

## 250107 - GMETSISREP - Metric Geometry and Representation Systems

Coordinating unit:	250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit:	751 - DECA - Department of Civil and Environmental Engineering
Academic year:	2018
Degree:	BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Teaching unit Compulsory) BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits:	6
Teaching languages:	Catalan, Spanish

### Teaching staff

Coordinator:	JORDI POBLET PUIG
Others:	MARIO FERNANDEZ GONZALEZ, NARCISO PIGEM RICART, JORDI POBLET PUIG

### Opening hours

Timetable: Tuesday and Wednesday from 11: 00 to 13:00. Or at agreed hours (via email).

### Degree competences to which the subject contributes

#### Specific:

- 3052. Students will acquire spatial vision and graphic presentation skills using both traditional metric and descriptive geometry methods and CAD applications.
- 3053. Students will acquire the ability to select and use graphic presentation techniques and CAD programs to solve civil engineering problems.
- 3054. Students will acquire basic knowledge of the use and programming of computers, operating systems, databases and applications for 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

The course consists of 4 hours per week of classroom activity (large size group).

The 4 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

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### Learning objectives of the subject

Students will develop their capacity for spatial vision, learn to use traditional graphical representation techniques (line drawing and freehand drawing) and acquire an understanding of metric geometry.

On completion of the course, students will have acquired the ability to:

1. Solve problems requiring the use of plane and spatial geometry;
2. Produce floor plans for a specific engineering structure;
3. Use computer-assisted design software to solve simple problems, and use the conic system to represent a specific engineering structure.

Basic tools in metric geometry: Ruler-and-compass constructions and demonstrations; Floor plans; Technical drawing; The conic system

### Study load

Total learning time: 150h	Hours large group:	27h	18.00%
	Hours medium group:	25h 15m	16.83%
	Hours small group:	7h 45m	5.17%
	Guided activities:	6h	4.00%
	Self study:	84h	56.00%

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### Content

<p>Basic geometric drawings</p>	<p>Learning time: 4h 48m Theory classes: 1h Practical classes: 1h Self study : 2h 48m</p>
<p>Description: Description of basic geometric constructions that will be used during the course. These include: 1) Constructions about segments and angles; 2) regular polygons; 3) Constructions about circumferences; 4) conical curves; 5) Other discrete curves. Performing exercises directly related to the previous meeting, drawing trajectories of a given law of motion, or solving other problems of logical geometry.</p> <p>Specific objectives: Learn how to make the proposed geometric constructions and understand their basic properties. 1) Put into practice the theoretical knowledge of the previous session; 2) Acquiring skills while drawing two-dimensional geometric figures; 3) Be familiar with the use of drawing tools like the compass or template of curves (and similar); 4) Learn to solve simple geometric problems.</p>	
<p>Orthographic projection</p>	<p>Learning time: 10h 12m Theory classes: 2h Practical classes: 2h 15m Self study : 5h 57m</p>
<p>Description: Definition and classification of various types of projections that will be used throughout the course. 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.</p> <p>Specific objectives: 1.1) Understand the concept of projection on a plane; 1.2) Understand various ways to make these projections.  2.1) Knowing orthographic projection system; 2.2) To be familiar with the concepts of: front, right, left, top, bottom, and back views; 2.3) Knowing how to properly place each of the views or projections in both American and European systems; 2.4) Differentiate between shown and hidden edge / faces.  3.1) Learn to make orthographic projections of a piece; 3.2) 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); 3.3) To be familiar with different figure typologies. Pieces with curved faces will be considered; 3.4) Being able to imagine a sectioned piece.</p>	



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Freehand drawing	Learning time: 9h 36m Theory classes: 1h Practical classes: 3h Self study : 5h 36m
<p>Description:</p> <p>Define the concept of freehand drawing and the basic rules to follow. To interpret and draw a figure, whose orthographic views are known. Exercises where in addition of the direct view of a figure, its opposite view is demanded. The case of arbitrary point on view observed will be also considered.</p> <p>Specific objectives:</p> <p>1.1)Assimilate the concept of freehand drawing.</p> <p>2.1) Acquire sufficient spatial vision to imagine a piece, given its orthographic views; 2.2) to acquire sufficient skills in freehand drawing to make an intelligible drawing; 2.3) Being able to respect parallelism and proportionality in a freehand drawing.</p> <p>3.1) Ability to imagine the opposite view of a piece; 3.2) ability to imagine what an observer sees at any point of the space.</p>	



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Contour maps	Learning time: 19h 12m Theory classes: 6h Practical classes: 2h Self study : 11h 12m
<p>Description:</p> <p>Definition of the contour map system. Representation of points and lines. To describe how to represent planes and perform basic operations with them. Concepts of parallelism and perpendicularity in the context of contour map plots. Describe how to represent surfaces. Definition of basic elements that are part of a roof and description about how to solve the problem of a roof with contour maps. Apply the concept of "scale"; and "contour interval" in the practical exercises. Roof exercises. Description of the use of contour maps to topographic surfaces. Determination of constant and maximum slope paths. Development of longitudinal profiles. Introduction to the concept of "precision" and "approximation" when representing a topography. Definition of platform and line-shaped construction work. Concepts of dismantling and embankment. To define the surface type in cuttings and fills (embankments) depending on the shape of the border of a road (constant or null slope, curve or straight line). Resolution of exercises dealing with platforms and line-shaped works (roads) or other similar cases of civil engineering by applying the concepts explained in the previous session.</p> <p>Specific objectives:</p>	

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1.1) Learn the basic principles of contour map system; 1.2) know how they represent the points and lines; 1.3) acquire the skills to do most basic operations on points and lines (put a point on a straight line; determine the distance between two points).

2.1) Understand how to represent a plane; 2.2) To learn concepts like:the maximum slope line 2.3) Learn how to perform operations that include planes (intersection of two planes, draw a line contained in a plan, ...).

3.1) To learn how to draw straight lines and planes that are parallel and perpendicular; 3.2) Being able to perform other 3D operations such the intersection of a line and a plane, to find planes and line that define a given angle with another plane or line, ... To know how to represent the most common surfaces (spheres, cones, cylinders).

4.1) To learn the name of the basic elements of a roof; 4.2) To understand how to define a roof from its boundary by using contour maps; 4.3) To clearly know which is the provided data in a contour map problem and what kind of outputs are required.

5)To learn how to define a roof (contour lines of each zone) when the boundary, the surface type, the geometric properties, the scale and the contour interval are provided.

6.1) To Understand how we describe a terrain by means of contour maps; 6.2) To identify singular points in a topography (small mountains, valleys, ...); 6.3) To acquire basic skills for working with topographic maps; 6.4) Understand the limitations of a topographic representation by means of contour maps.

7.1) Understand the concept of building platform and line-shape civil engineering construction; 7.2) Understand the concept of "clearing/grubbing/cutting" and "filling or embankment"; 7.3) To learn the surface type to be drawn depending on the road border shape.

8)Learn how to determine surfaces generated in the construction of a linear or a work platform and its intersection with the ground. Geometric interpretation of the results.

### Axonometric projection

Learning time: 4h 48m

Theory classes: 1h

Practical classes: 1h

Self study : 2h 48m

#### Description:

Defining the orthogonal axonometric perspective

To draw simple figures

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### Oblique projection

Learning time: 9h 36m

Theory classes: 2h  
Practical classes: 2h  
Self study : 5h 36m

#### Description:

Defining the oblique (cavalier) projection.

Representation of points, lines and planes by using cavalier projection. Explaining how to perform basic geometric operations (intersection of planes, intersection of lines and planes,...).

Exercises dealing with the following topics: representation of figures, intersection of planes and figures, shadows caused by parallel and central lights.

#### Specific objectives:

1.1) To know the parameters defining the cavalier projection; 1.2) Graduate axis and apply the scales.

2.1) To learn how to represent points, lines and planes; 2.2) To understand the concept of perspective of the projection (of an element on the coordinate plans) ; 2.3) To have the ability of: intersect lines, planes, lines and planes ...

3)To learn how to solve, applying the topics developed in the previous session, problems of shadows and intersections.

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<p>Central projection</p>	<p>Learning time: 16h 48m Theory classes: 3h Practical classes: 4h Self study : 9h 48m</p>
<p>Description:</p> <p>The central projection is classified among the projection types studied during the course. Their elements and general 3D mechanics is defined and the concepts of "vanishing point" and "trace" introduced. The rules used in order to represent a 3D reality in a 2D space are defined. A method used to find the central projection of points is defined. Central projection of simple figures are done. Specific procedures for the cases in which the vanishing point falls outside the paper are exposed. The scale concept of central projection is defined. Two different methods to impose scaling are exposed. They can be combined in the proposed of exercises. The special case of figures contained in the same plane than the focal point is studied. In that cases, the central projection is a segment and specific methodologies are explained. Basic theory for the case of aerial views done with central projection (the image plane parallel to the base plane). Practical exercises of aerial views.</p> <p>Specific objectives:</p> <p>1.1) To understand the mechanism that allows us to represent in the paper, operations (central projection) that actually occur in the three-dimensional space; 1.2) To assume that both, the base and image planes, are represented in our paper; 1.3) To understand that in central projection it is faster first to find some particular lines (horizontal) and afterwards the points.</p> <p>2) Taking advantage of the proposed very simple examples, the basic procedures are practised.</p> <p>3) Purchase tools to overcome the fact that a vanishing point may be out of the paper. Learning to work with visual plans.</p> <p>4.1) Understand the meaning of scaling in central projection; 4.2) To know the two scaling methodologies and how to combine them; 4.3) Acquire criteria for choosing a correct scale combination.</p> <p>5.1) To recognise when a figure and the focal point are in the same plane; 5.2) To know specific techniques for that situation; 5.3) To perform central projections of circles or figures containing curved surfaces.</p> <p>6) To learn the basic concepts and mechanisms related to the aerial views. To apply the theoretical knowledge learned in the previous session to some practical cases.</p>	

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<p>Geometry</p>	<p>Learning time: 50h 24m Theory classes: 11h Practical classes: 10h Self study : 29h 24m</p>
<p>Description:</p> <p>Definition and explanation of basic geometrical concepts including: 1) Movements (definitions of central symmetry, rotation, translation and axial symmetry); 2) movement product (general properties and product of axial symmetries); 3) Tales theorem; 4) Definition of homothety and similarity. Exercises related to lesson 1 (basic geometrical concepts).</p> <p>Definition and explanation of basic concepts related to triangles, including: classification of triangles and similarity/equality criteria, fundamental theorems, use of triangles in order to obtain other geometrical properties. Exercises that include aspects related to lesson 2 (triangles).</p> <p>Explanation of general polygon properties. Describe specific properties of parallelograms, trapezoid, rectangle, rhombus and rhomboid.</p> <p>Definition and explanation of basic concepts related to circles, including: basic properties of inscribed, semi-attached, external or interior angles; orthic triangle. Exercises that include aspects related to lessons 3 and 4 (polygons and circles).</p> <p>Specific objectives:</p> <p>1.1) To know the basic movements and learn how to apply them to figures in practice. Understand their properties; 1.2) To learn how to make movement products, respecting the basic rules; 1.3) To understand and apply to practical cases the Tales theorem; 1.4) To understand and apply to practical cases the homothety concept;</p> <p>2) Correct application of theoretical concepts explained in the previous session.</p> <p>3.1) Understand the basic properties of triangles; 3.2) To understand other geometric properties derived from the triangle knowledge.</p> <p>4) Correct application of theoretical concepts explained in the triangle theoretical lessons.</p> <p>5) Knowing basic properties of polygons</p> <p>6) Knowing the basic properties of circles and related subjects: orthogonal circles , properties defined by circle angles etc.</p> <p>7) Correct application of theoretical concepts explained in the lessons 3 and 4 (polygons and circles).</p>	
<p>Course tests and improvement exams</p>	<p>Learning time: 18h 36m Laboratory classes: 7h 45m Self study : 10h 51m</p>

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### Qualification system

The final course mark (N) will be calculated as follows:

$$N = 0.3 N_c + 0.35 N_{e1} + 0.35 N_{e2} \quad (/ 10, \text{ pass} > 5)$$

Where:

$N_{e1}$  (/ 10) is the mark of the first exam of the subject, which will include technical drawing (Geometric constructions, orthographic projection, free-hand drawing and perspective projection) and contour plots. The exam will consist of two or three exercises.

$N_{e2}$  (/ 10) is the mark of the second exam of the subject, which will include the plane geometry part. The exam will consist of a theoretical part and one or two practical exercises.

$N_c$  (/ 10) is the note of the exercises that are done in class. 50% will correspond to technical drawing and contour plots, while the other 50% to plane geometry. Class tests and exercises will be done without announcement. It will be able to use class notes and books.

The students who does not pass the regular evaluation even if they attended lessons and test, will have the option to carry out a reassessment test during the period set in the academic calendar. In this second opportunity the students will be able to choose between an exam that includes the whole course or only those parts with mark ( $N_{e1}$  or  $N_{e2}$ ) less than 5.

The maximum mark for the reassessment test is five (5.0). No other opportunity is planned.

Extraordinary tests (or modifications in the calculation of  $N_c$ ) are considered for those students who properly justified an absence in advance. It is needed to send an email to the teacher in charge of the course. A posteriori notifications are only considered in case of big emergency.

Any non-attendance to the tests  $N_c$ ,  $N_{e1}$ ,  $N_{e2}$  may lead to a "non-attended" final mark.

### Regulations for carrying out activities

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

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### Bibliography

#### Basic:

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