





EUROPEAN SCHOOL OF ANTENNAS (ESoA) 2016

SHORT RANGE RADIO PROPAGATION: THEORY, MODELS AND FUTURE APPLICATIONS

University of Bologna – Cesena Campus (Italy) - September 26-30, 2016



(source: http://www.cs.unibo.it/~ghini/cesena.html)

In the context of the European School of Antennas 2016, the course on *Short range radio propagation* is scheduled for the end of September at the University of Bologna, Italy. The course will take place at the university campus located in Cesena, at nearly 15 km from the Adriatic Sea.

The course will deal with channel modelling for medium/short range wireless systems and services, including millimetre wave and Terahertz radio propagation for 5G, as well as aspects related to MIMO and UWB technologies for wireless body area networks, medical and short range radar applications.

The lecturers are from University of Bologna, Technische Universität Braunschweig, Dublin City University, Karlsruhe Institute of Technology, Université Catholique de Louvain and Polaris Wireless (CA, USA).

The course is supported by the European COST Action 15104 "IRACON" and by the Guglielmo Marconi Foundation.

For registration, please fill up the payment form and send it to: <u>franco.fuschini@unibo.it</u> AND <u>esoa2016@fgm.it</u>.

| <u>Further info</u> : | http://www.antennasvce.org/Community/Education/Courses? | id_folder=630 |
|-----------------------|--|----------------|
| <u>Course fees</u> : | University Students (full time Master or PhD students): | 440€ |
| | Any other participant: | 880€ |
| | The fee includes tuition, course material, coffee breaks and a se | ocial event. |
| Location: | "University of Bologna – Cesena Campus ", Department of Cor and Engineering, via Sacchi 3, 47521 Cesena (Italy). | nputer Science |
| <u>Contact</u> : | Franco Fuschini, e-mail: <u>franco.fuschini@unibo.it</u> , phone: +390 | 512093437 |

Course Schedule

Monday 26/9/2016

| 8:30 - 9:30 | Welcome, Introduction, Overview on radio channel modelling for wireless |
|-------------|---|
| | communications |
| | Franco Fuschini - University of Bologna |
| 9:30-10.30 | Fundamentals of propagation and scattering I: Maxwell's equations, electromagnetic |
| | waves in lossless and lossy media, polarisation, reflection, transmission and diffraction |
| | Conor Brennan – Dublin City University |
| 10.30-11.00 | Coffee break |
| | Fundamentals of propagation and scattering II: Maxwell's equations, electromagnetic |
| 11.00-12:00 | waves in lossless and lossy media, polarisation, reflection, transmission and diffraction |
| | Conor Brennan – Dublin City University |
| | Full wave techniques for wave scattering computation I: FDTD, Discretisation and |
| | Stability, Courant condition, absorbing boundary conditions and perfectly matched |
| 12:00-13:00 | layers, IE formulation and MoM, Fast Multipole Method and acceleration techniques, |
| | FEM |
| | Conor Brennan – Dublin City University |
| 13:00-14:00 | Lunch break |
| | Full wave techniques for wave scattering computation II: FDTD, Discretisation and |
| | Stability, Courant condition, absorbing boundary conditions and perfectly matched |
| 14:00-15:00 | layers, IE formulation and MoM, Fast Multipole Method and acceleration techniques, |
| | FEM |
| | Conor Brennan – Dublin City University |
| | Geometrical Theory of Propagation: the concept of ray, rays trajectories, flux tube, |
| 15:00-16:30 | divergence factor, ray polarization, geometrical description of electromagnetic |
| | interaction (reflection, transmission, diffraction, diffuse scattering). Multiple |
| | interactions and multipath |
| | Franco Fuschini - University of Bologna |
| 16:30-17:00 | Coffee break |
| 17:00-18:00 | Exercises |
| | Conor Brennan – Dublin City University |

Tuesday 27/9

| | Claude Oestges - Université Catholique de Louvain |
|-------------|---|
| 15:00-16:30 | MIMO channel sounding techniques: sounder architectures, parameter estimation |
| | (SAGE, Rimax, Kalman, etc.) |
| | Claude Oestges - Université Catholique de Louvain |
| 16:30-17:00 | Coffee break |
| 17:00-18:00 | Exercises |
| | Conor Brennan – Dublin City University |

Wednesday 28/9

| 8:30–10:00 | Propagation for body area network: on-body propagation, off-body and body-to- |
|-------------|---|
| | body propagation, stationarity and channel models |
| | Claude Oestges – Université Catholique de Louvain |
| 10:00-11:00 | UWB propagation: UWB channel definitions, UWB propagation, antenna and channel |
| | characteristics, UWB hybrid channel, True Time Delay, IR-Fidelity, UWB antenna |
| | principles |
| | Werner Wiesbeck- Karlsruhe Institute of Technology |
| 11:00-11:30 | Coffee break |
| 11:30-13-30 | UWB applications: UWB radar for precise, short-range measurement, UWB for |
| | medical applications |
| | Werner Wiesbeck- Karlsruhe Institute of Technology |
| 13:30-14:30 | Lunch break |
| | Implementation of a ray based prediction tool: digital description of antennas and |
| 14:30-16:30 | environments, ray tracing (RT) and ray launching (RL), tracking of rays trajectories, |
| | field computation along the rays, computational cost and prediction accuracy. |
| | Potential and limitations of RT/RL |
| | Vittorio Degli Esposti – Polaris Wireless |
| 16:30-17:00 | Coffee break |
| 17:00-18:00 | Exercises |
| | Conor Brennan – Dublin City University |

Thursday 29/9

| 8:30-10:30 | Speed up techniques for RT prediction: database reduction and simplification, code |
|-------------|--|
| | parallelization and GPU exploitation, real time RT |
| | Vittorio Degli Esposti – Polaris Wireless |
| 10:30-11:00 | Coffee break |
| 11:00-13:00 | Mm-wave and Terahertz propagation I: wireless Communication Systems at 60 GHz |
| | and beyond, Propagation Conditions and Channel Models at 60 GHz |
| | Thomas Kürner - Technische Universität Braunschweig |
| 13:00-14:00 | Lunch break |
| 14:00-16:30 | Mm-wave and Terahertz propagation II: wireless Communication Systems at 60 GHz |
| | and beyond, Propagation Conditions and Channel Models at 300 GHz |
| | Thomas Kürner - Technische Universität Braunschweig |
| 16:30-17:00 | Coffee break |
| 17:00-18:00 | Exercises |
| | Conor Brennan – Dublin City University |

Friday 30/9

| 8:30-10:30 | Mm-wave and Terahertz propagation III: stochastic channel model for THz |
|-------------|---|
| | frequencies |
| | Thomas Kürner - Technische Universität Braunschweig |
| 10-30-11:00 | Coffee break |
| 11:00-12:30 | Mm-wave and Terahertz propagation IV: stochastic channel model for THz |
| | frequencies, impact of antenna misalignment in THz Channels, future tasks and |
| | challenges |
| | Thomas Kürner - Technische Universität Braunschweig |
| 12:30-13:30 | Lunch break |
| 13:30-15:00 | Final exam |
| 15:30-16:00 | Wrap-up and distribution of certificates |