of computer graphics.	6.1. Basic geometric transformations. 6.2. Graphing of lines: basic algorythms. 6.3. Approximative and interpolative curves: types and applications. 6.4. Geometric modeling. Information structure in 2D and 3D CAD files. Entities and models for solids / surfaces / wireframes / points. 6.5. Graphics libraries. 6.6. Product-oriented CAD systems for mechanical design.
7. Geometrical specification of products.	7.1. The Geometrical Specification concept according to ISO. 7.2. Standards-chains. 7.3. GPS Fundamental and Global standards. 7.4. GPS General Standard Matrices. 7.5. GPS Complementary Standards Matrices. 7.6. Specification operations. 7.7. Interpretation of geometrical specifications based on the operations used to build them.
8. Representation of industrial buildings and installations.	8.1. Symbolic representation of structures. 8.2. Detail drawings of metallic structures. 8.3. Representation and annotation of welded joints. 8.4. Drawings for metalworking. 8.5. Symbols and schematics for hydraulic and pneumatic circuits. 8.6. Symbols and schematics for piping works.

9. CAD/CAE/CAM systems. Systems for data acquisition of real shapes. Rapid prototyping.	9.1. CAx systems. 9.2. CAD/CAM tools. 9.3. CAE tools in the design engineering context. 9.4. Virtual reality: features and devices. Applications in the Engineering field. 9.5. Digitization of shapes. Reverse engineering projects. 9.6. Rapid prototyping systems. 9.7. Information exchange formats.
10. Introduction to Industrial Design.	10.1. Design. Types. Industrial Design: product, communication and corporative image. 10.2. Design methodologies. 10.3. Stages in the design process. 10.4. Creativity in the design process. 10.5. Assessment of design alternatives. 10.6. DfX techniques.
CONTENTS FOR PRACTICAL LECTURES:	.
1. Sketching of a mechanical assembly.	The sketching of a mechanical assembly by every student will be proposed. It will include power transmission elements and a high number of standard components. The preliminary process, involving the study, information gathering and analysis, will be performed by groups of three/four students.
2. Modelling of the previous assembly.	Once the previous practical work has been corrected and given back to the students, the modelling of parts and its assembly will be performed, using the CAD software that is available at the laboratory. Every student will work on his own, but groups will be made for idea-sharing and collaborative learning.
3. Making of 2D drawings.	Details and assembly drawings will be made from the previous models of the assembly, using the CAD software available. The drawings will contain the bill of materials and all necessary specifications -dimensions, macro- and micro-geometrical tolerances, special indications- needed to guarantee optimal operation of the mechanism to which each part belongs.
4. Representations for metalworking.	Solid modelling and plane developments will be performed on a metalworking element, including all the necessary dimensional specifications, using the CAD software available.
5. Making of a report for functionality and exchangeability analysis.	A critical analysis will be performed on the design of exercises 1 to 4, containing an estimation of the expected operational conditions, based on the applied tolerances and their combined effect. A study showing how the tolerance costs could be reduced based on the combined effect of all the intervening ones will also be carried out. CAE analysis will be performed on a relevant part of the design. All pieces from the report will documented, applying as much graphical information from the course work as possible in order to achieve a better understanding of the document.
6. Representation of an industrial facility. Schematics of piping works and other installations.	A small building of the 'industrial unit' kind, hosting a workshop or small mechanical industry, will be represented using the CAD software available, including drawings with all the necessary dimensions and the corresponding construction details of the metallic structure. The symbolic representation of the various relevant installations in the unit: energy, fluids, etc. will be also carried out.
THEORY CONTENTS:	.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	39	65
Troubleshooting and / or exercises	24	36	60
Integrated methodologies	5	5	10
Group tutoring	5	5	10
Others	5	0	5

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

Methodologies

	Description
Master Session	Active master session. Each topic will be presented by the lecturer using audiovisual resources, this being complemented with the comments that students make, based either on the recommended references or on any others that are relevant for this part of the suject.

Troubleshooting and / or exercises	Exercises and/or problems will be proposed to be solved along the masterclasses, either partially or fully in class, either individually or in groups, and always with the active orientation of the lecturer. These activities will be oriented to make easier a better understanding of the application and practical utility of the contents of each topic. The purpose of these exercises will also be to provide an orientation on the contents and aims of the laboratory classes.
Integrated methodologies	Realisation of activities that require the active participation of students and the collaboration among them.
Group tutoring	Realisation of activities to reinforce the learning by means of the tutored resolution in groups of practical cases related with the theory contents of the subject, evaluating along them how the students associate these contents to each one of the different stages developed in the analysis and solution processes of each problem.
Others	PERSONALISED ATTENTION: Proposition of learning support activities and review of its results, either individually or in small groups of students.

Personalized attention

Methodologies	Description
Group tutoring	A review will be made on the proposed exercises to be performed in groups, analysing and commenting in the group the possible errors and alternative solutions.

Assessment

	Description	Qualification	Training and Learning Results
Master Session	A number of tests -at least two, according to the lecturer's judgment- will be performed in designed dates. In those tests it would be possible for the students to pass either all or any of the parts of the subject. In this 'Continuous Assessment' modality the maximum score the student could achieve will be 10 points over 10.	ata 60	C19 D10 D16
Troubleshooting and / or exercises	The practical activities to be performed are listed in the section of 'Contents for Practical Lectures', and will be explained for their development, resolution and hand-in to the lecturer on the date indicated for each of them. Each handed-in activity will be evaluated according to the criteria previously indicated, and will be given back quickly to the student, so that the learning from each correction could be incorporated to the following practical activities. The calendar for execution and presentation of the practical activities will be communicated to the students at the beginning of the course.	ata 40	B1 C19 D2 D6 D9 D14 D16 D17
Others	Besides the previous modality, the student could choose the 'Final Assessment only' modality with an only test of the whole of the contents. This assessment could include test or reasoning questions, resolution of problems and development of practical cases. The maximum score the student could get in this modality will be of 8 points over 10.	ata 10	B1 D2 D9 D10 D17

Other comments on the Evaluation

The 'Continuous Evaluation' modality will assess all the work developed, either face-to-face or not, in the programmed activities to be performed individually and/or in groups. Each student can pass the subject in the continuous evaluation modality if (s)he scores 5,00 points in each one of the parts. In this case it is not necessary to perform the official assessment included in the schedule announcement by the School.

If in the continuous evaluation process some parts are 'not passed', the student should perform the assessment of these parts in the final assessment, both the theoretical and the practical contents, except in case the lecturer offers him/her the chance to pass those parts through a specific additional or complementary work. The 'passed' parts will then be kept until the second assessment.

The final assessment will include the whole contents of the subject for those students who have rejected the 'continuous evaluation', and also for those who, having gone through the 'continuous assessment' modality, wish to better the score they already got in that modality.

Sources of information

AENOR, **Normas UNE diversas actualizadas**, AENOR,

Aguayo, F.; Soltero, V., **Metodología del Diseño Industrial. Un Enfoque desde la Ingeniería Concurrente.**, Ed. Rama,

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

Cordero, J.M.; Cortés, P., **Curvas y Superficies para Modelado Geométrico**, Ed. RA-MA,
Farin, G., **Curves and surfaces for computer aided geometric design**, Academic Press,
Félez, J.; Martínez, M.L., **Ingeniería Gráfica y Diseño**, Síntesis, D.L.,
Fischer, B. R., **Mechanical Tolerance Stackup and Analysis**, Marcel Dekker, Inc.,
Foley, J. D.; Van Dam, A.; Feiner, S. K.; Hughes, J. F.; Philips, R. L., **Introducción a la Graficación por Computadora**, Addison-Wesley Ib.,
García, M.; Alcaide, J.; Gómez, T.; Collado-Ruiz, D., **Fundamentos del diseño en la ingeniería**, UPV,
Giesecke F.E.; et al., **Technical Drawing with Engineering Graphics**, Prentice Hall (Pearson Education),
Gómez, S., **El Gran Libro de SolidWorks Office Professional**, Ed. Marcombo,
Hearn, D.; Baker, P., **Gráficos por computador**, Prentice Hall Hispanoamericana,
Jensen, C.; Helsel, J. D.; Short, D. R., **Dibujo y diseño en Ingeniería**, Mc Graw-Hill,
Molero, J., **Autocad 2010: Curso Avanzado**, Anaya Multimedia,

Recommendations

Subjects that continue the syllabus

Product Design and Communication, and Automation of Plant Elements/V12G380V01931
Systems for Product Design and Development/V12G380V01934
Bachelor Degree Thesis/V12G380V01991

Subjects that are recommended to be taken simultaneously

Machine Design I/V12G380V01304

Subjects that it is recommended to have taken before

Fundamentals of Engineering Graphics/V12G380V01101
Fundamentals of Manufacturing Systems and Technologies/V12G380V01305

Other comments

It is required in order to register in this subject to either have passed all subjects in the former courses, or to be registered in all of them.
It is specifically recommended to have passed the 'Graphic Expression' subject from first year.