EEE5104F INTRODUCTION TO RADAR

1 Pre-requisites

This course requires students to have a good background in Mathematics, Physics, and computer programming, to Honours Level (4 years of study). Many of the problems can be solved using a spreadsheet, since they are largely parametric studies. The treatment is at systems level, so the depth of knowledge of these fields can be corrected with some extra reading while working through the course.

2 Course Format and Dates

The course is given in a five day, intensive format, followed by a further five tutorial and seminar sessions over the weeks following the intensive session. These sessions are based on problem sets which the student must attempt in order to gain benefit from the seminars. In addition, students may book appointments with the Course Convener and the Tutor. The course Calendar is the governing document for planning: please monitor it frequently. https://sites.google.com/site/radarmasters/schedule

Course interaction is via the UCT Vula System. You will have access to this information once you have registered for the course. It is important that you provide your preferred email address (one that it checked frequently) for your Vuvuzela registration.

3 Staff

Convener Prof. M.R. Inggs UCT mikings@gmail.com

Lecturers: Prof. H.D. Giffiths UCL H.Griffiths@ee.ucl.ac.uk and Prof. C.J. Baker OSU baker@ece.osu.edu

Tutor: Roaldje Nasjiasnagar UCT neddje(a)gmail.com

4 Course descriptions:

This course presents the principles and techniques fundamental to the operation of a radar system. Radar Engineering is very much a system level topic, as the field requires at least some knowledge of a wide range of other engineering specialties. The course follows the recommended text-book largely although there is additional material not covered. Specific course topics include:

4.1 Overview

Introduction, including course format, radar basics and the fundamental concepts of radar. The Radar Equation, which allows us to estimate the performance of a radar system and thus, to design radars for a specific purpose. Radar search and overview of detection and interference, which improves our models of performance, to be used in design.

4.2 Subsystems

Radar Transmitters are examples of microwave power engineering, and are essential for creating suitable waveforms for the radar, at a level sufficient to allow for detection of targets. Radar Receivers are responsible for processing of received energy, without adding significant thermals noise and susceptibility to other EM signals. The energy is then presented for signal processing. Radar Exciters are specialised hardware for creating radar waveforms and synchronizing the radar circuitry. The Radar Signal Processor is responsible for taking the radar signals from the receiver and processing them further to extract target information. This topic is taken up in much more detail in another course in this series.

4.3 Electronically scanned radar
This includes an understanding of basic antenna theory and operation, array antennas, phase shifting, hardware and radar resource management

4.4 Radar concepts and techniques.
These include Frequency Modulated Continuous Wave (FMCW) radar, Tracking, Moving Target Indication (MTI), Space Time adaptive Processing (STAP), Synthetic Aperture Radar (SAR), Aviation radar and Bistatic radar

4.4 Software Expertise
Students are expected to be proficient in tools such as Octave, MathCad, Mathematica, Simulink/Matlab, spreadsheets (OpenOffice, Excel. Students will use the tools most familiar to themselves.

5 Learning outcomes:
Having successfully completed this course, students should be able to:
5.1 Knowledge Base:
1. Understand the fundamental operation of radar to measure distance, angle, velocity using a modulated carrier;
2. Describe the key subsystems of a typical radar sensor;
3. Be able to identify which kind of radar sensor is best for a particular application;
4. Identify the key effects of the propagation medium on sensor performance and some countermeasures;
5. Describe the properties of targets and their fluctuations;

5.2 Engineering ability:
1. Explain in simple words the working principles and basic building blocks of a different types of radar system;
2. Model radar systems using appropriate mathematical techniques, including probability distributions, link power budgets, effects of clutter;
3. Have a top-level understanding of important parameters relating to subsystems (antennas, amplifiers, transmitters, targets) to be able to design a radar system;

5.3 Practical skills:
1. Carry out top-level designs and trade-offs of radar sensors, taking into account the important characteristics of the subsystems and other factors;
2. Simulate all or part of a radar system using computer software;
3. Calculate results of designs using programming techniques (languages or spreadsheets).

6 Textbook

No notes are given for this course and all students are expected to have a copy of, “Principles of Modern Radar” Volume 1, Ed. Richards, Scheer and Holm, Scitech Publishing, 2010. All lecture content will be examinable

8 Drill Problems

Students are expected to complete five sets of Drill Problems, handed out after the intensive lecture period. Students will be provided with at least 5 seminar opportunities of about an hour each with the lecturer, convener and tutors, and will be expected to attend 4 out of the 5 seminars, and attendance is only credited if the solutions have been submitted. The student's solutions to the problem set must be submitted on Vula before the start of the seminar. The seminars will be carried out with access by Skype for students off campus after the lecture session. For bandwidth reasons, the number of parallel sessions will have to be limited. For example, all students resident in the same city will be expected to attend at a common venue, and students will have to organize their own venue and projection facilities. Screen sharing will be enabled, but it is unlikely that video will be supported, again due to bandwidth limitations. Within reason, and with prior arrangement, students can approach the tutor / and / or the lecturer for help with problem sets.

9 Course Assessment and Examination

The assessment of this course is wholly dependent on a three hour, written examination, with the Duly Performed (DP) requirement of 4 out of 5 seminars attended. The examination is closed book, i.e. no notes may be brought into the examination venue. Students are not expected to memorize any formulas: all formulas and results will be supplied on the examination paper. Students may write the examination in their home location, provided satisfactory supervision of the examination can be arranged in good time.

10 Course Load

Item	Number	hrs/per	Hours
Lectures	40	1	40
Assimilation	40	2	80
Seminar Attendance	5	2	10
Drill Problems	5	3	15
Examination preparation	1	8	8
Examination	1	3	3
TOTAL			156