

230647 - ACWS - Advanced Communications for Wireless Systems

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 TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Compulsory) MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional) MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
ECTS credits:	5
Teaching languages:	English

Teaching staff

Coordinator:	Vazquez Grau, Gregori
Others:	Riba Sagarra, Jaume Vazquez Grau, Gregori

Requirements

Students are required to certify that they have previously followed courses on digital communications with similar technical contents than the master adaptation course ' Digital Communications' (http://infoteleco.upc.edu/documents/guia_docent/assignatures/all/ang/230600.pdf) or as for the undergraduate subjects ' Introduction to Communications' (<https://www.upc.edu/content/grau/guiadocent/pdf/ing/230018>) and ' Advanced Digital Communications' (http://infoteleco.upc.edu/documents/guia_docent/assignatures/all/ang/230051.pdf).

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.

Teaching methodology

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

Learning objectives of the subject

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The aim of this course is to present advanced concepts on digital communication systems. The course is divided in two

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main sections, that is, the point-to-point communication theory and the extension to multiuser scenarios. From a definition and a measure of information, the course develops the theory associated to the important concept of channel capacity. Impact of frequency-flat fading channels and frequency selective channels are analyzed. Performance degradations are mitigated through the use of transmission and reception diversity techniques. The extension of all the former concepts to a multiuser framework is done, providing a more rich and interesting context for current and future communication networks.

Learning results of the subject:

- To achieve a solid background on fundamental concepts of digital communications and information theory.
- Ability to understand the physical layers of modern advanced communication systems in point-to-point and multiuser networks.
- Ability to analyze, characterize and develop the physical layers of modern advanced communication systems in point-to-point and multiuser networks.

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%

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Content

<p>1. Introduction: A Definition of Information.</p>	<p>Learning time: 42h Theory classes: 12h Self study : 30h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Discrete memoryless sources and source entropy. - Discrete memoryless channels, mutual Information and channel capacity. - Continuous time-amplitude channels. The Gaussian channel. - Water-pouring and bit-loading approaches. 	
<p>2. Additive White Gaussian Channel (AWGN).</p>	<p>Learning time: 7h Theory classes: 3h Self study : 4h</p>
<p>Description:</p> <p>Signalling and optimal detection. Performance bounds and case studies.</p>	
<p>3. Frequency-Flat-Fading Channels: the wireless channel.</p>	<p>Learning time: 16h Theory classes: 6h Self study : 10h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Statistical Models. - Performance degradation and diversity schemes. - Use of the channel-state information. - Slow-fading: outage probability and outage capacity. - Fast-fading: ergodic capacity. 	
<p>4. Frequency-Selective Channels: the multipath channel.</p>	<p>Learning time: 20h Theory classes: 6h Self study : 14h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Bello's channel model and channel transfer matrix. - SVD and optimal communication schemes. - OFDMA: Orthogonal Frequency Division Multiple Access. - Hybrid SVD on OFDMA solutions. 	

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5. Multiple-Access Channel.	Learning time: 40h Theory classes: 12h Self study : 28h
Description: <ul style="list-style-type: none">- Ahiswede-Liao multiple-access capacity region.- Multiple-access schemes and capacity regions: TDMA, FDMA-OFDMA, CDMA.- Multiuser detection.- Uplink fading channel.- Downlink fading channel.- Multiuser diversity.	

Planning of activities

EXERCISES

EXTENDED ANSWER TEST (MID TERM EXAMINATION)

EXTENDED ANSWER TEST (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.

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Bibliography

Basic:

Viterbi, A.J.; Omura, J.K. Principles of digital communication and coding. New York: Dover, 2009. ISBN 9780486469010.

Tse, D.; Viswanath, P. Fundamentals of wireless communication. Cambridge: Cambridge University Press, 2005. ISBN 9780521845274.

Complementary:

Benedetto, S.; Biglieri, E. Principles of digital transmission: with wireless applications [on line]. New York: Kluwer Acad./Plenum PWB, 1999 [Consultation: 17/07/2013]. Available on:
<<http://link.springer.com/book/10.1007/b117711/page/1>>. ISBN 0306457539.

Goldsmith, A. Wireless communications. Cambridge ; New York: Cambridge University Press, 2005. ISBN 0521837162.

Gallager, R.G. Information theory and reliable communication. New York: John Wiley & Sons, 1968. ISBN 0471290483.

Cover, T.M.; Thomas, J.A. Elements of information theory. 2nd ed. New York: John Wiley & Sons, 2006. ISBN 0471241954.