



UNIVERSITÀ
degli STUDI
di CATANIA

DIPARTIMENTO DI SCIENZE BIOLOGICHE, GEOLOGICHE E
AMBIENTALI

Corso di laurea magistrale in Biologia ambientale

Anno accademico 2021/2022 - 2° anno

PARTIAL DIFFERENTIAL EQUATIONS IN APPLIED SCIENCES

MAT/05 - 6 CFU - 1° semestre

Docente titolare dell'insegnamento

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Orario ricevimento: martedì 14-16 e giovedì 11-13

OBIETTIVI FORMATIVI

Knowing how to construct and understand mathematical models that describe qualitatively and quantitatively some phenomena related to the environment. Knowing how to use the main concepts of differential equation theory for application in the biological, geological and environmental fields. Knowing how to predict and justify the evolution of simple phenomena, described by ordinary differential equations, related to the biological, geological and environmental sciences.

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO

Frontal class.

Should teaching be carried out in mixed mode or remotely, it may be necessary to introduce changes with respect to previous statements, in line with the programme planned and outlined in the syllabus.

Learning assessment may also be carried out on line, should the conditions require it.

PREREQUISITI RICHIESTI

Differential and Integral Calculus. Basic Analytic Geometry.

FREQUENZA LEZIONI

Recommended.

CONTENUTI DEL CORSO

1. **Ordinary differential equations and systems of ordinary differential equations.** Differential equations: definition and terminology. First-order differential equations: separable equations and first-order linear equations. Lagrange's method of variation of the constant. Cauchy's problem. Systems of ordinary differential equations: definition and terminology. Existence and uniqueness of the solution of a system of ordinary differential equations. Systems of linear differential equations. Autonomous systems of linear differential equations. Homogeneous systems of linear differential equations, eigenvalues, eigenvectors and solutions. Systems of nonlinear ordinary differential equations: autonomous systems, stability of systems of linear ordinary differential equations, linearization and local stability, stability criteria for nonlinear first-order differential equations and for autonomous plane systems.
2. **Partial differential equations.** Classifications. Partial differential equations in the Applied Sciences. Superposition principle. Boundary value problems. Classical PDEs: heat equation, wave equation, Laplace's equation. Some remarks on nonhomogeneous boundary value problems. Orthogonal Series Expansions. Problems in polar coordinates: introduction, steady temperatures in a circular plate, steady temperatures in a semicircular plate. Problems in cylindrical coordinates: introduction, radial vibrations of a circular membrane, standing waves, Laplacian in cylindrical coordinates, steady temperatures in a circular cylinder. Problems in spherical coordinates: introduction, Laplacian in spherical coordinates, steady temperatures in a sphere.
3. **Physical models.** Elementary dynamics of the Earth's Mantle. Climate and paleoclimate: types of models, global climate models, dynamics of glacial masses, climatic oscillators. Viscous gravitational currents: theory of lubrication and advancement of a lava front.
4. **Models for pollution.** Models for pollution. Models for atmospheric pollution: model of the transport of pollutants, model of transport and diffusion of pollutants, control of the propagation of pollutants in the atmosphere, hints on the model for the construction of plants and control of polluting emissions, interaction of pollutants. Models for water pollution: structure and classification of models, one-dimensional model and its analytical solutions, equation, some remarks on multi-dimensional models.

TESTI DI RIFERIMENTO

1. S. Motta, M.A. Ragusa, A. Scapellato - *Methods and mathematical models* - ed. CULC (2020)
2. N. Hritonenko, Y. Yatsenko - *Mathematical Modeling in Economics, Ecology and the Environment. Second edition* - Springer (2013).
3. A. Fowler - *Mathematical Geoscience* - Springer (2011).
4. Lecture notes.

ALTRO MATERIALE DIDATTICO

Si faccia riferimento all'apposita sezione su Studium.

PROGRAMMAZIONE DEL CORSO

Argomenti	Riferimenti test
1 Ordinary differential equations and systems of ordinary differential equations	Testi: 1, 2, 4
2 Partial differential equations	Testi: 2, 3, 4
3 Physical models	Testi: 3, 4
4 Models for pollution	Testi: 3, 4

VERIFICA DELL'APPRENDIMENTO

MODALITÀ DI VERIFICA DELL'APPRENDIMENTO

Oral examination. Criteria for assigning the final grade: verification of the achievement of the educational objectives expressed through the European Descriptors of the qualification. Verification of learning can also be carried out electronically, should the conditions require it.

ESEMPI DI DOMANDE E/O ESERCIZI FREQUENTI

Ordinary differential equations and systems of ordinary differential equations; partial differential equations and their applications; physical models; models for pollution.
