Last update: 04-07-2019

230600 - DC - Digital Communications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Vazquez Grau, Gregori

Others: Riba Sagarra, Jaume
Vazquez Grau, Gregori

Prior skills

Students are required to certify that they have previously followed an introductory course on communications with a similar content as the undergraduate subject ‘ Introduction to Communications ’ (https://www.upc.edu/content/grau/guiadocent/pdf/ing/230018)
Basic concepts on signal and systems:
- Time domain and frequency domain analysis of deterministic and random signals and linear systems.
- Characterization of random signals (stochastic processes).
- Stationarity and Ergodicity.
- Real and complex Gaussian processes. Thermal noise.
- Power spectral density.
- Pass-band random signals. Base-band equivalent representation. In-phase and quadrature components.

Basic concepts on digital communications:
- Additive White Gaussian Noise (AWGN) channel.
- Matched filter and signal detection.
- Time and frequency domain Nyquist ’ s criterions.
- Band-limited pulse shaping. Nyquist ’ s pulses.
- Symbol and bit error probabilities in PAM modulations.
- Frequency selective channels and inter-symbol interferences.

Degree competences to which the subject contributes

Specific:

1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

Transversal:

2. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
3. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Last update: 04-07-2019

230600 - DC - Digital Communications

Teaching methodology

- Lectures
- Application classes
- Individual work (distance)
- Exercises
- Mid-Term Exam
- Final Exam

Learning objectives of the subject

Learning objectives of the subject:

The aim of this course is to provide the fundamental concepts on digital communication systems. The course must habilitate students coming from heterogeneous different disciplines for being able to follow advanced studies in this field. Fundamental concepts on signals and systems, probability, base-band and pass-band random processes will be reviewed. Pulse-Amplitude Modulation (PAM) will be the basic tool for introducing important concepts as optimal detection, matched filtering, pulse-shaping, symbol and bit error probabilities, power spectral density and inter-symbol interference. The course will be concluded with the theory needed to understand more sophisticated modulations based on the Signal Space concept, the MAP/ML optimal detection theory, diversity concept and Orthogonal Frequency Division Multiplexing (OFDM). Most important pass-band modulations (ASK, PSK, QAM) will be studied as case examples.

Learning results of the subject:

- To achieve a basic background on signals and systems, probability, random processes and digital communications concepts and theory.
- Ability to use and to understand a vectorial and matrix representation of signals and multidimensional modulations.
- Ability to use and to characterize the most important pass-band digital modulations.

Study load

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

Last update: 04-07-2019

230600 - DC - Digital Communications

Content

2. Frequency Flat-Fading Channels

Learning time: 57h

Theory classes: 15h
Self study : 42h

Description:
- Channel models. Bello ' s model.
- Delay-spread and coherence-bandwidth. Doppler-spread and coherence-time.
- Rayleigh and Rice fading channels.
- Diversity concept. Case study: repetition code and the Maximum Ratio Combiner (MRC).
- Spatial Diversity: SIMO, MISO, MIMO. Diversity gain vs array gain.
- Temporal diversity: Interleaving, time-codes and maximum product distance.
- Case study: Rotational codes.
- Space-Time coding: Alamouti ' s scheme.

1. Signal Space and Optimal Detection

Learning time: 45h

Theory classes: 15h
Self study : 30h

Description:
1. Transmission in AWGN channels
- Signal Space
- Optimal MAP receiver
- Union Bound.
- Basic modulations (ASK, PSK, FSK, QAM).

3. Frequency-Selective Channels: Orthogonal Frequency Division Multiplexing (OFDM)

Learning time: 23h

Theory classes: 9h
Self study : 14h

Description:
- Bello's channel model and the channel matrix.
- Block transmission and SVD solution.
- OFDMA: Orthogonal Frequency Division Multiple Access.

Last update: 04-07-2019

230600 - DC - Digital Communications

Planning of activities

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge.

EXTENDED ANSWER TEST (MID TERM EXAMINATION)

Description:
Mid term control.

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Description:
Final examination.

Qualification system

Final examination: 40 %
Mid-Term examination: 60 %
Final Grade: The final grade is the maximum between the Final Exam mark and the weighted former mark.

Bibliography

Basic:

Proakis, J.G.; Salehi, M. Digital communications. 5th ed. Boston: McGraw-Hill, 2008. ISBN 9780072957167.

Gallager, R.G. Principles of digital communication [on line]. Cambridge ; New York: Cambridge University Press, 2008 [Consultation: 23/07/2013]. Available on: <http://site.ebrary.com/lib/cbuc/docDetail.action?docID=10224535>. ISBN 0521879078.

Benedetto, S.; Biglieri, E. Principles of digital transmission: with wireless applications [on line]. New York: Kluwer Acad./Plenum PWB, 1999 [Consultation: 23/07/2013]. Available on: <http://link.springer.com/book/10.1007/b117711/page/1>. ISBN 0306457539.

Artés, A.; Pérez, F.; Cid, J.; López, R.; Mosquera, C.; Pérez, F. Comunicaciones digitales. Madrid: Pearson Educación/Prentice Hall, 2007. ISBN 9788483223482.