Ingegneria Informatica (2021)

29228 - Geometry and Algebra T

PDF, ADOC.

Learning outcomes

Knowledge of the main tools in linear algebra (matrices, vector spaces, linear systems, eigenvalues, quadratic forms) and their application in geometry, ensuring both the understanding of the links between the different parts of the theory, and operational capability.

Course contents

THEORETICAL PART

[Equations and linear systems] Some algebraic structures (groups, rings, fields). Standard operations on K^n. Linear systems.

[Matrices] Main definitions. Operations. Linear systems and matrices.

[Vector spaces] Main definitions. Vector subspaces. Linear combinations. Sum space. Row space and column space of a matrix.

[Bases] Linear dependence. Bases and dimension. Rank of a matrix. Linear systems.

[Linear maps] Linearity. Isomorphisms. Kernel and image of a linear map.

[Matrix representation of a linear map] Linear maps, bases, matrixes.

[Determinants] Permutations. Determinant and its main properties. Laplace expansion. Inverse matrix. Determinant of an endomorphism. Rank of a matrix. Linear systems.

[Representation of a vector subspace] Rank, kernel, image. Cartesian and parametric representations.

[Eigenvalues and eigenvectors] Eigenvalues and eigenspaces of an endomorphism. Similar matrices. Characteristic polynomial. Diagonalization of matrices.

[Euclidean vector spaces] Inner products and norms induced by inner products. Orthogonality. Orthogonal bases and orthonormal bases. Isometries. Orthogonal complement. Wedge product.

[Euclidean spaces] Euclidean subspaces. Representations of Euclidean subspaces. Parallelism and orthogonality in R^3.

PRACTICAL PART

Computation of determinants and ranks of matrices. Discussion and solution of linear systems. Computation of matrices associated with linear maps. Computation of equations for vector

subspaces. Computation of eigenvalues and eigenvectors. Diagonalization of matrices. Exercises on parallelism and orthogonality in R^3. Computation of angles between lines.

Further details at the web page http://www.dm.unibo.it/~frosini/programmi/programmacorso2021.shtml

Reading

27993 - Mathematical Analysis T-2

PDF, ADOC.

Learning outcomes

Refinement and enrichment of basic mathematical tools (series, curves, several types of integral, differential equations) for solving typical problems in applies sciences.

Course contents

Theory of numerical series.The Euclidean space R^n. Differential calculus of functions of several real variables. Ordinary differential equations. Measure and integration in the sense of Lebesgue. Curvilinear integrals and vector fields. Sequences and series of functions.

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28006 - Foundations of Informatics T-2

PDF, ADOC.

Learning outcomes

The course aims to provide an in-depth concptual & practical knowedlge about the basics concepts, methodologies, technologies and tools for the design and development of medium-size applications according to the object-oriented paradigm.

At the end, the student:

- knows the methodological foundations for the analysis and development of object-oriented software applications
- knows the corresponding techniques in depth both from the conceptual and practical viewpoints
- is able to apply such knowledge and techniques to medium-size applications using the Java language
- knows in depth the fundamental data structures and related algorithms
- has the fundamental notions of functional programming in modern OO-blended languages (Java, Kotlin, Scala, C#)

-is able to develop simple graphical user interfaces in JavaFX according to the event-driven programming pattern

Throughout the course, while the Java language and platform are the main reference (and the only one required for assessment in the final examination), a multi-language approach is adopted when introducing concepts and constructs, presenting the Java approch in comparison with other object-oriented languages such as C#, Scala, Kotlin, so as to provide a broader view.

Course contents

Basic concepts of programming languages. Language families — imperative, functional, logic, and object-oriented languages (5hrs).

Introduction to software design: software components, abstract data types, objects. Basic concepts of the Java language and architecture: classes, instances, object construction and deletion, inheritance, polymorphism. Abstract classes, interfaces, multiple inheritance. (30hrs + 12hrs lab)

Lambda expressions and functional interfaces. (12hrs + 6hrs lab)

Exceptions and exception handling. I/O streams and file access, object serialization. Data structures: lists, hashmaps, trees and related algorithms. (20hrs + 12hrs lab)

Introduction to Java operation streams. (3rhs)

Basic elements for GUI construction in Java on the JavaFX platform: event-driven programming, event listeners. (10hrs + 10hrs lab)

28011 - Logic Design T

PDF, ADOC.

Learning outcomes

Knowledge of models and methodologies to design digital systems.

Knowledge of methodologies for the analysis and design of conbinational circuits and asynchronous and synchronous sequential circuits

Course contents

The course is held in the second semester, from February to June.

Design layers of a digital machine: block description of a machine and verbal description of its behavior. Signal classification. Logic circuits as networks of switches. Logic gates.

Binary representation of information. Properties of codes. Codes to represents texts and numbers.Classification of digital systems: combinational, asynchronous and synchronous circuits.

Combinational logic circuits. Functions, truth tables, and logic diagram views. Commutation Algebra: operations, expressions, and equivalence theorems. Design and analysis through canonical

forms and standard forms. Real combinatorial networks: transient and steady-state behavior.

Gate-level minimization with Karnaugh maps.

Standard combinational logic circuits: decoder and multiplexer. Design by means of decoders and OR gates. Shannon's expansion theorem and design by means of multiplexers. Programmable circuits. ROM as programmable combinational circuits. Three-state buffer.

Binary arithmetic with unsigned and signed numbers. 2-complements representation for signed numbers. Half adder, full adder, and n-bit adder. Arithmetic-Logic Unit (ALU).

The asynchronous sequential logic circuit as a combinational circuit with direct feedback. Behaviors, constraints for correct use and techniques aimed at a priori removal of undesired behaviors. Finite state machine (FSM); description of the behavior by means of state diagram and state table. Design and analysis of asynchronous sequential logic circuits.

Asynchronous sequential logic circuits for binary memories: latches and flip-flops.

The synchronous sequential logic circuit as a combinational circuit with feedback loops based on flip-flops. Timing constraints to choose the clock period. Formal design method for circuits with D flip-flops.

Standard synchronous circuits: registers, shift registers, and counters. Examples of design of synchronous logic circuits containing registers, counters, and shift registers and not based on the conventional graph-based method.

28012 - Electronic Calculators T

PDF, ADOC.

Learning outcomes

The course aims at providing basic computer architecture principles focusing on RISC (Reduced Instruction Set Computer) processors such as DLX and ARM. The outcome of the course are methodologies to design systems based on modern microprocessors focusing on interfacing techniques for memory and input/output devices.

Course contents

Microprocessor evolution - Processor hierarchy and design methodologies - RISC architectures and comparison to CISC architectures - Memories and address decoding techniques - Sequential control units - Pieplined control units - I/O handling - ARM Processor

28032 - Applied Mathematics T

PDF, ADOC.

28029 - Electrotechnics T

PDF, ADOC.

Learning outcomes

Methodologies for studying electrical circuits in stationary, sinusoidal and transient operations.

Course contents

Electromagnetism

Magnitudes and equations of the electromagnetic field. Fundamental equations of Electromagnetism: laws of Maxwell, law of Gauss and law of divergence, law of conservation of the charge. Laws of material bond.

Circuit Theory

Circuit element and electric circuit, Kirchhoff's laws, and descriptive laws of the ideal elements: the resistor, the capacitor and the ideal inductor, the independent generators, and the piloted generators. Methods of circuit analysis: general method of analysis, method of elimination of tensions, method of nodes, principle of superimposing effects. Transfer function, Thèvenin theorem, Norton's theorem. Tellegen's theorem and power adversities. Transients, first (RC and RL) and second order circuits.

Sinusoidal Regime

Definition of amplitude, radian frequency and phase of sinusoidal quantities. Definition of phasors. Transformation from the time domain to the frequency domain: resistor, capacitor, and inductor and RLC circuit. Series and parallel resonance. Power in AC circuits. Three-phase system definition and properties; Y-connected and D-connected load. Use of the neutral wire. Power in three-phase systems.

Elements of Electrical Machines, Systems and Safety

Transformer; general methods for the study of rotating machines, the rotating field; the asynchronous and synchronous machine; continuous current machines; production, transmission and distribution of electricity. Electrical safety elements.

28014 - Foundations of Telecommunications T

PDF, ADOC.

Learning outcomes

Basic knowledge on Fourier analysis (continous- and discrete-time signals) and linear systems.

Introduction to communication networks. Introduction to ISO-OSI model and TCP/IP protcols.

Course contents

Fourier Analysis (time-continuous signals)

Analysis in the frequency domain of deterministic time-continuous signals. Fourier Series; Fourier Transforms; Dirac's Delta; Fourier transform of distributions (generalized functions), step signals and periodic signals.

Fourier Analysis (time-discrete signals)

Analysis in the frequency domain of deterministic time-discrete signals. Discrete-Time Fourier Transform (DTFT), Nyquist-Shannon's sampling theorem, Shannon's series, Discrete Fourier Transform (DFT), FFT.

Linear systems

Definition of linearity. Impulse response and transfer function of time-invarying linear systems. Non distortion conditions. Ideal, real and FIR filters.

Analog to digital conversion

Analog to digital conversion (PCM).

Generalized Fourier Analysis

Cross and auto correlation functions of deterministic signals. Energy and power spectra.

Modulation Theory

Introduction; analogue modulations (AM, PM, FM, DSB-SC, QAM).

Digital signals

Digital PAM signals. Power spectra of deterministic PAM signals. Extension to ergodic random signals. Bipolar and multi-level encoding, power spectra of multi-level PAM signals. Basic elements of digital modulations, including OFDM. General description of phisical layer of WiFi (IEEE 802.11n, ac and ax).

ISO-OSI model and TCP-IP protocols

Network architectures: layers, protocols and services. ISO-OSI and TCP-IP models.

Layer 2 (link)

Link layer services. Basics of Ethernet (10, 100 e 1000 Mbit/s); CSMA/CD protocol; basics of IEEE 802.11 (WiFi); CSMA-CA protocol, MAC addresses, hubs e switches.

Layer 3 (Network)

Network layer services; connection oriented and connectionless protocols (datagram), logical addresses, routing table, IPv4, basics of IPv6, NATs.

Layer 4 (Transport)

Transport services; UDP and TCP protocols (ACK, retransmission mechanisms, flow control, congestion control); ports.

DTN

Basics of “challenged networks” and of DTN (Delay-/Disruption-Tolerant Networking) architecture.

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28015 - Automatic Controls T

PDF, ADOC.

Learning outcomes

The course aims at providing the following basic skills in the area of control theory of dynamical systems: (i) describe a dynamical system via state-space and input-output mathematical models, (ii) analyze the output response of linear time-invariant (LTI) systems, (iii) analyze the stability of LTI systems, (iv) design a feedback controller for LTI systems with a special focus on single-input single-output (SISO) systems, (v) use software tools for the design of a control system.

Course contents

Introduction to automatic control and autonomous systems, and main application fields. Dynamical systems and state-space representation. Examples of state-space dynamical systems in different domains.

Classification of dynamical systems. Main properties of linear systems. Trajectories and equilibria of dynamical systems. Linearization of nonlinear systems.

Stability of trajectories and equilibria of a dynamical system. Stability of linear time-invariant systems. State feedback control.

Laplace transform and inverse transform. Transfer function. Step response. Response for first and second order systems.

Fourier series and transform. Frequency response. Bode diagrams. Filtering action of dynamical systems.

Introduction to control systems. Root locus. Phase and gain margins. Sensitivity functions. Control specifics and schemes. Frequency domain controller design. Design of main control schemes.

Simulation tools for analysis and design of control systems.

28016 - Electronics T

PDF, ADOC.

Learning outcomes

Basic elements of analog and digital electronics

Course contents

MOS transistor, technology and circuits

Elementary analog circuits based on opamps

AD and DA converters

28072 - Laboratory of System Administration T

PDF, ADOC.

38378 - Reliability and Quality Control

PDF, ADOC.

Learning outcomes

Fundamentals of quality control and reliability

Course contents

Requirements/Prior knowledge

A prior knowledge and understanding of the basic course od mathematics and physics is warmly recommended to attend with profit this course

Course Contents

Fundamentals of Probability and Statistics; fundamentals of metrology; definitions in the field of Reliability; Availability and Reliability functions, MTTF, MTBF, MTTR, reliability of mission; hazard models, reliability analysis of components and systems; degradation models; FMEA, FMECA, FTA, accelerated and truncated life tests, exponential and Weibull functions. Statistical Process Control, control charts for variables (x, R, S) and attributes (p, c, u). Capability process index, ARL, ATS

The course includes numerical exercises on the main topics.

32099 - Computer Law T

PDF, ADOC.

Learning outcomes

The course aims at providing future engineers with the essential knowledge tools to:

a) become aware of the existence of legal issues related to information and communication technologies;

b) understand how to be able to develop and use such technologies in a law-abiding way;

c) develop the ability to autonomously manage projects with a wider perspective, which includes understanding the related legal aspects;

d) interact with lawyers and legal experts in a qualified way.

Course contents

Introduction to the course

Why should an engineer study law? Objectives of the course. Structure of the course and lecture plan.

Basic legal concepts

What is the law. The concept of legal norm. The sources of law. Effectiveness of the law in time and in space. Criteria for the application of the law. Interpretation of the law. Relevance of court decisions. Natural and legal persons. Legal capacity and capacity to act. Obligations. Liability. Guided analysis of laws and court decisions.

Access and consultation of legal sources

The search for legal information: what to search and where to search for. Official and non-official sources. On-line and off-line legal databases. Institutional websites. Legal portals. The sources of the Bologna University Library System (SBA, Sistema Bibliotecario di Ateneo). Legal journals, codes and manuals. Guided search in legal databases. Training in the search for legal sources.

Copyright

The legal framework on copyright in the Italian legal system. Software, databases, multimedia works, websites. Proprietary and Open Source software. The ownership of software developed within research projects/in a company/on the basis of a professional consulting contract. Musical and cinematographic rights. Peer to peer. Digital Rights Management. Protection of domain names. Sanctions. Guided analysis of case studies and court decisions.

Industrial property

The Consolidation act on industrial property. Trademarks, domain names and patents. Patent protection of software. Patent applications. The claims. National and international patent databases. Patent searches; guided analysis of patent examples.

Software contracts

The concept of contract. Legal requirements of the contract. Voidness and voidability of contracts. Nominate and innominate contracts. Main types of contracts useful for the engineer. Transfer of the economic rights on software. Software licenses, open source licenses. Creative commons. Software development contracts. Guided analysis of contracts and relevant clauses.

Data protection and security

The legal concepts of privacy and confidentiality. The processing of personal data in the Information Society: general principles. Information obligation and consent. Rights of the data subject. Sensitive Data. Minimum and adequate security measures. User profiling on the Internet. Sanctions.Guided analysis of information documents, privacy clauses.

Electronic/digital signatures and electronic documents

Documents and signatures: basic legal principles. Digital signatures and cryptography: some technical notes. Electronic signatures: types and legal discipline. The electronic document: definition, validity and legal relevance, admissibility as evidence before court. The legal validity of e-mails, web pages, electronic registers. The certification of digital signatures. Certified e-mail (PEC). Optical archiving and conservation of electronic documents. Guided analysis of cases and court decisions.

Electronic commerce

Types of electronic commerce. Information Society Services. Obligations and responsibilities of on-line service providers. Liability of intermediaries (mere conduit, caching, hosting). Commercial communications. Contracts made with electronic means. Electronic payments. The protection of consumers on-line. Right of withdrawal from on-line contracts for consumers. Vexatious clauses. Resolution of on-line disputes. Guided analysis of cases, e-commerce web sites and on-line contract clauses.

Computer crimes

Basic elements of criminal law: concepts of crime, fault and intentional wrongdoing, the principle of strict application. Illicit access to an IT system. Detention and diffusion of codes of access to IT systems. Damaging or interruption of an IT or distance-communication system. Illicit interference in electronic communications. IT fraud. Guided analysis of court decisions.

94442 - Design of Web Applications T

PDF, ADOC.

Learning outcomes

At the end of the course, the student masters the principles of the design and development of Web applications, with particular attention to data-intensive applications.

Course contents

Models for Designing Web Applications

Data model: E/R e UML

Hypertext model (WebML)

Content management model (WebML)

Design of Web Applications

Overview of the development process

Requirements specifications and data design

Hypertext design in WebML

Implementation of Web Applications

Architecture design and multilayer organisation: Services, Business Logic, and Application

Data implementation

Hypertext implementation

Tools for model-based development of Web applications: Web Ratio and IFML

Services: Models and technologies for the effective and efficient management of the impedance mismatch

Direct access to databases: Interfaces and abstractions

Object-based architectures vs. relational databases: The impedance mismatch

Methodologies for persistence designing and developing: The "brute force" approach (JDBC), pattern DAO, and Object-Relational Mapping (ORM) - Entity Beans - Hibernate library

Services: Transactional models

Isolation levels

Transactional models: JDBC, JTA e Hibernate

Data description and XML

Descrizione delle informazioni: XML e XHTML

Tipizzazione di XML: DTD vs. XML Schema

Accenni a XSL e XSLT

XML e Java: Parser XML (modelli DOM e SAX)

N.B. Significant part of the course is dedicated to carrying out guided laboratory exercises. A good knowledge of Java language and its application framework is required, as well as the fundamentals of Web Technologies and Databases.