High Frequency Technology

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Problem definition

Physical problem

Electromagnetic signals with wavelength between $\sim$ 1 m and 1 mm

- Too small for lumped element electronics
- Too large for optical methods

Applications

- Radiocommunications (broadcast and point-to-point)
  - Range from cm (e.g. bluetooth) to $> 22 \times 10^9$ km (Voyager 1)
- Radar (military, flight control, automotive, geology)
- Radiometry (radio astronomy, Earth remote sensing)
- Heating (industrial, medical, home appliances)
- Energy transport

Integration with other courses

Prerequisites (expected):

- Linear Algebra (1^{st} c.): basic matrix operations
- Advanced Mathematics (2^{nd} c.): complex numbers
- Trigonometric functions (circular and hyperbolic)
- Linear Network Analysis and Synthesis (2^{nd} c.)
- Electromagnetic Fields (2^{nd} c.)

Related to:

- Propagación y transmisión inalámbrica (4^{nd} c., opt.)
- Subsistemas de radiofrecuencia y antenas (Master)

Topics

- Review of transmission lines and waveguides

Tools for analysis of microwave circuits

- Smith chart
- Scattering (S) parameters

Analysis and design of passive microwave circuits

- Two-port networks
- Three-port networks: lossless, Wilkinson power dividers (lossy), circulator (non symmetrical)
- Four-pole networks: 90° and 180° hybrids, coupled-line couplers
- Resonators and microwave filters

- Introduction to microwave measurements

Course organization

Contact info

- **Alejandro García Lampérez** aglamper@ing.uc3m.es
- Office hours (4.3.B08): Friday from 15:00 to 17:00.
  - In fact, any time by appointment
  - Also online
- Theoretical & exercise classes

Coordinator

- Daniel Segovia Vargas (4.3.B12) dani@tsc.uc3m.es

Other

- Adrian Amor Martín (4.2.E01) aamor@ing.uc3m.es
- Ahmed El Yousfi (4.3.B11) aelyousf@ing.uc3m.es

Bibliography

Basic

- David M. Pozar, *Microwave Engineering*, Wiley
- Robert E. Collin, *Foundations for Microwave Engineering*, McGraw-Hill / Wiley-IEEE Press
- D. Segovia Vargas, L. E. García Castillo, A. García Lampérez *Microondas y Circuitos de Alta Frecuencia (2009)* OpenCourseWare notes

  http://ocw.uc3m.es/teoria-de-la-senal-y-comunicaciones/microondas-y-circuitos-de-alta-frecuencia
- M. Steer *Fundamentals of Microwave and RF design* North Carolina State University, 2019

  https://repository.lib.ncsu.edu/handle/1840.20/36776

Evaluation

Continuous assessment: 55 %

- Lab project (15 %)
- Two short tests, 30' (10 %)
- Two mid-term exams, 80'–90' (15 % + 15 %)

Exam: 45 %

- Minimum mark to pass: 4.0
- Theoretical questions, short problems (no material)
- Two long exercises (formula sheets included)
- 2 hours 30 min – 3 hours

Extra call (June) only: alternatively, 100 % final exam

Important dates

Short tests (Monday)

- February 28 (week 5)
- April 4 (week 10)

Mid-term tests

- March 18 (week 7)
- April 25 (week 12)

Lab exercises (Monday)

- February 28, 19:00, exercise 1 (week 5)
- April 8, exercise 2.1 (week 10)
- April 22, exercise 2.2 (week 11)
- April 29, exercise 2.3 (week 12)

Lab exercises

Sessions

1. Simulation of standing wave measurements (Matlab) and matching networks (MWO)
   - Short exercise
   - Introduction to CAD tool (Microwave Office)
2. Design and simulation of a full circuit (MWO)
   - Full project
   - Three sessions

- Must be repeated even if already done
- Groups of 2 (in your class group)
- CAD tool: Cadence AWR Design Environment – Microwave Office
  https://www.awr.com/awr-software/products/awr-design-environment