UNIVERSITÀ DI PISA

SATELLITE COMMUNICATIONS

MARCO LUISE

Academic year	2022/23
Course	INGEGNERIA DELLE TELECOMUNICAZIONI
Code	1040I
Credits	6

Modules	Area	Type	Hours	Teacher(s)
SATELLITE COMMUNICATIONS	ING-INF/03	LEZIONI	60	MARCO LUISE

Obiettivi di apprendimento

Conoscenze
By attending this course, students learn the fundamental elements of the architecture and technologies necessary for the operation of a satellite network for broadcasting (for example in technologies for DVB-Sx television transmission), for broadband Internet connection with a fixed point (to the end user or as a network backbone), or for mobile communications (in a dedicated network or integrated as a Non-Terrestrial Network in the 5G network). Part of the course is also dedicated to examining satellite tracking and navigation systems (GNSS, Global Navigation Satellite Systems such as GPS and / or GALILEO) which are based on technologies similar to those needed for communication.

Modalità di verifica delle conoscenze
30 min. interview (exam) with simple written problems.

Capacità
The student who successfully completes the course will have the ability to understand the main communication standards for the delivery of digital information by satellite, and for pisitioning of the user terminal on Earth. He/She will master technologies and network architecture for satelite broadcasting, communicatins, and navigation, and will have a fundamental knowledge about the issues of spacecraft architecture and launch. The student will also be able to perform a basic system design of a satellite link.

Modalità di verifica delle capacità
30 min. interview (exam) with simple written problems.

Prerequisiti (conoscenze iniziali)
Basic knowledge of digital communications, communication systems, networking, elementary physics.

Corequisiti
None

Prerequisiti per studi successivi
None

Indicazioni metodologiche
Delivery: face to face
Attendance: Not mandatory
Learning activities:

- attending lectures
- individual study
- Bibliography search

Teaching methods:

- Lectures
- Seminar
- laboratory

Programma (contenuti dell'insegnamento)

1. **What is Satellite Communications for ?:** Main SatCom services: TV/Radio broadcasting, Fixed Internet Access, mobile connectivity, IoT, Military – History of SatCom: from Clarke to Intelsat to Megaconstellations – General Architecture of a Satellite Network - Integration of Satellites into Cellular Networks - PROs and CONs of Terrestrial vs. Non-Terrestrial Networks (0.2 cfu)
2. **Spacecraft and Earth Station/Terminal Architecture:** Launch/Tracking of a Satellite - General Architecture of a Communications Satellite – Transparent and regenerative Communications payloads - Orbits for Communication Satellites – Orbit determination and keeping – Constellations of Satellites - General Earth Station and User Terminal Architecture – (1.0 cfu)
3. **Basic Technologies, Design Objectives, and Performance Metrics of Satellite Links and Networks**: Main satellite RF bands - Modulation and Multiple Access – Link Budget – Latency – Antennas – High-Power Amplifiers – Atmospheric Propagation – Mobile channels – Intersatellite Links and Free-Space Optical Communications – Satellite Network Architecture (1.5 cfu)
4. **Examples of Current GSO and NGSO SatCom Constellations and Related Services/Standards:** Classification of services/orbits– Iridium, Globalstar, Inmarsat, Thuraya – ViaSat, EchoStar, SpaceX/StarLink, Google/OneWeb, O3b, Eutelsat, SES (0.5 cfu)
5. **Fundamentals of Satellite Positioning and Navigation:** Space Segment, Earth Segment, user segment, pseudorange derivation, positioning/navigation algorithms, bounds – GALILEO/GPS constellations, frequencies, bands, services, main differences, integration with terrestrial mobile networks (1.8 cfu)
6. **GNSS Receiver Design and Performance Evauation:** General receiver architecture, loops, acquisition, tracking, performance, modern network aided positioning (1.0 cfu)

Bibliografia e materiale didattico

Lecture notes on the course website
Suggested Reading: G. Maral, M, Bousquet, “Satellite Communications”, 5th ed., Wiley – E.D. Kaplan, C.J. Hegarty (eds.), “Understanding GPS - Principles and Applications”, 2nd ed., Artech House

Modalità d'esame

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Pagina web del corso

http://docenti.ing.unipi.it/m.luise/#satcom

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