



Course guide

300520 - OE-S - Electromagnetic Waves

Last modified: 27/01/2026

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN SATELLITE ENGINEERING (Syllabus 2024). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

PRIOR SKILLS

Real and complex numbers
Coordinate systems and changes of variable
Vector spaces. Linear applications
Differential equations and linear systems with constant coefficients. Properties and solutions
Scalar and vector fields
Waves: Transversal and longitudinal waves Wave equation
Reflexion, refraction and diffraction. Doppler effect
Superposition and stationary waves. Interference. Dispersion. Group velocity
Coulomb force, electrical charge and electrostatic field
Electric potential
Electrostatic energy. Capacity
Electric current
Magnetic field. Sources of magnetic field
Maxwell Equations.
Fourier series. Fourier transform. Frequency response
Circuit analysis in DC and AC
Basic concepts. Kirchhoff laws, Joule's law

TEACHING METHODOLOGY

Four hours per week (in two-hour blocks) of lectures, with visual aids (slides) and exercises completed on the board. In even-numbered sessions, a short quiz on the week's material will be administered on the ATENEA platform. The scores on these quizzes are essential to the continuous assessment grade. Students will have access to the course slides on the ATENEA platform.

LEARNING OBJECTIVES OF THE SUBJECT

To understand, analyze, and design basic electromagnetic communication systems in both the RF and optical bands. Both wired systems (transmission lines and fiber optics) and wireless systems (radio and laser communication systems) will be covered. Given that the terminals involved in wireless communication are mobile, special attention will be paid to concepts such as point-ahead and Doppler shift. Particular attention will also be given to optical band transmitters/receivers.

The emphasis is on the transmission of carrier signals (in both bands), as aspects related to information transmission are covered in the "Fundamentals of Communications" course.



STUDY LOAD

Type	Hours	Percentage
Hours large group	55,0	44.00
Self study	70,0	56.00

Total learning time: 125 h

CONTENTS

Transmission Lines

Description:

Transmission Lines:

Concept of interfering waves in a transmission line.

Circuit model of transmission lines.

Examples of transmission lines: coaxial cable, microstrip line. Software: Txline.

Impedances, reflection coefficient, and standing wave ratio.

Wave power in the line and power delivered to the load.

Microwave circuits: S-parameters.

Smith chart: impedance matching with lumped elements and stubs. Software: Smith.

Full-or-part-time: 30h

Theory classes: 12h

Self study : 18h

Fiber optics

Description:

Main characteristics of optical fibers and advantages/disadvantages

Characteristic parameters (attenuation coefficient, dispersion coefficient, bandwidth)

Dimensioning of an optical fiber system

Full-or-part-time: 15h

Theory classes: 6h

Self study : 9h

Optical transmission and reception devices (intra- and inter-satellite)

Description:

Analysis of requirements and complete transmission and reception schemes

Optical transmitters (1064 and 1550 nm): laser diodes, fiber amplifiers

Optical receivers (PIN, APD)

Full-or-part-time: 17h 30m

Theory classes: 6h

Self study : 11h 30m



RF communication

Description:

Electromagnetic waves in free space
Electric and magnetic fields radiated by a current element.
Polarization: linear and circular.
Transmitted power flux density.
Radiation pattern of different antenna types.
Basic transmission equation: directivity, effective receiving area; antenna gain concept.
Description of basic propagation loss.
Transmitting and receiving antennas.
Losses in system elements.
Propagation losses: clouds, gases, terrain effects.
Complete transmission equation.

Full-or-part-time: 26h

Theory classes: 10h
Self study : 16h

Wireless laser communications

Description:

Directivity in optical transmission systems.
Satellite-to-satellite communication
Satellite-to-ground communication:
Cloud attenuation
Gas attenuation
Refractive turbulence:
Downlink:
Received power fluctuation
Apparent angle of arrival (AOA) fluctuation
Uplink:
Wavefront power fluctuation
Beam wandering
Beam spreading

Full-or-part-time: 26h

Theory classes: 10h
Self study : 16h

Additional considerations regarding wireless communication

Description:

Point-ahead angle.

Doppler effect in the propagation of electromagnetic waves.

Full-or-part-time: 10h 30m

Theory classes: 4h
Self study : 6h 30m

GRADING SYSTEM

The evaluation criteria defined in the infoweb of the subjects will be applied.



EXAMINATION RULES.

Short tests:

At the end of each even-numbered session, a brief quiz on the session's content will be conducted. To expedite feedback to students, answers will be submitted via the ATENEA platform. Laptops, tablets, mobile phones, and calculators may be used. The estimated duration of each quiz is 15 minutes.

MQ and FQ Exams:

Written exam. Books, notes, computers, tablets, and mobile phones are not permitted. Duration: 120 minutes

BIBLIOGRAPHY

Basic:

- Javier Bará Temes. Ondas electromagnéticas en comunicaciones [on line]. Barcelona: Edicions UPC, 1999 [Consultation: 12/01/2026]. Available on: <https://hdl.handle.net/2099.3/36205>. ISBN 9788498802405 .
- Javier Bará Temes. Circuits de microones amb línies de transmissió [on line]. Barcelona: Edicions UPC, 1993 [Consultation: 12/01/2026]. Available on: <https://hdl.handle.net/2099.3/36162>. ISBN 9788498800456.
- J. Senior. Optical Fiber Communications, principle and practice [on line]. 3. Essex: Pearson, 2009 [Consultation: 12/01/2026]. Available on: <https://shijuinpallotti.wordpress.com/wp-content/uploads/2019/07/optical-fiber-communications-principles-and-pr.pdf>. ISBN 978-0-13-032681-2.

Complementary:

- Cardama Aznar, Ángel ; Jofre Roca, Lluís ; Rius Casals, Juan Manuel ; Romeu Robert, Jordi ; Blanch Boris, Sebastián ; Ferrando Bataller, Miguel. Antenas [on line]. Barcelona: Edicions UPC, 2002 [Consultation: 12/01/2026]. Available on: <https://hdl.handle.net/2099.3/36797>. ISBN 9788483019900.

RESOURCES

Other resources:

Slides, available at ATENEA.