School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4001—High Frequency Techniques

Course Brief and Outline—2020

Academic Staff:

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1 Course Background

Antennas form a vital link between transmitters (receivers) and the propagation medium. As such they perform as electromagnetic transducers by converting current and voltage into E and H fields and vice versa. (Forgetting this leads to the iPhone4 antenna fiasco!)

The sudden interest in all things "Wireless" was first ushered in by the phenomenal success of GSM, which has evolved exponentially.

Although from a DataComms perspective, we are simply the "air-interface" it is a very misunderstood area: it is ultimately the antenna (system) that determines the interface to the medium.

The main aim of lectures is to convey some experience, insight and intuition as well as to stimulate discussion.

2 Course Objectives

Largely, High Frequency Techniques build on the foundation laid by Electromagnetics to cover the Antenna Design aspects of the communications channel. However, any High Frequency (ie High Speed circuits) relies on the techniques developed in this course.

3 Course Outcomes

On successful completion of this course, the student is capable of:

1. understanding antenna terminology and fundamental characteristics.
2. using antenna simulation programs effectively.
3. designing and understanding the operation of some common antenna types.
4. performing basic electromagnetic derivations on simple antenna types.
5. performing some basic antenna measurements.

4 Course Content

Revision of Antenna Fundamentals Electromagnetic Spectrum, Radiation Basics, Polarization, Directivity and Gain, Reciprocity, Aperture, Radiation Resistance, Link Equation (Friis), Field and Power Flow, Modulation Schemes and Noise.

Thin Linear Antennas Fields from Potentials, Fields from Current carrying wires, The ideal dipole, Short Dipole, Short Monopole, Reactance of small antennas, Sinusoidal Dipole, Ohmic Losses, Matching, Baluns, Thickness Factor.

Array Theory Isotropic arrays, Pattern Multiplication, Binomial Arrays, Uniform Arrays, Interferometer, Multi-beam "Smart Antennas", Continuous Aperture distributions.

Common Antenna Types Travelling wave (HF) antennas, Small loop, and slot antennas, Normal mode helical, Axial mode helical, Reflector antennas, including the Corner Reflector, Yagi-Uda, LPDA.

Propagation Ionospheric propagation, Line of Sight, Penetration

EMC/I Electromagnetic Compatibility: Regulations, methods, compliance.

5 Prior Knowledge Assumed

A *strong* Electromagnetics background is assumed.

6 Assessment

All submissions must be in strict accordance with the guidelines contained in the *School's Blue Book* and the rules contained in the *School's Red Book.* No exceptions will be considered.

6.1 Formative Assessment

None.

6.2 Summative Assessment

Assessment Contributor	Duration (hours)	Component Yes/No	Method & Weight%	Calculator Type	Permitted Supporting Material
Lab	3	No	20%	3	N/A
Project	30	No	30%	3	N/A
Exam	2	No	50%	2	Note

Note:

- Dictionary permitted,
- Handwritten A4 formula sheet permitted[1].

The examination will cover *all* material covered in the course, and especially discussion topics in lectures.

6.3 Assessment Criteria

The student's understanding of the fundamental aspects of the course will be probed. Exam questions etc will need to be answered in order to answer the question: "WHY?" as opposed to the simplistic "HOW". I am not attempting to assess a simple methodology, I will assess fundamental understanding of concepts.

Note that the onus is upon the student to convey this understanding in an examination. A terse, correct "answer" may not necessarily attract marks! Please refer to my exam writing skills notes at `ytdp.ee.wits.ac.za/ExamWritingSkills.html`.

[1] All 6 sides may be used

7 Satisfactory Performance (SP) Requirements

For the purpose of Rule G.13, *satisfactory performance in the work of the class* means attendance and completion of prescribed laboiratoty activities, attendance at tutorials designated as compulsory in this CB&O, submission of assignments, writing of scheduled tests unless excused in terms of due procedure.

8 Teaching and Learning Process

8.1 Teaching and Learning Approach

My lecturing style is highly interactive, and largely of the "chalk and talk" variety. This means that the emphasis during lectures is upon understanding, and not on "transferring the lecturer's notes to those of the student, without passing through the minds of either". Interaction on the part of the student is ***required.***

One negative consequence of an interactive lecturing style (as opposed to a transfer of notes style), is that the student actually gains *an* understanding in the lecture. If it assumed that this *initial* understanding is all that is required, disaster occurs. Learning is an *iterative* exercise, and requires constant re-inforcement. My lecturing style can thus lead to a complacency which is rudely interrupted at examination time. ***HENCE:***

Tutorial exercises are designed to complement and probe material *currently being taught.* They are *not* necessarily designed as examination questions, which typically cover more comprehensive, integrated material. Doing these tutorial exercises only just before the exams will not help. They are to be done concurrently with the material being explored. The past exam papers are to be used as a benchmark for examination questions.

8.2 Information to Support the Course

There is a prescribed text for this course, the same as was used for the Electromagnetics course.

There are no notes handed out for this course.

In addition, there is a 122 page "Study Guide", by some obscure bloke:

- Clark A. R. (2004) "SuperNEC Study Guide for Electromagnetics and Antennas", Poynting Innovations, Wynberg, Sandton.

available from the Course Home Page. (See below).

Other References

- Kraus JD (1988) Antennas (2nd ed.) McGraw-Hill.
- Collins, RE (1985) Antennas and radiowave Propagation. McGraw-Hill.
- Jordan EC and Balmain KG (1968) Electromagnetic Waves and Radiating Systems. Prentice-Hall.
- Balanis CA(1982) Antenna Theory—Analysis and Design. Harper and Row
- Stutzman WL and Thiele GA, (1981) Antenna Theory and Design. John Wiley and Sons.
- Hall GL (ed) (yearly publication) The ARRL Antenna Book, American Radio Relay League.

8.3 Learning Activities and Arrangements

Lectures:

There will be two lectures per week. Students are expected to attend all lectures and to make their own notes.

I keep strictly to South African Standard Time (SAST). I respect your time, and will not drag on my lectures, and I expect you to respect my time, and that of your colleagues, by arriving on time, so that latecomer disruption is avoided.

Tutorials:

There will also be a tutorial by arrangement only.

Project:

In common with all fourth year courses in the "Honours" year, there will be a project—see handout, deadline as per 4th year schedule.

Laboratory:

There will be a laboratory associated with this course with a booking sheet posted later. The laboratory is felt to be an extremely important part of this course: hence the assessment rating. A thorough and properly presented report is expected. Students who cannot produce evidence of preparation will be asked to leave the laboratory.

School Policy states that there are no lab exemptions.

Consultation:

I have what I call a "Modified Open Door" policy. You can come and see me at any time, but only in groups! I have a great regard for the peer-support system; you only really understand something if you can explain it to your peers. I have long ago forgotten the particular difficulties I had with some of the concepts taught in this course, they now appear to me as "obvious"; peers do not have this myopia.

The preferred method of contact, however, is email.

It is generally convenient to grab me between and after lectures.

9 Course Home Page

For other information related to the course, please refer to the Course Home page at
`http://ytdp.ee.wits.ac.za/elen4001Home.html`

The online version is `http://ytdp.ee.wits.ac.za/elen4001outline.html`