EE153-MICROWAVE CIRCUITS & ANTENNAS

Spring 2016, 12 Units (3-2-7): Tue 3-5, Thu 3-4

In the ongoing quest for ever increasing speeds of communication and bandwidth, 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 hovering in the multiple GHz. Computer wireless local area networks (Wi-Fi), originally at 900 MHz, have now transitioned from 2.4 to 5 GHz, with throughputs exceeding 1 Gb/sec. Cell phones started at 900 MHz, then moved to 1900 MHz and now, with the advent of 4G, have moved into the 2.1 GHz band. Automotive radars operate at 77 GHz. Point-to-point microwave links connecting buildings operate at 23 and 80 GHz.

- **The problem:** When the frequency of operation becomes so high that the wavelength is comparable to the physical size of a circuit, the traditional circuit analysis techniques, based on Kirchhoff's voltage and current law, fail. With the continuing trend towards higher frequencies, the specialized design and analysis 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 high frequency circuits used in computers, cellular telephony, space communications, radar and broadcasting!

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

In the labs you will design and measure microwave circuits, such as microstrip filters, directional couplers, low-noise amplifiers and oscillators, using sophisticated network analyzers worth well over $100,000.

The commercial Computer-Aided Engineering (CAE) software package *Microwave Office* will be provided for you to design and analyze your circuits. *Microwave Office* is a powerful microwave CAE software package that is **actually used by engineers in the field**.