MICRO AND NANOSTRUCTURED TRANSMISSION-LINE METAMATERIALS AND THEIR APPLICATIONS

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In this short course we will describe the fundamental properties, the physical realizations and the applications of negative-refraction and single-negative (e.g., plasmonic) metamaterials. These are engineered materials and artificially constructed structures that are characterized by negative effective permittivity and/or permeability in a given frequency band. The main emphasis will be placed upon the realization and interpretation of double-negative (DNG) and single-negative (SNG) metamaterials utilizing loaded transmission lines. With the aid of the powerful transmission-line concept, we will explain how to physically realize such SNG and DNG metamaterials from RF/microwave frequencies all the way up to the optical regime. We will also discuss some aspects of metamaterials with near-zero relative permittivity or permeability (i.e., epsilon-near-zero (ENZ) or mu-near-zero (MNZ) materials).

The applications to be discussed include microstructured electrically small resonant antennas, scannable leaky-wave antennas radiating in the fundamental spatial harmonic, compact sub-wavelength cavities and waveguides, phase shifters and compact/broadband antenna feed-networks, high-directivity couplers, multiplexing and de-multiplexing devices, transparency and low-observability, scatterers with reduced or enhanced RCS, nanocircuit elements, and lenses that are capable of resolving beyond the limits of diffraction. When relevant, the nano-scaled optical counterparts of some of these devices will also be described.