



Course guide

250226 - TECREPR - Representation Techniques

Last modified: 21/11/2022

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: **Academic year:** 2022 **ECTS Credits:** 6.0
Languages: Spanish

LECTURER

Coordinating lecturer: MARIO FERNANDEZ GONZALEZ

Others: ALBA CALVET SISÓ, MARIO FERNANDEZ GONZALEZ, JORDI POBLET PUIG

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

3097. Capacity for spatial vision and knowledge of graphic representation techniques based on both traditional metric geometry and descriptive geometry methods, and computer-assisted design applications

3098. Basic knowledge of computer use and programming, operating systems, databases and software as applied to engineering

Transversal:

592. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

595. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

599. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

602. 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.

584. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

This subject is taught with 4 lessons of one hour per week during 15 weeks.

Each week has 2 hours theoretical knowledge lessons, 1 hour is dedicated just to solve exercises and the last one is focused on practical laboratory class, having to be made in person compulsorily.

The 2 hour theoretical knowledge lessons take place in a big group of several students, where the teacher explains the concepts and the basic contents of the subject as it shows many examples of them with different type of exercises.

There exists one hour of class addressed to an small group of students where different kind of exercises are solved with the intention to consolidate the main and specific concepts and also for the lecture to be more interactive among all of them.

From the total of the 15 hours of practical lessons along the school year, 5 of them are for the continuous assessment test, 5 of them are for the teachers to solve the exercises and the following 5 ones are for the continuous assessment practices to be done.

Finally there is 1 hour of laboratory class in a reduced group of students, where the CAD tools and program's use will be taught.

According to the scheduled sessions, the SX-Y nomenclature it has been used, where the meaning is the following: "X" to indicate the week lesson (from 1 to 15) while "Y" indicates the type of lesson (1 for theory, 2 for solving exercises and 3 for the CAD labs lessons)

There exists a support material in the virtual campus, ATENEA, where a detailed teaching plan is located. There can be found information on it such as contents (pdf 's notes), activities and learning assessment schedule (with past years exercises and exams) so as bibliography.

The final school year mark is obtained by adding the class exercises (30%) ,where personal exercises, Cad's lab practices and continuous assessment exercises are included, and the continuous assessment test (70%).

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

Students will acquire complex knowledge of traditional graphic representation (descriptive geometry) and learn about computer-assisted design applications in computer software commonly used in engineering.

Upon completion of the course, students will have acquired the ability to: 1. Solve complex geometry problems. 2. Use computer-assisted design software in complex geometry problems. 3. Develop multiview orthographic projections of complex geometry problems.

Numerical geometry, including the use of computer tools; Constructions in metric plane geometry; On-site layout, rendering and three-dimensional visualisation; Multiview orthographic projection, including homology, affinity, collapsing, shadows, polyhedra, and radiated, revolved and ruled surfaces

STUDY LOAD

Type	Hours	Percentage
Self study	84,0	56.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00
Guided activities	6,0	4.00
Hours large group	30,0	20.00

Total learning time: 150 h



CONTENTS

Item 01. Fundamentals, points, lines and planes

Description:

S1-1. THEORY

Lesson 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 ° 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.

Lesson 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.

Lesson 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.

S1-2. PROBLEMS.

Non working session. Reserve for proof of continuous assessment.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 02. Intersections of planes and lines

Description:

S2-1. THEORY

Lesson 4. Planes' and lines' intersections.

4.1 Two planes' intersection. General case.

4.2 Two planes' intersection. Particular cases:

- Plans with traces cutting out of the picture.
- Plans without trace, defined by two lines.
- Plans with the four traces coinciding with the ground line.
- One of the planes passing through the ground line.

4.3 Planes and straight lines' intersection.

- Plane defined by its traces.
- Plane defined by two straight lines.
- Intersection of a line with a flat figure.

4.4 Relative position of crossing straight lines.

4.5 Views and hidden parts of an opaque plane and straight line's intersection.

Lesson 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.

S2-2. PROBLEMS.

Non working session. Reserve for proof of continuous assessment.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 03. Affinity and abatement plans

Description:

S3-1. THEORY

Lesson 6. Affinity

6.1 Flat Affinity .

- Affinity's properties and definition.

6.2 Affinity's definition: by the axis and two affinity points.

6.3 Circunference affinity figure. Double straight lines and double points.

- Ellipse's axis determination.

6.4 Ellipse's affinity figures

6.5 Axes of an ellipse known two conjugate diameters:

- Mannheim's construction.

- Chasles's construction.

- Affinity's method.

Lesson 7. Plans' Abatment

7.1 Plane's abatment on the horizontal plane:

- Point's abatment.

- Straight line's abatment. Horizontal and frontal straight lines.

- Flat figure's abatment.

- Vertical and horizontal trace abatment.

7.2 Abatement using the affinity.

7.3 Disabatment:

- Horizontal projection's determination.

- Vertical projection's determination.

7.4 Plane's abatment on another one:

- Plan defined by its two traces.

- Plan defined by two straight lines.

7.5 Vertical plane's abatment.

S3-2. PROBLEMS.

Non working session. Reserve for proof of continuous assessment.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 04. Circumference and distances

Description:

S4-1. THEORY

Lesson 8. Circumference and distances

8.1 Circumference's representation.

- Ellipse's axis horizontal projection.
- Ellipse's axis vertical projection.
- Maximum and minimum elevation height's points.
- Maximum and minimum distance's points.
- Far right and far left points location

8.2 Distance between 2 points: segment's true magnitude.

8.3 Minimum distance between two crossing straight lines.

8.4 Two parallel planes' distance.

8.5 Two parallel lines's distance.

8.6 Two points' distance in a plane.

8.7 Distance between a point and an straight line.

S4-2. PROBLEMS.

Non working session. Reserve for proof of continuous assessment.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 05. Shadows

Description:

S5-1. THEORY

Lesson 9. Shadows

- 9.1 Concepts, definitions and types.
- 9.2 Parallel and focal light.
- 9.3 Own and cast shadow.
- 9.4 Point's shadow cast:
 - over any plane.
 - over an horizontal plane.
 - over a vertical plane.
 - over the two projection's planes.
- 9.5 Segment shadow cast:
 - over any plane.
 - over the horizontal plane.
 - over the vertical plane.
 - over the two projection's planes.
- 9.6 Flat figure released shadow.
- 9.7 Flat figure's own shadow.
- 9.8 Straight line cast shadow over a flat figure.
- 9.9 Flat figure's cast shadow over another flat figure one.
- 9.10 Circle's cast shadow.
 - Parallel light.

S5-2. PROBLEMS.

Non working session. Reserve for proof of continuous assessment.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 06. Angles.

Description:

S6-1. THEORY

Lesson 10. Angles

10.1 Straight lines forming a determinate angle with a plane by a point.

- by any plane.
- by a projection's plane.

10.2 Planes forming a determinate angle with a plane by a point.

- by any plane.
- by a projection's plane.

10.3 Straight line's angles with projection planes.

- Angle's determination when straight line's are known.
- Straight line's determination when angles are known.

10.4 Planes projection angles with a plane.

- Angles' determination when plane are known.
- Plane's determination when angles are known.

10.5 Angles between two lines:

- when they cut themselves.
- when they cross themselves.

10.6 Angle of two planes.

10.7 Angle between a straight line and a plane.

10.8 Plane's determination when angles between traces are known and the angle between a projection plane and the plane itself are known aswell.

10.9 Straight line parallel to a plane forming a determinate angle with a plane by a point.

S6-2. PROBLEMS

Explanation exam problems from past years.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 07. Auxiliary Methods.

Description:

S7-1. THEORY

Lesson 11. Auxiliary Methods

11.1 Plane's changing method. Horizontal and vertical's changing plane.

- Point's representation.
- Line's representation.
- Plane's representation.

11.2 Change of planes of projection: applications.

- Straight line's conversion into a vertical one.
- Straight line's conversion into a straight edge one.
- Two lines minimum distance.

11.3 Vertical straight line or edge line's rotation:

- Point's rotation.
- Straight line's rotation.
- Plane's rotation.

11.4 rotation's applications:

- Straight line's conversion into a vertical one.
- Straight line's conversion into a straight edge one.
- Two lines minimum distance.

S7-2. PROBLEMS

Proposed problems resolution (problems of continuous assessment).

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 08. Trihedral and polyhedra.

Description:

S8-1. THEORY

Lesson 12. Trihedral

- 12.1 Definitions, elements and representation.
- 12.2 Trihedral construction with a straight edge line and a side over the horizontal plane:
 - when three sides are known.
 - when two sides are known and the dihedral contained too.
 - when two sides are known and so is the opposite dihedral to one of them.
 - when two sides and its common edge are known.
 - when two dihedrals and the opposite side of one of them are known.
- 12.3 Trihedral side's and diehdral's determination.
- 12.4 Trihedral's any position construction.
- 12.5 trirectángulo trihedral.

Lesson 13. Polyhedra

- 13.1 Definitions, elements and representation.
- 13.2 Regular Polyhedra (Platonic solids). Definition, views and hidden parts.
- 13.3 Polyhedron's intersection with a vertical plane.
- 13.4 Polyhedron's intersection with a straight line.
- 13.5 Polyhedron's interseccion with any plane
- 13.6 Polyhedra's shadows.
- 13.7 Regular Polyhedra: definition, enumeration and main section.

S8-2. PROBLEMS

Explanation exam problems from past years.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 09. Regular tetrahedron.

Description:

S9-1. THEORY

Lesson 14. Regular tetrahedron

- 14.1 Definition and description.
- 14.2 Properties.
- 14.3 Main Section.
- 14.4 Different flat sections.
- 14.5 Representations:
 - With an horizontal side.
 - With a vertical edge.
 - With two horizontal edges.

S9-2. PROBLEMS

Proposed problems resolution (problems of continuous assessment).

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m

Item 10. Regular hexahedron.

Description:

S10-1. THEORY

Lesson 15. Regular hexahedron

- 15.1 Definition and description.
- 15.2 Properties.
- 15.3 Main Section.
- 15.4 Different flat sections.
- 16.5 Representations:
 - With an horizontal side.
 - With a main vertical diagonal.
 - With a main section parallel to the horizontal plane.

S10-2. PROBLEMS

Explanation exam problems from past years.

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m



Item 11. Regular octahedron.

Description:

S11-1. THEORY

Lesson 16. Regular octahedron

16.1 Definition and description.

16.2 Properties.

16.3 Main Section.

16.4 Different flat sections.

16.5 Representations:

- With an horizontal side.

- With a vertical main diagonal.

- With a main section parallel to the horizontal plane.

S11-2. PROBLEMS

Proposed problems resolution (problems of continuous assessment).

Full-or-part-time: 7h 11m

Theory classes: 2h

Practical classes: 1h

Self study : 4h 11m

Item 12. Radiated surfaces.

Description:

S12-1. THEORY

Lesson 17. Radiating surfaces

17.1 Definition and classification.

17.2 Prisma

17.2.1 Representation.

17.2.2 Prism point's location.

17.2.3 Prism and straight line's intersection.

17.2.4 Prism and plane's intersection.

17.2.5 Prism's developement.

17.3 Pyramid.

17.3.1 Representation.

17.3.2 Pyramid point's location.

17.3.3 Pyramid and straight line's intersection.

17.3.4 Pyramid and plane's intersection.

17.3.5 Pyramid's development.

S12-2. PROBLEMS

Explanation exam problems from past years.

S13-1. THEORY

17.4 Cone.

17.4.1 Representation.



- 17.4.2 Points location on the cone.
- 17.4.3 Cone and straight line's intersection.
- 17.4.4 Cone's development.
- 17.4.5 Sections flat and true magnitude:
 - Circumference.
 - Oval.
 - Parable.
 - Hyperbola.
- 17.4.6 Cone's tangent planes:
 - by a surface's point.
 - by a external surface's point.
 - tangent plane's to a given direction.
- 17.5 Cylinder
- 17.5.1 Representation.
- 17.5.2 Cylinder's points location.
- 17.5.3 Cylinder and straight line's intersection.
- 17.5.4 Cylinder's development.
- 17.5.5 Sections flat and true magnitude:
 - Circumference.
 - Oval.
- 17.5.6 Cylinder's tangent planes:
 - by a surface's point.
 - by a external surface's point.
 - tangent plane's to a given direction.
- 17.6 Shadows of surfaces (prism, pyramid, cone, cylinder)
 - Own shadow.
 - Cast shadow.

S13-2. PROBLEMS

Proposed problems resolution (problems of continuous assessment).

Full-or-part-time: 14h 23m

Theory classes: 4h

Practical classes: 2h

Self study : 8h 23m



Item 13. The sphere.

Description:

S14-1. THEORY

Lesson 18. The sphere

- 18.1 Sphere's projections.
- 18.2 Horizontal and vertical plane's sphere sections.
- 18.3 Sphere's points projections.
- 18.4 Horizontal straight line and sphere intersection.
- 18.5 Straight line and sphere's intersection.
 - by a straight line passing through the sphere's center.
 - by any straight line (rotation).
 - by any straight line (abatement case 1 on the horizontal plane)
 - by any straight line (abatement case 2 on the horizontal plane)
- 18.6 Sphere's section by a vertical plane passing it's center.
- 18.7 Sphere's section by an edge plane passing it's center.
- 18.8 Sphere's section by a vertical plane.
- 18.9 Sphere's section by an edge plane.
- 18.10 Sphere's tangent plane by a surface point.
- 18.11 Sphere's tangent plane passing through the ground line.
- 18.12 Sphere's tangent plane by a known direction.
- 18.13 Sphere's tangent plans containing an external straight line.
- 18.14 Sphere's intersection by any oblique plan passing throught its own center.
- 18.15 Cast and own sphere's shadows over projection's planes.
 - Abating's method.
 - Projecting planes' method.

S14-2. PROBLEMS

Explanation exam problems from past years.

S15-1. DOUBTS

S15-2. PROBLEMS

Proposed problems resolution (problems of continuous assessment).

Full-or-part-time: 14h 23m

Theory classes: 4h

Practical classes: 2h

Self study : 8h 23m



Item 14. CAD Laboratory.

Description:

- 14.1 Introduction. Description of the system.
- 14.2 Basic tools for the design in 2D: Drawing.
- 14.3 Basic tools for designing 2D: edition.
- 14.04 Management Tools I: layers, properties and elements.
- 14.05 Management Tools II-layer properties and elements.
- 14.06 repetitive elements: blocks and attributes.
- 14.7 Dimensioning and text.
- 14.8 Presentations in paper space.
- 14.9 Setup for printing drawings.
- 14:10 Introduction to 3D space: work plans and views.
- 14:11 Creation of solid primitives.
- 14.12 Boolean operations with solid.
- 14:13 Editing solid.
- 14:14 3D Transformations.
- 14:15 Surface meshes and 3D primitives.

Specific objectives:

The ultimate objectives of the CAD's laboratory are:

- Prepare the students to allow them to use informatic tools when solving the geometric problems.
- Identify and represent multiple views using the features of point, line drawings and objects, according to their location in space.
- To identify and use the flat surfaces and volumes known geometry.
- Application of modern tools in the graphical representation in the field of Civil Engineering.
- Introducing students to the rational use of computers as a working basis, under the "interface" of operating systems and application specific software as a tool for 2D drawing. Always under the guidance of the conceptual structure to represent geometric projects and support of information technology in the field of technical drawing and descriptive geometry.

Full-or-part-time: 36h

Laboratory classes: 15h

Self study : 21h

GRADING SYSTEM

The final score is the sum of partial scores following:

NPRp: qualification Personal internships (15 internships)

NPRc: qualification Continuous assessment practices (5 classroom practices)

NPRbim: qualification BIM practices (classroom practices)

NEec1: continuous assessment rating 1 review

NEec2: continuous assessment test grade 2

The final practice mark is obtained from the following operation:

$$NPR = 0.1 * NPRp + 0.15 * NPRbim + 0.1 * NPRc$$

The final mark for continuous assessment tests will be:

$$NE = 0.30 * NEec1 + 0.35 * NEec2$$

The FINAL YEAR COURSE MARK is obtained from the following operation:

$$NF_{course} = NPR + NE + 0.1 * NF$$

(10% of the NF will be added to the final grade of the course if the student has a mark through the evaluation ≥ 4.5 , and has also carried out an adequate follow-up of the subject, taking as a reference an attendance $> 85\%$ of the classes).

PRACTICE:

Students will have a collection of 20 exercises in Diedric system divided into two groups: personal practices (15) and classroom practices (5). In this collection, students must submit all of the practices conveniently resolved. Deliveries will be made on a date to be determined by the teacher.

The average of the 15 personal practices, the 5 classroom practices and the BIM practices will result in the qualification of the personal practices (NPP), the qualification of the continuous evaluation practices (NPec) and the qualification of the BIM practices (NPbim) respectively.

The score of the practices will have a weight of 35% in the final grade of the subject, so it is recommended its completion and maximum care, as well as attendance to class.

CONTINUOUS ASSESSMENT

Continuous assessment is to make different individual activities, additive and formative in nature, made during the course (classroom).

Continuous assessment is divided in two parts: the practice of continuous assessment and continuous assessment tests.

During the course, and in the days stipulated for such programming on the subject, there will be 5 continuous assessment practices, half of which will result NPec rating. Their weight in the final of the course is 10%.

There will be two exams, whose contents correspond to the subject taught in class until the date of each one of them. The total weight of these in the final grade is 65%.

Final Exam (for students who have not obtained the approval of course), all matters shall be provided along the course.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

EXAMINATION RULES.

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

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Basic:

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