Introduction to the course

Discrete Time Systems (DTS)

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Professors (this year)

- Luca Martino (luca.martino@urjc.es)

- Francisco Valverde (francisco.valverde@urjc.es)

Schedule of the classes

- Tuesday, 11-13 am

- Wednesday, 11-13 am

First rule

- You can ask in English, Spanish…or any language…but ASK, please.

Main idea of the course

- DTS = Linear systems but in discrete time

- Compared with "Linear systems and circuit applications (LSCA)":

- **DTS = LSCA - Circuits + Much more Material of signals and systems**

Topics

Topic 1: Signals and discrete systems in the time domain
- Signs in discrete time - Systems in discrete time
- System properties.
- Sum convolution

Topic 2: Signals and discrete systems in the frequency domain
- Fourier series development of discrete signals: Definition, Properties, Fourier Series and linear systems. invariant
- Fourier transform of discrete signals: Definition, Properties, Frequency response of linear systems and invariant

- which are the topics corresponding to ("almost" all) LSCA

Topics

Topic 3: Sampling

- Sampling of continuous signals: Sampling theorem; Reconstruction of a signal in continuous time through interpolation
- Discrete time processing of continuous signals
- Sampling discrete signals: decimation and interpolation

Topic 4: Discrete Fourier Transform: frequency sampling

- Definition: the DFT as the sampling of the Fourier Transform
- Properties
- Practical implementation in Matlab
- Circular convolution: definition, relationship with the DFT, relationship with linear convolution

- very important part - we need concepts/definition of LSCA, but new part

Topics

Topic 5: Transformed Z
- Definition - Region of convergence
- Properties - Diagram of poles and zeros
- Analysis of discrete systems described by equations in differences
- Block diagrams

Topic 6: Introduction to the design of discrete filters
- Fundamentals of digital filtering
- Design of FIR filters
- Overview of IIR filter design
- Design of digital filters with Matlab

- Zeta transform <===> Laplace Transform

- Topic 6: usually I just start this topic but….(long discussion)

Before - evaluation and exams

- …discussion about **who decides here**…

- my CV

- my duties and responsibility

- I am completely AGAINST the "synchronization idea"…. (**do not refer to it to me**)…

- I do not like *at all* "partial exams"…..(but)….

- I like a possible oral exam

Evaluation and exams: ordinary call

Global Final Mark = 40% Partial Exam 1 (Topics 1-3) + 60% Final Exam (Topics 1-6)

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The Partial Exam has not minimum mark. It can be redone in the extraordinary call ONLY if the obtained mark is <5.

The Final Exam has a minimum mark of 5. It can be redone in the extraordinary call ONLY if the obtained mark is <5.

The Global Final Mark must be >or = 5.

- *Possible additional oral exams requested (required) by the Professors.*

Evaluation and exams: ordinary call

ALL THE PERIOD OF CLASSES CAN BE A POSSIBLE DAY FOR DOING THE PARTIAL EXAM.

- *If you are travelling or have any other problem during exam days, that is your own concern!*

- *You must be available everyday during February, March, April, May, etc.*

Additional oral exam

- During the period of evaluation, the Professor may require an **additional oral exam** that can change the final mark (to check if someone really did the exam by themselves or "cheated", for instance).

  - **Your mark in that case can also decrease.**

Extraordinary Call

EXTRA CALL:

At the same day established for the extra call, the student can redo the Partial Exam and/or the Final Exam (could be redone both) ONLY if the obtained mark is <5 in the ordinary call.

Global Final Mark = 40% Partial Exam (Topics 1-3) + 60% Final Exam (Topics 1-6)

Minimum marks

- The mark of the final (second) exam >=5 (also in the extra call)

- The global mark must be >=5

Warning: possible negative marks

- There may be possible **negative marks** in some parts of the exams (penalties).

- The exams will contain **questions regarding the theory** (even some problems will be strictly related to theoretical questions).

Meetings before/after classes

- They can be either "in presence" or "online".

- **In any case, SEND ME AN EMAIL to luca.martino@urjc.es to schedule the meeting.**

- **Online:** by Microsoft Team.

Documentations, slides, videos etc.

- **Documentations (slides etc.) in Aula Virtual.**

- videos in YouTube or other platforms

- Books, references:

○ Fundamentals of Signals and Systems, using the Web and Matlab, Edward W. Kamen Bonnie S. Heck
○ Signals and Systems, Alan V. Oppenhem and Alan S. Willsky. Prentice Hall, 2nd ed.
○ Análisis de Circuitos en Ingeniería. Hayt and Kemmerly. Sexta Edición. McGrawHill
○ Conceptual Digital Signal Processing with Matlab, K. Kim, Springer 2021 (free for URJC as of today)

(you can find all of them in English or in Spanish)

Warning

- **EXTREMELY DIFFICULT COURSE** (specially for you)

- …for several reasons….

- and **EXTREMELY IMPORTANT** (not only for biomedical applications; but also for this relationship with data analysis - signal processing: data are signals…)

Required Background

- **Complex numbers**

- **Integrals, series and their convergence**

- **Function analysis, vertical and horizontal asymptotes, limits, derivatives etc.**

Warning: theory in the exams

- Again, there will be theory in the exams

- We have no interest in measuring your memory

- **We want to test whether you understand and learn or not**

- For understanding: you have to study, mainly….

Warning: no complains, yes study…

- This is not a course on "syndicalism" or how to "cheat" in a better way.

- The Professors desire just to help you understand the main concepts and models and to be good Engineers (*and citizens*) in the future.

- I have an excellent CV with a PhD, several research publications and hours of teaching experiences. **Try to learn a lot.**

- I will meet (online) your "delegado/a" to clarify these points further.

Warning: no complain, study…

- For any issues, enquiries, requests, questions, please *first* contact the Professor (at least once).

- Again, I will meet (online) your "delegado/a" to clarify more this point.

Practical warning: emails

- When writing an email to the Professor: please first **introduce yourself (stating also what the related course is)**, and then **explain adequately what your problem/question is**.

- For professor Luca Martino: send the email to: luca.martino@urjc.es,

  - U*sing also from your institutional email* (preferably).

  - **Do NOT send email to the of aula virtual.** (there is also an email in aula virtual…)

- For professor Francisco Valverde: use Aula Virtual

Summary: what do you have to do?

- **JUST STUDY**

"Studying" means "Understanding"

- **Do not memorize….**

- **Try to understand**

- The exam will contain theoretical questions and even the problems will be always different, containing new "theoretical riddles".

Questions?