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| Course Unit | Calculus II | Field of study | Mathematics |
| Bachelor in | Civil Engineering | School | School of Technology and Management |
| Academic Year | 2022/2023 | Year of study | 1 |
| Type | Semestral | Semester | 2 |
| Level | 1-1 | ECTS credits | 6.0 |
| Code | 9089-322-1201-00-22 | | |
| Workload (hours) | 162 | Contact hours | T - TP 60 PL - TC - S - E - OT - O - |

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Florbela Alexandra Pires Fernandes, João Carlos Oliveira Nunes

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Solve ordinary differential equations by using the described methods.
2. Interpret and solve simple problems that lead to first and second order ordinary differential equations.
3. Solve differential equations by means of Laplace transforms.
4. Calculate double and triple integrals directly or by changing the order of integration and use of appropriate coordinates.
5. Apply double and triple integrals when calculating areas and volumes.
6. Parameterize curves and surfaces and calculate the length of a curve and the area of a surface.
7. Calculate the gradient of a function and the curl and divergence of a vector field.
8. Apply the integral theorems of vector analysis: Green, Stokes and Gauss.

Prerequisites

Before the course unit the learner is expected to be able to:
Solve problems and apply the skill/knowledge acquired in Calculus I and Algebra.

Course contents

Ordinary differential equations. The Laplace transform. Double and triple Integrals. Vector Calculus.

Course contents (extended version)

1. Ordinary Differential Equations (ODEs):
 - First order ODEs: singular, particular and general solution.
 - Cauchy's problem. Separable, exact, and linear differential equations. Bernoulli equation.
 - The theorem of existence of solution for Cauchy's problem.
 - Problems leading to first order ODEs.
 - ODEs of order n: constant coefficients homogeneous equation. Cauchy's problem.
 - Linear differential equations of order greater than one: General solution and particular solution.
 - Homogeneous and non-homogeneous equations, constant coefficients and Euler-Cauchy's equation.
 - Method of undetermined coefficients, method of variation of parameters.
 - Problems leading to ODEs with order greater than one.
2. The Laplace Transform:
 - Definition and basic properties.
 - Existence of the Laplace transform.
 - The inverse of Laplace transform.
 - Properties of Laplace transform.
 - Solution of differential equations by means of Laplace transforms.
 - The shift theorems.
3. Double and Triple Integrals:
 - Double and triple integrals over elementary regions.
 - Fubini's theorem.
 - Change of variables in double and triple integrals: polar and cylindrical coordinates.
 - The change of variables theorem.
 - Applications of double and triple integrals.
4. Vector Calculus:
 - Paths in the plane and in the space.
 - Line integral and path integral.
 - Length of a parameterized curve.
 - Work done by a force field over a path.
 - Parameterized surfaces.
 - Integrals of scalar functions and vector fields over surfaces.
 - Area of a surface.
 - Gradient, curl and divergence.
 - The integral theorems of vector analysis: theorems of Green, Stokes and Gauss.

Recommended reading

1. Stewart, J. (2005). Cálculo Volume I e II, 5ª edição, Cengage Learning.
2. Marsden, J. M., & Tromba, A. J. (2003). Vector Calculus, 5ª ed., Freeman.
3. Fernandes, F. P. (2022). Theory, Problems and Exercises for Calculus II, DMat -- ESTiG

Teaching and learning methods

Course contents will be introduced in lectures. Complementary, there will be tutorial and practical classes where the students are guided in the accomplishment of practical exercises focusing on applications of theoretical concepts.

Assessment methods

1. Partial Exams - (Regular, Student Worker) (Final)
 - Intermediate Written Test - 50% (Partial Exam 1: At the end of ODE's and Laplace transform chapter.)
 - Intermediate Written Test - 50% (Partial Exam 2: At the end of double and triple integration and vectorial calculus.)
2. Final Exam - (Regular, Student Worker) (Supplementary, Special)

Language of instruction

1. Portuguese
2. English

Electronic validation

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| Florbela Alexandra Pires Fernandes, João Carlos Oliveira Nunes | Carla Sofia Veiga Fernandes | António Miguel Verdelho Paula | José Carlos Rufino Amaro |
| 03-03-2023 | 07-03-2023 | 07-03-2023 | 10-03-2023 |