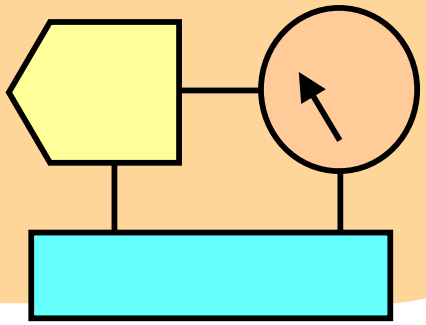
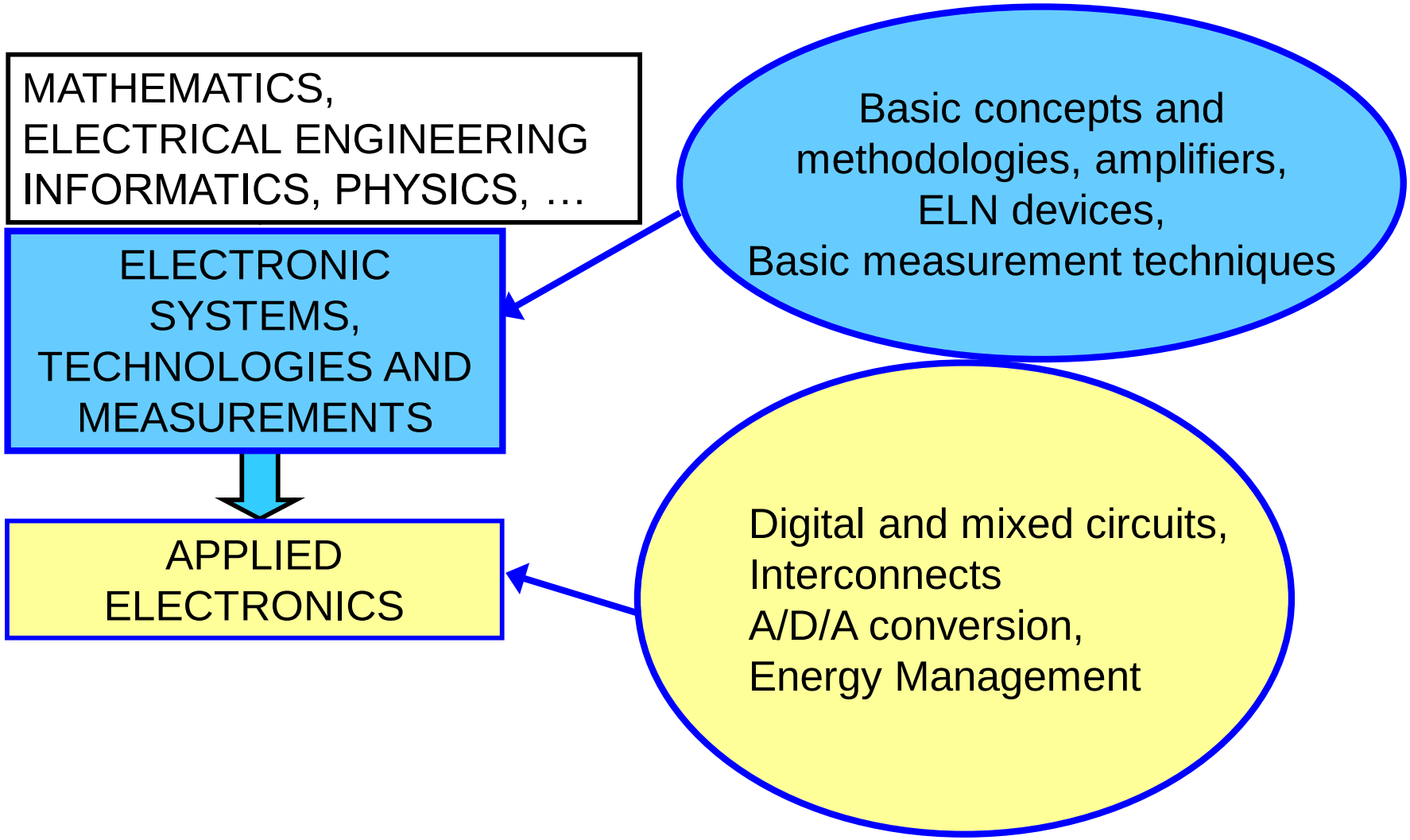
Applied Electronics

A1 – INTRODUCTION

- Objectives
- Organization
- Exams
- Recalls



Electronics for Non-Electronics Tracks



Electronic Systems, Tech. & Meas.

- Electronics basic concepts and specific methodologies
  - Functional units, defined by models (terminal parameters)
  - Reaction principle and use (operational amplifiers)
  - Difference between analog and digital signals and techniques
  - Basic electronic devices
- Fundamentals of electronic measurements
  - Basic concepts and methods
  - Use of the main measurement instruments
- Objectives
  - Ability to analyze simple electronic circuits
  - Ability to use basic measuring instruments

Applied Electronics

- Analysis of analog and digital functional modules
  - Parameters, internal structure and module circuits for
    - Digital Circuits
    - Interconnections
    - A/D and D/A conversion
    - Energy management
- Objectives
  - Analysis, design and testing of simple electronic systems

Course Materials, Communication

- Course portal: didattica.polito.it
  - **Official communications** (exams, …)
  - **Didactic material** for enrolled students
    - Course slides, lab material, etc.
    - Examples of exercises and exams
  - **On-line platforms** for exercises and exams
- **Use email** to contact me
  - Email notifications → persistent, I can address them later
  - *Chat notifications vanish → I'll forget to reply*

Teaching

- Course *Applied Electronics* and *Measurements* has:
  - Part 1: *Applied Electronics* has two sections:
    - First section: Prof. Lazarescu
      - 12 lectures and exercises in class (3 hours each)
    - Second section: Prof. Francesco Gregoretti
      - 12 lectures and exercises in class (3 hours each)
  - Part 2: *Measurements*
    - Refer to Prof. Carullo for its organization

Examples, Tests, Exercises

- **Examples**
  - Presented during the lecture
- **List of questions**
  - At the end of each lecture
  - Verify your understanding of the *key points*
  - Advice: study to *immediately fill* your knowledge gaps
- **Exercises**
  - Classroom exercises with solution
  - Solved step-by-step in the classroom
  - *Try to solve them yourself*
    (maximum learning, but requires autonomous effort)

Questions, Exercises, and Tests

- Identify early on the “learning issues”
  - Knowledge gaps must be corrected before the exam
- *Questions* asked during lectures
  - Spot immediately knowledge gaps or misunderstandings
- *Exercises* → apply the theory to *new* situations
  - Exam exercises may *not be identical*,
    and *not even like* the exercises or the examples you have seen
- Engineers do *projects* (not exercises or exams), but
  - To become an *engineer*, you must (also) pass *exams*
  - To pass *exams*, you must (also) know how to *solve exercises*
  - To *solve exercises*, you must (also) know *the theory*
  - Exercises are *mini-examples* of *real problems*
    to test both your ***knowledge*** and your ***understanding***

Collaboration and Coordinated Work

- The engineers rarely works alone
  - Cooperation is an important part of the real work
- Learn to collaborate effectively
- Form groups to solve the exercises in the classroom
  - But do **not** collaborate at the exams
  - Exams are individual activities, for *individual evaluation*
  - Do **not** attempt to cheat
    - Your work is voided at the slightest hint of cheating
    - May subject you to disciplinary or even legal actions

Topics and Lectures

- Lectures divided into topic groups:
- Prof. Mihai Lazarescu:
  - A - Introduction (this lecture)
  - B - Digital circuits, memories, filters
  - D - Data acquisition systems
- Prof. Francesco Gregoretti:
  - C - Interconnections
  - E - Energy management and implementation
- Before the lectures
  - Download the slides from the course portal on didattica.polito.it
  - Read them *before* the lecture
  - Try to understand and prepare questions for the lecture

General Prerequisites

- Applied Electronics use a *broad range* of knowledge
- *Electrical engineering, mathematics, physics*
  - RLC networks with controlled generators, symbolic method
- *Computers*
  - Digital architectures and circuits, memories,
- *Electronic systems and technologies*
  - Behavior and parameters of elementary devices
  - Circuits with Operational Amplifiers
  - Basic logic gates, electrical parameters
- *Signal theory*
  - Frequency analysis (qualitative)

Examination

- Written exam using the didattica.polito.it exam platform
- **Exam** (pass with grade ≥18/30 points, ~1 h 30 min)
  - Applied Electronics (Prof. Lazarescu): 21 points
  - Measurements (Prof. Carullo): 9 points (+ 3 lab) but
    - Lab points are valid **only** to reach the 60 % of full exam grade (18 points)
    - Lab points are not added to exam grades above 18 points
- **Applied Electronics** (max 21 points)
  - Tests both the *knowledge* and the *understanding*
    - You **must** combine knowledge, **not** just apply some formulas
  - *7 quizzes*, only one good answer: 1 point good, 0 points wrong
  - *2 exercises* (calculations, quizzes, waveforms, …): 7 points each
  - *No additional oral exam*

Textbooks

- Textbooks are *not required* (for further study, clarification)

- **N. Storey**
  Electronics: a system approach
  Pearson, fourth edition

  - Ch. 23: review of Boolean Algebra
  - Ch. 25: static and dynamic electrical parameters of logic circuits, logic families, interfacing, …
  - Ch. 24: sequential logic
  - Ch. 26: programmable logic (26.1, 26.2)

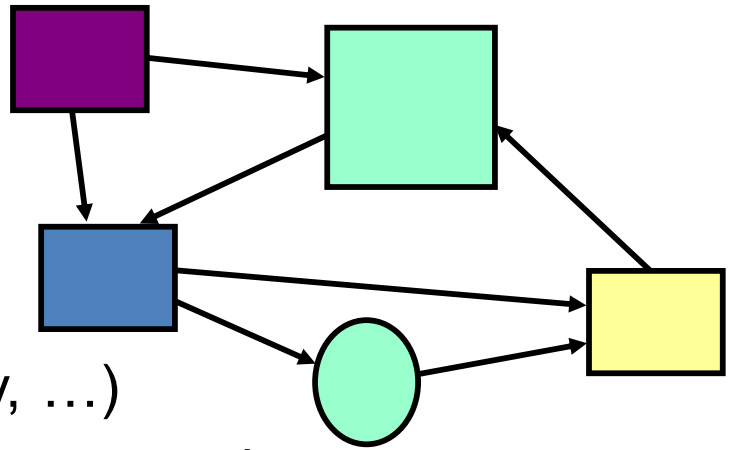
Textbooks

- **F. MALOBERTI**
  Understanding Microelectronics: A Top-Down Approach
  John Wiley & Sons, 2011, ISBN: 978-0-470-74555-7
  (available on https://www.biblio.polito.it/en/)

- **D. DEL CORSO et al.**
  Telecommunication Electronics
  Artech House, 2020, ISBN: 978-1-630-81736-7

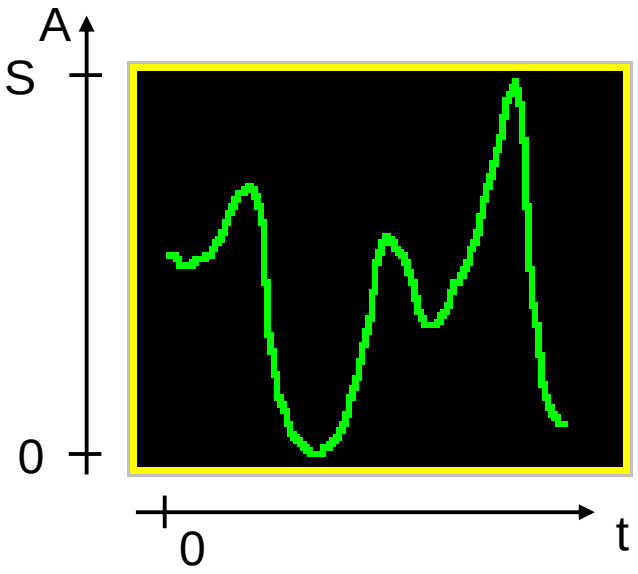
Electronic Systems and Modules

- An electronic system is made of *interconnected modules*
- Most designers use modules and components *built by other people/companies*
- What should we know to *use* the modules?
  - Their function
  - Their I/O signals
    - Meaning, timings
  - Their supply requirements
  - EMC (radiated, susceptibility, …)
  - Operating conditions (temperature, ...)
  - Mechanical properties/requirements
  - …



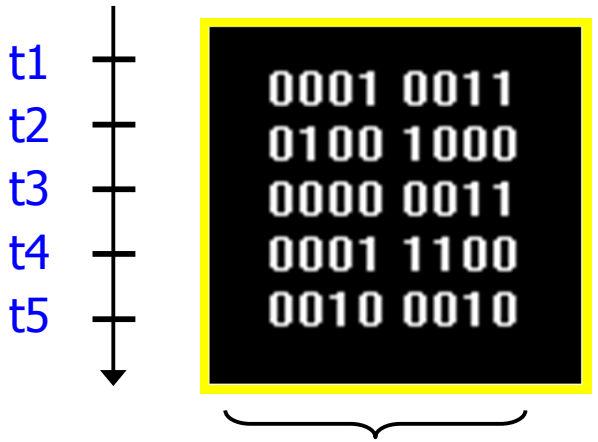
Analog Signals

- The analog signal is *continuous* on two axes
  - *Time*: is defined for any instant within a certain interval
  - *Amplitude*: can have any value within a certain range
- Main parameters
  - Amplitude range
    - Max and min value (its dynamic)
    - Possible dc component (shift)
  - Frequency content
    - Frequency band
    - Shape of the frequency spectrum



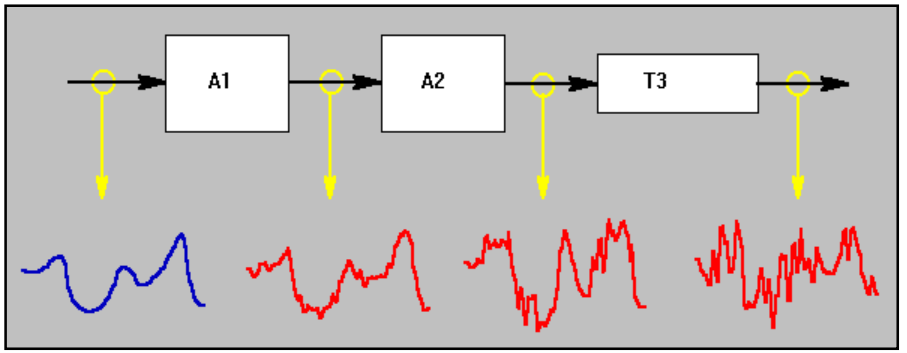
Digital Signals

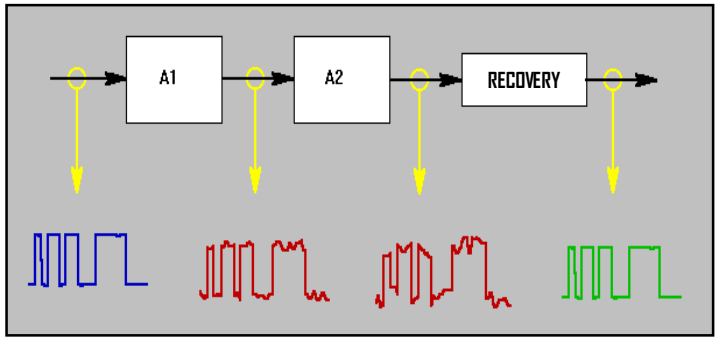
- Digital signal are a *sequence of numbers*
  - *Discreet time*: defined only for a few instants within an interval
  - *Discreet amplitude*: can only have some values within a range
  - Very often encoded in base 2
- Parameters
  - Amplitude *dynamic*
    - Depends on the number of bits
  - Frequency *band*
    - Depends on the cadence of sampling
- Format (transmission)
  - Parallel
  - Serial



Reconstruction of the Digital Signals

- Every analog operation *adds noise*
- Analog signals
  - Are degraded by noise, *information cannot be recovered*
- Digital signals
  - Degradation due to noise *is recoverable* (within certain limits)





Advantages of Digital Signals

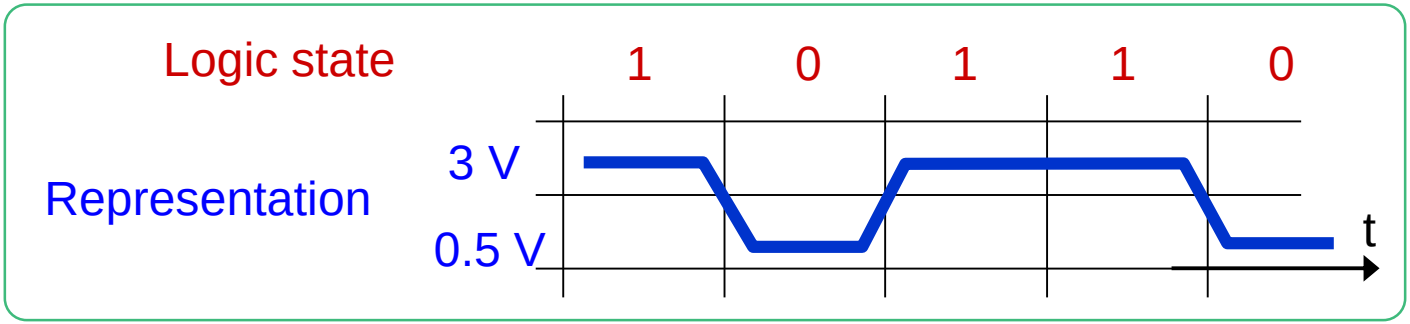
- *Can be restored*
  - Noise effects are *rarely cumulative*
  - We can apply *complex operations* on the signals
    - Impossible with analog signals because they *accumulate too much noise*
- *Automatic tools* help design and implementation of digital modules
  - Digital circuit design is *fast* and largely *automated*
  - → Digital integrated circuits have *lower costs*
- The function of the digital circuits can be *easily changed*
  - Through software (at various levels)
  - Other types of programming

How to Use Digital Signals?

- To avoid information loss with a digital signals
  - Use correct *interfacing*, both static and dynamic
  - Check their *operational limits*
  - Choose an adequate *system technology*
  - *Periodically reconstruct* the signal
- These are the topics covered in “Electronic Systems and Technologies”, in the lectures of *group B*

How are Digital Signals Implemented?

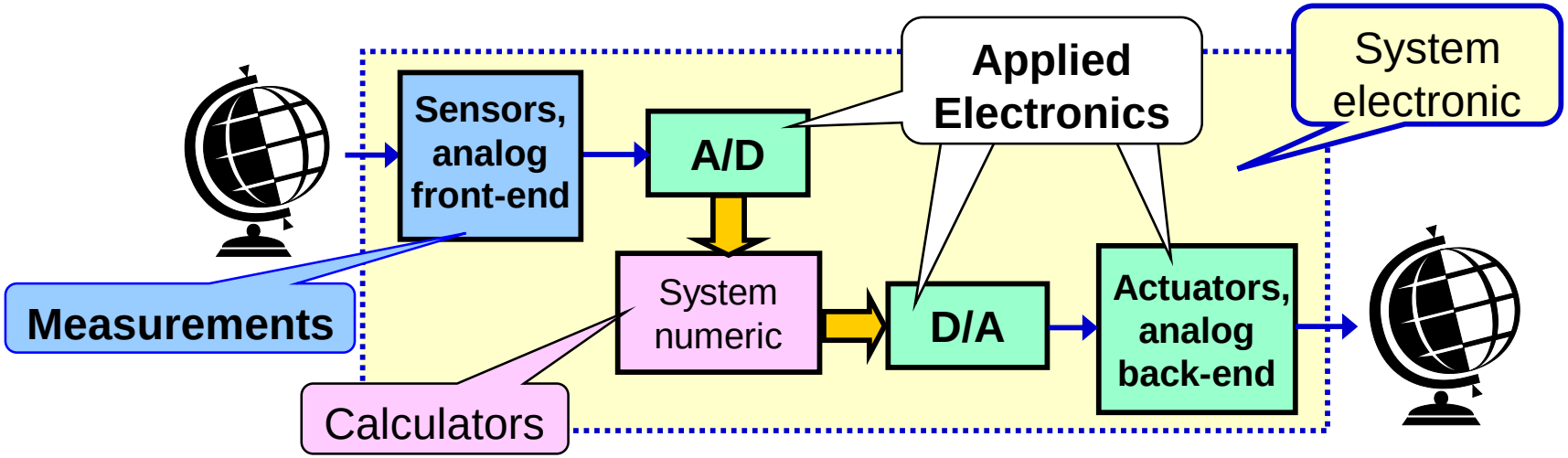
- Digital electronics are based on analog signals
- *Logic states* are physically represented by *voltages* (volt)



- Voltages
  - Are affected by noise, disturbances
  - Need time to change
  - Consume energy
  - Radiate electromagnetic waves
  - ...
- Topics covered in the lectures of *group C*

Analog → Digital → Analog

- An electronic system includes
  - *Interfaces* to the *analog* outside world (front-ends)
  - Conversion to *digital*
  - Digital signal processing
  - Conversion to *analog*
  - *Interfaces* to the analog outside world (back-ends)

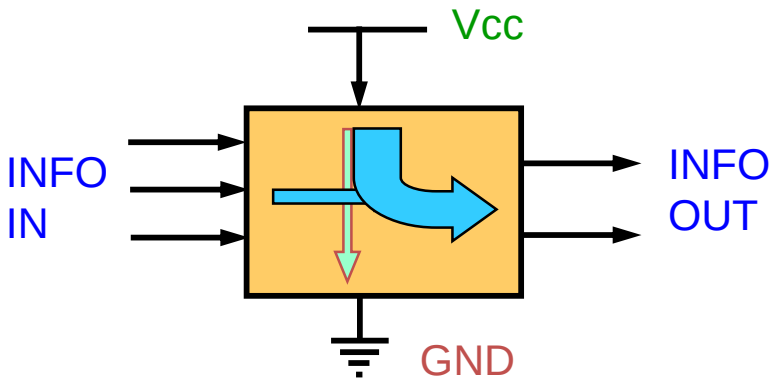


Do Signals Digital Solve Everything?

- Digital signals have inherent *limitations*
  - *Sampling*: the values are defined only at *discrete times*
    - Can represent signals with frequency band limited to $F_S/2$ (Nyquist)
  - *Quantization*: the values are represented as integer numbers
    - N bits: 2^N values, hence quantization error $\frac{1}{2^N}$
- For low error conversion from A to D and from D to A
  - Analyze the system parameters
  - Choose a suitable type of A/D and D/A converter
  - Apply appropriate signal conditioning
- Topics covered in the lectures of *group D*

Where Does the Energy Come From?

- Electronic modules use
  - Signals
    - Carry *information*
  - Power supplies
    - Carry *power*
- Power systems distribute energy as *direct voltage* (V_{CC})
- Are *complex subsystems*
- Topics covered in the lectures of *group E*



Lecture A – Summary

- Objectives of this course
- Teaching materials
- Method of examination
- Organization of contents
- Prerequisites
  - Analog circuits with operational amplifiers
  - Combinational logic circuits
    - Electronic Elements: check them *before* the lectures

Review Questions

- What will I learn during this course?
- Where can I find the didactic material?
- Do I have to be in class or just watch the recordings?
  - Can I learn just by doing exercises?
- Why are electronic systems increasingly digital?
- What are the electrical parameters of a logic circuit?
- Do I meet the prerequisites for the course?
- What should I do if I cannot answer these questions?