Universitat Autònoma de Barcelona

2020/2021

Differential Equations

Code: 100152
ECTS Credits: 8

Degree	Type	Year	Semester
2500097 Physics	OB	2	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: José María Crespo Vicente
Email: JoseMaria.Crespo@uab.cat

Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: Yes

Teachers

José María Crespo Vicente
Eduard Massó Soler
María del Pilar Casado Lechuga

Prerequisites

It is advisable to have a good knowledge of calculus in one variable

Objectives and Contextualisation

Give tools to solve the most common types of ordinary differential equations and equations with partial derivatives that appear in Physics. Learn to model different physical phenomena.

Competences

- Develop the capacity for analysis and synthesis that allows the acquisition of knowledge and skills in different fields of physics, and apply to these fields the skills inherent within the degree of physics, contributing innovative and competitive proposals.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project

Learning Outcomes

1. Applying Sturm-Liouvilles theory to physical problems with boundary conditions.
2. Identify situations in which a change or improvement is needed.
3. Solve Laplace and Poisson equations for simple geometries.
4. Solve the equations of simple harmonic, damped and forced motion.
5. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
6. Use the mathematical tools developed in this subject for the quantitative study of advanced problems in any branch of knowledge.
7. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.

Content

1. Introduction to differential equations in ordinary derivatives
   Picard method
   Existence and uniqueness theorem.
   2. First order differential equation
   One parameter families of curves. Clairaut equation. Singular soluitions. Envelopes.
   Linear, Bernoulli, Ricatti and homogeneous equations.
   Exact equations. Integrating factors. Second order equations solved by first order methods.
   3. Higher order linear equations
   Reduced and complete equations. Wronskians. Reduced equation with constant coefficients.
   Complete equation methods : undetermined coefficients, variation of parameters, symbolic.
   Order reduction. Cauchy-Euler equation.
   Application : One dimension oscillations.
   4. Laplace Transform
   5. Solutions in power series
   Ordinary and singular regular points. Frobenius method.
   Hipergeometric and Legendre equations. Legendre polynomials.
   Application : Laplace equation in spherical coordinates. Associated Legendre equation.
   Bessel equation. Bessel functions. Application : Laplace equation in cylindrical coordinates.
   Laguerre and Hermite equations and polynomials.
   6. Sturm-Liouville problem
   Generalized Fourier series. Orthonormal functions.
   Regular Sturm-Liouville problem. Application : Heat equation.
   Application : Schrödinger equation. Associated Laguerre equation.
   Some singular Sturm-Liouvills problem.
   7. Introduction to differential equations with partial derivatives

Methodology

The subject is structured as follows:

- Theory lectures. The definitions, theorems, and methods of resolution of differential equations are presented, also solving some examples.
- Problem solving classes. Some of the problems of the lists that are made available to students at the beginning of the course through the Virtual Campus are resolved
- Supervised problem solving classes. Students try to solve problems in the classroom under the supervision of a teacher
- Homework assigments. Problems of more complexity and extension that are periodically posted throughout the course. The students must solve and submit before their correction in class in previously agreed dates. The objective is to encourage self-learning.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problem solving classes	22	0.88	1, 5, 3, 4, 7, 6
Theory lectures	44	1.76	1, 5, 3, 4, 7, 6
Type: Autonomous			
Homework assigments	18.5	0.74	1, 5, 3, 4, 7, 6
Problem solving	60	2.4	1, 5, 3, 4, 7, 6
Study of the theoretical concepts and methods	47	1.88	1, 5, 3, 4, 7, 6

Assessment

- First partial exam (45%)
- Second partial exam (45%)
- Homework assignements (10%)
- Students with a resultant grade below 5, or students wishing to improve their grades, can take a reassessment exam. They have to have taken both partial exams to qualify for reassessment.
- Reassessment exam (100%)

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First Partial exam	45%	2.5	0.1	2, 5, 4, 7, 6
Homework assignements	10%	0	0	1, 2, 5, 3, 4, 7, 6
Reassessment exam	100%	3.5	0.14	1, 2, 5, 3, 4, 7, 6
Second Partial Exam	45%	2.5	0.1	1, 2, 5, 3, 7, 6

Bibliography

- Notes on the subject by Dr. José María Crespo which will be available to students as semester advances
- Problems on the subject by Prof. Sergio González which will be available to students as semester advances
- Notes on the subject by Dr. Marià Baig which are made available to students through the Virtual Campus
- *Teoría y Problemas de Ecuaciones Diferenciales Modernas*, Schaum, McGraw-Hill
- *Ecuaciones Diferenciales y sus Aplicaciones*, M. Braun, Grupo Editorial Iberoamericana