Enhancing the Efficiency of Metamaterial-based Microwave Components: Transversal Filter Approach in Radiated- and Guided-Wave Applications

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Abstract: Metamaterials are artificial electromagnetic materials with novel effective medium properties that may not be available in nature. The concept of metamaterial structures has led to the design of many novel circuits exhibiting component enhancements. One type of metamaterial-based antenna structure that has been widely studied is the composite right/left-handed transmission line (CRLH-TL) leaky-wave antenna (LWA). This antenna structure has been shown to offer significant advantages over conventional LWAs. For example, a balanced CRLH-TL LWA is able to achieve continuous backfire-to-endfire frequency-dependent beam scanning with a true broadside beam, good impedance matching over an entire operating band, and simple feeding structure. Furthermore, if CRLH-TL LWAs are integrated into distributed amplifiers (DAs), a microwave transversal filter with broadband amplification, DA-based CRLH-TL LWAs can realize high gain antennas while maintaining the aforementioned beam-scanning capability. Although the radiation power of the antennas can be increased by distributed amplification, power is dissipated in the termination. This issue can be resolved by introducing novel power recycling schemes to redirect the dissipated power and inject it into the antenna system again, thereby improving antenna efficiency significantly. The remaining half of this talk will be on negative group delay (NGD) circuits, another kind of artificial material engineered to exhibit negative group delays. Conventionally, in microwave regime, NGD circuits are based on bandstop structures using lumped elements such as parallel RLC resonators that usually have a narrower bandwidth of NGD and lack a systematic design method. Toward this end, NGD circuits using transversal filter approach are proposed and have been shown to have a wide bandwidth of NGD with a comprehensive design method. By using these artificially engineered material based components, novel microwave imaging and communication systems as well as power amplifiers with enhanced efficiency can be realized.

Speaker: Chung-Tse Michael Wu received his B.S. degree from National Taiwan University (NTU) and M.S. degree from University of California at Los Angeles (UCLA) in 2006 and 2009, respectively, both in Electrical Engineering. He is currently finishing his Ph.D. degree in the Department of Electrical Engineering, University of California at Los Angeles (UCLA). Since September 2008, he has been a Graduate Student Researcher at the Microwave Electronics Laboratory in UCLA. In 2009, He worked as a summer intern in Bell Labs, Alcatel-Lucent, Murray Hills, NJ. In 2012, he was a special-joint researcher with Japan Aerospace Exploration Agency (JAXA) in Kanagawa, Japan. Mr. Wu was the recipient of 2011 Asia Pacific Microwave Conference (APMC) Student Prize and the recipient of 2013 APMC Best Student Paper Award. He is a student member of IEEE, IEEE-MTTs, and IEEE-ComSoc. He also serves as a reviewer for several journals, including IEEE Transactions on Microwave Theory and Techniques, IET Microwaves, Antennas and Propagation, Journal of Electromagnetic Waves and Applications, and International Journal of Electronics. His research interests include applied electromagnetics, antennas, passive/active microwave components, microwave systems and metamaterials.