EE153: MICROWAVE CIRCUITS & ANTENNAS

Winter 2026, 12 Units (3-2-7), Tue 3-5, Thu 3-4 – Instructor: Antsos

In the ongoing quest for ever-increasing communication and computation speeds, the frequencies and clock rates of analog and digital circuits have continued their steep ascent over the past three decades. Computer CPU clocks, at about 100 MHz in the early 1990s, are now in the multiple GHz. Computer wireless networks (WiFi), originally at 900 MHz, have now transitioned from 2.4 to 5 GHz, with throughputs exceeding 1 Gb/s. Cell phones, initially at 900 MHz, successively moved to 1900 MHz (3G), 2.1 GHz (4G LTE), and, with the advent of 5G, to 3.7 GHz, 28 GHz and, in places, as high as 59 GHz. 6G is expected to utilize millimeter-wave (30-300 GHz) and terahertz (0.3-3 THz) bands. Automotive radars operate at 77 GHz. Point-to-point microwave links between buildings operate at 23 and 80 GHz.

- **The problem:** When the frequency of operation of a circuit is so high that the wavelength is comparable to its physical size, the traditional analysis techniques that are based on Kirchhoff's voltage and current laws fail. With the continuing trend towards higher frequencies, the specialized analysis and design techniques that apply to this higher frequency domain have found a host of new applications. As a Caltech professor once jokingly remarked, even the "digital guys" have had to acknowledge that there is something between 0 and 1!... 😊

Come discover the specialized analysis and design techniques that apply to the high frequency circuits used in computers, cell phones, space communications, radar and broadcasting!

The **lectures** will cover the theory of transmission lines, characteristic impedance, maximum power transfer, impedance matching, reflections, signal flow graphs, power dividers, coupled lines, even and odd mode analyses, couplers, filters, noise, amplifiers, oscillators, mixers and antennas.

In the **labs**, you will design, simulate, build and characterize microwave circuits such as microstrip filters, power dividers, directional couplers, low-noise amplifiers and oscillators, using the commercial Computer-Aided Engineering (CAE) software package *Microwave Office*, which is **actually used in the field by engineers**, and sophisticated and expensive network analyzers to measure their performance.