Lecturer: Chao-Fu Wang

Title: Characteristic Mode Theory for Lossless Objects and Its Applications to Analyzing and Designing Antennas

Level: Intermediate (graduate level background in electromagnetic theory and numerical methods)

Abstract: Theory of characteristic modes (TCM), also known as characteristic mode (CM) theory, was pioneered and developed by Garbacz, Turpin, Harrington, Mautz, Chang, and others during the late 1960s and 1970s. It has recently received renewed attention and attracted much interest in electromagnetics community as TCM can provide a convenient approach to determine the inherent resonant behavior and obtain modal solutions of arbitrarily shaped objects, without considering specific excitation sources. Such TCM solutions offer clear physical insight and fundamental degree of freedom for the efficient analysis and novel design of antennas and scatterers. TCM has become extremely popular, especially in the last 10 years, and until now many advances have occurred.

This lecture will provide an overview of the current status and development of TCM, specifically focusing on its formulations for lossless objects and their applications in analysing and designing various antennas. Detailed presentations will be provided to address the fundamental principle of TCM formulations, explore the underlying physics of TCM solutions, and highlight the distinctive aspects of the TCM analysis and design process for antennas. Through typical antenna examples, attendees will gain insight into the promising applications of TCM in antenna engineering. This lecture covers some representative materials from a recent book, co-authored by the Instructor, "*Characteristic Modes: Theory and Applications in Antenna Engineering*, Wiley, 2015".

Biography: Chao-Fu Wang was a Postdoctoral Research Fellow with the Center for Computational Electromagnetics, University of Illinois at Urbana-Champaign (UIUC), USA, from 1996 to 1999. He came to Singapore in 1999 to join the National University of Singapore and became a Principal Research Scientist in 2011. He co-authored ***Characteristic Modes: Theory and Applications in Antenna Engineering*** (Hoboken, NJ: Wiley, 2015).

Dr. Wang was a co-recipient of the 2009 Best Applied Computational Electromagnetics Society (ACES) Journal Paper Award. He served as a Chairman of the IEEE Singapore MTT/AP Chapter in 2013. He has been actively involved in organizing many conferences, including the General Chair of 2020 IEEE International Conference on Computational Electromagnetics (ICCEM 2020). As a regular reviewer of many international journals, he was an Associate Editor of the *IEEE Transactions on Microwave Theory and Techniques* from 2020 to 2022, and he is currently an Associate Editor of *IEEE Journal on Multiscale and Multiphysics Computational Techniques*, *International Journal of Numerical Modelling: Electronic Networks, Devices and Fields*, and *Electronics Letters*.