Course guides
230649 - TSYS - Telecommunications Systems

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.
Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Compulsory subject). MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
Academic year: 2020 ECTS Credits: 5.0 Languages: English

LECTURER
Coordinating lecturer: FERRAN CASADEVALL,
Others: RAMÓN AGUSTÍ, FERRAN CASADEVALL

PRIOR SKILLS
Basic knowledge about communications.

REQUIREMENTS
None specific to the subject

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
2. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
3. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

Transversal:
4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY
- Lectures
- Individual/ Group's work
- Short questions/test (Control and Final exams)
LEARNING OBJECTIVES OF THE SUBJECT

The aim of this course is to provide a holistic and high-level approach to the Telecommunication Systems, including their architectures, central functionalities and main technological characteristics. Within this framework, the course will firstly present the basic concepts related to regulation, standardization and services, thus establishing the context for the different Telecommunication Systems that will be subsequently addressed. Then, each one of the key different Telecommunication Systems will be introduced, with the goal of describing and differentiating its main characteristics and capabilities, including the involved technologies, the internetworking level when applicable, as well as their social-economics trends. After completion of the course students should be able to identifying each one of the main involved technologies and its target objectives within a complete map of existing Telecommunication Systems.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours large group</td>
<td>39,0</td>
<td>31.20</td>
</tr>
<tr>
<td>Self study</td>
<td>86,0</td>
<td>68.80</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

TELECOMMUNICATION SYSTEMS

Description:
Topic 1.- INTRODUCTION TO TELECOMMUNICATION SYSTEMS
1.1 Telecommunication System Definition: Actors and Rolls
1.2 Regulatory authorities and standardization bodies

Topic 2.- REGULATORY AND STANDARDISATION FRAMEWORK
2.1 Telecommunication Market Regulation: Evolution
2.2 Network Neutrality and QoS
2.3 Spectrum Regulation: Regulatory framework for the use of radio spectrum
2.4 Standards: International Standardization Bodies

Topic 3.- FIXED TELECOMMUNICATION SYSTEMS: FROM PSTN TO INTERNET
3.1 PSTN (Public Switched Telephone Network)
3.1.1 Multiplexing and switching
3.1.2 Signalling Systems in PSTN
3.1.3 SS7 and Intelligent Networks
3.2 X.25 (Public Switched Data Networks) Basics
3.3 ISDN (Integrated Services Digital Network): Definition and Bearer Services
3.4 Frame Relay
3.5 ATM (Asynchronous Transfer Mode): Definition and System considerations
3.6 INTERNET
3.6.1 Concept and main drivers
3.6.2 Architecture, actors and rolls
3.6.3 Public and Private Internet
3.6.3.1 DiffServ Domain
3.7 MPLS (Multiprotocol Label Switching): Reference architecture
3.8 Access Network: Access and aggregation segments definition
3.9 X-DSL (X-Digital Subscriber Line) Systems
3.9.1 ADSL (Asymmetric-Digital Subscriber Line)
3.9.2 VDSL (Very high-bit-rate Digital Subscriber Line)
3.10 IP telephony and Multimedia Signalling: H.323 and SIP
3.11 TNM (Telecommunication Network Management): Building blocks.

Topic 4.- CELLULAR MOBILE COMMUNICATIONS SYSTEMS: FROM 1G TO 5G
4.1 Introduction: Definitions, and technology evolution
4.1.1 General Architecture of a Mobile Communications System
4.2 2G Communications Systems
4.2.1 GSM System: General features and architecture
4.2.2 GPRS System: General features and architecture
4.2.3 EDGE System: General features and EDGE Evolution
4.3 3G Communications Systems
4.3.1 UMTS and HSPA Systems
4.4 4G Communications Systems: LTE System Main features and architecture
4.5 5G Systems: An introduction
4.6 Radiation Health Effects

Topic 5.- NETWORK VIRTUALIZATION
5.1 Introduction: Server virtualization and data centers
5.2 Network Virtualization
5.2.1 ETSI NFV reference architecture framework
5.3 Software Defined Networks (SDN): Key Points
5.4 Virtualization in Mobile Communications Systems
5.4.1 Virtualization of Mobile Base Station: LTE example
5.4.2 5G Virtualization: Network Slices concept.

Topic 6.- TRANSPORT NETWORKS
6.1 Telecommunications Network Architecture
6.2 TDM-based transport protocols
6.2.1 PDH multi-stage multiplexing
6.2.2 Synchronous Digital Hierarchy (SDH)
6.2.2.1 Packet-over-SONET (POS)
6.2.2.2 Ethernet-over-SONET (EoS)
6.3 Ethernet/Carrier Ethernet transport technology
6.4 Optical Transport Network (OTN)

Topic 7.- MICROWAVE RADIO LINKS
7.1 Concept: Advantages and drawbacks of Microwave Radio
7.2 Link deployment and system configuration
7.3 Radio Link Application Forecast
7.4 Technology issues;
7.4.1 Asynchronous Ethernet and TDM: CES (Circuit Emulation Service)
7.4.2 Packet Transport: Carrier Ethernet
7.5 Propagation Issues: Refraction, Diffraction, Rain effects, Soil Reflections
7.5.1 Antenna Height Calculation
7.5.2 Fading characterization
7.6 Link Budget
7.7 Frequency Planning
7.8 Quality and unavailability prediction
7.8.1 Back-up systems

Topic 8.- SATELLITE TELECOMMUNICATION SYSTEMS
8.1 Introduction
8.1.1 Services, Application Scenarios
8.2 Satellite Industry
8.2.1 Satellite Orbits: Geostationary orbit (GEO), Medium earth orbit (MEO), Low earth orbit (LEO)
8.3 Propagation and link budget
8.4. Frequency bands and multiple access
8.5. Satellite system architecture
8.5.1 Control and Management Satellite Subsystems
8.5.2 Main Components of a Communication Satellite System
8.6 Effect of Delay and BER on TCP Throughput
8.7 VSAT (Very Small Aperture Terminal) Network
8.7.1 Star Topology
8.7.2 Inbound TDMA-SCPC
8.8 BGAN (Broadband Global Area Network)
8.9 LEO Satellites: IRIDIUM

Topic 9.- OTHER TELECOMMUNICATION SYSTEMS
9.1 Professional Mobile Communications: TETRA
9.2 Aeronautical Communications Systems
9.2.1 LOS and Non-LOS communications: Scenarios
9.2.2 HF communications
9.3 Aeronautical Communications: Passenger and Non-Safety Services
9.4 WIMAX: Concepts and configurations
9.4.1 Layer structure and QoS Parameters
9.5 Internet of Things
9.5.1 IoT basic architecture
9.5.2 Network Layer: Short and Long Range IoT
9.5.3 IoT-oriented new cellular technologies:
9.5.3.1 EC-GSM-IoT (Extended Coverage GSM IoT)
9.5.3.2 NB-IoT (Narrow Band IoT)
9.5.3.3 eMTC (Enhanced Machine Type Communications)
9.6 Hybrid fiber-coaxial (HFC)
9.6.1 General architecture and spectrum allocation
9.6.2 DOCSIS (Data Over Cable Service Interface Specification)
9.7 Systems for Broadcasting
9.7.1 Terrestrial Digital Television (TDT)
9.7.2 IPTV
9.8 Power Line Communications

Related competencies:
CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
CE2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
CE15. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Full-or-part-time: 125h
Theory classes: 39h
Self study: 86h

GRADING SYSTEM

Final Examination
Partial examination and Controls
Individual and/or group work
Individual assessments (Attendance/participation in class, etc)

The final exam weighs the 50% final grade. The continuous evaluation (includes the rest of the activities) weights the other 50% of the final grade.
BIBLIOGRAPHY

Complementary:

RESOURCES

Other resources:
Ramon Agustí, Ferran Casadevall, Course Slides, ETSETB, ATENEA