INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

MATHEMATICS, PHYSICS AND AUTOMATION FIELD_13 ECTS

Introducing

Description

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

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Analysis 1

Introducing

Description

Integration

Improper integrals: integrals of positive functions, functions of any sign, absolute convergence and semi-convergence

Parameter-dependent integrals: dominated convergence theorem, continuity, differentiability

Multiple integrals: Fubini's theorem, change of variable theorem

Numerical Series

Introduction, partial sums and summation techniques

Series with positive terms, comparison theorem

Series with arbitrary terms: absolute convergence, alternating series test

List of Competencies:
1_1: Master the mathematical concepts and computational tools of the engineer
1_2: Establish rigorous scientific reasoning and develop the capacity for abstraction
2_1: Master the fundamental tools of the mathematical engineer

Objectives

The student shall be able to:

Study the differentiability of a function of several variables and perform a limited (Taylor) expansion

Perform integral calculations of functions of several variables or over unbounded domains

Search for extrema of a function of class C1C1 or C2C2

Study the convergence of a numerical series using bounding and comparison methods

The student shall have understood and be able to explain (main concepts):

The notion of the differential of a function of several variables, partial derivatives, and their relation to the differential

The notion of improper integrals, integrals of parameter-dependent functions or of functions of several variables

The notion of numerical series and the concept of convergence of numerical series

Necessary prerequisites

First-year Linear Algebra: Vector spaces, linear maps, matrices, concept of image and kernel of a linear map.
First-year Analysis Course: Functions, limits, continuity, differentiability in one dimension, linear algebra (vector spaces, linear maps, matrices, vectors).

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Algebra

Introducing

Description

Solving Linear Systems

Gaussian elimination, row and column operations, matrix interpretation

Pre-Hilbert and Euclidean Spaces

Scalar product: examples and properties

Orthogonality: Pythagoras' theorem, orthogonal bases, orthogonal projection

Reduction of Endomorphisms

Eigen-elements: eigenvalues, eigenvectors, characteristic polynomial

Diagonalization, triangularization

Applications: differential systems and linear recurrences

Endomorphisms of Euclidean Spaces

Isometries, orthogonal matrices

Reduction

Bilinear Algebra

Symmetric positive definite matrices: definition, properties, characterization

Orthogonality

List of Competencies:

1_1: Master the mathematical concepts and computational tools of the engineer

1_2: Develop rigorous scientific reasoning and the capacity for abstraction

2_1: Master the fundamental tools of the mathematical engineer

Objectives

The student should be able to:

Solve linear systems using row and column operations and provide a matrix-based interpretation.

Compute an orthogonal basis and perform orthogonal projections.

Provide a matrix interpretation of the main classes of endomorphisms in Euclidean spaces.

Diagonalize and triangularize simple matrices.

The student should have understood and be able to explain (main concepts):

The main results concerning matrix reduction.

The concept of scalar product and orthogonality.

The notion of Euclidean space and isometry.

Necessary prerequisites

First-year Linear Algebra: Vector spaces, linear maps, matrices, the concepts of image and kernel of a linear transformation.

First-year Analysis: Functions, limits, continuity, differentiability in one dimension, linear algebra (vector spaces, linear maps, matrices, vectors).

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Continuous automatics

Introducing

Description

This course deals with the modeling, analysis and control of continuous linear systems. It presents the classical methods of frequency automata. They are based on the transfer function representation, obtained from the Laplace transform. The stability property and their temporal and frequency responses, in the form of Bode and Nyquist diagrams, are studied. We analyze the performance of a servo system, in terms of accuracy, transient regime and stability margins. Finally, the synthesis of correctors is approached by studying the effects of elementary corrections, before combining them to set PI, PID and phase lead controller.

Objectives

At the end of this module, the student should have understood and be able to explain the main concepts of the automatic control of continuous linear systems:
- model a continuous linear system in the form of transfer functions and block diagrams
- calculate the time and frequency responses of a continuous linear system, and analyze its stability
- analyze the main properties of a servo system (stability, transient regime, accuracy and stability margins)
- synthesize, using the classical frequency method, some controller (elementary corrections, PI, PID, phase lead)

Évaluation

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Discrete automatics

Introducing

Description

The second part covers discrete event systems control. It includes the general structure of a sequential system and the study of elementary sequential functions (flip-flops, counters). It also addresses the synthesis and analysis of a sequential logic system. The Huffman method is introduced, as well as simplified sequencer synthesis. The realization will be done using flip-flops for synchronous systems. Additional information is provided on Huffman synthesis for asynchronous sequential logic systems (issues of hazards and races). The formalism of Petri nets is introduced for specifying problems related to parallelism, synchronization, and critical resource management, as well as the statecharts formalism.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
• Sequential logic: synthesis and analysis
The student should be capable of:
• Conducting minimal synthesis and analysis of a sequential system based on flip-flops, including that of a sequencer (synchronous systems).
• Analyzing and synthesizing complex asynchronous sequential logic systems, identifying and resolving issues related to static hazards and races.
• Modeling a system with parallelism, synchronization, and shared resources using the formalism of Petri nets or statecharts, and analyzing properties (safe, live, and sound) of a network through the marking graph.

Necessary prerequisites

Combinatory logic

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Electrostatics (Elective course)

Introducing

Description

Mathematics needed to solve problems
Electric charge and distribution of electric charges
Electric field
Electric potential
Gauss's theorem

Objectives

Acquisition of the basics of electrostatics.
Learning formalism, implementation of scientific reasoning and calculation methods.

Évaluation

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