European School of Antennas and Propagation

2026

ESoA courses

EurAAP

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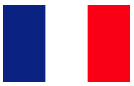
2	February 9-13	 Paris	COMBINATION OF SIMULATION AND MEASUREMENTS IN ANTENNA DESIGN
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OBJECTIVES

ESoA was founded in 2004 by a group of institutions in the framework of the FP6 Network of Excellence "ACE" (Antenna Centre of Excellence) and it was afterwards financed in FP7 by a Marie Curie Action (MCA) project till 2007.

From 2008 ESoA is part of EurAAP (https://www.euraap.org/) .

The ESoA courses are distributed in the most accredited research centers on antennas and propagation in Europe.

Reinforcing the European excellence in EM engineering with emphasis on antennas;

Creating an effective advanced formative offer at international level to complete individual PhD curricula;

Increasing the ties in research and development between Universities and Industries on a European scale;

Facilitating the interchange of ideas among early-stage researchers and trainers as well as among young researchers, thus increasing the future mobility and synergy.

ENLARGE YOUR NETWORK

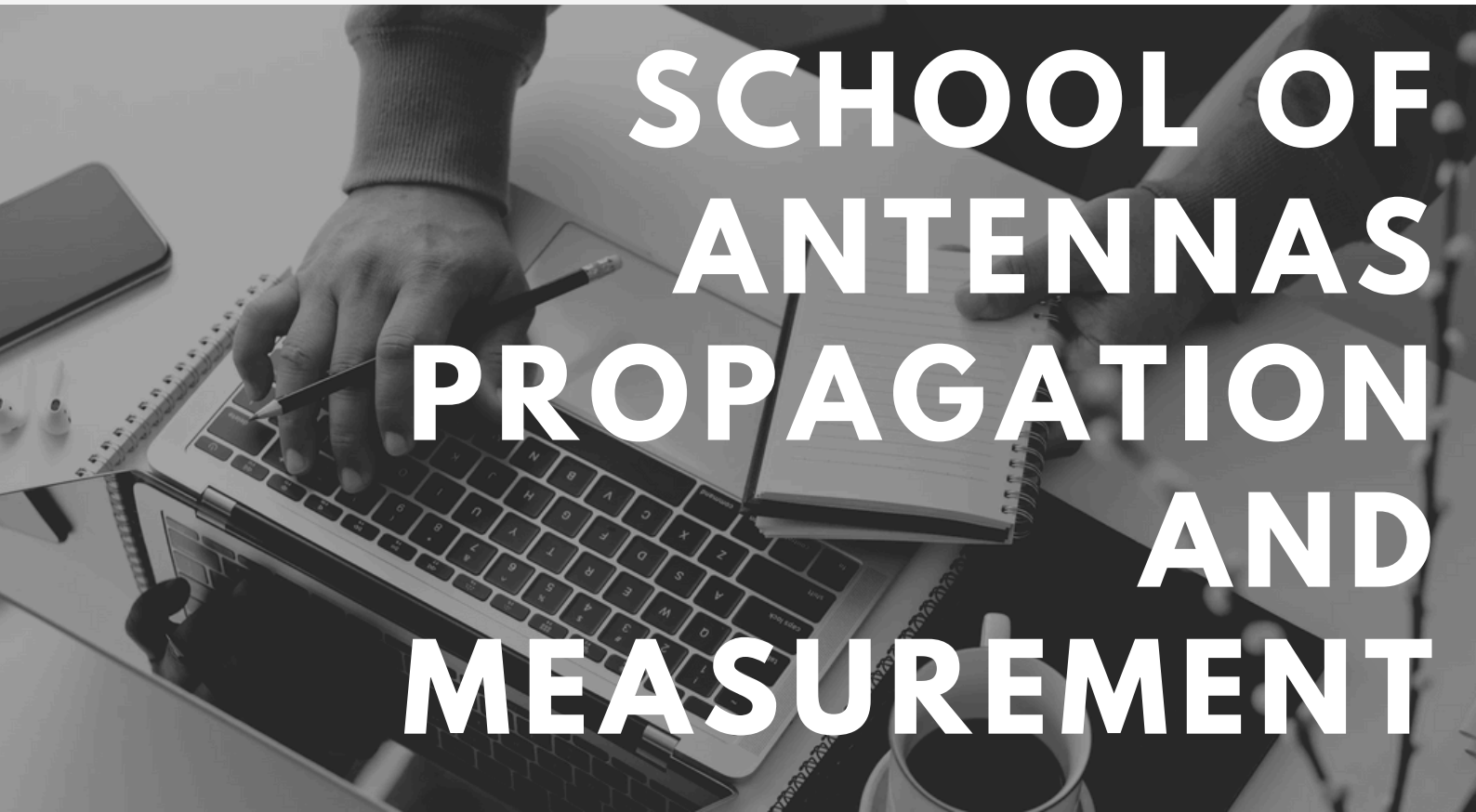
REGISTRATION FEE

The price is the same for all courses.

- 550 € for a full time university student
- 1100 € for others (lunch included in the price)

You will receive a certificate at the end of the course and an invoice with the information of the course for any accounting purpose.

All ESoA courses are conducted in person, and we are delighted to reunite with you face-to-face. Additionally, for certain courses, an online option may be accessible. If you have any inquiries, please don't hesitate to reach out to the respective coordinators



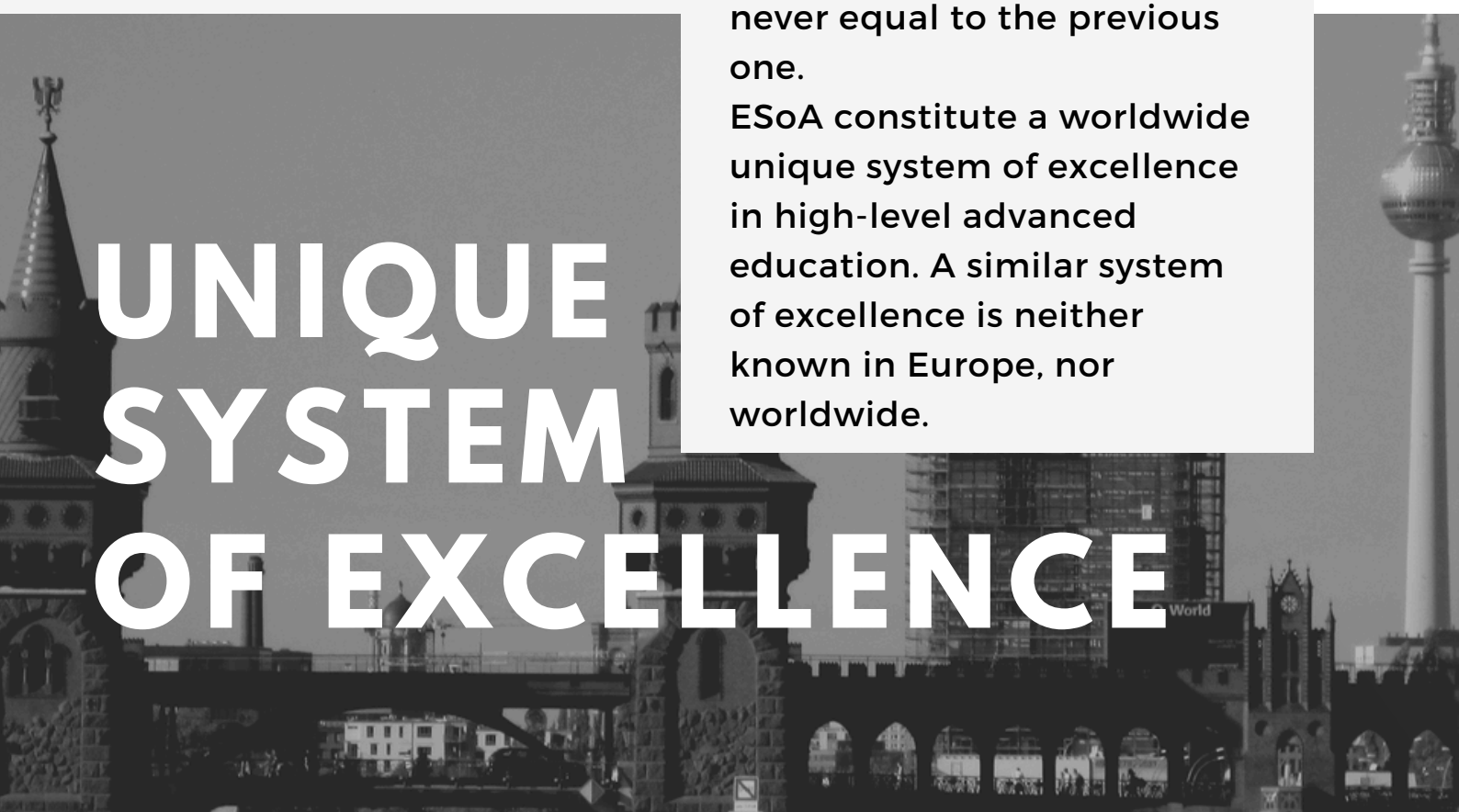
SCHOOL OF ANTENNAS PROPAGATION AND MEASUREMENT

FEATURES

The most attractive feature of ESoA is the fact that it is geographically distributed, giving the students a unique opportunity to attend courses in the most relevant Scientific Centers of Excellence, and to attend lectures from the best local and visiting instructors.

Simultaneously, the instructors learn from their colleagues different ways to teach. ESoA includes the best 100 teachers in Europe, among which they are seventeen IEEE Fellows, and many other lecturers. ESoA is attended by an average of 220 students per year, with a peak of 450 students in 2023.

The courses are continuously updated and each edition is never equal to the previous one.
ESoA constitute a worldwide unique system of excellence in high-level advanced education. A similar system of excellence is neither known in Europe, nor worldwide.



UNIQUE SYSTEM OF EXCELLENCE

GOVERNANCE

Stefano Maci
European School of
Antennas Chair

The ESoA board is composed by 40 members. These members are from each affiliated institution, who are also coordinators of courses. Moreover, the ESoA board also includes members from European Space Agence (ESA), European Microwave Association (EuMA), the Institute of Engineering and Technology (IET), IEEE Antennas and Propagation Society (IEEE AP-S) and EurAAP Propagation Working Group.

The ESoA Board meets two or three times per year and gets continuously stimulus to updating the courses and introducing new ones. The coordinators of the courses improve the content of each edition to maintain each course at the state-of-the-art level. Several new junior professors are included in the structure when they reach the right maturity, and in doing so, the ESoA board members perform a talent scouting action in conferences.

EsoA also constitutes a strong tool for improving the dialogue between the universities and the industries, giving thereby employment opportunities to students.

ESoA

A way to excellence

European School of Antennas and Propagation

1 DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF ELECTROMAGNETICS

January 19-25 *Naples, Italy*

Coordinators	**L. Crocco, G. Vecchi, M. Cavagnaro**

Purpose of the course

This course aims at introducing the interested audience to the increasingly relevant clinical application of EM fields. The course is primarily conceived for Doctoral students and early-career researchers with an engineering or physics background. In this cross-disciplinary course, instructors from EM engineering, physics, biology and clinical communities will be involved. The 2026 edition is focused on therapeutic applications of EM fields at microwave frequencies. To lead the students towards such applications, it starts by reviewing the basics of the interaction between EM fields and bio-systems. Then, a general overview of the effects of EM fields at different frequencies, and underlying mechanisms, is given. Microwave hyperthermia and thermal ablation are discussed, from the engineer, clinical and industrial points of view. An outlook to future medical applications of EM fields will complete the course.

Prerequisites	basics of antennas and microwaves, basic knowledge of electromagnetics and mathematics
Course Duration	5 days = 40 hours
Expected speakers	P. Saccomandi, Politecnico di Milano (IT) P. Kosmas, National Centre for Scientific Research "Demokritos" (GR) M. Paulides, Technical University of Eindhoven (NL) S. Romeo, IREA-CNR (IT) R. Scapaticci, IREA-CNR (IT)

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2 COMBINATION OF SIMULATIONS AND MEASUREMENTS IN ANTENNA DESIGN

February 9-13 *Paris, France*

Coordinator	**L. Foged, M. Sierra, M. Ruetschlin, G. Vecchi**

Purpose of the course

Simulation and measurements are routine procedures in any antenna design, yet in different phases.

In this course you will learn how to integrate these two aspects to make the design process more efficient, and/or to reach higher goals (cost, speed, performance). This possibility has emerged recently from (applied) research and is now part of a streamlined procedure that can be based on commercially available tools.

The course is an intensive 5 day study that combines theoretical sessions with hands-on exercises; it includes experience of design down to 3D rapid manufacturing and testing.This allows participants to put newly acquired theory to practice and presents insight into all aspects of practical antenna measurements.

Prerequisites	basics of antennas and microwaves, basic knowledge of electromagnetics and mathematics
Course Duration	5 days = 30 hours
Expected speakers	Giuseppe Vecchi (Politecnico de Torino) Eddy Jehamy (Dassault Systems) Manuel Sierra Castañer (UPMadrid) Lars Foged (MVG) Jean Charles Bolomey (Université Paris Sud – Emeritus)

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3 NEAR-FIELD ANTENNA SYSTEMS AND DESIGN

April 6 - 10 *Lisbon, Portugal*

Coordinators	**S. Matos, M. Arrebola**

Purpose of the course

The current need for wireless systems operating effectively in the near-field region of the radiating device highlights a significant shift, both in industry and research. Nearfield (NF) conditions, where standard far-field approximations might fail to provide accurate results, demand a specialized approach to the development of radiating devices and propagation models. These are essential for developing the next generation antennas to meet the stringent requirements of near-field environments in many applications. This course will focus on the fundamentals of NF radiating systems and as well as techniques for analyzing, design, and modelling antennas for NF systems for communications and sensing.

Prerequisites	Basics of antennas and electromagnetics
Course Duration	40h
Expected speakers	• Prof. Anja Skrivervik, EPFL, Switzerland • Dr. Antonio Clemente, CEA-Leti, France • Prof. Carlos Fernandes, IST-IT, Portugal • Prof. Manuel Arrebola, Universidad Politécnica de Madrid, Spain • Prof. Mauro Ettorre, Michigan State University, USA • Prof. Nuria Llombart, TU Delft, The Netherlands • Prof. Oscar Quevedo, KTH Royal Institute of Technology, Sweden • Prof. Paolo Nepa, University of Pisa, Italy • Prof. Sérgio Matos, ISCTE-IUL and IT, Portugal

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4 METASURFACES FOR ANTENNAS

May 11-15 *Dubrovnik, Croatia*

Coordinators	**S. Maci, Z. Sipus**

Purpose of the course

Metasurfaces, a class of thin metamaterials, have shown unprecedented capabilities in the local manipulation of phase, amplitude and polarization of electromagnetic waves from microwave to optical frequencies by tailoring the geometry of building elements. At microwave frequencies, they are constituted by sub-wavelength size patches or pins printed on thin grounded dielectric substrates or realized as a texture in a metal surface. During this course the background and basic theory of different types of canonical metasurfaces will be explained, as well as how to realize such surfaces for different applications, and how to devise good theoretical models and implement them numerically.

Prerequisites	none
Course Duration	5 days = 40 hours
Expected speakers	Anthony Grbic Stefano Maci Nader Engheta Enrica Martini David González Ovejero Eva Rajo-Iglesias Zvonimir Sipus Silvio Hrabar

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5 ANTENNAS FOR SPACE APPLICATIONS

May 18 - 22 *Noordwijk, Netherlands*

Coordinators	**G.Toso, E. Gandini**

Purpose of the course

Given every second year since 2006, the course “Antennas for Space Applications” provides an overview of design approaches, constraints and technical solutions for space antennas, addressing both theoretical and technological issues. The course includes application oriented lectures, focusing on the specific needs and antenna solutions for telecommunication, earth observation, science and satellite navigation missions. It also includes technology oriented lectures, covering topics such as beam forming techniques and technologies, large reflector antennas and periodic structures. While the course mostly addresses radio frequency aspects, dedicated lectures will also address manufacturing, as well as mechanical and thermal design aspects, as complex space antenna systems often require co-engineering involving multi-disciplinary expertise. The course will end with a visit to the ESTEC satellite and antenna test facilities.

Prerequisites	basics of antennas and electromagnetics
Course Duration	5 days = 35 hours
Expected speakers	E. Gandini G. Toso P. Angeletti I. Barbary P.M. Besso B. Byrne P. de Maagt A. Ihle V. Iza S. Mercader-Pellicer G. Rodrigues L. Rolo E. Saenz C. Tienda D. Trenta H. Nematollahi S. D’Addio E. Van Der Houwen M. van der Vorst

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6 METALENSES FOR ANTENNA APPLICATIONS

June 1-5 *Stockholm, Sweden*

Coordinators	**O. Quevedo, F. Mesa**

Purpose of the course

Lenses are used to increase the directivity of conventional antennas. New 5G/6G and satellite communications, as well as radars, are increasing their frequency of operation. When this frequency increases, lenses are ideal to reduce the complexity of the feeding networks, while keeping a moderate cost. Lenses can be implemented with conventional dielectric materials but also with periodic structures and geodesic shapes.

In this course, you will learn the fundamentals of lenses, including homogenous and graded-index lenses. Later, you will acquire knowledge on how modelling these lenses with ray-tracing techniques. You will implement your own ray-tracing codes in lab sessions. You will also learn how to design innovative lenses with transformation optics and geodesics. Furthermore, you will learn how to implement lenses with periodic structures, including those with higher symmetries. Finally, you will receive the industrial view about the prospective use of lenses for satellite communications, 5G/6G, and automotive radars.

Prerequisites	Engineering or physics background
Course Duration	5 days = 30 hours
Expected speakers	Prof. Tomas Tyc, Masaryk University, Czech Republic Prof. Guido Valerio, Sorbonne University, France Prof. Simon Horsley, University of Exeter, UK Dr. Agnese Mazzinghi, University of Florence, Italy Dr. Jose Rico-Fernandez, Northern Waves, Sweden Dr. Celia Gomez, Ansys, Spain Dr. Astrid Algaba-Brazalez, Uni. of Cartagena, Spain Dr. Carolina Viganó, Viasat, Switzerland Sören Poulsen, Saab, Sweden

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European School of Antennas and Propagation

7 OPTIMAL ANTENNAS: Performance Limits and Inverse Design

June 8 - 12 *Lund, Sweden*

Coordinators	**M. Gustafsson, M. Capek**

Purpose of the course

Questions regarding the efficacy of electromagnetic devices and their optimal design are central to antenna and microwave technology, optics, and plasmonics. This edition of the European School of Antennas equips participants with both theoretical and practical tools to address these questions and ultimately create optimal devices. The term “optimality” is addressed first, determined from physical bounds formulated as optimization problems over electromagnetic quantities (surface current density, terminal voltages). These problems are solved using convex optimization techniques and contribute to understanding the trade-offs between studied metrics, electrical size, material parameters, or matching. The bounds are compared with classical and optimized designs and put into the context of historical attempts to demarcate various performance metrics. The course covers inverse design techniques, including topology optimization, surrogate modeling, machine learning, and heuristics. We also emphasize a recently developed technique based on topology optimization in a method-of-moments setting. This technique is computationally efficient and can often automatically design antennas with performance close to the physical bounds. Many figures of merit are to be defined and optimized: Q-factor, radiation efficiency, antenna gain, realized gain, directivity, capacity, focusing efficiency, and extinct power, to name a few. The participants will receive the presented codes and worksheets summarizing the theory. The course concludes with a discussion of open problems related to optimality in antenna design.

Prerequisites	basics of antennas and electromagnetics
Course Duration	5 days = 35 hours
Expected speakers	Mats Gustafsson, Lund University Miloslav Capek, CTU in Prague Oscar Borries, Ticra Owen Miller, Yale University Kurt Schab, Santa Clara University Rasmus Ellebæk Christiansen, DTU Niels Aage, DTU

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8 CO DESIGN OF ANTENNAS AND ACTIVE ELECTRONICS

June 29 - July 3 TBD

Coordinators	**M. Ivashina, D. Pesina, C. Fager**

Purpose of the course

This new ESoA edition is the first joint effort of EuMA and EurAAP; it bridges two academic communities that rarely meet in one classroom: antenna designers and active microwave/mm-wave circuit designers. The course develops a unified, system-level view of Active Receiving Antennas and Active Transmitting Antennas, from electromagnetic principles and array architectures to power/low-noise device technologies, packaging, and nonlinear system metrics.

Participants will learn antenna–amplifier co-design methods and concepts such as direct impedance matching, antenna multi-port distributed amplification, load-modulation techniques, and efficient mm-wave on-antenna power combining. We address the effects of antenna mutual coupling on LNA noise correlation and PA nonlinear distortion in array antennas that exhibit mutual coupling effects, along with new methods for co-design, integration, and packaging.

Because traditional tools for numerical simulations and experimental validation differ across communities, the course harmonizes analysis techniques by using Keysight ADS (or a free alternative to ADS) as a common “hinge” across modules, connected to commercial 3D EM solvers (e.g., ADS–HFSS, ADS-CST co-simulation). The week culminates in a hands-on assignment where participants assess active array sub-system (front-end blocks and active radiating elements) and validate results by measurement at the hosting university and its supporting industrial infrastructures.

Prerequisites	A master's level degree in Electrical Engineering or similar. Basics of electromagnetics, antennas, and microwaves/RF circuits; familiarity with numerical modeling and complex calculus is helpful
Course Duration	40 hours

Expected speakers

- Marianna Ivashina
- Christian Fager
- Rob Maaskant
- Ashraf Uz Zaman
- Bart Smolders
- Ulf Johannsen
- Vojkan Vidojkovic
- Christophe Craeye
- Dimitri Lederer
- Martin Rack
- Martijn de Kok

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9 ELECTROMAGNETIC INTELLIGENT COMMUNICATIONS

May 25-29 *Siena, Italy*

Coordinators	**S. Maci, F. Bilotti, A. Massa**

Purpose of the course

The sixth-generation (6G) system, to be deployed in the upcoming years, is expected to fully support artificial intelligence. To go “beyond 5G” there are some fundamental issues which need to be addressed concerning with higher system capacity, higher data rate, lower latency, and improvement of quality of service (QoS). This course presents the vision of future wireless communication. The reflecting intelligent metasurface (RIS) technology is one of the most interesting candidate technologies.
This course includes the fundamental properties and limits of RISs; its analysis, sensing and design; capacity/data rate analyses, power/spectral optimizations, channel estimation, deep learning-based design, etc. The teaching team includes well-recognized worldwide researchers in academia and industry

Prerequisites	Basic knowledge on antennas and electromagnetism
Course Duration	5 days = 30 hours
Expected speakers	Andrea Abrardo Andrea Alú Filiberto Bilotti Bruno Biscontini Marco Di Renzo Nader Engheta Renato Lombardi Stefano Maci Andrea Massa Sergei Tretyakov

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10 MOBILE RADIO PROPAGATION FOR 5G AND BEYOND

August 24 - 28 *Lund, Sweden*

Coordinators	**F. Tufvesson, T. Kuerner, C. Brennan**

Purpose of the course

The course will cover propagation aspects for 5G and beyond cellular and vehicular communications. Starting with the basics of propagation, modern methods used in cellular network planning as well as aspects relevant for future 5G networks, e. g. MIMO, multi-link aspects, localisation, car2X and railway communications, drones, are taught. The course includes also computer-based exercises.

Prerequisites	basics in electromagnetics and communications
Course Duration	5 days = 37 hours
Expected speakers	Thomas Kürner Fredrik Tufvesson Claude Oestges Werner Wiesbeck Conor Brennan Vasilii Semkin

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European School of Antennas and Propagation

11 ARRAYS AND REFLECTARRAYS

August 31 - September 4 Louvain La Neuve, Belgium

Coordinators	**Christophe Craeye**

Purpose of the course

This course is aimed at postgraduate research students and industrial engineers who want to acquire insight into the physical behavior of antenna arrays and reflectarrays, as well as learn methodologies for array optimization.

The course will provide a global understanding of the electromagnetic behavior of antenna arrays and reflectarrays, with a special emphasis on wideband arrays, on the effects of mutual coupling, on optimization methods and on applications. A software for reflectarray analysis and design will be handed over to the students.

Prerequisites	Masters level course on antennas
Course Duration	5 days = 38 hours
Expected speakers	Prof. Sean Hum Prof. Manuel Arrebola Prof. Daniele Cavallo Prof. Giacomo Oliveri Dr. Nicola Anselmi Dr. Hervé Legay Prof. Raphaël Gillard Prof. Christophe Craeye

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European School of Antennas and Propagation

12 FREQUENCY DOMAIN TECHNIQUES:FROM INHOUSE TO COMMERCIAL EM SOLVERS

October 5-9 *Florence, Italy*

Coordinators	**A. Freni, J. Mosig**

Purpose of the course

The course aims to give the student an appreciation of the uses and limitations of frequency domain computational techniques applied to scattering and antenna problems. The module gives the student a thorough background in the methodology of these techniques from a fundamental standpoint, while providing a grasp of the practical applications. Emphasis will be given to the practical problems encountered in the implementation of the integral equation techniques (Method of Moments, linear systems, integration techniques, Green's functions, stratified media, convergence, singularities, periodic problems). Simple problems are considered to give an understanding of how the choices made in designing the algorithms translate into the real strengths and limitations of the software.

Prerequisites	Basic electromagnetic theory, Basic antenna theory
Course Duration	5 days = 25 hours
Expected speakers	Juan Mosig Anja Skrivervik Zvonimir Sipus Angelo Freni Agnese Mazzinghi

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European School of Antennas and Propagation

13 ANTENNAS AND MICROWAVE PHOTONICS

A gap for joining guided and radio very high data rate communications

October 19-23 *Madrid, Spain*

Coordinators	**D. Segovia-Vargas**

Purpose of the course

Microwave photonics is becoming a mature, but still emerging, technology that tries to fill the gap for very high-speed and very high data-rate communications. It is well known that optical fiber communications offer very high bandwidths for the current very-high data rate communication systems. It is also well known that wireless and antennas is the only way to provide mobility and flexibility to any communication system. For the first time the European School of Antennas propose a course trying to overcome these two complementary technologies: antennas and microwave photonics. The purpose of the course is to open the knowledge on antennas, optics and communication communities to a set of essential knowledge for future communication services.

Prerequisites	knowledge on antennas, waveguides and basic communication theory
Course Duration	5 days = 30 hours
Expected speakers	*Prof. Daniel Segovia-Vargas (GREMA-UC3M group)* *Prof. Elliot Brown (Wright University)* *Dr. Alejandro Rivera-Lavado* *Prof. from GOTL-UC3M group (tbc)* *Prof. from GREMA-UC3M (tbc)* *Prof. expert on microwave photonics metasurfaces (tbc)*

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European School of Antennas and Propagation

14 TERAHERTZ ANTENNAS AND IMAGING SYSTEMS

October 26 - 30 *Delft, Netherlands*

Coordinators	**A. Neto, N. Llombart, L. Joffre**

Purpose of the course

In the cm-wavelength regime, digital signal processing can be used, in connection to ad hoc front end designs, to increase the signal to noise ratios. In the mm and sub-mm wave regimes only analogue antenna techniques can be used to obtain high signal to noise ratios at reasonable costs.

The Tera Hertz Antennas and Imaging Systems course will take place in Delft at the end of October 2022.
The course will discuss the antenna theory and techniques most widely used in the design of imaging systems aimed to operate in the sub-mm wave regime. Examples will consider on going state of the art research in a number of application domains in which sub-mm wave antenna imaging is truly key to the developments: these include space science radiometry, security, medical imaging, no destructive testing, automotive Radars and Telecommunications. The course will involve every day, theoretical lectures as well as exercises in the advanced TU Delft laboratories.

Prerequisites	Basic Electromagnetics and Antenna Theory
Course Duration	5 days = 32 hours
Expected speakers	Prof. Andrea Neto Prof. Nuria Llombart Prof. Luis Jofre Prof. Jochem Baselmans Prof. Angelo Freni Dr. Maria Alonso

2026

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