Fundamentals on Radar and Navigation

Academic Year: (2021 / 2022) **Review date: 09-06-2021**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: SEGOVIA VARGAS, DANIEL

Type: Electives ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is expected that students have knowledge on: - Electromagnetics fields. - Antennas and wave propagation. - Radiofrequency systems. - Signal processing.

OBJECTIVES

Basic skills

CB6 To acquire and understand knowledge that provides a basis and opportunity to be original in the development and/or application of ideas, often in a research context.
CB7 To allow the students to apply the acquired knowledge for the resolution of problems in new or not well-known environments, inside wide or multidisciplinary contexts related with their area of study.
CB9 To qualify the students to communicate their conclusions, and the knowledge and reasons that support them, in a clear and unambiguous way, to both specialized and non-specialized audiences.
CB10 To acquire the learning skills to enable them to continue studying in a way that will be mainly self-directed or autonomous.

General skills

CG1 Systematic understanding of a study field, and knowledge of the research skills and methods associated with that field.
CG4 Ability to perform a critical analysis and synthesis of new and complex ideas.
CG5 Communication skills with the academic and scientific community and society in general about their expertise areas in the ways and languages commonly used in the international scientific community.

Specific skills

CE1 Ability to study and review scientific and technical documents about radar and radionavigation systems.
CE2 Ability to capture a deep view of the state-of-the-art in radar and radionavigation technology, as well as to forecast the near future in the field.
CE3 Ability to carry out an original work of entity in a specific radar or radionavigation topic, including its presentation and discussion with other scientists.
CE4 Ability to apply math, statistics and science knowledge to radar and radionavigation problems.
CE5 Ability to design and carry out experiments, as well as to analyze and interpret their outcome.
CE6 Understand, and be able to analyze and design, the subsystems that compose a radar or a radionavigation system. Analyze the performance of such systems and be able to make decisions about their design and implementation:

¿ Election of fundamental sytem parameters (antenna, power, range, SNR, detection probability....)
¿ Understand and apply signal processing techniques.
¿ Ability to communicate and discuss the adopted design and implementation decisions with other colleagues.

The results of the learning process should be the following ones:

¿ Understand the foundations of a pulsed radar and the target detection principles.
¿ Knowledge of the classification and operating modes of radar systems.
¿ Knowledge of the building blocks of a radar system.
¿ Knowledge of the effects of wave propagation on radar signal.
¿ Knowledge and implementation of radar signal processing techniques for improving the estimation of the radar parameters of a target and tracking it.
¿ Knowledge and implementation of radar image formation algorithms and error compensation techniques.
¿ Ability to analyze the performance and limitations of a radar system.
¿ Ability to plan and design a complete radar system that fulfill certain specifications and quality

parameters.
¿ Understand the fundamentals of a radionavigation system.
¿ Knowledge of the different radionavigation systems currently in place, as well as its advantages and limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

Module I. Radar systems
1. Introduction. Historical background.
2. Basic concepts of radar
3. Classification of radar systems.
4. Radar equation.
5. Detection of signal in noise.
6. Doppler processing.
7. Tracking and parameter estimation.
8. Synthetic aperture radar.
9. Introduction to Radiometric systems

Module II. Radionavigation systems.
1. The fundamentals of terrestrial navigation.
2. Radio beacons and hyperbolic systems.
3. The fundamentals of satellite navigation systems.
4. Examples of satellite navigation systems.

LEARNING ACTIVITIES AND METHODOLOGY

Formative activities included in the curriculum

AF1 Theoretical lesson
AF2 Practical lesson
AF3 Computer lab lesson.
AF4 Laboratory practices
AF6 Teamwork
AF7 Individual work of the student
AF8 Midterm and final exams

Activity code		Total hours	Classroom hours	% classrooms hours
AF1	32	32	100	
AF2	4	4	100	
AF3/AF4		10	10	100
AF6	0	0	0	
AF7	100	0	0	
AF8	4	4	100	
TOTAL	150	50	33	

Methodology

MD1 Master class supported by computing and audiovisual media, where the main topics are exposed, and bibliography is provided to complement the learning by the students.
MD2 Critical reading of recommended texts: press articles, reports, textbooks and/or academic papers, both to be later discussed in class, or to complement and consolidate the knowledge of the topic.
MD3 Resolution of practical cases, problems, etc., proposed by the teacher, individually or in groups.
MD4 Exposition and discussion in class of topics related to the course and practical cases, under teacher moderation.
MD5 Elaboration of assignments and reports individually or in groups

ASSESSMENT SYSTEM

Evaluation methods
SE2 Individual or group exercises during the term.
SE3 Final exam.

Evaluation method	Minimum weighing (%)	Maximum weighing (%)
SE2	40	100
SE3	0	60

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- B. Forssell, Radionavigation systems, , Artech House Publishers,, 2008.

- F. P. Martínez, Sistemas de navegación por satélite, , Servicio de Publicaciones de la E.T.S.I. Telecomunicación, Universidad Politécnica de Madrid, 2000.

- F. Ulably, Microwave Remote Sensing, , Wiley, , 1986

- M. I. Skolnik, Introduction to Radar Systems, , 3ª ed., McGraw-Hill Education,, 2002

- M. Richards, J. Scheer y W. Holm, Principles of Modern Radar Vol. I: Basic Principles. , SciTech Publishing Inc.,, 2010.

- W. Carrara, R. Goodman y R. Majewski, Spotlight Synthetic Aperture Radar: Signal Processing Algorithms,, Artech House,, 1995.

- W. L. Melvin y J. A. Scheer, Principles of Modern Radar Vol. II: Advanced Techniques. , SciTech Publishing, , 2014.