

Postgraduate Course on Radio Frequency Technologies (MSc)

Instructor Information

José Ramón Montejo Garai (supervisor) B-421

E-mail: jr@etc.upm.es

Jesús Grajal C-407.2

E-mail: jesus@gmr.ssr.upm.es

Course Information

Course Description

This course presents advanced concepts related to passive and active microwave devices implemented in different technologies.

Regarding to the passive devices, the technology is mainly focus on waveguide structures for the implementation of the components forming the antenna feeder system on board communication satellites. Filters, multiplexers, beam-forming networks, couplers, orthomode transducers and polarizers will be presented, analyzing the required specifications when used in real communication systems. The students will acquire the required knowledge for understating the analysis and design of these devices by means of in-house software developed in Matlab as well as commercial software.

Prerequisites

Electromagnetic Theory.

Microwave Engineering.

Radiofrequency Subsystems.

Working knowledge of MATLAB is required.

Course Goal

The student will understand the concepts related to the analysis and design of waveguide passive devices.

The student will be able to afford all the stages of the design of one specific passive device.

Syllabus

Chapter 1: Summary of waveguide concepts and microwave circuit theory.

(6 hours)

- 1.1 Basic concepts of waveguides.
- 1.2 Rectangular waveguides: modes and symmetries.
- 1.3 Circular waveguide: modes and symmetries.
- 1.4 Waveguide engineering; industrial standards
- 1.5 S parameters and multiport analysis.

Chapter 2: Microwave filters and multiplexers.

(10 hours)

- 2.1 Overview of filter transfer functions for satellite applications.
- 2.2 Synthesis techniques and matrix coupling.
- 2.3 Elliptic response: high rejection & equalization.
- 2.4 Multiplexing: single & double loaded topologies.

Chapter 3: Orthomode transducers OMT, polarizers, couplers and beam-forming networks.

(10 hours)

- 3.1 Overview of feeder architectures.
- 3.2 Orthomode transducers: Turnstile-junction & BØifot-junction.
- 3.3 Polarizers: single-double band, rectangular/circular types.
- 3.4 Couplers: Riblet & branch-line types
- 3.5 Beam-Forming Networks: corporative & manifold configurations

Chapter 4: Issues in waveguide devices on board satellites

(4 hours)

- 4.1 Introduction to the Multipaction.
- 4.2 Multipactor Calculator by ESA.
- 4.3 Calculation of breakdown voltage in diplexers and OMTs.
- 4.4 Introduction to Corona Effect.
- 4.5 Introduction to Passive Intermodulation (PIM).

Software material

- CST Studio Suite (CST Microwave Studio, CST Design Studio)
- MICIAN
- Matlab

Suggested readings

1. Waveguide Components for Antenna Feed Systems: Theory and CAD,1993
Jaroslav Uher, Jens Bornemann.
2. Microwave Engineering, David.M. Pozar, John Wiley and Sons Inc., 2012,
4th edition.
3. Foundations for Microwave Engineering , Robert E. Collin, McGraw-Hill
Inc. 1992.
4. Microwave Engineering Passive Circuits , Peter A. Rizzi, Prentice-Hall Inc.,
1998.
5. Field and Waves in Communications Electronics, S. Ramo, J.R. Whinnery,
T.V. Duzzer, 3th edition, John Wiley and Sons, 1993.
6. An Introduction to Guided Waves and Microwaves Circuits, R.S. Elliot, Ed.
Prentice-Hall, 1998
7. Advanced Engineering Electromagnetics, C.A. Balanis. John Wiley and Sons.
8. Microwave filters, impedance-matching networks and coupling structures,
G.L. Matthaei, L. Young, E.M.T. Jones, Artech House, 1980.
9. Computer Aided Design of Microwave Circuits, K. C. Gupta,
10. Principles of Microwave Circuits, C. G. Montgomery, R. H. Dicke, and
E. M. Purcell

Student Assessment Criteria

- 25% Homework chapter 1
- 25% Homework chapter 2
- 50% Design of a passive device: presentation and quality of the final deliverable.