



## COMMISSION B SCHOOL

### RFIDs: A Wireless Technology Enabling new communications and sensing paradigms

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#### Course Title

##### RFIDs: A Wireless Technology Enabling new communications and sensing paradigms

Why this topic ? More than 70 years after H. Stockman's publication of the landmark paper “communications by means of reflected waves,” and L. Theremin's demonstration of the wireless microphone, RFID continues to attract increasing interest for an extensive set of applications. Its implementation for traceability and identification is enjoying remarkable success in many applications. Indeed, RFID is a major technology used for the implementation of IoT sensors and for enabling Artificial Intelligence. This course will provide the theory, functioning, and applications of RFIDs to communication and sensing will be reviewed.

#### Course Schedule

- Date and time : Sunday, May 29, 2022; 8:30 am – 12 am and 1.30 pm -2.30 pm (total: 4 hours)
- Venue: AT-AP-RASC 2022, Gran Canaria, Spain

#### Syllabus

##### 1. Backscattering communications

Backscatter phenomena are well-known in RF technologies, in particular Radar, Scattering, and more recently in RFIDs (RadioFrequency IDentification). Some early work on backscatter is the landmark 1948 paper by Harry Stockman, titled “Communication by Means of Reflected Power” and published in the Proceedings of the IRE (pp 1196–1204, October 1948). Stockman noted in his conclusion that “...considerable research and development work has to be done before the remaining basic problems in reflected-power communication are solved, and before the field of useful applications is explored”. In this course, the history of backscatter and the theory behind its physics will be reviewed. Several examples of its exploitation for wireless communication and sensing will be discussed.

##### 2. Conventional RFID: Theoretical basis, implementation and applications

RFID system components will be discussed along with their classification. The most emblematic component of RFID is the tag that stores the information and responds to the RFID reader when interrogated. Tags are very compact devices, composed of an Integrated Circuit (IC) connected to the antenna. They are typically passive device empowered by the interrogation signal generated by the RFID Reader. The operation of tags will be discussed along with design approaches, in particular the antenna and generation of backscatter signals. A survey of tag categories, their performance, existing applications, evolutions and challenges will be included in this section of the course.

##### 3. Chipless RFID: Theoretical basis, implementation and applications

Information encoding on the tag without the support of an Integrated Circuit (IC) will be addressed along with different solutions will be presented in detail and discussed. A survey of potential applications of this technology and challenges will also be addressed.

##### 4. RFID for sensing: Introduction to sensors, implementations and applications

A brief review for the main features of a sensor and their characterization will be provided. Different examples of their implementation will be described with emphasis on the exploitation of RF technologies.

##### 5. ‘Hands on’ session using testing equipment for measurements (optional)

## Short Biography :

**Smail TEDJINI**, IEEE Senior Member, URSI Fellow, Doctor Physics Grenoble University 1985. 1981-1986 Assistant Professor at Grenoble Institute of Technology, Senior Researcher of CNRS (Research French National Center) 1986 to 1993. He became University Full Professor in 1993. Since 1996 he is Professor at esisar: Dpt. of Grenoble-inp. His main teaching topics concern Electromagnetism, RadioFrequency, Wireless Systems and Optoelectronics. He served as coordinator/member in numerous academic programs both for education and research. He was coordinator for Ph.D., Master and Bachelor Programs for Grenoble University, some programs are under international collaboration from Europe, USA, Canada, Brazil, Vietnam, Egypt, Maghreb. He founded the LCIS lab and served as its Director. He also served as the Director of esisar. He has more than 35 year experience in Education, Research and management of university affairs. Now, he is project manager at the ORSYS group of the LCIS that he founded 18 years ago and led until 2014. He supervised more than 45 Ph.Ds, and participated as Ph.D jury examiner/opponent for tens of defenses. He has more than 300 publications and patents. He organized several conferences/workshops. Senior Member IEEE, Past-President and founder of the IEEE-CPMT French Chapter, Vice-President of IEEE Section France (2008-2014) and Vice-Chair of URSI Commission D “Electronics & Photonics” in 2008. He served as the Chair of URSI Commission “D” for the triennium 2011-2014. In 2015 he was elected President of URSI-France. He served as the Vice-chair of the MTT-TC24 on RFID, and since 2020 he is the Chair of MTT-TC26 on “RFID , IOT and wireless sensor”.

**Simone GENOVESI**, IEEE Senior Member, received the laurea degree (summa cum laude) in Telecommunications Engineering from the University of Pisa in 2003 and the Ph.D. degree in Ingegneria dell’Informazione, from the same university, in 2007. In 2006 he was a Visiting Research Scholar at the Electrical Engineering Department at the Pennsylvania State University working on frequency selective surfaces and numerical methods, funded by the Italian National Research Council (CNR). From 2004 to 2006, he was a Research Fellow at the Istituto di Scienza e Tecnologie dell’Informazione “A. Faedo” of the CNR in Pisa and in 2011 he has been an Associate Researcher at the Institute for Microelectronics and Microsystem of the CNR in Agrate Brianza. From 2007 to May 2012 he has been an Associate Researcher at the Dipartimento di Ingegneria dell’Informazione (DII) of the University of Pisa and from June 2012 to September 2018 he has been an Assistant Professor in the same department. From October 2018 he is an Associate Professor of Electromagnetic Fields at the Dipartimento di Ingegneria dell’Informazione (DII) of the University of Pisa. In 2018 he has been appointed Coordinator of the Additive Manufacturing Crosslab founded in the framework of the Departments of Excellence (“Dipartimenti di Eccellenza”) funded by the Italian Ministry of Education, University and Research (“Ministero dell’Istruzione dell’Università e della Ricerca”). Since 2021 he is the Vice-Coordinator of the PhD program in ‘Smart Industry’ of the University of Pisa. He has coauthored more than 60 journal papers and more than 90 conference contributions (most of them published by IEEE), and two book chapters. He is also an Editor of the ‘IEEE Transaction on Antennas and Propagation’ and he is also in the Editorial Board of the journals “Sensors” and “Technologies” both by MDPI. His main research activities are focused on Radio Frequency Identification and Sensing (chipless RFID, chipless RFID sensors, wireless sensors), additive manufacturing for electromagnetic design (metamaterials, material characterization, 3D-2D printing for new devices), novel antenna designs (characteristic modes, reconfigurable antennas, wearable antennas, antenna optimization)