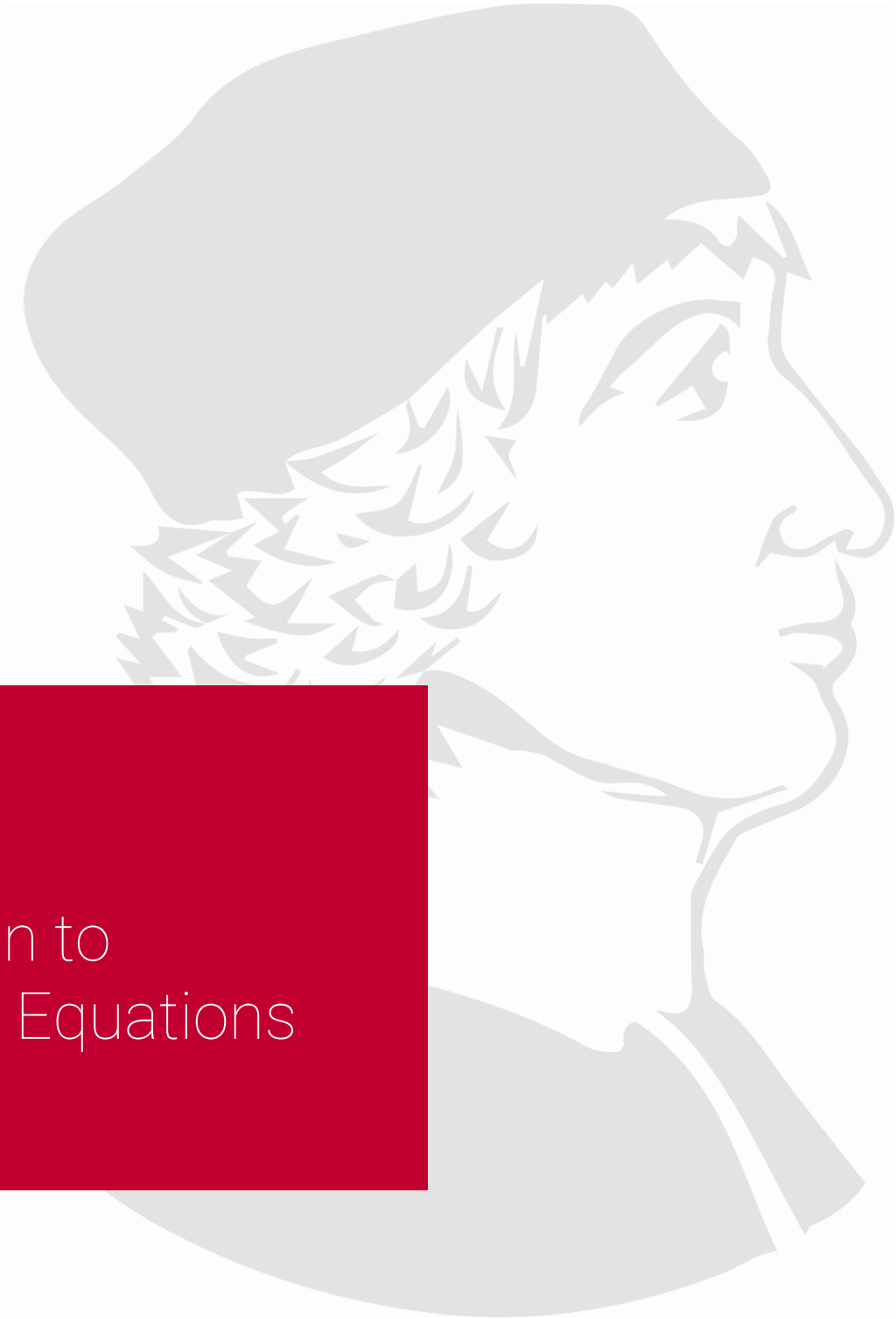

MAT230
Introduction to Differential Equations

UNIVERSIDAD
NEBRIJA

Centro de Estudios Hispánicos

UNIVERSIDAD NEBRIJA
Centro de Estudios Hispánicos

Introduction to Differential Equations

Hours: 45
Credits: 6 ECTS
Prerequisites: basic calculus and algebra
Instructor name: to be determined
E-mail: @nebrija.es
Office hours: to be communicated the first day of class

1. Course Description

The laws of nature are expressed as differential equations. Scientists and engineers must know how to model the world in terms of differential equations, and how to solve those equations and interpret the solutions. This course focuses on linear differential equations and their applications in science and engineering. There will be some activities with mathematical software.

2. Learning Objectives

Students who successfully complete this course will be able to:

 classify differential equations as to ordinary, partial, linear, non-linear, order and degree, and to construct differential equations under given conditions;

 solve first order differential equations employing the techniques of variables; separable, homogeneous coefficient, or exact equations;

 solve applied problems which are linear in form;

 solve linear differential equations employing the techniques of integrating factors, substitution, variation of parameters and reduction of order;

 use methods for obtaining exact solutions of linear homogeneous and non-homogeneous higher-order differential equations;

 use elementary methods for linear systems of differential equations.

3. Methodology

The majority of the course syllabus follows the main methodological guidelines of the Communicative Approach, based on the core principles of procedure conception and constructive acquisition of knowledge. The methodology is based on the teaching-learning procedures, focused on the learner, which encourages active participation and results in the development of general and specific competencies that prove knowledge, capacities and attitudes for their future professional careers.

4. Evaluation

The form of assessment is based on the core principles of the educational assessment, i.e., an active and participative teaching-learning process focused on the learner. The instructor uses numerous and differentiated forms of assessment to calculate the final grade received for this course. For the record, these are listed below. The content, criteria and specific requirements for each assessment category will be explained in greater detail in class.

5.1. Grading system

In the Spanish educational system, it is required to quantitatively express the result of each student's evaluation. In order to do so, Nebrija faculty uses different strategies and instruments such as: papers, exams, tests, projects, self-evaluation activities, etc. In order to issue a final grade for the Spanish Plus programs the following scale is established:

- 30 % Attendance and active participation in class
- 30% Daily work/ Papers/ Essays
- 40% Exams/ Final papers or projects*****

Therefore, the final grade is the average between attendance and participation, daily work and exams, presentations, projects and essays.

Active participation in class is evaluated by means of different activities such as:

- Activities and exercises correction;
- Reflection upon the different contents in the course;
- Oral activities (individual, in pairs or in groups). Fluency, correction, adequacy and relevance are taken into account.

Daily work makes reference to any activity or task that is done inside or outside of the classroom, whether during the class time or at any other time.

Exams/ Final papers or projects

The course includes a midterm and a final written exam on theoretical concepts and course facts. If a student, unjustifiably, does not do or submit an exam, paper or project, it will be graded with a '0'.

*** A minimum grade of 5 must be obtained in a final exam/ final project in order to pass the course.**

5.2. Attendance, participation and grading policies

5.2.1. Attendance policy

Attendance is mandatory. In case of missing 5 or more sessions in one course, the student will receive a zero in his/her participation and attendance grade. In addition, not attending classes will not excuse the student from handing in in any homework, papers or essays previously assigned.

The following situations must be considered:

- Each session of class will count as an absence.
- Two delays of more than 15 minutes will be considered an absence. The entrance to class will not be allowed after 30 minutes once it has started.
- There are no excused absences. E.g.: Not attending class because of sickness will count as an absence. The student is responsible for catching up with any homework done while absent.
- Exams dates have been officially approved by the University, therefore, they will not be changed.*

*Except for those courses where the professor will set up specific dates and inform the students at the beginning of the program.

5.2.2. Criteria to evaluate participation

Criteria to evaluate participation	Grade
The student participates very actively in the class activities. S/he successfully does the requested tasks. S/he contributes to a good development of the course, encourages his/her classmates and favor debate in class.	8.5 - 10
The student participates actively in the class activities. S/he does the requested tasks and submits them on time. Shows great interest to learn.	7 - 8.4

The student, occasionally, makes interesting remarks, but s/he basically answers when s/he is asked. S/he does not show a clear interest in the course. Misses classes occasionally.	5 - 6.9
The student does not participate unless s/he is asked. S/he has unjustified absences and delays. His/her attitude is not very participative.	0 - 4.9

5.2.3. Criteria to evaluate Daily Work

Criteria to evaluate Daily Work	Grade
The student always does all the work demanded by the professor, not only during the class but also at home. He/she always or almost always meets the deadlines established.	8.5 - 10
The student almost always does all the work demanded by the professor, not only during the class but also at home. Occasionally, he/she submits work after the established deadline.	7 - 8.4
The student occasionally does the work demanded by the professor, not only during the class but also at home. He/she does not normally meet the established deadlines and even occasionally does not submit the work.	5 - 6.9
The student never or almost never does the work demanded by the professor. He/she never or almost never meets the established deadlines.	0 - 4.9

5.2.4. Grading criteria

Number Grade	Letter Grade	Percentage
10	A+	100%
9.5 – 9.9	A	95 – 99 %
9 – 9.4	A-	90 – 94 %
8.5 – 8.9	B+	85 – 89 %
7.5 – 8.4	B	75 – 84 %
7 – 7.4	B-	70 – 74 %
6.5 – 6.9	C+	65 – 69 %
6 – 6.4	C	60 – 64 %
5 – 5.9	C-	5 – 59 %
0 – 4.9	F	0 – 49 %

5.3. Warning on plagiarism

When writing a University paper or essay and reference is made to certain authors, it is mandatory to cite them by means of a footnote or a direct reference. In no case it is acceptable that a student uses a text, no matter how brief it is, written by somebody else without putting it in inverted commas, as this means s/he is trying to make it look as his/her own. This is called plagiarism and in a university context it could be penalized with expulsion.

6. Bibliography

Basic bibliography

- Zill, Dennis. (2017) *A First Course in Differential Equations with Modeling Applications*. 11th ed. Cengage Learning.
- Brannan, James and Boyce, William (2015). *Differential Equations: An Introduction to Modern Methods and Applications*. 3rd ed. Wiley.

7. Office Hours

Tutorial schedule will be confirmed in the first couple of sessions, to guarantee that the time schedule suits the needs of students and instructor. However, it is always advisable to make an appointment with the lecturer beforehand in order to ensure availability.

Campus Madrid Princesa
E-mail: to be determined

8. Course Content

TOPICS	DESCRIPTION
1. Introduction to Differential Equations	• Definitions and terminology • Initial-value problems • Differential equations as mathematical models
2. First-Order Differential Equations	• Solution curves without a solution; direction fields, autonomous first-order differential equations • Separation of variables • Linear equations • Exact equations • Solutions by substitutions • Numerical methods; Euler's method, numerical solvers
3. Modeling with First-Order Differential Equations	• Linear models; exponential growth and decay, Newton's law of cooling, mixture problems, series circuits • Non-linear models; logistic growth, chemical reactions • Systems of differential equations; radioactive series, mixtures, predator-prey models, competition models, networks
4. Higher-Order Differential Equations	• Linear differential equations; initial-value and boundary-value problems, homogenous equations, non-homogeneous equations • Reduction of order • Homogenous linear equations with constant coefficients • Undetermined coefficients; superposition approach, annihilator approach • Variation of parameters • Cauchy-Euler equation • Solving systems on linear equations using elimination • Non-linear differential equations
5. Modeling with Higher-Order Differential Equations	• Linear models with initial value problems; spring/mass systems with free undamped motion, free damped motion, and driven motion; series circuit analogue • Linear models with boundary value problems • Nonlinear models
6. The Laplace Transform	• Definition of the Laplace transform • Inverse transforms and transforms of derivatives • Derivatives of a transform, transforms of integrals, • Transforms of periodic functions • Systems of linear differential equations
7. Systems of Linear First-Order Differential Equations	• Preliminary theory; superposition principle, general solutions • Linear independence/dependence; Wronskian • Homogenous linear systems; distinct real eigenvalues, repeated eigenvalues, complex eigenvalues • Nonhomogeneous linear systems; undetermined coefficients, variation of parameters • Matrix exponentials
8. Numerical Solutions of Ordinary Differential Equations	• Euler's method • Improved Euler's method • Runga-Kutta methods (RK4)