Principles of Communications (通信系统原理)

Undergraduate Course

Presentation of the Course

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Tongji University

Presentation of the Course
Contents

1. About me
2. Textbook
3. Contents of the Course
4. Learning and Evaluation Methodology

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About me

- 2009: B.Sc. Telecommunications Engineering (University of Vigo, Spain)
- 2011: M.Sc. Signal Processing Applications for Communications (University of Vigo, Spain)
- 2016: Ph.D. in Information Techn. and Mobile Network Comm. (Univ. of A Coruña, Spain)
- 2008-2011: Researcher at the Signal Processing in Comms. Group, Univ. of Vigo (Spain)
- 2011-2017: Researcher&lecturer at the Group of Electronic Tech. and Comms. (GTEC), University of A Coruña (Spain)
- 2012, 2015, 2016: Visiting researcher and lecturer at National University of Asunción (Paraguay)
- 2014, 2015: Visiting researcher at TU Wien (Vienna, Austria)
- 2017-2019: Researcher at the College of Electronics and Information Engineering, Tongji University (Shanghai, P.R. China)
- 2020-2023: Assistant Professor at the College of Electronics and Information Eng., Tongji University (Shanghai, P.R. China)
- 2021-Now: Master advisor at the China-Deutsch Center of Intelligent Systems, Tongji University (Shanghai, P.R. China)
- 2011-Now: External researcher&lecturer at the Dept. of Power and Control Systems, National Univ. of Asunción (Paraguay)
- 2020: Post-Doctoral Award “Tongji University 2020 Outstanding Post-Doctoral Researcher”
- 2021: 1st Prize of “2021 Young Teacher Award”, at the College of Elect. and Information Eng., Tongji University
- 2018, 2022: Chinese Foreign Experts Bureau for Foreign Young Talents Fellow
- 2023: IEEE Vehicular Technology Society (VTS) Propagation Committee: Member, General Secretary, Steering Committee
- 2023: Spanish “Beatriz Galindo” Fellow
- 2023-Now: Associate Professor at the College of Electronics and Information Eng., Tongji University (Shanghai, P.R. China)
- 2024-Now: ITU-R and COST representative of Tongji University
- Obtained 2 Ph.D. grants, 3 research stay grants and 3 post-doctoral fellowships
- Participated in 50+ research projects, 9 as leader
- Co-authored 25+ journal papers, 60+ conference papers, 5 patents and 1 book
- Research topics: documental security and image processing, mobile processing, compressive sampling, digital mobile communications (especially for high mobility environments), channel modeling and performance analysis for digital communication systems

About me

Practical Data

- Personal contact information
  - Office address: Room 714-A, School of Electronics and Information Engineering, Jiading Campus
  - E-mail: j.rpineiro@tongji.edu.cn
  - Mobile phone: (+86) 18302173862
- Research group information
  - Channel Research Group, Department of Communications
  - Research directions:
    - Propagation channel analysis (mmWave propagation, UAV propagation, V2V propagation, positioning analysis...)
    - Performance of communication systems (system- and link-level simulation of communication systems, analysis of throughput of communication systems, latency of communications...)

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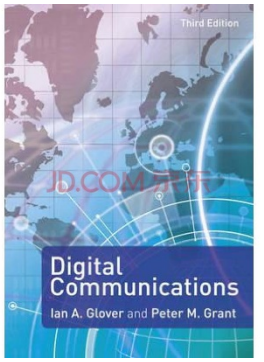
Textbook

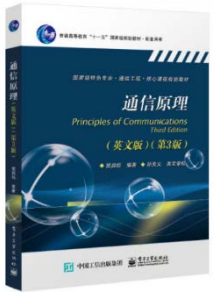
Main Textbook

- Ian A. Glover, Peter M. grant, “Digital Communications”, 3rd Edition, 2010. ISBN: 978-7-111-31669-5.

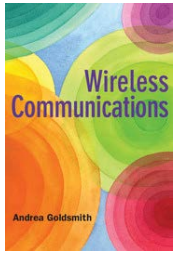


Reference Books

- Fan Changxin, “Principles of Communications”, 3rd Edition, 2020. ISBN: 978-7-121-39255-9.



- Andrea Goldsmith, “Wireless Communications”. Cambridge University Press, 2005.



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Contents of the Course

1. Introduction
   - History of Communications
   - Message, Information and Signal
   - Digital Communications
   - Communications Channel and Noise
2. Periodic and Transient Signals
   - Periodic signals and Fourier series
   - Spectrum and power spectrum
   - Transient signals and Fourier transform
   - Spectrum density and energy spectrum density
   - Correlation functions
3. Random Signals and Noise
   - Probabilities and Bayes's rule
   - Cumulative distributions, probability density functions, and moments
   - Joint and marginal pdfs, correlation and covariance
   - Addition of random variables and the central limit theorem
   - Stationary and ergodic random processes, Gaussian processes
4. Linear Systems
   - Properties of linear systems
   - Time domain and frequency domain descriptions of linear systems
   - Random signals and linear systems

Contents of the Course

5. Analogue Modulation
   - Amplitude modulation
   - Double-sideband modulation
   - Single-sideband modulation
   - Vestigial sideband modulation
   - Phase modulation
   - Frequency modulation
6. Sampling, Quantization, and PCM
   - Pulse modulation, natural and flat topped sampling
   - Nyquist's sampling criterion and aliasing
   - Bandpass sampling
   - Linear and companded PCM
   - Delta PCM, differential PCM, and delta modulation
7. Baseband Transmission and Line Coding
   - Baseband centre point detection
   - Error accumulation over multiple hops
   - Line coding
   - Multiplex telephony
   - Digital signal regeneration

Contents of the Course

8. Decision Theory
   - A priori, conditional, and a posteriori probabilities
   - Bayes's decision criterion
   - Neyman-Pearson decision criterion*
9. Optimum Filtering for Transmission and Reception
   - Pulse shaping for optimum transmission
   - Matched filtering and correlation detection
   - BER performance of optimum receivers
10. Multiplexing and Multiple Access
   - Frequency division multiplexing
   - Time division multiplexing
   - Code division multiplexing
   - Multiple access
11. Advanced Digital Bandpass Modulation and Demodulation
   - Offset QPSK
   - Minimum shift keying and Gaussian minimum shift keying
   - Orthogonal Frequency Division Multiplexing
   - Trellis coded modulation
   - Spread spectrum modulation

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Learning and Evaluation Methodology

How I want you to learn

1. **I believe that quality is better than quantity**: I will adapt to the learning speed of the classroom. I want that each one of you understand all the contents. I prefer to dynamically reduce the contents of the course but that all of you can understand all the contents.
2. **Understand and not memorize**: In order to pass this course you will not need to memorize many concepts, but to understand and apply them. I can guarantee that you do not need to worry about your mark if you understand the concepts.

Learning and Evaluation Methodology

How I want you to learn

3. **I would like participation from the students during the lecture:** If you do not understand something, interrupt me as many times as required until you understand it. The only question that can may stupid is the one that remains unasked.
4. **I do not value the attendance to class(*):** I want you to learn and that is my only objective. I will help as much as I can on that, but you can learn in the way you want. If you learn and you understand the concepts, my goal is fulfilled.

(*) According to the rules, we should value the attendance with at least 10% of the mark, hence I will do this.

Learning and Evaluation Methodology

How I want you to learn

5. **Not everything is the lecture:** If you have any doubt after the lecture, you can send an email to me or you can come to my office (better with appointment; just ask by email and I will reply as soon as possible). I will always try my best to help timely.
6. **And after the course:** If you liked this course so much, we can find the way to try to expand it for your future career. Just talk to me and we will find the way.
   - In previous editions of the course:
     - Several students joined our research team
     - Several students performed her bachelor thesis with me

Learning and Evaluation Methodology

Evaluation at a Glance

Percentages of the different evaluation metrics

1. Lectures attendance(*): 10%
2. Performance in lectures (online/offline): 10%
3. Intermediate exercises: 25%
4. Final assessment: 55%
    1. Communications system project: 25%
    2. Final examination: 30%
5. Quiz after lecture: 0% (but it will help you to learn…)

(*) It is not necessary to attend to all the lectures to get the maximum mark. Regular attendance is sufficient.

Learning and Evaluation Methodology

Evaluation Methods in Detail

1. **Intermediate Exercise (Cooperative Presentation) [25%]**
   - Students become teaches for a day
   - A group of students will need to cooperatively teach one/two chapters of the course in a day
   - I will help during the presentation and eventually ask some simple question
   - The main benefits of the presentations are:
     - They help you to review the concepts. It is very different to “read” a book than to tell the story in the book to others.
     - They help you to improve your analysis and synthesis skills, as well as to work on a group.
     - They help you to learn how to organize, expose, present and defend your ideas in public.
     - They foster a culture of looking for answers, the critical evaluation of the knowledge of the technology and to highlight the importance of study and innovation[1].
     - They help me to early detect problems in your learning.

[1] P. H. Winne, "Cognition and metacognition within self-regulated learning", Handbook of self-regulation of learning and performance. Routledge, 2017, pp. 36-48, ISBN: 9781315697048.

Learning and Evaluation Methodology

Evaluation Methods in Detail

2. Communications System Project [25%]

- A small computation project that will combine several of the main theoretical concepts introduced during the lecture
- The contents will be defined dynamically depending on the evolution of the lecture
- Both the generated code and a detailed report will be required by the end of the semester, as well as a brief interview to identify some misunderstandings of the concepts acquired
- The project will be started after the basic concepts of the course are introduced and you can evolve it when you learn the concepts of the different chapters
- I will guide you during the process and solve any doubts and problems during the project. This is the way of learning on a project-basis scheme

Learning and Evaluation Methodology

Evaluation Methods in Detail

3. Final Exam [30%]

- The rules of the university recommend to always have a final examination, being 30% the minimum weight of it
- The exam will include the basic concepts of the course. It focuses on the understanding and not on the memorization of the concepts
- If you understand all the concepts in the course, I can assure that you will not need to worry about the exam at all

Learning and Evaluation Methodology

Evaluation Methods in Detail

4. Quiz after lecture [0%]

- After some lectures, I will provide you with some questions, that should be answered before the next lecture
  - However, nothing happens if you do not do it, since they do not count for the mark
  - Nothing happens if you answer them wrong, since they do not count for the mark
  - Then why we do this?
    1. They help you to reflect about the contents of the course
    2. They help you to identify the key concepts of the course
    3. They help me to early detect problems in your learning process
- At the starting of the next lecture, I will try to give a review to the misunderstandings found in your answers and review any concept that can be unclear
- A discussion on the concepts can be raised out if different opinions are exhibited by the students

Learning and Evaluation Methodology

Evaluation Methods in Detail

Benefits of the Proposed Learning Methodology

1. Based on my experience, you will learn more with a project-based approach than with traditional exercises. The concepts used freshly after being introduced are more difficult to be forgotten
2. The project-based approach is a two-fold learning strategy: you can use the concepts learned daily to solve the project and use the project to understand the concepts more deeply
3. For many of you, the communications project will be the first time in your bachelor studies to learn how to solve a practical problem
4. With the help of the cooperative presentations, you will improve many different skills: public presentation and defense of the concepts, synthesis and analysis of the concepts and team work. As a whole, you will learn how to learn.
5. You can easily pass the course by devoting a bit more daily work instead of risking most of your mark in a single examination
6. You will discover that you can do things you have never imagined

Learning and Evaluation Methodology

Final Remarks

Materials for the course

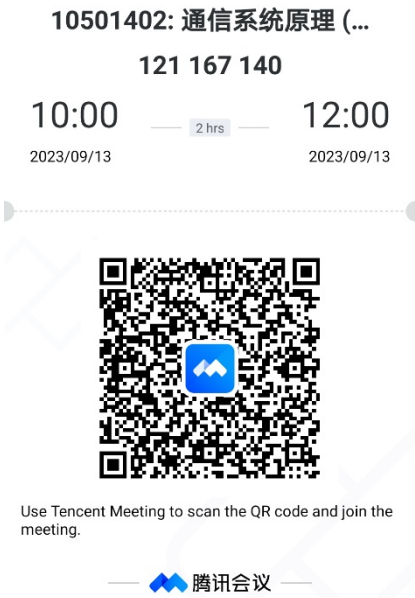
- Textbooks and reference books: they are available at the library of the university. If someone has some trouble to get a copy, let me know.
  - There may be Chinese versions of the main textbook and the reference books. It is fine for me that you use the Chinese textbooks if you wish, although I can only refer to the English book for my explanations or solving doubts
- Slides and other teaching documentation
  - They will be available before each session in the CANVAS system
- If you need any extra documentation, you can ask me anytime

Learning and Evaluation Methodology

Final Remarks

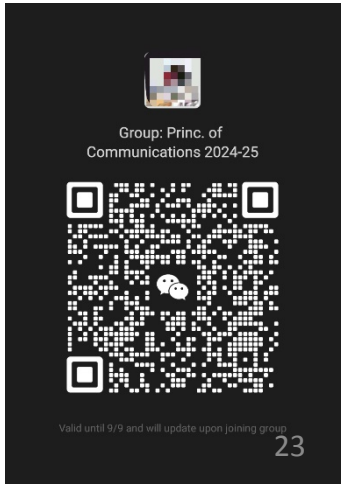
Organization of the Lecture

- Dual online/offline lectures
  - Every lecture will be taught offline and online simultaneously
    - Details for offline teaching: https://1.tongji.edu.cn
    - Details for the online teaching: https://courses.tongji.edu.cn
  - All the materials, including the recorded video of each session will be shared
    - Online access to resources (password “Communications”): https://tongjieducn-my.sharepoint.com/:f:/g/personal/j_rpineiro_tongji_edu_cn/EhuerOPmmCpFgJMogN0XhgkBVfu1sYCrr5hVIfVLzL1-UA?e=VXZkmt



General Announcements about the Course

- Official channel for announcements: WeChat group “Princ. Of Communications 2024-25”



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