

Michel Ivrláč

Study Guide

Physical Principles of
Antenna Systems

STUDY **G**UIDE
FOR THE
PHYSCAL **P**RINCIPLES **O**F
ANTENNA **S**YSTEMS

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Berichte aus der Hochfrequenztechnik

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Physical Principles of Antenna Systems

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This book is intended as a STUDY GUIDE to my textbook

»*Physical Principles of Antenna Systems*«

Michel Ivrlač

Shaker Verlag 2017.

I wrote this study guide in order to help the self-studying student
to master the textbook's contents. Fourteen lectures,
questions & answers and problems with
solutions are awaiting you!



I dedicate this book to
my wife *Lai-U* and our children *Gallus* and *Felina*.



Welcome on Board!

GENTLE STUDENTS: so you aim at uncovering the mysteries and wonders of the electromagnetic field, and you finally wish to know how an antenna really works? I am glad to welcome you to our course on the *Physical Principles of Electromagnetic Fields and Antenna Systems*.

WHAT are we going to do? From first principles, we are going to derive and explore the great laws of conservation, the EINSTEIN-equivalence principle of mass and energy, the LORENTZ-transformation, four-vectors, special relativity, the covariant formulation of the theory and the general solution of the field equations and make them the foundation for engineering applications for the analysis and design of single- and multi-antenna systems. Radiation resistance, available power, effective antenna area, the reciprocity theorem, electric currents in conductors, induced antenna current and voltage, directivity and super-directivity, antenna mutual coupling, multiport modeling, matching networks and near-field communication, are all covered in depth with detailed mathematical derivations.

HOW we will do that? In a way that you will be able to grasp an *honest* understanding of the subject. This way is based on the following four pillars:

1. TAILOR-MADE TEXTBOOK: Electrodynamics is hard, and the best texts on it were written for the professionals. In this course, you are lucky! There is a textbook which is written with the student in mind. Yet it does not hide any difficulties from you but rather slows down when necessary to let you grasp the nature of the difficulty first, and then teaches you how to master it. How do I know this? I happen to be the author of this textbook and have year long experience in teaching its contents and have received valuable feedback from generations of students. You can get it as an e-book here:

<https://www.shaker.de/de/content/catalogue/index.asp?lang=de&ID=8&ISBN=978-3-8440-5094-3>

2. WEEKLY GUIDANCE: Do you need some guidance in learning? Sure, who doesn't? And again you are lucky, as there are *weekly guidances* where I introduce and discuss the topics of the week. There you will see what you are expected to learn in that week, where to find the material in the textbook, additional details, hints and examples, which will help you mastering the

concepts. From time to time I also include additional material which is not covered in the textbook. Some of this material stems from recent research, yet is instructive for the student. There are 14 such guidances. All of them are contained in this book you are currently reading!

3. QUICK QUESTIONS: These are meant to help you check whether you have understood a particular concept or topic from the weekly guidance. They can be answered rather quickly and are not too difficult. Essentially every student should do them. They come with solutions, of course. They are meant to be done on a weekly basis. All 13 sets of quick questions and corresponding answers are contained in this book you are currently reading, right after the respective weekly guidance.

4. PROBLEMS for SOLUTION: These are meant to help you apply several concepts and techniques from the lecture to solve more elaborate problems. The problems will take longer to work on than the quick questions, and some problems are designed to be challenging even for the best of students. So, at some point, every student will get stuck some place in some problem. What then? No harm done! There are exceedingly detailed solutions available. I recommend that you give the problems a fair try and look up the solution once you got stuck, or you want to confirm that you did it right. All six sets of problems and the corresponding solutions are contained in the book you are currently reading.

NOTE: This course is by no means a survey but is very serious. I do believe that a student who has understood everything in the weekly guidances, studied the textbook and worked all problems, has obtained a first class education in the physical principles of electromagnetic fields and antenna systems. And do not forget that *time* is an important issue here (Proverbs 20:21).

AND: do not just learn the laws, but ponder on them ceaselessly, dig as deep as you can into the details of everything and find there new interpretations, new applications and new marvels!

Welcome on Board!

Michel T. Ivrlač

If there is any wisdom to be found in this work,
the author wishes to attribute it to the one source of all wisdom.

קרא אלי ואענה ואניידה לך גדלות ובצרות לא ידעתם: ס

*Call you to me, and I shall answer you, and I shall tell to you great things
and restricted things, which you know them not.*

(Jeremiah 33:3)

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