Principles of RF and Microwave Measurements

Finalità
A basic course in microwave measurements and measurement techniques from RF through microwave. Topics include characteristics of microwave generators, passive devices and detection systems; power, frequency, swept frequency network and spectrum analysis, time domain reflectometry and noise measurement. Techniques, precautions for each measurement type, and required instrumentation configurations are stressed.
Lecture and lab.

Programma
Review of trasmission line, Smith chart and matching network design.

Impedance and admittance relationships. Scattering parameters and transmission parameters. Topographical and analytical resolution of signal flowgraphs.

Power splitters, dividers, combiners. Bridges. Couplers.

Diode detectors: general theory, noise, main characteristics. Passive mixers: mathematical theory, architectures, parameters.
Thermal detectors: thermocouple and bolometers.

Power measurements: expression for power (average, pulse, and peak envelope power). Power-head elements. Uncertainty due to DC-RF substitution error, efficiency, and multiple reflections. The microcalorimeter.

Attenuation measurements
Noise temperature and noise figure measurements: the Y-factor measurement technique, noise measurement by spectrum analyser. Gain and noise-figure optimisation.

Network analysers: block diagram of the vector network analyser (microwave test sets, signal detection, synchronous detection, computer control). Scalar network analyser. The six-port network analyser. Error analysis and calibration techniques (12 parameters, TRL). Applications.

Time-domain reflectometry: general principles, fault location in transmission lines, evaluating cable loss, measurement of parasitic capacitance and inductance, time-domain from frequency-domain measurements.

Spectrum analyser: the traditional super-heterodyne architecture (tuning equation, frequency resolution and sweep time, display smoothing, multi-heterodyne, harmonic mixing). Amplitude and frequency accuracy, frequency resolution, noise and distortion, dynamic range. Modern performance spectrum analysers (digital IF section, swept and FFT analysis, compensation of the effects of phase noise and thermal noise). Applications (tracking generator, time-gating).

Attività d'esercitazione
14 hours with 1 laboratory assignment.

Modalità d'esame
Final Exam, Laboratory Report

Propedeuticità
Transmission line theory - Theory of wave propagation in waveguide (Propagazione guidata)

Testi consigliati
G.H. Bryant: Principles of microwave measurements. Peter Peregrinus Ltd.
A. E. Bailey: Microwave measurements, 2nd ed., Peter Peregrinus Ltd.