INTRODUCTION TO RADAR

1. Prerequisites

- Background in Mathematics and Physics.
- Basic knowledge of MATLAB programming.

2. Course format and dates

The course is divided in two sections. A first section will consist of five days of intensive lectures over a week period. The second part of the course will have duration of three weeks with five hours per week. This part of the course will be organized by using videoconference tools, such as Skype or others.

The student assessment is organized into a single test:

1) Assignment (30%)
2) 3-hour examination (70%)

During the intensive five-day course, practical sessions, also with the use of MATLAB, will be interwoven with classic lectures. Practical sessions are intended to strengthen the understanding of the theory and are based on running MATLAB. The students will familiarise with the problems and will learn how to set system parameters to achieve desired performances.

Follow up sessions will aim to:

1. provide support for solving the assignments
2. provide further clarifications about course topics
3. give specific seminars on topics related to the assignments

3. Staff

Prof. Marco Martorella – University of Pisa – m.martorella@iet.unipi.it

4. Course description

The course is organized as follows:

L1. Introduction (3h)

1.1 Radar concepts, definitions and nomenclature

1.2 Radar signals and systems

1.3 Overview of types of radar and applications

L2. Radar range equation (3h)

2.1 Power budget

2.2 Radar range equation in terms of SNR

2.3 Radar losses

2.4 Uses of radar range equation

P1. Range range equation (2h)

P1.1 Implementation of the radar range equation

P1.2 Performance analysis via the radar range equation

L3. Incoherent Pulse Radar (5h)

3.1 Concept

3.2 Implementation and components

3.3 Detection with incoherent pulse radar

P2. Nautical radar design (3h)

P2.1 Design of an incoherent pulse radar for maritime navigation

L4. Coherent Radar (5h)

4.1 Concept

4.2 Implementation and components

4.3 Detection with incoherent pulse radar

L5. Continuous Wave (CW) Radar (3h)

5.1 CW Radar concept

5.2 CW Radar functional scheme

5.3 CW Radar signal processing

L6. Frequency Modulated Continuous Wave (FMCW) Radar (3h)

6.1. FMCW Radar functional scheme

6.2. FMCW signal processing

P3. FMCW Radar (2h)

P3.1. An example of FMCW (PIRAD system)

P3.2. Data structure

P3.3. Data analysis

L7. Array Radar (3h)

9.1. Introduction to array radar

9.2 Signal modelling

9.3 Beamforming

9.4 Resolution, sidelobes and grating lobes

9.5 Integration with a coherent radar

P4. Beamforming (2h)

P3.1. Implementation of conventional beamforming

L8. Overview of radar applications (2h)

5. Learning outcomes

Having successfully completed this course, students should achieve:

- Understanding of radar as a concept and knowledge of various types of radar and its applications
- Understanding of radar functioning and its performance
- Understanding of the signal processing techniques that are currently used in radar to optimise its performance
- understanding of the radar components and how they are related and interconnected to realise a radar

6. Textbook

- Detailed presentation slides will be made available to students before the course starts.
- M. A. Richards, J. A. Scheer, W. A. Holm, "Principles of modern radar – Basic principles", Scitech Publishing (an inprint of IET)

7. Lecture programme

Time	Mon 18/7	Tue 19/7	Wen 20/7	Thu 21/7	Fri 22/7
08h30	L1	L3	L4	L4	P3

09h30	L1	L3	L4	L5	L7
10h30	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11h30	L1	L3	L4	L5	L7
12h00	L2	L3	L4	L5	L7
13h00	Lunch	Lunch	Lunch	Lunch	Lunch
14h00	L2	L3	Reutech	L6	P4
15h00	L2	P2	Reutech	L6	P4
16h00	P1	P2	Reutech	L6	L8
17h00	Tea	Tea	Tea	Tea	Tea
17h30	P1	P2	Reutech	P3	L8
18h30	Close	Close	Close	Close	Close

Item	Number	Hrs/per	Hours
Lectures	40	1	40
Assimilation	40	3	120
Seminar attendance	3	5	15
Drill Problems	3	5	15
Examination preparation	1	8	8
Examination	1	3	3
Total			201