TeTech

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Practical design of small RF Antennas

Introduction.

The use of wireless communication is still growing. More and more Electronic Engineers become involved with antennas. They are even close to the electronics on the PCB. Many (RF) Engineers consider Antennas as magic.

Many books on antennas are more like a compilation of recipes. Others can only be understood with fluent knowledge of differential vector calculus. This antenna course covers antenna *design*, without being a course on higher mathematics.

This course deals with the design of antennas with size up to about two wavelengths. This category of antennas includes antennas used in the fixed service and mobile, portable applications. One can think of: cell phone antennas, WIFI antennas (both desktop, laptop and router), GPS (patch) antennas, whips on vehicles, low gain directional antennas and various RFID antennas (for both interrogator and tag or label).

The course is conducted for small groups only and has strong interaction. This almost "guarantees" good knowledge transfer and reduces foreign language related problems.

Who should attend?

This Course is for people that already are familiar with antennas, but want to familiarize themselves with antenna design. The focus is on mobile and portable communications like: LPD ISM equipment with Internal or External Antennas, RF & UHF RFID, Wireless add-ons for PC/laptop, wireless networking, Antennas for Covert Operations and Intelligence, Cellular Systems, etc. The concepts are easily applied to other fields of Antenna Design (for example Fixed Service HF or Microwave).

If you are a Technical user of Antennas, the *"Antenna Properties and Antenna Measurement"* course may be a better choice (available in Dutch and English).

If you are in magnetic field generating or receiving antennas (Inductive EAS, MF & RF RFID, power transfer, magnetic field sensing), please contact TeTech.

If you want to study antennas on a strictly mathematical basis (differential vector calculus), this course is not suited for you.

What you will learn?

After course completion, attendees will:

- know the physical limitations of Antenna Systems,
- have good understanding of the relationship between: Radiation Pattern, Gain, Geometry, Wavelength and Radiation Resistance,
- be able to design electrically large en small Antennas with a limited number of practical and/or simulation (iterative) steps,
- be able to tailor the geometry to ease matching.

Prerequisite.

Attendees should have a Secondary Vocational or Polytechnic level in Telecommunications, Physics or Electronics. Attendees should be familiar with:

- arithmetic & goniometric functions
- complex calculus (a+jb)
- the concept of Fields (E- and H-Field)
- RLC Lumped Component & Transmission Line Circuits
- Smith Chart (preferred).
- 3D imagination
- definitions used within the antenna community.
- average knowledge of English Language

This course has a relative high prerequisite. When you follow TeTech's *"Antenna Properties and Antenna Measurement"* course before this course, you are fully prepared for this Antenna Design Course.

Do you have doubt about your level with regards to RF-circuit theory and Antennas? Don't hesitate to contact TeTech. Additional classes can be added to make sure you are best prepared to attend this course. For example, "Electromagnetism for Antennas and Electronics" can easily be added when your electromagnetism isn't up to date.

A basic skills assessment test is available for this course.

The course is conducted in Dutch or English.

Course Content.

A Quick tour through relevant definitions, concepts and relations.

Basic function of an Antenna, seen as a "black box", Gain, Directive Gain, Radiation Efficiency, Radiation Pattern, Effective Area (Ae), Power Flux Density, E- and H-field, Poynting Vector (Poynting's Theorem), Polarization, Line Of Site transmission (LOS), Gain versus Frequency, Wavelength, physical size and trade-offs, reciprocity, spherical coordinates, etc.

Radiation basics and Radiation Resistance.

Field and radiation pattern from a single wire element (focus on far field Radiation Pattern), Radiated power, principles of superposition of radiated E- or H- field, Field Pattern from multiple wire, concept of Radiation Resistance,

Estimation of current distribution in antenna structures.

Characteristic impedance of transmission line without return conductor, Traveling waves versus standing wave patterns, smart source insertion, radiation pattern and radiation resistance of half wave dipole and classical quarter wave ground plane antenna (GPA).

Estimation of radiation pattern and gain.

Determination of radiation pattern with use of "group pattern" and "element pattern", discrete and continuous sources of radiation, estimation of gain with the help of the radiation pattern (to avoid evaluation of (difficult) integrals).

Modeling of antenna structures.

Extraction of transmission line models and lumped circuit (RLC) models for determining impedance versus frequency (this is the basis for determining losses and useful bandwidth of antennas).

Useful Bandwidth and Losses.

Skin effect, determination of ohmic and dielectric losses, quality factor (Q factor) of antenna, effect on bandwidth of multiple coupled resonators.

Matching, Baluns and Common Mode Aspects.

Matching by changing the geometry of the antenna (Inverted F, Half Wave Microstrip Antenna, asymmetrical dipole, End-fed Dipole), matching with lumped components (L, C. etc), monopole and dipole structures (inclusive common mode aspects), Baluns.

Antennas perpendicular and parallel to ground planes

Use of principle of reflection (positive and negative image), limitations of reflection theory (Fresnel zones), Impact of reflecting planes on radiation pattern, impedance, bandwidth and radiation efficiency.

Practical information to speed up your antenna design.

Formulas for characteristic impedance, length extension due to end-effects (fringing), determination of inductance and capacitance of traces, capacitance of short whip antennas.

Common electrically “small” antennas (so < 0.5·lambda).

Quarter wave above or on the edge of a ground plane, reduced length quarter wave resonating antennas in general (T-Antenna, Helical, inductive loaded, meandering quarter wave), inverted F, Patch antenna, Notch in ground plane, effect of limited ground plane/PCB size, Measurement complications with small ground plane / PCB size.

Radiation safety.

A quick tour through the ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). This is a "must" in case of body worn applications and high power applications.

Slot Antennas in metallic sheet, tube, angle, etc. (Optional).

Current distribution, Impedance, radiation pattern, Matching of slot antennas, blocking of backwards radiation, Effect of limited sheet size or tube diameter, open slots at edges of sheets and tubes,

All course material is presented in a mixture of theory, sound examples and exercises (both theoretical and practical). During the practical part of the course, 13 cm equipment is used.

Every course attendee receives a special prepared handout that consists of about 100 pages (70% text and 30% illustrations) and the examples that have been discussed during the course.

Would you like to discuss some special topics (for example antenna measurements without a network analyzer)? Don't hesitate to ask for them. It is very likely that your wishes can be incorporated into this antenna design course.

This course can be completed with an examination (English or Dutch language).

Location, Schedule and Number of Attendees.

This course is mostly given on-site, inside or outside the Netherlands and can be conducted within or outside office hours.

Depending on: the agreed program, entry level and number of attendees, about 3 to 6 days are required (for the standard course).
It is recommended to conduct the course over a period of several weeks. This is to enable smooth assimilation of the material. It is also recommended to limit the number of attendees to 10 per session.

Price.

The price is about E 850.-- per day (exclusive transportation and, when required, visa, accommodation, etc), plus E 46.-- per attendee (for the full course).

Discounts are applicable (exclusive transportation and/or lodging):
3 days are E 2295,-- (you pay 2.7 days)
4 days are E 2975,-- (you pay 3.5 days)
5 days are E 3570,-- (you pay 4.2 days)
6 days are E 4250,-- (you pay 5.0 days)

The exact price will be determined based on your requirements. When a 4 day program is agreed for 4 attendees, the price will be about 850.--/attendee.

Interested?

If you are interested, please contact TeTech, free of any obligation. This Course can easily be adapted to your special needs. TeTech will be happy to discuss your requirements and convert them into a course that will help you meet your goals.

This course covers just a part of TeTech's Expertise. There are several other courses with a strong relation to this course. In addition, TeTech can fulfill your educational needs in the field of Electronic Design (System & Component level) and Analog Signal Processing.

December 2019

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