

**Lecturer:** Eric Michielssen

**Title:** Wigner-Smith Methods for Electromagnetics

**Level:** Intermediate (graduate level background in electromagnetic theory)

**Abstract:** Wigner-Smith (WS) time delay concepts have been used extensively in quantum mechanics to characterize delays experienced by particles interacting with a potential well. These lectures formally extend WS time delay theory to Maxwell's equations and explore its potential applications in electromagnetics. The WS time delay matrix relates a lossless and reciprocal system's scattering matrix to its frequency derivative and allows for the construction of modes that experience well-defined group delays when interacting with the system. The matrix entries for guiding, scattering, and radiating systems are energy-like overlap integrals of the electric and/or magnetic fields that arise upon excitation of the system via its ports. Numerous applications in electromagnetics will be highlighted, including the characterization of group delays in multiport systems, the description of electromagnetic fields in terms of elementary scattering processes, and the characterization of frequency sensitivities of fields and multiport antenna impedance matrices. Extensions of WS methods towards lossy and dispersive systems will be analyzed as well, and avenues for leveraging WS concepts in computational electromagnetics will be discussed.

**Biography:** Eric Michielssen received his M.S. in Electrical Engineering (Summa Cum Laude) from the Katholieke Universiteit Leuven (KUL, Belgium) in 1987, and his Ph.D. in Electrical Engineering from the University of Illinois at Urbana-Champaign (UIUC) in 1992. From 1992 to 2005, he served on the faculty at UIUC. In 2005, he joined the University of Michigan (UM), Ann Arbor, where he currently is the Louise Ganiard Johnson Professor of Engineering and Professor of Electrical Engineering and Computer Science. He also serves as UM's College of Engineering's Associate Dean for Research.

Eric Michielssen received a Belgian American Educational Foundation Fellowship in 1988. He was the recipient of a 1995 National Science Foundation CAREER Award and the 1998 Applied Computational Electromagnetics Society (ACES) Valued Service Award. In 1999, he was named 1999 URSI United States National Committee Henry G. Booker Fellow and selected as the recipient of the URSI Koga Gold Medal. In 2003 he served as a Scholar in the Tel Aviv University Sackler Center for Advanced Studies. He was the recipient of the 2014 IEEE AP-S Chen-To-Tai Distinguished Educator Award, the 2017 IEEE APS Sergei A. Schelkunoff Transactions Prize Paper Award, the 2020 IEEE APS Harrington-Mittra Computational Electromagnetics Award, the 2020 ACES Computational Electromagnetics Award, and the 2022 IEEE APS R.W.P. King Award. He is a Fellow of the IEEE and a member of URSI Commission B.

Eric Michielssen authored or co-authored over 230 journal papers and book chapters and over 400 papers in conference proceedings. His research interests include all aspects of theoretical and applied computational electromagnetics. His research focuses on the development of fast frequency and time domain integral-equation-based techniques for analyzing electromagnetic phenomena, and the development of robust optimizers for the synthesis of electromagnetic/optical devices.