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COURSE GUIDE

**Geometry and Topology Workshop
(27011C3)**

Grado (Bachelor's Degree)	Grado en Matemáticas	Branch	Sciences				
Module	Complementos de Geometría y Topología	Subject	Taller de Geometría y Topología				
Year of study	4 ^o	Semester	2 ^o	ECTS Credits	6	Course type	Elective course

PREREQUISITES AND RECOMMENDATIONS

It is recommended that the student has passed the subjects Geometry I - II - III.

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

Euclidean geometry: Constructions with ruler and compass. Polyhedra. Universes of dimension two. Non -euclidean geometries. Computer aided geometry.

SKILLS

GENERAL SKILLS

- CG01 - Poseer los conocimientos básicos y matemáticos de las distintas materias que, partiendo de la base de la educación secundaria general, y apoyándose en libros de texto avanzados, se desarrollan en esta propuesta de título de Grado en Matemáticas
- CG02 - Saber aplicar esos conocimientos básicos y matemáticos a su trabajo o vocación de una forma profesional y poseer las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de las Matemáticas y de los ámbitos en que se aplican directamente
- CG03 - Saber reunir e interpretar datos relevantes (normalmente de carácter matemático) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
- CG04 - Poder transmitir información, ideas, problemas y sus soluciones, de forma escrita u oral, a un público tanto especializado como no especializado
- CG05 - Haber desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía
- CG06 - Utilizar herramientas de búsqueda de recursos bibliográficos

SUBJECT-SPECIFIC SKILLS



- CE01 - Comprender y utilizar el lenguaje matemático. Adquirir la capacidad de enunciar proposiciones en distintos campos de las matemáticas, para construir demostraciones y para transmitir los conocimientos matemáticos adquiridos
- CE02 - Conocer demostraciones rigurosas de teoremas clásicos en distintas áreas de Matemáticas
- CE03 - Asimilar la definición de un nuevo objeto matemático, en términos de otros ya conocidos, y ser capaz de utilizar este objeto en diferentes contextos
- CE04 - Saber abstraer las propiedades estructurales (de objetos matemáticos, de la realidad observada, y de otros ámbitos) y distinguirlas de aquellas puramente accidentales, y poder comprobarlas con demostraciones o refutarlas con contraejemplos, así como identificar errores en razonamientos incorrectos
- CE05 - Resolver problemas matemáticos, planificando su resolución en función de las herramientas disponibles y de las restricciones de tiempo y recursos
- CE06 - Proponer, analizar, validar e interpretar modelos de situaciones reales sencillas, utilizando las herramientas matemáticas más adecuadas a los fines que se persigan
- CE07 - Utilizar aplicaciones informáticas de análisis estadístico, cálculo numérico y simbólico, visualización gráfica, optimización u otras para experimentar en matemáticas y resolver problemas
- CE08 - Desarrollar programas que resuelvan problemas matemáticos utilizando para cada caso el entorno computacional adecuado

TRANSFERABLE SKILLS

- CT01 - Desarrollar cierta habilidad inicial de "emprendimiento" que facilite a los titulados, en el futuro, el autoempleo mediante la creación de empresas
- CT02 - Fomentar y garantizar el respeto a los Derechos Humanos y a los principios de accesibilidad universal, igualdad ante la ley, no discriminación y a los valores democráticos y de la cultura de la paz

LEARNING OUTCOMES

- Recognize symmetries in planar and spatial figures.
- Determine the group of symmetries of a rosette, frieze and mosaic.
- Know the different types of non-Euclidean geometries, as well as the aspects in which they differ.
- Model geometric problems, especially using geometry oriented software.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

- **Lesson 1. Classical geometry:** Euclid's Elements and other axiomatic approaches. Constructions.
- **Lesson 2. Symmetries:** Movements in the plane and symmetries of objects.
- **Lesson 3. Non-Euclidean Geometries:** The postulate of the parallels. The birth of non-euclidean geometries. The sphere and the hyperbolic plane. Constructions in the hyperbolic plane: parallel and ultraparallel lines, angles and triangles, regular polygons.



- **Lesson 4. Introduction to polyhedra:** Constructing polyhedra. Platonic and Archimedean polyhedra. Descartes' formula. Euler's formula: different proofs.
- **Lesson 5. Surfaces and 3-manifolds:** Exploring the shape of a universe. Connected sums. Orientability vs. two faces. Geometry of a Universe. flat manifolds.

PRACTICAL SYLLABUS

RECOMMENDED READING

ESSENTIAL READING

1. C. ALSINA, R. PEREZ y C. RUIZ, *Simetría Dinámica*, Síntesis 1989.
2. W. BARKER, H. ROGER. *Continuous Symmetry*. American Mathematical Society, Providence, RI. 2007.
3. M. BERGER. *Geometry*, vol. 1 y 2, Springer-Verlag 1987.
4. R. BONOLA, [Non-Euclidean Geometry](#), A critical and Historical Study and its Development, Dover Publications, Inc., New York (USA) 1955.
5. F. BORCEUX, [An axiomatic approach to geometry](#) (Geometric Trilogy I), Springer 2014.
6. O. BYRNE. [The First Six Books of the Elements of Euclid](#) in Which Coloured Diagrams and Symbols Are Used Instead of Letters for the Greater Ease of Learners. Taschen GmbH, Cologne 2010.
7. J. N. CEDELBERG, [A Course in Modern Geometries](#), Undergraduate Texts in Mathematics, Springer, New York (USA) 2001.
8. J.H. CONWAY, H. BURGIEL y C. GOODMAN-STRUSS, *The Symmetries of things*, A K Peters Ltd. 2008.
9. H.S.M. COXETER, *Introduction to Geometry*, John Wiley 1969.
10. P.R. CROMWELL, *Polyhedra*, Cambridge University Press 1999.
11. EUCLID. *The Thirteen Books of Euclid's Elements* Translated from the Text of Heiberg. Introduction and Books I, II. Translated by Thomas L. Heath. Vol. I. 3 vols. Dover Publications, Inc., New York. 1956.
12. R. L. FABER, *Foundations of Euclidean and non-Euclidean Geometry*, Monographs and Textbooks in Pure and Applied Mathematics, Marcel Dekker, New York (USA) 1983.
13. M. J. GREENBERG. *Euclidean and Non-Euclidean Geometries: Development and History*. 3rd ed. New York: W.H. Freeman 1993.
14. D. HILBERT y S. COHN-VOSSEN, *Geometry and the imagination*, Nueva York: Chelsea Publishing Co. 1952 (AMS Chelsea Publishing 1999)
15. M. KLEIN, *Mathematical Thought From Ancient to Modern Times*, Volume 3. Oxford University Press 1972.
16. J. M. LEE, *Axiomatic Geometry*, Pure and applied undergraduate texts 21, American Mathematical Society 2013.
17. W. P. THURSTON. "[The Geometry and Topology of Three-Manifolds](#)." Princeton, N.J. 1980.
18. J.R. WEEKS, *The Shape of Space*, Marcel Dekker, New York 2002.

COMPLEMENTARY READING



RECOMMENDED LEARNING RESOURCES/TOOLS

- Geogebra (gratis and free software for dynamical geometry):
<https://www.geogebra.org/classic>
- Euclid's Elements, José Luis Bueso Montero,
<https://www.ugr.es/~jlbueso/euclides/1/index.html>
- Byrne's Euclid: A reproduction of Oliver Byrne's celebrated work from 1847 plus interactive diagrams, cross references, and posters designed by Nicholas Rougeux, Nicholas Rougeux, <https://www.c82.net/euclid/>
- Byrne's Euclid, Jimmy Button,
https://github.com/jemmybutton/byrne-euclid/releases/download/Current/byrne_context.pdf

TEACHING METHODS

- MD01 - Lección magistral/expositiva
- MD02 - Sesiones de discusión y debate
- MD03 - Resolución de problemas y estudio de casos prácticos
- MD04 - Prácticas en sala de informática
- MD05 - Seminarios
- MD06 - Análisis de fuentes y documentos
- MD07 - Realización de trabajos en grupo
- MD08 - Realización de trabajos individuales

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

In accordance with the "Evaluation and Qualification Regulations of the Students of the University of Granada", in order to evaluate the acquisition of the contents and competencies to be developed in the field, continuous evaluation systems and unique evaluation systems will be used alternately.

Continuous assessment:

It will be the preferential evaluation method. To evaluate the acquisition of the contents and competencies, a diversified evaluation system will be performed, selecting the most appropriate evaluation techniques for the subject at all times, which allows to highlight the different knowledge and capacities acquired by students, according to the following criteria:

- A written final exam will be performed that will weigh up to 50%. The remaining 50% of the total mark can be obtained through teamwork presentations (30%) and class participation, delivery of individual exercises and activities in Prado (20%).

EXTRAORDINARY EXAMINATION DIET

As established by the regulations, students who have failed the ordinary call will have an extraordinary call. All students have the right to attend it, regardless of whether or not they have followed the continuous evaluation process. The qualification of the students in the



extraordinary call will be adjusted to the rules established in this course guide. This way, those students not following the continuous evaluation system will be granted the possibility of obtaining up to 100% of the qualification by carrying out an exam of the same characteristics as the single final assessment.

SINGLE FINAL ASSESSMENT (evaluación única final)

This will be an exceptional evaluation method. A student who cannot follow the continuous evaluation system may be accepted after proper justification. This evaluation will be carried out in a single academic act that may include as many tests as necessary to prove that the student has acquired all the skills described in this guide. Essentially, it will consist of a theoretical-practical written or oral examination of the previously detailed syllabus. The final mark will be expressed by numerical qualification in accordance with the provisions of article 5 of the R.D. 1125/2003, of September 5, which establishes the European Credit System and the system of qualifications in the university degrees of an official nature and validity in the national territory. The global qualification will correspond to the weighted score of the different aspects and activities that make up the corresponding evaluation system.

Assessment by incidents

In this case, the evaluation regulations approved on November 6, 2016 by Governing Council of the University of Granada (BOUGG No. 112, of November 9, 2016) will be taken into account. In this way, students who cannot attend evaluation tests at the assigned date by the Faculty of Sciences, may request the Director of the Department for assessment by incidents in the cases indicated in the aforementioned regulations. In addition, the evaluation by court and the evaluation of students with disabilities or other specific educational support needs will follow the provisions of the aforementioned regulations.

