

---

# Information Theory: Principles and Applications

## MAP-I Curricular Unit in Theory and Fundaments

---

### Summary

*This document describes a Ph.D. level course intended as a Curricular Unit in Theory and Fundaments for the MAP-I Doctoral Programme in Informatics. It is offered jointly by (i) Departamento de Ciência de Computadores, Universidade do Porto and (ii) Departamento de Electrónica, Telecomunicações e Informática, Universidade de Aveiro. The objective is to expose students to the principles and practice of information theory, covering various topics in data/information compression, transmission, storage and processing, as well as cutting edge applications in the analysis, design and optimization of wireless systems and networks, sensor networks and network information flow. It is the intention to accredit the Curricular Unit in the Doctoral Programme of Carnegie Mellon University (CMU).*

### Instructors

Miguel Rodrigues (Coordinator)	DCC, FCUP	mrodrigues@dcc.fc.up.pt
José Vieira	DETI, UA	vieira@ua.pt

### Course Objectives

The objective of the course is to expose students to the principles and practice of information theory, covering both theoretical and applied issues of recognized importance in data/information compression, transmission, storage and processing. The first part of the course covers the basic principles of information theory, including the basic theory and algorithms behind source and channel coding for single-user (point-to-point) and multi-user systems. The second part of the course covers advanced applications of information theory, including the analysis, design and optimization of wireless communications systems and networks, sensor networks, and network information flow.

This course covers material typical of various advanced modules at leading academic institutions in the field, namely:

- Information Theory, Thomas Cover, Stanford University
- Information Theory, Sergio Verdú, Princeton University
- Transmission of Information, Lizhong Zheng, MIT
- Information Theory, Michael Mecking, Technische Universität München
- Information Theory, Pierre Moulin, University of Illinois at Urbana-Champaign

## Learning Outcomes

- Familiarity with the principles and applications of information theory in data compression, transmission, storage and processing, as well as in the analysis, design and optimization tool for wireless systems and networks, sensor networks, network information flow.
- Exposure to cutting-edge research topics in information theory and its applications.
- Ability to extract information from scientific papers in the field, and acquisition of technical writing and presentation skills.

## Teaching Methods and Assessment

The course is composed by a series of lectures, discussions, and student assignments and presentations. In accordance with the philosophy of the course, the theoretical material will be complemented with specific application examples and case-studies. The student assessment is based on the following key components:

- 50% Final Exam
- 40% Assignments and Presentations
- 10% Class Participation

## Course Content

The course consists of two parts: (i) principles and (ii) applications.

- **Part I: Principles**
  1. **Information Measures:** entropy; relative entropy; mutual information; Jensen's inequality; Fano's inequality; data processing inequality.
  2. **Source Coding:** asymptotic equipartition property; source coding theorem – achievability and converse; source coding algorithms – Huffman coding, Shannon-Fano-Elias coding, arithmetic coding, Lempel-Ziv coding.
  3. **Channel Coding:** joint asymptotic equipartition property; channel coding theorem – achievability and converse; channel coding and decoding algorithms – block codes, convolutional codes, Viterbi decoding, sequential decoding, belief propagation; joint source channel coding theorem; channel capacity with and without feedback.

4. **Rate Distortion Theory:** rate distortion function; rate distortion theorem – achievability and converse; channel capacity and rate distortion function computation algorithms.
5. **Multuser Information Theory:** multiple-access channel; broadcast channel; relay channel; Slepian-Wolf coding; source coding with side information; rate distortion with side information.

• **Part II: Applications**

1. **Wireless Systems and Networks:** fading channels capacity – the ergodic, block, and quasi-static fading channels; space-time coding; space-time multiplexing; diversity-multiplexing tradeoff.
2. **Sensor Networks:** sensing capacity; compressed sensing; distributed source coding; distributed inference.
3. **Network Information Flow:** routing versus network coding; network code construction; randomized network coding; network coding protocols.
4. **Advanced Coding Applications:** Coding in the real and complex number field; random codes; digital fountains; explicit and implicit graph (rateless) codes; LT and Raptor codes; joint source-channel coding; efficient and reliable downloads from multiple sources, distributed storage, multimedia broadcast.

## Course Schedule

The course will be covered by Miguel Rodrigues (MR), José Vieira (JV), and invited lecturers (IL) with research contributions in selected topics.

Topic	I.1	I.2	I.3	I.4	I.5	II.1	II.2	II.3	II.4
No. of lectures	1	2	2	1	2	2	1	1	2
Instructor	MR	MR	MR	MR	MR	MR	IL	IL	JV

## Bibliography

- T. M. Cover and J. A. Thomas. Elements of Information Theory, 2nd Edition. John Wiley & Sons, New York, 2006.
- R. G. Gallager. Information Theory and Reliable Communication. John Wiley & Sons, New York, 1968.
- R. W. Yeung. A First Course in Information Theory. Springer, New York, 2002.
- D. J. C. MacKay. Information Theory, Inference and Learning Algorithms. Cambridge University Press, Cambridge, 2003.

## Instructor Team

The team of instructors is actively involved in research in the field of information theory, addressing both theoretical issues as well as cutting-edge applications of recognized importance, as evidenced by an extensive publication list with articles in various relevant IEEE Transactions and IEEE Conference Proceedings. A brief biography of the instructors is provided below:

**Miguel Rodrigues:** Miguel Rodrigues was born in Porto, Portugal on May 30, 1975. He received the Licenciatura degree in Electrical Engineering from the Faculty of Engineering of the University of Porto, Portugal in 1998 and the Ph.D. degree in Electronic and Electrical Engineering from University College London, U.K. in 2002.

From January 2003 to September 2006, he has held postdoctoral research appointments at Cambridge University, U.K., both as a Research Associate and later as a Senior Research Associate. From September 2006 to March 2007, he was a Visiting Researcher at Princeton University, U.S.A. He joined the faculty of the Department of Computer Science, Faculty of Sciences of the University of Porto as an Assistant Professor in March 2007. He is an Honorary Senior Researcher at University College London, U.K. He has also been a Visiting Researcher at Princeton University, U.S.A. in the summer of 2007.

His research interests include the general areas of information theory, communications theory, signal processing and optimization, and their applications to wireless and optical systems and networks. He has over 70 publications in international journals and conference proceedings in these areas. He has also been lecturing frequently abroad and has also served as a technical consultant to major international telecommunication companies.

Dr. Rodrigues has served on the technical programme committee of various international conferences. He has been the recipient of the the Prize Engenheiro António de Almeida, the Prize Engenheiro Cristiano Spratley, and the Merit Scholarship from the University of Porto, and the best student poster prize at the 2nd IMA Conference on Mathematics in Communications. He has also been the recipient of doctoral and postdoctoral fellowships from the Portuguese Foundation for Science and Technology, and a postdoctoral fellowship from Foundation Calouste Gulbenkian.

**José Vieira:** José Vieira was born in Aveiro, Portugal on September 4, 1963. He received the Licenciatura degree in Electrical Engineering from University of Coimbra, Portugal in 1988, the Master degree in Electrical Engineering from the same university in 1993 and the Ph.D. degree in Electrical Engineering from University of Aveiro, Portugal in 2000.

From 1989 to 1991, he was a research assistant at the University of Coimbra working on the development of a digital seismograph. In 1991 he joined the Electronics and Telecommunications Department at the University of Aveiro where he is an Assistant Professor.

His main research interest is the general area of digital signal processing with applications to audio and communications. The main topic of its Ph.D thesis was signal reconstruction and its relations with coding theory. He has been working on real number coding, compressed sensing and digital fountains. He is one of the founders of the Portuguese section of the Audio Engineering Society. He is also an active reviewer of several journals on the area of digital signal processing.

# MIGUEL RAUL DIAS RODRIGUES

## IDENTIFICAÇÃO PESSOAL

**Nome:** Miguel Raul Dias Rodrigues  
**Nacionalidade:** Portuguesa  
**Endereço:** Departamento de Ciência de Computadores  
Faculdade de Ciências, Universidade do Porto  
Rua Campo Alegre 1021/1055  
4169-007 Porto, Portugal  
**Email:** mrodrigues@dcc.fc.up.pt

## HABILITAÇÕES ACADÉMICAS

**1998-2002** **University College London** **Londres, Reino Unido**

***Doctor of Philosophy in Electronic and Electrical Engineering***

TESE: *Modelling and performance assessment of OFDM communication systems in the presence of non-linearities.*

ORIENTADORES: Prof. John O'Reilly e Prof. Izzat Darwazeh.

**1997-1998** **UMIST** **Manchester, Reino Unido**

***Master of Science in Communications Engineering (TOP STUDENT)***

TESE: *Digital modulation techniques compared in a time varying and dispersive channel.*

ORIENTADOR: Prof. Geoffrey Gott.

**1993-1998** **Faculdade de Engenharia da Universidade do Porto** **Porto, Portugal**

**Licenciatura em Engenharia Electrotécnica e de Computadores (TOP STUDENT)**

## PRÉMIOS

- **Prémio de Melhor Poster (2002)**

Prémio atribuído ao poster *Volterra series assessment of non-linearly distorted OFDM signals: Error probability evaluation* (M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly) apresentado na *2nd IMA International Conference on Mathematics in Communications* realizada em Lancaster no Reino Unido em Dezembro de 2002.

- **Prémio Engenheiro Cristiano Spratley (1999)**

Atribuído pela Faculdade de Engenharia da Universidade do Porto aos estudantes da Licenciatura de Engenharia Electrotécnica e de Computadores da mesma Faculdade com a classificação mais elevada.

- **Prémio Engenheiro António de Almeida (1999)**

Atribuído pela Fundação Engenheiro António de Almeida aos estudantes da Licenciatura de Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto com a classificação mais elevada.

- **Bolsa de Mérito (1996-1997)**

Atribuída pela Universidade do Porto aos estudantes da Faculdade de Engenharia da Universidade do Porto com as classificações mais elevadas.

## EXPERIÊNCIA PROFISSIONAL

**Mar. 2007 - presente**      **Faculdade Ciências Universidade do Porto**      **Porto, Portugal**

**Prof. Auxiliar Convidado**, Departamento de Ciências de Computadores

**Mar. 2007 - presente**      **Instituto de Telecomunicações**      **Porto, Portugal**

**Coordenador**, Networks and Information Processing Group, Jan. 2008 - presente

**Investigador**, Networks and Information Processing Group, Mar. 2007-Dec. 2007

**Jul. 2007 - Set. 2007**      **Universidade de Princeton**      **Princeton, NJ, EUA**

**Visiting Researcher**, Department of Electrical Engineering

**Set. 2006 - Fev. 2007**      **Universidade de Princeton**      **Princeton, NJ, EUA**

**Visiting Researcher**, Department of Electrical Engineering

**Jan. 2003 - Set. 2006**      **Universidade de Cambridge**      **Cambridge, Reino Unido**

**Senior Research Associate**, Computer Laboratory, Jan. 2006-Set.2006

**Research Associate**, Department of Engineering, Jan. 2004-Dez. 2005

**Visiting Researcher**, Department of Engineering, Jan. 2003-Dez. 2003

**Nov. 2004 - Set. 2006**      **Corpus Christi College**      **Cambridge, Reino Unido**

**Research Associate**

**Mai 2003-presente**      **University College London**      **Londres, Reino Unido**

**Honorary Senior Research Fellow**, Dept. E&EE, Maio 2005-presente

**Honorary Research Fellow**, Dept. E&EE, Maio 2003-Maio 2005

## EXPERIÊNCIA DE ENSINO

**2007-presente**      **Universidade do Porto**      **Porto, Portugal**

Coordenador da disciplina de Digital Communications do Programa Doutoral em Telecomunicações Minho-Aveiro-Porto, 1º semestre 2007-2008.

Regente da cadeira de *Teoria da Informação* do Mestrado Integrado de Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 1º semestre 2007-2008.

Regente da cadeira de *Comunicações Móveis* do Mestrado Integrado de Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 1º semestre 2007-2008.

Regente da cadeira de *Tópicos Avançados de Redes* do Mestrado Integrado de Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 2º semestre 2007-2008.

Regente da cadeira de *Tópicos Avançados de Redes* do Mestrado Integrado de Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 2º semestre 2006-2007.

Aulas práticas de *Paradigmas da Programação* da Licenciatura em Ciência de Computadores/Licenciatura em Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 2º semestre 2007-2008.

Aulas práticas de *Programação Estruturada* da Licenciatura em Ciência de Computadores/Licenciatura em Engenharia de Redes e de Sistemas, Departamento de Ciência de Computadores, 2º semestre 2006-2007.

**Miguel Raul Dias Rodrigues**

**Abril 2008**

**2003-2006**

**Universidade de Cambridge**

**Cambridge, Reino Unido**

Aulas teórico-práticas de *Complexity Theory* ao 2º ano do *BA in Computer Science, Computer Laboratory*, 3º trimestre 2005-2006.

Aulas teórico-práticas de *Bioinformatics* ao 3º ano do *BA in Computer Science, Computer Laboratory*, 2º trimestre 2005-2006.

Aulas teórico-práticas de *Information Theory and Coding* ao 3º ano do *BA in Computer Science, Computer Laboratory*, 1º trimestre 2005-2006.

Aulas teórico-práticas de *Mathematical Methods* ao 1º ano do *BEng/MEng in Engineering, Department of Engineering*, 3º trimestre 2004-2005.

Aulas teórico-práticas de *Systems and Control* ao 3º ano do *BEng/MEng in Engineering, Department of Engineering*, 2º trimestre 2003-2004.

Aulas teórico-práticas de *Signals and Systems* ao 3º ano do *BEng/MEng in Engineering, Department of Engineering*, 1º trimestre 2003-2004.

Aulas teórico-práticas de *Data Transmission* ao 3º ano do *BEng/MEng in Engineering, Department of Engineering*, 1º trimestre 2003-2004.

**1999-2006**

**University College London**

**Londres, Reino Unido**

Aulas teóricas no *Mobile and Personal Communications Module* do *MSc in Telecommunications, Department of Electronic and Electrical Engineering*, 2002-2006.

Aulas teóricas no *Communications Systems Modelling Module* do *MSc in Telecommunications, Department of Electronic and Electrical Engineering*, 2002-2006.

Aulas laboratoriais no *Communications Systems Modelling Laboratory* do *MSc in Telecommunications, Department of Electronic and Electrical Engineering*, 2001-2002.

Aulas laboratoriais no *Technologies for Broadband Communications Laboratory* do *MSc in Broadband Communications, Department of Electronic and Electrical Engineering*, 2001-2002.

Aulas laboratoriais no *Microwave and Opto-Electronics Laboratory* do *MSc in Microwave and Opto-Electronics, Department of Electronic and Electrical Engineering*, 1999-2001.

## **EXPERIÊNCIA DE CONSULTORIA**

**Jan.-Mar. 2004**

**Enertel**

**Roterdão, Holanda**

Consultor para um dos principais operadores de telecomunicações holandeses, sendo responsável por aconselhar e formar uma equipa de engenheiros sobre os vários aspectos tecnológicos de redes de acesso sem-fios de banda larga. A Enertel implementou desde então uma rede de acesso sem-fios de banda larga com bastante sucesso.

## **INTERESSES DE INVESTIGAÇÃO**

Teoria da informação, teoria da comunicação, processamento de sinal e optimização. Redes e sistemas de comunicações móveis e comunicações ópticas.

## **BOLSAS DE INVESTIGAÇÃO**

- Bolsa de pós-doutoramento atribuída pela Fundação Calouste Gulbenkian para a realização de um pós-doutoramento na Universidade de Princeton (Set. 2003-Fev. 2003).
- Bolsa de pós-doutoramento atribuída pela Fundação para a Ciência e a Tecnologia para a realização de um pós-doutoramento na Universidade de Cambridge (Jan. 2003-Dec. 2003).
- Bolsa de doutoramento atribuída pela Fundação para a Ciência e a Tecnologia para a realização de um doutoramento no University College London (Oct. 1998-Oct. 2002).

**Miguel Raul Dias Rodrigues**

**Abril 2008**

## PROJECTOS DE INVESTIGAÇÃO

- *Foundations of Future Wireless Communications Systems: Analysis, Design and Optimization*. Projecto financiado pela Fundação Luso-Americana entre Jan. 2008–Dez. 2010. Investigador Principal.
- *Wireless information-theoretic security*. Projecto financiado pela Fundação para a Ciência e a Tecnologia entre Jan. 2008–Dez. 2010. Membro da equipa de investigação.
- *Design and optimisation of WDM millimetre-wave fibre-radio systems*. Projecto financiado pela Fundação para a Ciência e a Tecnologia entre Out. 2007–Set. 2009. Membro da equipa de investigação.
- *Bandwidth efficient multi-carrier systems for wireless communications*. Projecto financiado pelo *Engineering and Physical Sciences Research Council* (EPSRC) entre Out. 2006–Set. 2009. Membro da equipa de investigação.
- *Broadband fixed wireless access: capacity and throughput improvement techniques*. Projecto financiado pelo *Engineering and Physical Sciences Research Council* (EPSRC) entre Jan. 2004–Dez. 2006. Membro da equipa de investigação.

## ORIENTAÇÕES DE DOUTORAMENTO

- Ioannis Kanaras, aluno de doutoramento do Department of Electronic and Electrical Engineering, University College London. Co-orientação com o Prof. Izzat Darwazeh. Projecto: 'Bandwidth efficient multi-carrier systems for wireless communications'. Out. 2006-presente.
- João Manuel Barbosa de Oliveira, aluno de doutoramento do Departamento de Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade de Porto, Portugal. Co-orientação com o Prof. Henrique Salgado. Projecto: 'Fibre Bragg gratings analysis, design and optimisation for WDM millimetre-wave fibre-radio systems'. Jan. 2006-presente.
- William Carson, aluno de doutoramento do *Computer Laboratory* da Universidade de Cambridge, Reino Unido. Co-orientação com o Prof. Ian Wassell. Projecto: 'Iterative detection techniques for wireless communications'. Jan. 2006-presente.
- Jaime Adeane, aluna de doutoramento do *Department of Engineering* da Universidade de Cambridge, Reino Unido. Co-orientação com o Prof. Ian Wassell. Tese: 'Spatial diversity in wireless communications: Multiple antenna systems and virtual antenna arrays'. Grau de doutoramento conferido em 2007.
- Ioannis Chatzigeorgiou, aluno de doutoramento do *Department of Engineering* da Universidade de Cambridge. Co-orientação com o Prof. Ian Wassell. Tese: 'Performance analysis and design of punctured turbo codes'. Grau de doutoramento conferido em 2007.

## ORIENTAÇÕES DE MESTRADO

- Hugo Reboredo, aluno de mestrado do Departamento de Engenharia Electrotécnica da Faculdade de Engenharia da Universidade do Porto, Portugal. Co-orientação com o Prof. Henrique Salgado. Projecto: 'Turbo processing techniques for optimal communications systems'. Set. 2007-presente.

## BOLSEIROS

- Pedro Almeida, aluno de mestrado do Departamento de Matemática Pura da Faculdade de Ciências da Universidade do Porto. Projecto: 'Wireless information-theoretic security'.

## ACTIVIDADES PROFISSIONAIS

- *Publications Chair*, 2008 IEEE Information Theory Workshop, Porto, Portugal
- *Technical Programme Committee Member*, 2008 IEEE International Conference on Broadband Communications, Networks and Systems, London, U.K.
- *Technical Programme Committee Member*, 2008 IEEE Vehicular Technology Conference-Spring, Singapore
- *Technical Programme Committee Member*, 2008 IET Conference Wireless, Mobile, Multimedia Networks, Mumbai, India
- *Technical Programme Committee Member*, 2005 European Conference on Networks & Optical Communications, London, U.K.
- Revisor de várias revistas internacionais (*IEEE Transactions on Signal Processing*, *IEEE Transactions on Communications*, *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Vehicular Technology*, *IEEE Transactions on Circuits and Systems I*, *IEEE Communications Letters*, *European Transactions on Telecommunications*, *IEE Proceedings-Communications*, *Electronics Letters*) e várias conferências internacionais (e.g., *IEEE International Symposium on Information Theory*, *IEEE International Conference on Communications*, *IEEE Global Telecommunications Conference*).
- *Comissão Científica* do Programa Doutoral em Ciência de Computadores, do Departamento de Ciência de Computadores da Faculdade de Ciências da Universidade do Porto.
- *Comissão Executiva* do MAP-I Programa Doutoral em Informática das Universidades do Minho, Aveiro e Porto.

## PUBLICAÇÕES

### Teses

1. M. R. D. Rodrigues. *Modelling and performance assessment of OFDM communication systems in the presence of non-linearities*. PhD Thesis, University College London, London, U.K., October 2002.
2. M. R. D. Rodrigues. *Digital modulation techniques compared in a time varying and dispersive channel*. MSc Thesis, UMIST, Manchester, U.K., September 1998.

### Capítulos em livros

3. P. Xiao, I. Chatzigeorgiou, M. R. D. Rodrigues, R. Carrasco and I. J. Wassell. *Design Considerations and Algorithms for Broadband Fixed WiMAX Systems*. NOVA Publishers.

### Artigos em revista científicas (publicados, submetidos e em preparação)

4. F. Pérez-Cruz, M. R. D. Rodrigues and S. Verdú. *Optimal precoding for multiple-input multiple-output Gaussian channels with discrete input distributions*. IEEE Transactions on Information Theory, in preparation.
5. M. R. D. Rodrigues and P. D. M. Almeida. *Filter design with secrecy constraints: The degraded parallel Gaussian wiretap channel*. IEEE Transactions on Information Theory, submitted.
6. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *Analysis and design of punctured rate-1/2 turbo codes exhibiting low error floors*. IEEE Transactions on Information Theory, submitted.
7. I. A. Chatzigeorgiou, A. Demosthenous, M. R. D. Rodrigues and I. J. Wassell. *On the performance-complexity tradeoff of convolutional codes for broadband FWA systems*. IEEE Transactions on Broadcasting, submitted.

8. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *The augmented state diagram and its applications to convolutional and turbo codes*. IEEE Transactions on Communications, first round of reviews.
9. M. Bloch, J. Barros, M. R. D. Rodrigues and S. W. McLaughlin. *Wireless information-theoretic security*. IEEE Transactions on Information Theory - Special Issue on Information-Theoretic Security, accepted.
10. M. R. D. Rodrigues, I. A. Chatzigeorgiou, I. J. Wassell and R. A. Carrasco. *Performance analysis of turbo codes in quasi-static fading channels*. IEE Proceedings-Communications, accepted.
11. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *A comparison of convolutional and turbo coding schemes for broadband FWA systems*. IEEE Transactions on Broadcasting, vol. 53, pp. 494-503, June 2007.
12. J. A. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Lattice reduction based detection techniques for MIMO-OFDM-CDM communication systems*. IEE Proceedings-Communications, vol. 56, pp. 526-531, June 2007.
13. J. A. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Centralised and Distributed Power Allocation for Cooperative Networks*. Electronics Letters, vol. 43, pp. 39-40, January 2007.
14. M. R. D. Rodrigues and I. J. Wassell. *IMD reduction with SLM and PTS to improve the error probability performance of non-linearly distorted OFDM signals*. IEEE Transactions on Vehicular Technology, vol. 55, pp. 537-548, March 2006.
15. M. R. D. Rodrigues and I. J. Wassell. *IMD reduction coding to improve the error probability performance of non-linearly distorted OFDM signals*. IEE Proceedings-Communications, vol. 152, pp. 559-566, October 2005.
16. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Volterra-series-based analytic technique to assess the power density spectrum of nonlinearly distorted OFDM signals*. IEE Proceedings-Communications, vol. 151, pp. 401-407, August 2004.
17. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Error probability behaviour of nonlinearly distorted OFDM signals*. IEE Electronics Letters, vol. 39, pp. 1620-1622, October 2003.

### **Artigos em actas de encontros científicos**

18. F. Pérez-Cruz, M. R. D. Rodrigues and S. Verdú. *Optimal precoding for digital subscriber lines*. Proceedings of the IEEE International Conference on Communications, Beijing, China, May 2008.
19. M. R. D. Rodrigues, F. Pérez-Cruz and S. Verdú. *Multiple-input multiple-output Gaussian channels: Optimal covariance for non-Gaussian inputs*. Proceedings of the IEEE Information Theory Workshop, Porto, Portugal, May 2008.
20. W. R. Carson, I. J. Wassell and M. R. D. Rodrigues. *Modelling the frame error rate for iterative demapping and decoding techniques over quasi-static fading channels*. Proceedings of the IEEE Sarnoff Symposium, Princeton, N.J., U.S.A., April 2008.
21. F. Pérez-Cruz, M. R. D. Rodrigues and S. Verdú. *Generalized mercury/waterfilling for multiple-input multiple-output channels*. Proceedings of the 45th Allerton Conference on Communication, Control, and Computing, Monticello, Illinois, U.S.A., September 2007.
22. J. M. B. Oliveira, M. R. D. Rodrigues and H. M. Salgado. *Optimum receivers for non-linear distortion compensation of OFDM signals in fiber supported wireless applications*. Proceedings of the 2007 IEEE International Topical Meeting on Microwave Photonics, Victoria, B.C., Canada, October 2007.
23. W. R. Carson, I. A. Chatzigeorgiou, I. J. Wassell, M. R. D. Rodrigues and R. A. Carrasco. *On the performance of iterative demapping and decoding over quasi-static fading channels*. Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Athens, Greece, September 2007.
24. J. M. B. Oliveira, M. R. D. Rodrigues and H. M. Salgado. *Non-linear distortion compensation of OFDM signals in radio-over-fiber systems*. Proceedings of the V Symposium on Enabling Optical Networks and Sensors, Aveiro, Portugal, June 2007.
25. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *Pseudo-random Puncturing: A Technique to Lower the Error Floor of Turbo Codes*. Proceedings of the IEEE International Symposium on Information Theory, Nice, France, June 2007.

26. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *A Union Bound Approximation for Rapid Performance Evaluation of Punctured Turbo Codes*. Proceedings of the 41st Annual Conference on Information Sciences and Systems, Baltimore, Maryland, U.S.A., March 2007.
27. M. Bloch, J. Barros, M. R. D. Rodrigues and S. W. McLaughlin. *Good codes are good for security: information theoretic security for Gaussian and wireless channels*. Proceedings of the Information Theory and Applications Workshop, San Diego, California, U.S.A., January-February 2007.
28. M. Bloch, J. Barros, M. R. D. Rodrigues and S. W. McLaughlin. *LDPC-based secure wireless communication with imperfect knowledge of the eavesdropper's channel*. Proceedings of the IEEE Information Theory Workshop, Chengdu, China, October 2006.
29. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *Can punctured rate-1/2 turbo codes achieve a lower error floor than their rate-1/3 parent codes?* Proceedings of the IEEE Information Theory Workshop, Chengdu, China, October 2006.
30. M. Bloch, J. Barros, M. R. D. Rodrigues and S. W. McLaughlin. *An opportunistic physical-layer approach to secure wireless communications*. Proceedings of the 44th Allerton Conference on Communication, Control, and Computing, Monticello, Illinois, U.S.A., September 2006.
31. J. M. B. Oliveira, H. M. Salgado and M. R. D. Rodrigues. *Large signal analysis of Mach-Zehnder modulator intensity response in a linear dispersive fiber*. Proceedings of the London Communications Symposium 2006, London, U.K., September 2006.
32. M. R. D. Rodrigues and I. Darwazeh. *A spectrally efficient frequency division multiplexing based communications system*. Proceedings of the International Symposium on Broadband Communications, Moscow/St. Petersburg, September 2006.
33. J. Barros and M. R. D. Rodrigues. *Secrecy capacity of wireless channels*. Proceedings of the IEEE International Symposium on Information Theory, Seattle, Washington, U.S.A., July 2006.
34. João Oliveira, H. M. Salgado and M. R. D. Rodrigues. *Large signal analysis of Mach-Zehnder modulator intensity response in a dispersive fiber*. Proceedings of the IV Symposium on Enabling Optical Networks and Sensors, Porto, Portugal, June 2006.
35. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *A novel technique to evaluate the transfer function of punctured turbo codes*. Proceedings of the IEEE International Conference on Communications, Istanbul, Turkey, June 2006.
36. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *A novel technique for the evaluation of the transfer function of parallel concatenated convolutional codes*. Proceedings of the 4th International Symposium on Turbo Codes, Munich, Germany, April 2006.
37. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *Punctured binary turbo-codes with optimized performance*. Proceedings of the IEEE Vehicular Technology Conference-Fall, Dallas, Texas, U.S.A., vol. 3, pp. 1965-1969, September 2005.
38. M. R. D. Rodrigues, I. A. Chatzigeorgiou, I. J. Wassell and R. A. Carrasco. *On the performance of turbo codes in quasi-static fading channels*. Proceedings of the IEEE International Symposium on Information Theory, Adelaide, Australia, pp. 622-626, September 2005.
39. M. R. D. Rodrigues, J. A. Adeane and I. J. Wassell. *Cooperative networks for wireless access: Centralized and distributed power allocation algorithms*. Proceedings of the 10th European Conference on Networks & Optical Communications, London, U.K., pp. 320-327, July 2005. **(invited paper)**
40. J. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Optimum power allocation in cooperative networks*. Proceedings of the IEEE Workshop on Signal Processing Advances in Wireless Communications, New York City, New York, U.S.A., pp. 333-337, June 2005.
41. J. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Optimum power allocation in cooperative networks – Performance bounds*. Proceedings of the International Conference on Telecommunications, Cape Town, South Africa, May 2005.
42. J. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Characterisation of the performance of cooperative networks in Ricean fading channels*. Proceedings of the International Conference on Telecommunications, Cape Town, South Africa, May 2005.
43. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *A comparison of convolutional and turbo coding schemes for broadband FWA systems*. Proceedings of the International Conference on Telecommunications, Cape Town, South Africa, May 2005.

44. J. Adeane, M. R. D. Rodrigues and I. J. Wassell. *Optimum power allocation in cooperative networks*. Proceedings of the Postgraduate Research Conference in Electronics, Photonics, Communications and Networks, and Computing Science, Lancaster, U.K., pp. 23-24, March-April 2005.
45. I. A. Chatzigeorgiou, M. R. D. Rodrigues, I. J. Wassell and R. A. Carrasco. *Turbo coded OFDM/SC-FDE techniques for MIMO BFWA Channels*. Proceedings of the International Symposium on Broadband Communications, Harrogate, U.K., p. 35, December 2004.
46. J. Adeane, M. R. D. Rodrigues, I. Berenguer and I. J. Wassell. *Improved detection methods for MIMO-OFDM-CDM in fading channels*. Proceedings of the IEEE Vehicular Technology Conference-Fall, Los Angeles, California, U.S.A., vol. 3, pp. 1604-1608, September 2004.
47. M. R. D. Rodrigues and I. J. Wassell. *SLM and PTS based on an IMD reduction strategy to improve the error probability performance of non-linearly distorted OFDM signals*. Proceedings of the IEEE International Conference on Communications, Paris, France, vol. 2, pp. 857-861, June 2004.
48. M. R. D. Rodrigues and I. J. Wassell. *Optimum receivers for non-linearly distorted OFDM signals*. Proceedings of the IEEE Vehicular Technology Conference-Spring, Milan, Italy, vol. 2, pp. 1223-1227, May 2004.
49. M. R. D. Rodrigues and I. J. Wassell. *A novel coding strategy to improve the error probability performance of non-linearly distorted OFDM signals*. Proceedings of the IEEE Vehicular Technology Conference-Fall, Orlando, Florida, U.S.A., vol. 1, pp.294-298, October 2003.
50. M. R. D. Rodrigues and I. Darwazeh. *A spectrally efficient frequency division multiplexing based communications system*. Proceedings of the 8th International OFDM-Workshop, Hamburg, Germany, pp. 70-74, September 2003.
51. D. Karampatsis, M. R. D. Rodrigues and I. Darwazeh. *Performance comparison of OFDM and FOFDM communication systems: Effects of frequency selective fading, frequency and timing offsets and I/Q QAM modulator/demodulator imbalance*. Proceedings of the 7th World Multiconference on Systemics, Cybernetics and Informatics, Orlando, Florida, U.S.A., vol. 11, pp. 396-400, July 2003. **(invited paper)**
52. M. R. D. Rodrigues, J. E. Mitchell, I. Darwazeh and J. J. O'Reilly. *Error probability evaluation with a limited number of moments*. Proceedings of the IEEE International Symposium on Information Theory, Yokohama, Japan, p. 9, June-July 2003.
53. M. R. D. Rodrigues, J. E. Mitchell and I. Darwazeh. *On the error probability performance of non-linearly distorted OFDM signals*. Proceedings of the IEEE Vehicular Technology Conference-Spring, Jeju, Korea, vol. 2, pp. 1278-1282, April 2003.
54. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Volterra series assessment of non-linearly distorted OFDM signals: Error probability evaluation*. Proceedings of the 2nd IMA Conference on Mathematics in Communications, Lancaster, U.K., December 2002.
55. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Volterra series assessment of non-linearly distorted OFDM signals: Power density spectrum evaluation*. Proceedings of the 2nd IMA Conference on Mathematics in Communications, Lancaster, U.K., December 2002.
56. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Assessment of the impact of optical non-linearities on the performance of OFDM signals in optical fibre supported wireless networks*. Proceedings of the International Symposium on Information Theory and its Applications, Xi'an, China, vol. 1, pp. 375-378, October 2002.
57. N. Hathi, M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Analysis of the influence of Walsh-Hadamard code allocation strategies on the performance of multi-carrier CDMA systems in the presence of HPA non-linearities*. Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Lisbon, Portugal, vol. 3, pp. 1305-1309, September 2002.
58. D. Karampatsis, M. R. D. Rodrigues and I. Darwazeh. *Implications of linear phase dispersion on OFDM and Fast-OFDM systems*. Proceedings of the London Communications Symposium 2002, London, U.K., pp. 117-120, September 2002.
59. M. R. D. Rodrigues and I. Darwazeh. *On the behaviour of non-linearly distorted OFDM signals*. Proceedings of the London Communications Symposium 2002, London, U.K., pp. 113-116, September 2002.
60. M. R. D. Rodrigues and J. J. O'Reilly. *Statistical characterisation of the response of a Volterra non-linearity to a cyclo-stationary zero-mean Gaussian stochastic process*. Proceedings of the IEEE

International Symposium on Information Theory, Lausanne, Switzerland, p. 8, June-July 2002.

61. M. R. D. Rodrigues and I. Darwazeh. *Fast OFDM: A proposal for doubling the data rate of OFDM schemes*. Proceedings of the International Conference on Telecommunications, Beijing, China, vol. 3, pp. 484-487, June 2002. **(invited paper)**
62. N. Hathi, M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *Performance assessment of MC-CDMA and MC-DS-CDMA in the presence of high power amplifier non-linearities*. Proceedings of the IEEE Vehicular Technology Conference-Spring, Birmingham, Alabama, U.S.A., vol. 3, pp. 1467-1471, May 2002.
63. M. R. D. Rodrigues, I. Darwazeh and J. J. O'Reilly. *On the distribution of the intermodulation distortion and the error probability of non-linearly distorted OFDM signals*. Proceedings of the 36th Annual Conference on Information Sciences and Systems, Princeton, New Jersey, U.S.A., pp. 636-641, March 2002.
64. M. R. D. Rodrigues and J. J. O'Reilly. *On the distribution of the intermodulation distortion in OFDM communication systems*. Proceedings of the London Communications Symposium 2001, London, U.K., pp. 87-90, September 2001.
65. M. R. D. Rodrigues and J. J. O'Reilly. *An analytic technique to assess the impact of non-linearities on the error probability of OFDM signals in RoF based wireless networks*. Proceedings of the IEEE International Symposium on Information Theory, Washington, D.C., U.S.A., p. 316, June 2001.
66. M. R. D. Rodrigues and J. J. O'Reilly. *An analytic technique to assess the impact of frequency dependent non-linearities on the error probability of OFDM/M-PSK and OFDM/M-QAM signals*. Proceedings of the 35th Annual Conference on Information Sciences and Systems, Baltimore, Maryland, U.S.A., vol. 2, pp. 748-752, March 2001.
67. M. R. D. Rodrigues and J. J. O'Reilly. *An analytic technique to determine the impact of non-linearities on the PDS of OFDM signals in RoF based wireless networks*. Proceedings of the International Symposium on Information Theory and its Applications, Honolulu, Hawaii, U.S.A., vol. 2, pp. 769-773, November 2000.
68. M. R. D. Rodrigues and J. J. O'Reilly. *Error probability assessment of radio over fibre based wireless networks employing OFDM signalling*. Proceedings of the London Communications Symposium 2000, London, U.K., pp. 95-99, September 2000.
69. M. R. D. Rodrigues and J. J. O'Reilly. *Assessment of the performance of radio over fibre based wireless networks employing OFDM signalling*. Proceedings of the London Communications Symposium 1999, London, U.K., pp. 47-50, July 1999.

## APRESENTAÇÕES

1. *Optimum power allocation for MIMO systems with discrete input distributions: An information theoretic-estimation theoretic approach*. Carnegie Mellon University, Pittsburgh, Pennsylvania, U.S.A., March 2008. Host: José Moura.
2. *Optimum resource allocation in MIMO systems: An information theoretic-estimation theoretic approach*. Department of Electronic and Electrical Engineering, University College London, London, U.K., November 2007, Host: Izzat Darwazeh.
3. *Optimum resource allocation in MIMO systems: An information theoretic-estimation theoretic approach*. Computer Laboratory, University of Cambridge, Cambridge, U.K., November 2007, Host: Ioannis Chatzigeorgiou.
4. *Optimum resource allocation in MIMO systems: An information theoretic-estimation theoretic approach*. Departamento de Engenharia Electrotécnica e de Computadores, Instituto Superior Técnico, Lisboa, Portugal, November 2007. Host: João Luís Sobrinho.
5. *Optimum power allocation for MIMO systems with discrete input distributions: An information theoretic-estimation theoretic approach*. Bell Laboratories, Murray Hill, New Jersey, U.S.A., September 2007. Host: Emina Soljanin.
6. *Resource optimization in communications systems: An information theoretic-estimation theoretic approach*. Departamento de Matemática Aplicada, Faculdade de Ciências da Universidade do Porto, Porto, Portugal, May 2007. Host: Maria Eduarda Silva.

7. *Wireless communications revolution: From reliability to security. Departamento de Engenharia Electrotécnica e de Computadores, Faculdade de Engenharia da Universidade do Porto, Porto, Portugal, June 2006. Host: Henrique Salgado.*
8. *Cooperative networks for wireless communications. Departamento de Sistemas de Informação, Universidade do Minho, Guimarães, Portugal, June 2006. Host: Luís Amaral.*
9. *Cooperative networks for wireless communications. Departamento de Electrónica e Telecomunicações, Universidade de Aveiro, Aveiro, Portugal, June 2006. Host: José Vieira.*
10. *Reliability and security in wireless networks: A computer science perspective. Departamento de Ciência de Computadores, Faculdade de Ciências da Universidade do Porto, Porto, Portugal, June 2006. Host: João Barros.*
11. *Information-theoretic security in wireless networks: From theory to practice. Cavendish Laboratory, University of Cambridge, Cambridge, U.K., June 2006. Host: David MacKay.*
12. *Turbo techniques for fixed wireless access communications systems. AT&T Research, Middletown, New Jersey, U.S.A., July 2006. Host: Paul Henry.*
13. *Cooperative networks for wireless communications. Departamento de Ciência de Computadores, Faculdade de Ciências da Universidade do Porto, Porto, Portugal, November 2005. Host: João Barros.*
14. *Turbo techniques for fixed wireless access communications systems. Institute for Infocomm Research, Singapore, September 2005. Host: Lu Chao.*
15. *Volterra series based analytic techniques to assess the performance of non-linearly distorted OFDM signals. INESC, Porto, Portugal, March 2003. Host: Henrique Salgado.*

## **SEMINÁRIOS**

1. *Resource Optimization in Communications Systems: An information theoretic-estimation theoretic approach, Seminário do Programa Doutoral em Telecomunicações MAP, Aveiro, Portugal, Fevereiro 2008.*
2. *Secrecy rate of wiretap channels with arbitrary inputs, 3º Seminário da Rede Temática em Segurança da Informação, Porto, Portugal, Dezembro 2008.*

# Curriculum Vitae

Name: José Manuel Neto Vieira  
Date of Birth: 4/9/1963  
Citizenship: Portuguese  
Place of Birth: Aveiro  
Address: Departamento de Electrónica, Telecomunicações e Informática /  
IEETA  
Universidade de Aveiro  
3810-193 Aveiro  
Email: [jnieira@ua.pt](mailto:jnieira@ua.pt)  
www: <http://www.ieeta.pt/~vieira>  
Tel. +351 234 370 500  
Fax: +351 234 370 545

## Scholastic Training:

- 1988 University of Coimbra, Licenciatura in Electrical Engineering.
- 1993 University of Coimbra, M. Sc. in Systems and Automation.
- 2000 University of Aveiro, Ph.D. in Electrical Engineering.

## Professional Experience

- 1988-1989 Lecture, University of Beira Interior.
- 1989-1991 Research Assistant, Dep. of Electronics of Univ. de Coimbra.
- 1991- 1992 Lecture, Dep. of Electronics, Univ. de Aveiro.
- Since 1993 Assistant professor, Dep. of Electronics, Univ de Aveiro.
- Since 2000 Auxiliar Professor , Dep. of Electronics, Univ de Aveiro.

**Specialisation Fields:** Instrumentation Electronics, Digital Signal Processing, Random coding.

## Fields of Interest

Digital Signal Processing, Digital Audio, Random coding

## AES activities

Since 2004 he is the president of the AES Portuguese section.

Promotion and organization of one meeting per year of the AES Portuguese section since 2001.

### **Languages**

English and French.

### **Publications:**

- Ferreira, Paulo J. S. G., and Vieira, José M. N., "Stable DFT Codes and Frames", IEEE Signal Processing Letters, Vol.10, N.2, pp.50-53, February, 2003
- Ferreira, Paulo J. S. G., and Vieira, José M. N., "Designing Fast Interpolation and Extrapolation Algorithms", ICASSP 2000, pp.169-170, IEEE, Istanbul, Turkey, June, 2000
- Santos, José, Reis, João, and Vieira, José, "Goodears - A Small Robot with Ears", TI DSP Challenge, 2001
- Vieira, José M. N., Almeida, Luís, Santos, Paulo, and Reis, João, "Goodears - Robot Orientado por Farol Acústico", 7as Jornadas Hispano-Lusas de Ingeniería Eléctrica, Madrid, Espanha, July, 2001
- Vieira, José and Tomé, Ana, and Rodrigues, João, "Providing an Environment to Teach DSP Algorithms", 10th Digital Signal Processing Workshop, IEEE, Callaway Gardens, Pine Mountain, Georgia, USA, October, 2002
- Vieira, José, "Stability Analysis of Non-Recursive Parallel Concatenated Real Number Codes", 2nd Signal Processing Education Workshop, IEEE, Callaway Gardens, Pine Mountain, Georgia, USA, October, 2002
- Vieira, José M. N., and Almeida, Luis, "A Sound Localizer Robust to Reverberation", AES 115th Convention, pp.Preprint 5973, AES, Ney York, USA, October, 2003
- Vieira, José M. N., "Automatic Estimation of Reverberation Time", AES 116th Convention, AES, Berlin, Germany, May, 2004
- Almeida, Luis, Vieira, José, et al. "CAMBADA: Team Description Paper", Robocup2004, Symposium, Instituto Superior Técnico, Lisbon, Portugal, July, 2004
- Vieira, José M. N., "Automatic Estimation of Reverberation Time", AES 116th Convention, AES, Berlin, Germany, May, 2004
- Vieira, José M. N., "Estimation of Reverberation Time Without Test Signals", AES 118th Convention, AES, Barcelona, Spain, May, 2005

- Vieira, José M. N., Lopes, Sérgio I., Bastos, Carlos C., and Fonseca, Pedro N., "Sistema de Localização Mútua para Robots Utilizando Ultra-Sons", JETC05, ISEL, Lisboa, Portugal, 2005
- Santos, Dorabella M. S., Ferreira, Paulo J. S. G., and Vieira, José M. N., "Study of the Recovery of Missing Samples for Function and Derivative Oversampled Filter Banks", Sampta, Workshop on Sampling Theory & Applications, Samsun, Turkey, July, 2005
- Vieira, José M. N., Lopes, Sérgio, I, Bastos, Carlos A. C., and Fonseca, Pedro N., "Sistema de Localização Utilizando Ultra-Sons", Robótica 2006, Guimarães, Portugal, 2006
- Vieira, José M. N., Santos, Dorabella M. S., and Ferreira, Paulo J, S. G., "Error Detection with Real-Number Codes based on Random Matrices", 12th Digital Signal Processing Workshop, IEEE, Wyoming, USA, September, 2006
- Henriques, José Tomás, Vieira, José Neto, Vieira, António, Santos, and Beatriz Sousa, "Portal para apoio ao HelpDesk do Centro de Informática e de Comunicações da Universidade de Aveiro", CAPSI' 2006 – 7ª Conferência da APSI, APSI, Aveiro, Portugal, January, 2007
- Henriques, José Tomás, Vieira, José Neto, Vieira, António, and Santos, Beatriz Sousa, "Portal de Apoio aos Técnicos do Centro de Informática e Comunicações da Universidade de Aveiro", Revista do Detua, 2006
- Albuquerque, Daniel, Vieira, José M. N., and Bastos, Carlos, "Room Acoustics Simulator for Ultrasonic Robot Location", Robótica 2008, Associação Portuguesa de Robótica, Aveiro, Portugal, April, 2008