Abstract:

Despite the many studies that have been undertaken to understand the wonderful world of nonlinearity, most undergraduate electrical engineering programs are still confined to linear analysis and design tools. As a result, the vast majority of microwave designers still cannot profit from the significant technological advancements that have been made in nonlinear circuit simulation, active device modeling and new instrumentation for performance verification. So, they tend to conduct their designs relying on experience, empirical concepts, and many trial and error iterations in the lab. This talk will reveal the ubiquitous presence of nonlinearity in all RF and microwave circuits and the recent efforts made to understand, model, predict, and measure its diverse manifestations. We aim to bring microwave engineers' attention to newly available techniques, and attract researchers to pursue further studies on this scientifically exciting topic. Starting with some elementary properties of nonlinear circuits (like nonlinear signal distortion, harmonic generation, frequency conversion and spectral regrowth), we will show that nonlinearity is present in all wireless circuits, either to perform a desired signal operation or as unintentional distortion. In this way, we will show how oscillators, modulators or mixers could not exist without nonlinearity, while power-amplifier designers struggle to get rid of its distortion effects. After this theoretical overview, we will introduce some recent advancements in nonlinear microwave circuit analysis tools and illustrate different types of models that are currently being used to represent and predict device, circuit, and system performance. Finally, we will focus the talk on the key metrics that are used to characterize nonlinear behavior, as well as newly developed lab instruments and their ability to assess device performance.