

AREA	SUBJECT	CURSE	SEMESTER	CREDITS	TYPE
Mathematical Methods and programming	Mathematical Methods	2º	2º	6	Compulsory
PROFESORS <sup>(1)</sup>			FULL CONTACT ADDRESS FOR TUTORIALS (address, telephone, e-mail, etc.)		
<b>GROUP D (morning)</b> <ul style="list-style-type: none"> <li>Manuel Calixto Molina (<b>Coordinator</b>)</li> </ul>			<b>Address:</b> Facultad de Ciencias. Dpto. Matemática Aplicada <b>E-mail:</b> <a href="mailto:calixto@ugr.es">calixto@ugr.es</a>		
			SCHEDULE FOR TUTORIALS: see <a href="https://directorio.ugr.es/">https://directorio.ugr.es/</a>		
<b>GROUP E (afternoon)</b> <ul style="list-style-type: none"> <li>José Luis Gámez Ruíz</li> </ul>			<b>Address:</b> Dpto. Análisis Matemático, Facultad de Ciencias, Office 22 <b>E-mail:</b> <a href="mailto:jlgamez@ugr.es">jlgamez@ugr.es</a>		
			SCHEDULE FOR TUTORIALS: see <a href="https://directorio.ugr.es/">https://directorio.ugr.es/</a>		
<b>GROUP F (morning, in English)</b> <ul style="list-style-type: none"> <li>Daniel Rodríguez Rubiales</li> </ul>			<b>Address:</b> Facultad de Ciencias. Dpto. de Física Atómica, Molecular y Nuclear, 3 <sup>rd</sup> floor Physics building, Office 136 <b>E-mail:</b> <a href="mailto:danielrodriguez@ugr.es">danielrodriguez@ugr.es</a>		
			SCHEDULE FOR TUTORIALS: Monday: from 9:30 to 11:30 h. Tuesday from 16:00 to 18:00 h. Thursday from 17:00 to 19:00 h.		
DEGREE			OTHER DEGREES		
Bachelor in Physics			Bachelor in Mathematics, Civil engineering, Chemical engineering, Telecommunication and Electronics engineering.		

PRE-REQUISITES AND/OR RECOMMENDATIONS (if applicable)
It is recommended to have attended the lectures on Lineal Algebra and Geometry, Mathematical Analysis and Mathematical Methods for Physics I.
BRIEF DESCRIPTION OF THE CONTENTS (FOLLOWING THE BACHELOR VERIFICATION RULES)
Methods to solve ordinary differential equations and systems. Partial differential equations. The method of separation of variables. Special functions
GENERAL AND SPECIFIC COMPETENCES
<p><b>Transverse</b></p> <p>CT1 Capacity of analysis and synthesis. CT2 Capacity of organization and planning. CT3 Oral and/or written communication. CT6 Problems solving. CT8 Critical reasoning. CT13 Oral and written understanding of scientific English</p> <p><b>Specific</b></p> <ul style="list-style-type: none"> <li>CE3: To understand and learn the mathematical methods used to describe physical phenomena.</li> </ul>
OBJECTIVES (EXPRESSED AS EXPECTED RESULTS FROM THE TEACHING)
<ul style="list-style-type: none"> <li>To know the fundamental results of the theory of Differential Equations.</li> <li>To know some of the applications of the ordinary differential equations in different fields in Physics, especially in Classical Mechanics, Electromagnetism and Quantum Physics.</li> <li>To understand how special functions arise in the study of ordinary differential equations and understand how to apply them.</li> <li>To know the fundamental results of the theory of Partial Differential Equations.</li> <li>To know some applications of the theory of Partial Differential Equations the in different fields in Physics, especially in Classical Mechanics, Electromagnetism and Quantum Physics.</li> </ul>
DETAIL LIST OF TOPICS OF THE CURSE
<p>THEORETICAL LESSONS</p> <p><b>Differential equations</b></p> <ol style="list-style-type: none"> <li>Lesson 1. Ordinary differential equations of first order. Methods of integration.</li> <li>Lesson 2. Ordinary differential equations of higher order. Lineal equations.</li> <li>Lesson 3. Solving differential equations by power series.</li> </ol> <p><b>Special functions</b></p> <ol style="list-style-type: none"> <li>Lesson 4. Basic special functions.</li> <li>Lesson 5. Hypergeometric and Bessel functions.</li> </ol>



### **Partial differential equations**

6. Lesson 6. Classical partial differential equations of interest in physics: The method of separation of variables.
7. Lesson 7: The wave equation, the heat equation and the Laplace equation.
8. Lesson 8. Introduction to the Sturm-Liouville problem.

#### PRACTICAL LECTURES:

##### Seminars

1. The role of differential equations in Newton mechanics.
2. The Schrödinger equation in one dimension: Application to the Kronig-Penney model for the study of the band theory in solids.
3. Oscillations and resonances.
4. Variation methods: the Dirichlet principle.
5. The Schrödinger equation in more than one dimension. Application to the Hydrogen atom.
6. The Fourier transform and applications to differential equations.
7. The pendulum with variable length.
8. Stability of Lyapunov for systems in the plane. Applications

#### BIBLIOGRAPHY

##### FUNDAMENTAL BIBLIOGRAPHY:

- M. Abramowitz, I. A. Stegun, Handbook of mathematical functions, Dover, 1975.
- L. C. Andrews, Special functions of mathematics for engineers, Oxford Science Publications, 1998.
- W.E. Boyce, R.C. DiPrima, Ecuaciones diferenciales y problemas con valores en la frontera. Limusa Willey, 2010.
- L. C. Evans, Partial Differential Equations, AMS, 2002.
- V. Nikiforov, V. Uvarov, Special functions of mathematical physics (Birkhäuser Verlag, 1988).
- I. Peral, Primer curso de Ecuaciones en derivadas parciales. Addison-Wesley, Wilmington, 1995.
- E. Rainville, Intermediate Differential Equations, MacMillan, 1964.
- G.F. Simmons, Ecuaciones diferenciales con aplicaciones y notas históricas. McGraw Hill, 1993.
- W. A. Strauss, Partial differential equations, an introduction, New York, John Wiley and Sons, 2008.
- D.G. Zill, M.R. Cullen, Ecuaciones diferenciales con problemas de valores en la frontera, Cengage Learning, 2009.

##### SUPPLEMENTARY BIBLIOGRAPHY:

- F. Brauer y Nohel, *Ordinary Differential Equations with Applications*, Harper & Row, 1989.
- C. Carlson, *Special Functions of Applied Mathematics*, Academic Press.
- R. K. Nagle, E. B. Saff y A.D. Snider, *Ecuaciones diferenciales y problemas con valores en la frontera*, Pearson Educación, 2005.
- F.W. Olver, *Asymptotic and Special functions*, Academic Press, 1974.
- R.D. Richtmyer, *Principles of Advanced Mathematical Physics*, vol. 1, Springer-Verlag, 1978.

#### RECOMMENDED LINKS

Notes by Prof. R. Ortega "Métodos Matemáticos de la Física IV": <http://www.ugr.es/~rortega/M4.htm>



## METHODOLOGY

### - FACE-TO-FACE ACTIVITIES (40%)

- Theory lectures given by the lecturer with participation of the pupils.
- Lectures devoted to solve problems, given by the lecturer with participation of the pupils.
- Problems. Solving problems by the pupils and discussions.
- Seminars and presentation of the work by the students.
- Personalized tutorials to treat questions arising from the list of topics of the course, solving questions and discuss different aspects of the subject.

### - NON FACE-TO-FACE ACTIVITIES (60%)

- Study of the theory and solving problems.
- Preparation of seminars.

## EVALUATION (INSTRUMENTS, CRITERIA AND PERCENTAJE OF EACH ITEM IN THE FINAL SCORE, ETC.)

**In general, the attendance to the lecture is not compulsory without being an impediment to apply the evaluation criteria described in the following:**

In order to evaluate the knowledge and competences acquired by the pupils, the following criteria will be used with the indicated percentage:

- Written examination including basic questions and problems/exercises. This will count 70% of the total score.
- Homework and seminars done individually or in groups. This covers all work and seminars made by the pupils during the course (exercises and solving proposed problems). Importance will be given to the work itself, the slides presentation and the defense. Participation, aptitude and personal work in all programmed activities will be considered. The final score for this part will count up to 30%.

The final score will be a number resulting from the sum of the weighted scores from the different aspects integrated in the evaluation system.

In general, the attendance to the lecture is not compulsory without being an impediment to apply the evaluation criteria describe above.

Regarding the extraordinary examination, this will be in written form and will consist of questions and problems/exercises to guarantee that the student can get the total score from it (100%), as it is established in the regulation of evaluation of students at the University of Granada, published in the official bulletin of the university number 112. 9 November 2016.

Besides the above-mentioned evaluation procedure, the pupils will be allowed applying for an unique evaluation in the terms established in the regulation of evaluation of students at the University of Granada, approved on May the 20<sup>th</sup> of 2013.

All regarding evaluation will be applied according to the "Normativa de evaluación y calificación de los estudiantes" existing at the University of Granada and can be found at:

<http://www.ugr.es/~minpet/pages/enpdf/normativaevaluacionycalificacion.pdf>

*DESCRIPCIÓN DE LAS PRUEBAS QUE FORMARÁN PARTE DE LA EVALUACIÓN ÚNICA FINAL ESTABLECIDA EN LA "NORMATIVA DE EVALUACIÓN Y DE CALIFICACIÓN DE LOS ESTUDIANTES DE LA UNIVERSIDAD DE GRANADA"*



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Written examination that will include theory and problems on the list of topics of the course.

SUPPLEMENTARY INFORMATION



**UNIVERSIDAD  
DE GRANADA**

**INFORMACIÓN SOBRE TITULACIONES DE LA UGR**  
[grados.ugr.es](http://grados.ugr.es)