2023 URSI School for Young Scientists
URSI GASS 2023, Sapporo, Japan

COURSE TOPIC:

Electromagnetic measurements

MOST RELEVANT SCIENTIFIC COMMISSIONS:

A, B, C, E, F, G, H, K

COURSE SCHEDULE:

Saturday, August 19, 13:00-16:40

Sunday, August 20, 8:20-12:00

COURSE VENUE:

Sapporo Convention Center

ABSTRACT

Measurement has a fundamental role in science being the main tool to interact with and investigate the physical world. Measurement is the means through which a theory is confirmed or rejected. Test and measurements are daily carried out all over the world for conformity assessment of products to safety standards and for the implementation of new technologies. The scope of this first edition of the URSI School for Young Scientists is to present a broad view of the electromagnetic measurements adopted to investigate traditional and emerging research areas relevant to the URSI Scientific Commissions.

COURSE INSTRUCTORS AND PROGRAM

Saturday, August 19, 13:00 – 16:40

13:00 – 14:40
Measurement techniques for emerging wireless technologies
(This technical talk is in association with IEEE APS Antenna Measurements Committee)

Prof. Tian Hong LOH
Vice-Chairman of UK URSI
Principal Research Scientist
National Physical Laboratory, Teddington, Middlesex, United Kingdom
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14:40 – 15:00 Break

15:00 – 16:40
Human Electromagnetic Field Exposure Assessment: Incident Field Evaluations, Dosimetric Evaluations
Dr. Myles H. CAPSTICK
Project Leader, Head of Hardware and Associate Director
Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland
e-mail: capstick@itis.swiss

Sunday, August 20, 8:20 – 12:00

8:20 – 10:00
Natural electromagnetic noise measurements
Prof. Yasuhide HOBARA
Graduate School of Informatics and Engineering, Center for Space Science and Radio Engineering
The University of Electro-Communications, Tokyo, Japan
e-mail: hobara@ee.uec.ac.jp

10:00 – 10:20 Break

10:20 – 12:00
Is it difficult to Measure an Antenna?
(This technical talk is in association with IEEE APS Antenna Measurements Committee)
Prof. Debatosh GUHA
Institute of Radio Physics and Electronics
University of Calcutta, India
e-mail: dguha@ieee.org

Tian Hong Loh: Tian Hong Loh is a Principal Research Scientist at NPL. He leads work at NPL on a wide range of applied and computational electromagnetic metrology research areas to support the telecommunications industry. He is also a Visiting Professor at the University of Surrey, U.K., and the Vice-Chairman of UK URSI (International Union of Radio Science). He holds six patents, one book, and nine book chapters. He has authored and co-authored over 200 refereed publications. His research interests include beyond 5G communications, smart antennas, small antennas, metamaterials, body-centric communications, wireless sensor networks, electromagnetic compatibility, and computational electromagnetics.

Title: Measurement techniques for emerging wireless technologies (1.5 h)
(This technical talk is in association with IEEE APS Antenna Measurements Committee)

Abstract: The digital economy is essential for wealth creation and is increasingly underpinning all aspects of social and business activities. A raft of emerging wireless technologies is being considered in a wide range of spectrum bands to support a significantly increased user density. With the industrial exploitation and adoption of complex new radio (NR) signals, energy efficient devices and large-scale multi-antenna beamforming technologies at different RF bands in 5G and emerging wireless systems, several worldwide industries, research communities and standard bodies are now facing new measurement challenges on efficient and accurate verification of NR products that meet desired performance parameters for fulfilling the diverse technical requirements. This talk presents an overview of the measurement challenges of over-the-air (OTA), radio frequency (RF) exposure and propagation channel for emerging wireless technologies, the relevant international R&D activities on the measurement techniques as well as the measurements capabilities at NPL established under several UK and EU programmes. The topics covered include massive multiple-input-multiple-output (MIMO), MIMO-OTA, software defined radios (SDR), mm-wave hybrid beamforming with large-scale phased arrays, data handling for 3D holographic displays application using mm-wave and Li-Fi techniques, location-awareness full mesh network for indoor and outdoor scenarios, vehicle-to-infrastructure (V2I) propagation at mm-wave bands, etc.

Myles H. Capstick: Dr. Myles H. Capstick received his B.S. and Ph.D. degrees from the University of Wales in Bangor in 1987 and 1991, respectively. He was appointed as a lecturer in the School of Electronic Engineering Science at the University of Wales, Bangor, in 1990 and moved to the University of York, Department of Electronics, in 1996, where he was first lecturer and later senior lecturer. In May 2006, Dr. Capstick joined the Foundation for Research on Information Technologies in Society (IT'IS) in Switzerland where he currently serves as project leader, head of hardware and associate director. Dr. Capstick's expertise encompasses the design of analog, radiofrequency (RF), microwave, and millimeter-wave (mm-wave) systems, subsystems, circuits, and antennas, which he applies in the fields of device and system development for health risk assessment studies (in vitro, in vivo animal and human), measurement technology, and bio-medicine. He has been Chief Technology Officer of ZMT Zurich MedTech AG since 2006, and of TI Solutions AG since 2020. He is member of the BioEM Society and senior member of the UK's Institute of Engineering and Technology. The status of Chartered Engineer was awarded to Dr. Capstick by the UK Engineering Council in 2006.

Title: Human Electromagnetic Field Exposure Assessment: Incident Field Evaluations, Dosimetric Evaluations (1.5 h)

Abstract: Exposure to electromagnetic EM fields is normally assessed in one of two ways, namely, quantification of the incident fields upon the body or analysis of the induced fields within the body. In this talk we will consider both of these aspects for frequencies from extremely low frequency ELF to microwave and millimeter wave super high frequencies SHF, encompassing power transmission, inductive cooking, wireless power transfer, broadcast transmissions, mobile radio and mobile phones, tablets, base stations and computers with all their integrated wireless standards.

Evaluation of the fields incident upon humans is performed through measurements using suitable instruments at the locations to which a person can most closely approach the source of the EM fields in the absence of the person, i.e. where the fields that can interact with the body are at their strongest. We will look at the sorts of instruments available to perform these types of evaluations and the comparison of measured values with safety standards.

Dosimetry is the practice of evaluating the fields and currents that are induced inside the body by the EM fields incident upon the body. These fields cannot be directly measured as it would require probes to be placed inside the body. Hence, dosimetry has two branches, numerical and experimental. Numerical dosimetry uses anatomical models of the human body to perform simulations of the exposure scenario(s). Experimental dosimetry uses simplified phantoms filled with tissue simulating media into which measurement probes can be inserted to perform measurements, these are then compared to numerical assessments of the simplified phantom using the same simulation tool as used to perform the simulations on anatomical models. In this talk we will focus on the types of experimental phantoms and measurements that can be performed and look at the quantities outlined in safety standards.

Yasuhide Hobara: Yasuhide Hobara joined the University of Electro-Communications (UEC) in 2009. Following his graduation from the UEC in 1997, he worked at various educational and research institutes such as the Institute of Applied Physics Russian Academy of Sciences in Nizhny Novgorod, Earth Observation Research Center, JAXA, Laboratoire de Physique et Chimie de l'Environnement et de l'Eespace CNRS (France), Swedish institute of space physics (Sweden), The University of Sheffield (UK), and Tsuyama National College of Technology (Japan). Terrestrial and space electromagnetic environment is his main field of research such as space plasma physics, seismo-electromagnetics, and atmospheric electricity from ground-based and satellite measurements. He is interested in monitoring and predicting terrestrial and space environments using radio sensing techniques. He is currently secretary of the Japan National Committee (JNC) of the URSI, committee member of ICAE (International Commission on Atmospheric Electricity), member of ISC GeoUnions Standing Committee on Disaster Risk Reduction, head of the Centre for Space Science and Radio Engineering, Earth Environment Research Station of UEC.

Title: Natural electromagnetic noise measurements (1.5 h)

Abstract: We live in abundant electromagnetic noise from natural origins. Measurement of natural electromagnetic noise is very important both to understand how our nature works and to some precursors useful for potential natural disaster mitigation. In this lecture, I will introduce several examples of natural electromagnetic (EM) noise measurements in the terrestrial environment. Three interesting topics will be paid attention to which are (1) atmospheric natural EM noise (EM radiation from lightning discharges, atmospheric electric field), (2) EM noise related to seismic activities (geomagnetic field, VLF/LF transmitter signals), and (3) EM measurement in space (space plasma waves, etc.). Practical applications for the above-mentioned measurement will be provided as well. Moreover, if time allows, real-time measurement of EM noise (from VLF/LF transmitters and lightning strokes) will be demonstrated and participants will join and enjoy the experiment in the venue.

Debatosh Guha: Debatosh Guha is a Professor in Radio Physics and Electronics, University of Calcutta and Abdul Kalam Technology Innovation National Fellow. He is a fellow of IEEE and also a fellow of all four Indian National Academies for Science and Engineering. He served IEEE AP Transactions and IEEE Antennas and Wireless Propagation Letters as an associate editor and is currently serving as the Chair of *IEEE APS Member and Geographic Activities Committee* and *IEEE Technical Committee on Antenna Measurement*. He has authored nearly 100 technical articles in IEEE Transactions/Letters/Magazine along with a couple of books published by IEEE Press/Wiley. He is now serving as a Distinguished Lecturer of the IEEE AP Society.

Title: Is it difficult to Measure an Antenna? (1.5 h)
(The technical talk is in association with IEEE APS Antenna Measurements Committee)

Abstract: This talk will address some concerns and queries that most of the newcomers or even a little experienced antenna engineers ask frequently. They usually express some specific doubts in their approaches and understanding even after practicing measurements for a few times! Those fundamental aspects and the physics behind them will be addressed based on our personal experience over the years. Several challenges that we have faced from time to time and their solutions will be discussed as interesting real life examples. Another major issue is the order of disagreement between the measured data and theoretical predictions (computed or simulated). Antenna measurements, therefore, demands a thorough understanding of the theory, especially when we deal with some unconventional antenna geometry, and/or radiation aperture, and/or modal fields. A thorough discussion on this aspect including the required measurement tricks will be provided.