EUROPEAN SCHOOL OF ANTENNAS (ESoA) 2025

Short-Range Radio Propagation: Theory, Models and Applications
Dublin City University

Course Schedule

Monday 25/8/2025

8:30 – 9:00	**Welcome:** Introduction, Overview of radio channel modelling for wireless communications *Conor Brennan - Dublin City University*
9:00-10.30	**Fundamentals of propagation and scattering I** *Maxwell's equations, near-field and far-field, electromagnetic waves in lossless and lossy media, polarisation* *Conor Brennan – Dublin City University*
10.30-11:00	Coffee break
11:00-12:00	**Fundamentals of propagation and scattering II** *Reflection, transmission, diffraction, scattering* *Conor Brennan – Dublin City University*
12:00-13:30	**Geometrical Theory of Propagation:** spherical waves and local plane waves, the concepts of ray, tube of flux, spreading factor, astigmatic waves, interactions with canonical obstacles, GTD/UTD *Conor Brennan – Dublin City University*
13:30-14:30	Lunch break
14:30-16:00	**HFSS Workshop:** Antenna design, antenna coupling, propagation modelling and link budget estimation *Dimitris Tzagkas - Ansys*
16:00-16:30	Coffee break
16:30-18:00	**HFSS Workshop:** Antenna design, antenna coupling, propagation modelling and link budget estimation *Dimitris Tzagkas - Ansys*

Tuesday 26/8/2025

8:30 – 10:30	**Ray Tracing:** Ray based modeling. Digital description of antennas and environments, ray tracing (RT), ray launching (RL), parallelization *Enrico Vitucci - University of Bologna*
10.30-11:00	Coffee break
11:00-13:00	**Advanced Ray-Based Propagation Modeling Techniques I:** Ray-based propagation modeling in presence of reconfigurable intelligent surfaces. *Enrico Vitucci - University of Bologna*
13:00-14:00	Lunch break
14:00-16:00	**Advanced Ray-Based Propagation Modeling Techniques II:** Dynamic Ray Tracing / Diffuse Scattering models *Enrico Vitucci - University of Bologna*
16:00-16:30	Coffee break
16:30-17:30	**Exercises** *Conor Brennan – Dublin City University*

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Wednesday 27/8/2025

9:00 – 11:00	**Machine Learning Based Propagation Modelling: Machine-Learning : I**ntroduction to ML Application to propagation modeling. Examples *Enrico Vitucci - University of Bologna*
11.00-11:30	Coffee break
11:30-13:00	**Statistical Characterization of Multipath Propagation:** Stochastic and multidimensional aspects, stationarity, Bello formalism (Channel Transfer Functions). Small-scale fading (Rayleigh, Rice, Doppler spectrum, spreading in time/angles, selectivity in frequency/space). *Fredrik Tufvesson – Lund University*
13:00-14:00	Lunch break
14:00-15:30	**MIMO Channels I:** MIMO channel matrix, Eigenmodes and eigenvalues, Analytical MIMO matrix representations (correlation matrix, Kronecker and eigenbeam models) *Fredrik Tufvesson – Lund University*
15:30-16:00	Coffee break
16:00-17:30	**MIMO Channels II:** Indoor MIMO channels, MIMO channel dynamics, multi-link properties, MIMO antenna coupling, distributed and co-located MIMO *Fredrik Tufvesson – Lund University*
17:30-18:30	**Exercises** *Conor Brennan – Dublin City University*

Thursday 28/8/2025

08:30 – 9:30	**Joint Sensing and Communication (JSAC):** Radio based localization, radio-based sensing, reflection and scattering from a sensing perspective, monostatic and bi-static radar cross section *Fredrik Tufvesson – Lund University*
09:30-10:30	**Electromagnetic methods:** FDTD, Discretisation and Stability, Courant condition, absorbing boundary conditions and perfectly matched layers, IE formulation and MoM, Fast Multipole Method and acceleration techniques. *Conor Brennan – Dublin City University*
10:30-11:00	Coffee Break
11:00-13:00	**Mm-wave and THz Propagation and Channel Modelling I:** Wireless Communication Systems at 60 GHz and beyond; Propagation Conditions and Channel Models at 300 GHz *Thomas Kürner - Technische Universität Braunschweig*
13:00-14:00	Lunch
14:00-16:00	**Mm-wave and THz Propagation and Channel Modeling II:** Stochastic channel model for THz frequencies, impact of antenna misalignment in THz Channels, future tasks and challenges *Thomas Kürner - Technische Universität Braunschweig*
16:00-16:30	Coffee Break
16:30-17:30	**THz Link-Level Simulation:** Impact of RF Hardware Impairments on the performance of THz communication

	systems *Thomas Kürner - Technische Universität Braunschweig*
17:30-18:30	**Exercises** *Conor Brennan*

Friday 29/8/2025

9:00-10:30	**UWB Propagation**: UWB channel definitions; UWB applications, UWB propagation and channel characteristics, UWB antenna principles *Thomas Kürner - Technische Universität Braunschweig*
10-30-11:00	Coffee break
11:00-12:30	**Mm-wave and THz Applications:** MM-wave and THz application scenarios for next generation short range communications *Thomas Kürner - Technische Universität Braunschweig*
12:30-14:00	Lunch
14:00-15:00	**Final exam**
15:00-16:30	Correction, wrap-up and distribution of certificates