Course guide
2500004-GECEXPGRAF - Graphic Expression

| Unit in charge: | Barcelona School of Civil Engineering <br> Teaching unit: |
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| 751-DECA - Department of Civil and Environmental Engineering. |  |
| Degree: | BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject). |
| Academic year: 2023 | ECTS Credits: $6.0 \quad$ Languages: Catalan, English |

## LECTURER

Coordinating lecturer:
JORDI POBLET PUIG
Others:
ALBA CALVET SISÓ, MARIO FERNANDEZ GONZALEZ, ÀXEL LEGARES SIERRA, SERGIO LOPEZ LAZARO, JORDI POBLET PUIG, LLUÍS PRETEL FUMADÓ

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

## Specific:

14392. Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculation; differential equations and partial derivatives; numerical methods; numerical algorithmic; Statistics and optimization. (Basic training module)
14393. Capacity for spatial vision and knowledge of graphic representation techniques, both by traditional methods of metric geometry and descriptive geometry, as well as by computer-aided design applications. (Basic training module)
14394. Basic knowledge about the use and programming of computers, operating systems, databases and computer programs with engineering application. (Basic training module)

## TEACHING METHODOLOGY

The course consists of two sessions of 2 hours a week of face-to-face classes in the classroom. They are engaged in theoretical classes and exercises.

In the computer-aided drawing sessions, the group will be split in two.

There will also be a two-hour session a week of "workshops" (the weeks when there is no CAD session). These are optional. There will be a review of basic contents at the hish-school level and there will be guided practices related to the exercises of the conventional class.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of assessment and directed learning activities and bibliography.

The language in which the activities in each group will be held is:
-English group: 100\% in English
-Group 20: 100\% in Catalan

- Group 10: 60\% in Catalan and 40\% in Spanish

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

## LEARNING OBJECTIVES OF THE SUBJECT

Knowledge of metric plane geometry. Descriptive geometry I (basic fundamentals and dihedral operability). Representation systems and graphic design through specific programs of civil engineering.

1 Ability to solve problems requiring the use of plane and spatial geometry.
2 Ability to produce contour maps of a unique engineering structure
3 Ability to use computer-aided design programs, in simple problems. Ability to use the conical system to represent a unique engineering structure.
patial vision skills and knowledge of traditional graphic representation techniques. Knowledge of metric geometry. Knowledge of the basic tools of metric geometry: constructions and demonstrations with ruler and compass. Knowledge of dimensioned plans. Knowledge of technical drawing. Conical system knowledge. CAD.
1.- Development of the capacity for abstraction. 2.- To give solution to the problems of the geometry of the space by means of operations carried out on a plane. 3.- To accurately represent shapes and bodies in 3D in space on two-dimensional projection planes. 4.- Be able to deduce and transfer to the three dimensions the exact description of the bodies represented in 2D by means of the dihedral representation system and everything that necessarily follows from their shapes and their relative positions with respect to the projection planes. 5.- To be able to represent on the plane the exact projections of shapes and bodies in space, using the three basic projection planes of the dihedral system (elevation, plan and profile). 6.- Development of the student's spatial capacity through a process of spatial maturity, which allows him to reconstruct in the mind or materially the forms given by his flat representations (projections), to put his creative faculty at the service of the future civil engineer where the Geometry and spatial capacity play a vital role in the design of civil technical projects. In this way, knowledge of the subject in its development and spatial maturity will confer on the engineer a double aspect: on the one hand, he must become familiar with the management and representation of geometric shapes whose proper use may be considered a civil project, and on the other part will provide him with the technique that will allow him to correctly represent the forms created by him in such a way that they can be correctly interpreted from his representation by those who have to be in charge of their real construction and materialization.

## STUDY LOAD

| Type | Hours | Percentage |
| :--- | :--- | :--- |
| Guided activities | 6,0 | 4.00 |
| Hours medium group | 24,0 | 16.00 |
| Hours large group | 30,0 | 20.00 |
| Self study | 84,0 | 56.00 |
| Hours small group | 6,0 | 4.00 |

Total learning time: 150 h

## CONTENTS

## GM - Geometry

## Description:

-Bisector line of the segment
-Bisector line of the angle
-Proportionality, Thales theorem, scale factor
-Homothetic transform (applied to segments and circumferences)
-Conical curves
-Exercises related with the previous topics
Definition, basic properties and representation of:

- Translation
- Axial symmetry
- Rotation

Product of movements
Exercises
Study the following topics related with triangles:
-Sum of internal angles.
-Definitions and properties of: circumcentre, orthocentre, incentre/execentres, centroid
-Similarity of triangles, leg's / height / pythagoras / generalised pythagoras tehorems
-Exercises on the basic construction of triangles
-Definition of the regular polygons
-Property of the sum of interior/exterior angles
-Definition and classification of quadrilaterals
-Basic properties of the parallelogram and trapezium
-Exercices on the construction of basic quadrilaterals by means of locus intersection, triangles, or movements
-Definitions and basic properties of a circumference.
-Properties of the chords.
-Tangent lines
-Angles on the circumference: central, inscribed, semi-inscribed, internal, external. And their properties and relations.
-Arco capaz.
-Exercises on tangent
-Exercises with the circumference angles and arco capaz

## Specific objectives:

1.- Learn to make the proposed geometric constructions and understand their basic properties. 2.- Put into practice the theoretical knowledge. 3.- Acquire skills when drawing two-dimensional geometric figures. 4.- Become familiar with the use of drawing tools such as the compass or curve templates (and the like). 5.- Learn to solve simple geometric problems. Learn basic concepts of movements, properties, representation and composition.
Learn basic properties of triangles and solve basic exercises.
Learn properties of polygons and solve basic exercises
Know basic properties of the circumference and its angles
Full-or-part-time: 28h 47m
Theory classes: 12h
Self study : 16h 47m

## DI - Orthographic projection

## Description:

Definition of orthographic projection (American and European).
Exercises related to the orthographic projection. In general, a projection direction and a figure will be given and the view of the figure demanded. Exercises where some transformation is applied to the figure (rotations) will be considered.

## Specific objectives:

1.1.- Understand the concept of "projection on a plane". 1.2.- Know various ways of making these projections. 1.3.- Know the dihedral projection system. 1.4.- Become familiar with the concepts of: plan, elevation, profile. 1.5.- Know how to correctly position each of the views or projections in both the American and European systems. 1.6.- Differentiate between edge / face and hidden face.

1) Learn to make orthographic projections of a piece; 2) Ability to see a piece that moves in space (imagine the piece in the final position when the initial position and a movement are defined); 3) To be familiar with different figure typologies. Pieces with curved faces will be considered; 4) Being able to imagina a sectioned piece.

Full-or-part-time: 12 h
Theory classes: 1h
Practical classes: 4 h
Self study : 7h

## LLI - Free-hand drawing

## Description:

Basic theoretical indications on free prospects. Free view and interpretation of pieces. Opposite view and perspectives from a certain point of view. Basic points: - Basic rules of freehand drawing: parallelism, proportionality - Basic tips for making a freehand drawing: orientation of the appropriate axes, wire structures etc - Drawing of simple figures - Concept of elevation direction vs. observer's point of view - Drawing figures from a certain point of view. - 8 positions in space -Opposite view Figures with curved faces - Exercises
Session dedicated to solving the unit's own exercises, and exam problems from previous courses

## Specific objectives:

Assimilate the concept of one-piece free perspective and learn the basic tips. 1.1.- Acquire enough spatial vision to imagine a piece, given its dihedral projections 1.2.- Acquire enough freehand drawing skills to make an intelligible drawing 1.3.- Be able to draw a free perspective respecting aspects such as parallelism and proportionality. 1.4.- Ability to imagine the opposite view of a piece, known its direct view. 1.5.- Ability to imagine what an observer located at any point in space sees.

Full-or-part-time: 12h
Theory classes: 1h
Practical classes: 4 h
Self study : 7h

## GD - Introduction to the descriptive geometry

## Description:

GD_1. System elements; The point.
1.1 System elements definition.
1.2 Point representation.
1.3 Coordinate axes.
1.4 Identification of a point by its coordinates.
1.5 Different positions of the point

- Point at 1st dihedral.
- Point at 2nd dihedral.
- Point at 3rd dihedral.
- Point at $4^{\circ}$ dihedral.
- Point in the 1st bisector.
- Point in the 2nd bisector.
- Point in the vertical plane.
- Point in the horizontal plane.
- Point at the ground line.


## GD_2. The straight line.

2.1 Stright line's representation.
2.2 Point contained in a line.
2.3 Traces of a line.
2.4 Line defined by two points.
2.5 Intersection of two lines.
2.6 Parallel lines. Parallel stright line by a point to another one.
2.7 Relative straight line's positions.

- Horizontal straight line.
- Front straight line.
- Parallel strainght line to the ground line.
- Vertical straight line.
- Edge straight line..
- Straight line contained in the 1st bisector.
- Straight line contained in the 2nd bisector.
2.8 straight line's views: hidden and views parts.
2.9 Straight line profile.
2.10 Profile plane abatement and profile plane disabatement.
2.11 Straight profile lines' intersection.
2.12 Parallel line to a profile lines passing by a determinate point.

GD_3. The plane.
3.1 Plane's representation.
3.2 Plane's points. Horizontal projection of a known point vertical projection or vice versa.
3.3 Straight line contained in a plane.
3.4 Straight lines individuals contained in a plane.

- Front straight line.
- Horizontal straight line.
- Maximum slope straight line.
- Maximum tilt straight line.
3.5 Plane's particular positions.
- Vertical plane.
- Edge plane.
- Flat plane.
- Horizontal plane.
- Frontal plane.
- Parallel plane to the ground line.
- A plane that passes through the ground line.
- Perpendicular plane to the 1st bisector.
- Perpendicular plane to the 2nd bisector.
3.6 Traces of a plane defined by two lines.
3.7 Types of planes defined by a straight line.
- Vertical plane.
- Edge Plane.
- Parallel plane to the ground line..
- Perpendicular plane to the 1st bisector.
- Perpendicular plane to the 2nd bisector.

GD_5. Parallelism and perpendicularity
5.1 Parallel planes.
5.2 Parallel straight line to a plane by a point..

- General case.
- Plane parallel to the ground line.
- Plane passing through the ground line.
- Parallel straight line to a plane by a point.
- Parallel plane to two given straight lines by a point.
- Parallel straight line by a point to a plane which is built by a given straight line.
- Straight line supported in two ones' by a point.
- Straight line supported in two ones' by a given direction.
5.3 Theorem of the three perpendicular.
5.4 Perpendicular line to a plane passing by a point:
- General case.
- Perpendicular plane to the ground or passing through the ground line.
- Perpendicular plane to the bisectors.
5.5 Perpendicular plane to a line passing by a point.
5.6 Perpendicular straight line to other two ones. Common perpendicular.
5.7 Perpendicular plane to two ones:
- Straight line's projections on a plane.
- Orthogonal straight line to a given one which is build on another by a point.
- Straight line contained in a plane which is perpendicular to another one by a defined plane point.
- Straight line which is perpendicular and parallel to two differents planes by a point.

Session dedicated to solving the unit's own exercises, and exam problems from previous courses
GD_6. Affinity
6.1 Flat Affinity .

- Affinity's propertie


## Specific objectives:

1.1.- Be able to deduce and transfer from three-dimensional space to two-dimensional space using the dihedral system, and restore from dihedral projections to three-dimensional space. 1.2.- Represent three-dimensional solids and their basic geometric elements that make it up: points, lines and planes. 1.3.- Know the basic positions of the line and the plane. 1.4.- Determine the relative positions between the different geometric elements: points, lines and planes. 1.5.- Determine the conditions of membership of said elements. 1.6.- Learn to use the terminology of the dihedral system with fluency and solvency.
3.3.- Construction using operating methods of the subtraction dihedral system and parallel planes between them and others. 3.3.- Understanding and using the theorem of the three perpendiculars for their use in the construction of perpendicular lines between them, perpendicular lines with planes, and perpendicular planes between them.
4.1.- Learn the procedures of each of the auxiliary operating methods (abatement, change of plane and turns) of the dihedral system. 4.2.- Assess the importance of mastering the different auxiliary methods of the dihedral system, especially of the abatement, since it constitutes the most used way of descriptive geometry to solve problems related to distances, true magnitudes, angles, etc.

Full-or-part-time: 19 h 12 m
Theory classes: 4h
Practical classes: 4h
Self study : 11 h 12 m

## PA - Contour maps

## Description:

Definition of the dimensioned plane system. - Representation of points, lines and planes. - Basic operations: Parallelism, perpendicularity and distances
Representation and concept of: - Use of scales. Graphic scale. - Concept of contour (horizontal plane) - Geometric Surfaces Point curves in space - Definition of the basic elements that are part of a roof and description of what it is to solve the problem of a roof with bounded planes. Application of the concept of scale and equidistance to dimensioned plane problems. - Initial cover exercises.
Session dedicated to solving the unit's own exercises, and exam problems from previous courses
-Representation of land -Characteristic elements of the orography -Long profile. Constant slope path and maximum slope path. -
Cross section: concept of cut and fill. -Transition surfaces: cases with zero slope contours -Platform exercises
Session dedicated to solving the unit's own exercises, and exam problems from previous courses
Definition of linear work. Cut and fill concepts. Definition of the type of surface that is formed in the cuttings and embankments of a linear work depending on the type of plan layout (straight, circular or curved) and whether it is a section with zero or constant slope.
Session dedicated to solving the unit's own exercises, and exam problems from previous courses

## Specific objectives:

1.1.- Learn the basic principles of the Bounded Plans. 1.2.- Know how points and lines are represented. 1.3.- Acquire the most basic skills to carry out small operations related to points and lines (example: placing a point on a line; determining the distance between two points). 1.4.- Know how a plane is represented. 1.5.- Become familiar with concepts such as "maximum slope line", "trace of the plane", ... 1.6.- Learn to perform geometric operations that include planes (intersection of two planes, draw a line contained in a plane, ... 1.7.- Know how to draw planes and lines that are parallel and perpendicular 1.8.- Be able to do other three-dimensional geometric operations such as intersecting a line with a plane, collapsing planes, drawing planes and lines that form a given angle with another plane etc.
2.1.- Learn how to represent basic geometric surfaces (spheres, cones, cylinders) using dimensioned planes. 2.2.- Learn the name of basic elements of a roof. 2.3.- Understand what the definition of a roof consists of through dimensioned plans. 2.4.- Be clear about what the problem data may be and what results can be asked of us. 2.5.- Know how to determine a roof (level and intersection curves of each of the parts that form it), fixed: the outer contour, the type of surface that forms it and its geometric characteristics, the scale of the exercise and the equidistance of job.
2.6.-Know how to determine a roof (level lines and intersection of each of the parts that form it), fixed: the outer contour, the type of surface that forms it and its geometric characteristics, the scale of the exercise and the equidistance of job.
3.1.- Know the concept of platform. 3.2.- Know the concept of "cut" and "embankment" and in which cases we find each one of them. 3.3.- Know how to determine the surfaces generated in the construction of a platform as well as its intersection with the ground. Geometric interpretation of the results obtained.
4.1.- Know the concept of linear work. 4.2.- Know the concept of "clearing" and "embankment" and in which cases we find each of them. 4.3.- Know how to determine the type of cut or embankment surface that we will have to draw based on the plan layout or elevation of a linear work. 4.4.- Learn the "profile method".
4.5.- Know how to determine the surfaces generated in the construction of a platform or a linear work as well as its intersection with the ground. Geometric interpretation of the results obtained

Full-or-part-time: 20h 24 m
Theory classes: 5h
Practical classes: $3 \mathrm{~h} \mathrm{30m}$
Self study : 11h 54m

## CAD - Laboratory of CAD (vectorial software)

## Description:

1. Introduction. Description of the system. 2.- Basic tools for 2D design: drawing. - Exercises
3.- Basic tools for 2D design: editing. - Exercises
4.- Management tools: layers, properties and elements. - Exercises
5.- Blocks and attributes. 6.- Dimensions and text. - Exercises
7.- Paper space configuration. Windows, views and scales. 8.- Configuration for printing plans. - Application to exercises
9.- Introduction to 3D space: work plans and views. - Exercises
10.- Creation of primitive solids. 11.- Boolean operations with solids. - Exercises
12.- Editing and transformations of 3D solids. - Exercises
13.- Views and perspectives with 3D solids - Exercises

## Specific objectives:

The objectives of the CAD laboratory are: - Preparation of students for the use of computer instruments as a tool in solving geometric problems. - Identify and represent through the system of multiple, axonometric and conical views, the characteristics of bodies, surfaces and objects, according to their location in space. - Know, identify, represent and use the known surfaces and volumes in geometry using proprietary engineering software applied to projects. - Application of current computer tools to graphic representation in the field of Civil Engineering through the use of vector-assisted design programs. - Introduction of the student in the rational use of computing as a work base, under the "interface" of the operating systems, and the application of specific vector software as a 2D and 3D drawing tool. Always under the conceptual guideline of the geometric structuring of the projects to be represented and the help of informatics in the field of descriptive geometry and technical drawing.

Full-or-part-time: 27 h 36 m
Theory classes: 1h 30m
Practical classes: 10h
Self study : 16 h 06 m

## EV - Evaluation

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

## CL - Class activities

## Description:

Session dedicated to resolving doubts openly. It will typically be held on the days before the assessments. Completion of practical exercises in class. Performing virtual tests.

## Specific objectives:

Answer doubts and solve exercises
Complement the continuous assessment note. Fix theoretical concepts. Receive information before the partial assessments.
Full-or-part-time: 4h 48m
Practical classes: 2 h
Self study : 2 h 48 m

## H - Holiday days

## Description:

Course days that are affected by a public holiday
Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2 h 48 m

## GRADING SYSTEM

The final course mark ( $N$ ) is calculated as follows:
$N=0.25 N \_c+0.17 N \_e 1+0.38 N \_e 2+0.2 N \_c a d(/ 10$, pass $>5)$
where:

N_e1 (/ 10) is the first partial exam mark, which will include the topics of technical drawing and geometry. The exam will consist of two or three exercises.
N_e2 (/ 10) is the second partial exam mark, which will include the topics of technical drawing and metric geometry. The exam will consist of two or three exercises.
N_cad (/ 10) is the mark of the class activities, homework and exams in the CAD part.
N_c (/ 10) is the grade for the activities done in class. The worse mark will be discarded.

Students who did not pass the continuous evaluation but attended all the exams and activities will have the option to carry out a reassessment exam.

The students who already passed the course are not allowed to attend the reassessment exam. For the others, the maximum mark that can be obtained is 5.0.

Extraordinary exams (or adjustment in the calculation of $N \_c$ ) will be made for those students who due to an accredited cause have not been able to perform some of the continuous evaluation tests or activities. The justification of absence must be notified by email to the person in charge of the course (a posteriori notifications will only be considered in case of force majeure). These extraordinary tests must be authorized by the corresponding head of studies.

The non-attendance in any of the activities or the exams of the course N_c, N_e1, N_e2, N_cad may entail the final mark of "Not evaluated".

## EXAMINATION RULES.

If any of the continuous assessment activities are not carried out in the scheduled period, it will be considered as a zero score.

## BIBLIOGRAPHY

## Basic:

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