



Communication Networks & Services Syllabus

Industrial Organization Engineering Degree

Academic year 2012-2013

1. COURSE DETAILS

| Name Communication Networks & Services | | | | | | | | | | | |
|--|---|---|-----------------------------------|--------|---------------|--------------------------|----|--------|--|--|--|
| C | ourse field | Commu | unication | Networ | ks & Services | | | | | | |
| | Code | 511103 | 014 | | | | | | | | |
| Degi | ree Course Grado en Ingeniería de Organización Industrial | | | | | | | | | | |
| Р | rogramme | e 2009 (Decreto 269/2009 de 31 de julio) | | | | | | | | | |
| | Centro | O Universitario de la Defensa en la Academia General del Aire | | | | | | | | | |
| | Туре | Option | al | | | | | | | | |
| | Duration | Four-m | onth course | | | | | Year 3 | | | |
| | Language | Spanish | n/English | | | | | | | | |
| ECTS | 6 | Hour | s / ECTS | 25 | Tota | tal workload (hours) 150 | | | | | |
| Lectures Timetable | | | Tuesday & ThursdayRo16:05 – 17:50 | | | Roo | om | - | | | |
| Classes/Practicals/Seminars timetable | | | - | | | Buildi | ng | - | | | |

2. TEACHING STAFF CONTACT DETAILS

| Head of the course | Pedro | Pedro J. García Laencina | | | | | | | | |
|---------------------------------|--|--|-----|-----------|--|--|--|--|--|--|
| Department | - | - | | | | | | | | |
| Area of expertise | Computer Science, Signals & Communications | | | | | | | | | |
| Office location | Office 15, CUD Building | | | | | | | | | |
| Phone | 96818 | 39979 | Fax | 968188780 | | | | | | |
| E-mail | pedro | j.garcia@cud.upct.es | | | | | | | | |
| URL / WEB | http:/ | /moodle.upct.es/course/view.php?id=511103014 | | | | | | | | |
| Office hours (for supervi | sions) | Tuesday, 12:40-14:40; Thursday, 12:40-14:40 | | | | | | | | |
| Office hours locatio supervi | n (for sions) | Office 15, CUD Building | | | | | | | | |

3. COURSE OUTLINE

3.1. Presentation

The subject "*Communications Networks & Services (CNS)*" is presented as an elective in the formation of a future Air Force officer with the Engineering Degree in Industrial Management. Specifically, the main objective is that students learn the basic theoretical and practical concepts for networks and telecommunication systems, and thus, develop the skills needed to apply them in their future professional practice. It should be remarked that this subject provides the minimum knowledge needed to facilitate the development of later advanced subjects on telecommunication systems.

As it has been already mentioned, this course covers the fundamentals of network and telecommunication services. Since its beginnings in the XIX century, communication systems have been developed as a solution to the needs of industry and society. Currently, networks, systems and telecommunication services are present in numerous civilian and military contexts as the fundamental basis for the development of the Information Society in the XXI century. Like other organizations, the Security Forces and Defense need tools and solutions based on the Information Technology and Communications (ICT) to efficiently manage their processes and operations.

Therefore, the content of the course will extend over seven teaching units, covering both basic and specific aspects of types and network architectures, transmission and data encoding, transmission media, multiplexing, data link control, packet and circuit switching, structured cabling systems, LAN topologies, TCP/IP technology and the most widespread services and applications today.

The subject CNS is carried out under an eminently practical approach by making a special effort on the laboratory works. It is also an aim to develop generic skills such as teamwork, independent learning, and organizational capacity planning and concern for quality and a job well done.

3.2. Year and duration within the degree programme

The subject CNS is studied in the third year (first quarter). It is an elective course that provides basic knowledge to facilitate the learning of later advanced subjects on telecommunication systems.

3.3. Description of the course

Today, the learning of the basics of ICT, and particularly, the main networks, systems and telecommunications services is an integral part of the training of every professional, as the ICT technologies are part of the working environments in which they develop their careers. With the subject "Communications Networks & Services", students will be able to understand how the telecommunications systems work and, also, to manage the main equipment and technical documentation necessary for the design and configuration of networks and systems. Thus, it provides the basic knowledge of the different parts that make up a telecommunication system, ranging from the physical layer and the transmission of signals/data to the layer of ICT applications. At the end of this course, students will be able to make the appropriate use of the resources of the telecommunication systems and services in their specialty field.

The training provided to each student enables him to extrapolate the knowledge gained to other infrastructure, so that the skills acquired will be useful in their professional development in the medium and long term.

3.4. Related courses. Prerequisites and recommendations

This subject is optional and requires no other previous courses in the curriculum. Thus, there is no any prerequisite or recommendation associated with this subject.

Nonetheless, it is related to the subject of the degree "Electromagnetic Exploration Systems". Furthermore, although indirectly and to a lesser extent, this subject is also related with other technology subjects as "Computer Science" in the first year, "Electrical Technology" or "Electronic Automation and Instrumentation" for the second year.

3.5. Special measures

Special measures will be done for allowing simultaneous studies related to military & aeronautical training activities. Specifically, we will form working groups/cooperative learning of students with limited availability, fostering learning track by scheduling tutoring activities and developing theoretical/practical exercises by using the website of this subject.

4. COMPETENCES

4.1. Specific competences of the course

The specific skills of the subjects develop competence E2.8: "Ability to organize, control, protection and use of units responsible for force protection, control systems, control and operational support to air operations"

Details are specified in paragraphs 4.4 (learning objectives) and 5.1 (curriculum content).

4.2. Generic and transversal competences

INSTRUMENTAL COMPETENCES

- T1.1 Analytical and summary skills
- □ T1.2 Organizational and planning skills
- T1.3 Oral and written communication skills in their mother tongue
- T1.4 Oral and written comprehension skills in a foreing language
- □ T1.5 Basic computer skills
- □ T1.6 Information management ability
- ☑ T1.7 Problem solving skills
- □ T1.8 Decision making ability

PERSONAL COMPETENCES

- T2.1 Critical and self-critical ability
- ☑ T2.2 Teamwork
- □ T2.3 Interpersonal skills
- T2.4 Ability to work in an interdisciplinary team
- T2.5 Ability to communicate with experts in other fields
- T2.6 Ability to deal with diversity and multiculturalism
- □ T2.8 Ethical commitment

SYSTEMIC COMPETENCES

- IT T3.1 Ability to apply theory to practice
- ☑ T3.2 Learning ability
- □ T3.3 Ability to adapt to new situations
- □ T3.4 Creativity
- □ T3.5 Leadership
- T3.6 Knowledge about other cultures and customs
- T3.7 Ability to work autonomously
- □ T3.8 Initiative and entrepreneurship
- T3.9 Quality concern
- □ T3.10 Motivation for success

4.3. General aims/ Degree specific competences

PROFESSIONAL COMPETENCES

E 2.8. "Ability to organize, control, protection and use of units responsible for force protection, control systems, control and operational support to air operations"

4.4. Learning objectives

At the end of the course the student should be able to:

1. Knowing the historical evolution of networks and communication systems, allowing you to contextualize the current state of technology.

2. Learn the basic principles of communication systems, the main types of existing networks and the two models most widespread network architecture: OSI and TCP / IP.

3. Understanding the basics of signals and data in the time domain and frequency, along with the different types of analog and digital transmission.

4. Knowing the different transmission media-guided and unguided, which are present in most networks and communications systems.

5. Learning the basic principles of design and installation of a structured cabling system.

6. Knowing the services offered by the link-level protocols and their relationship with local area networks, both wired and wireless.

7. Understanding the basic mechanisms of the protocol for interconnecting IP networks, IPv4 and IPv6 extension, supported protocols and the main IP routing algorithms and routing Internet.

8. Understanding the basics of different types of communication equipment, such as hubs (hubs), bridges (switches) and routers (routers).

9. Learning the operation of the transport protocols UDP and TCP.

10. Learning more application protocols currently used, such as remote login, file transfer, e-mail, the Web, instant messaging and multimedia applications (Radio/Voice/Video over IP).

In short, at the end of this course, students will have learned new knowledge autonomously and, also, proper techniques for the design, development and operation of telecommunications systems and services.

The activities of teaching / learning have been designed to allow students to develop their ability to: teamwork, analysis and synthesis of information, writing and oral communication through the development of the labs and, then, performing oral exposition and comprehension of a communications network/system at the end of the course.

5. CONTENTS

5.1. Contents according to the Degree programme

Access network. Switching and transport network. Main current networks. Telephone networks. Mobile terrestrial networks. Data networks and Internet. Broadcast networks.

5.2. Lectures programme

PART I: OVERVIEW OF COMMUNICATIONS

UNIT 1. INTRODUCTION

- 1.1 Brief historical review of communications
- 1.2 Concepts and basic definitions
- 1.3 Basic diagram of a communications system
- 1.4 Types of networks

1.4.1 For connection type link: Networks of Diffusion and Point to Point

1.4.2 On the physical topology: bus, ring, star and mesh

1.4.3 For geographic scale: LAN, MAN and WAN

1.4.4 For field data: Public and Private

1.4.5 By establishing communication: Circuit Switched / Packages

1.5 Network Architecture

1.5.1 Reference Model OSI (Open Systems Interconnection)

- 1.5.2 TCP / IP Reference Model
- 1.6 Normalization and standards

PART II. SIGNALS AND DATA COMMUNICATIONS

UNIT 2. SIGNALS AND DATA TRANSMISSION

2.1 Concepts and terminology used in signal and data transmission.

2.2 Time domain and frequency domain.

- 2.2.1 Concepts in the time domain
- 2.2.2 Concepts in the frequency domain

2.2.2.1 Fundamentals of Fourier analysis

2.2.2.2 Power spectral density and bandwidth

2.2.2.3 Relationship between the transmission speed and the bandwidth

2.3 Interference in transmission

2.3.1 Energy Decibels and Signal

2.3.2 Attenuation

- 2.3.3 Delay Distortion
- 2.3.4 Noise

2.3.5 Channel Capacity

2.3.6 maximum transmission speeds

2.4 Transmission types

2.4.1 Transmission asynchronous / synchronous

2.4.2 Transmission series / parallel

2.4.3 Transmission simplex / half duplex / full-duplex

UNIT 3. ANALOG AND DIGITAL TRANSMISSION

- 3.1 Introduction to signal and analog and digital data
- 3.2 Transmission of digital data via digital signals
 - 3.2.1 Encoding NRZ (nonreturn to zero)
 - 3.2.2 Binary-Multilevel Coding

3.2.3 Biphase Coding

3.3 Transmission of digital data using analog signals

3.3.1 ASK (Amplitude-Shift Keying)

3.3.2 FSK (Frequency-Shift Keying)

3.3.3 PSK (Phase-Shift Keying)

3.4 Transmission of digital signals by analog data

3.4.1 PCM (Pulse Code Modulation)

3.4.2 PAM (Pulse Amplitude Modulation)

3.4.3 DM (Delta Modulation)

- 3.5 Transmission of analog data with analog signals
 - 3.5.1 AM (Amplitude Modulation)

3.5.2 FM (Frequency Modulation)

3.5.3 PM (Phase Modulation)

PART III. THE PHYSICAL LAYER

UNIT 4. TRANSMISSION MEDIA

- 4.1 Guided transmission media
 - 4.1.1 Twisted Pair
 - 4.1.2 Coaxial Cable
 - 4.1.3 Fiber Optics
- 4.2 Unguided transmission media
 - 4.2.1 Radiowaves
 - 4.2.2 Microwave
 - 4.2.3 Infrared

UNIT 5. Structured Cabling Systems

- 5.1 Introduction
- 5.2 Topologies

5.3 Subsystems of Structured Cabling

- 5.3.1 Distribution Subsystem campus
- 5.3.2 Vertical Distribution Subsystem
- 5.3.3 Horizontal Distribution Subsystem
- 5.4. Regulation
- 5.5. Network equipments
 - 5.5.1 Hub
 - 5.5.2 Switches
 - 5.5.3 Routers

PART IV. THE LINK LAYER

UNIT 6. INTRODUCTION TO LEVEL LINK

6.1 Features: Terminology and definitions

6.2 Types of links: point-to-point and broadcast

6.3 Services provided by the link layer

6.3.1 Management frames

6.3.2 Link Management

6.3.3 Error Control

6.3.4 Flow Control

6.3.5 Media Access Control

6.4 Importance of the link layer in context

UNIT 7. LINK LEVEL IN THE LOCAL AREA NETWORKS

7.1 Multiple access protocols (MAC, Media Access Control)

7.1.1 TDM (Time Division Multiplexing)

7.1.2 FDM (Frequency Division Multiplexing)

7.1.3 CDMA (Code Division Multiple Access)

7.1.4 Dynamic Access Protocols

7.1.5 Random Access Protocols

7.1.6 MAC level addressing

7.2 Ethernet

7.2.1 Format of Ethernet frames

7.2.2 Operation of CSMA / CD

7.2.3 Collision domain and Broadcast domain

7.2.4 Switched Ethernet

7.2.5 STP / RSTP

7.2.6 Ethernet half duplex

7.2.7 Virtual LAN

7.2.8 Ethernet Technologies

7.3 Wireless Networks

7.3.1 Characteristics of wireless networks

7.3.2 Wi-Fi IEEE 802.11

7.3.3 Protocol CSMA / CA

7.3.4 IEEE 802.11 Frames

7.3.5 IEEE 802.16 WiMax

PART V. THE NETWORK LAYER

UNIT 8. NETWORK LEVEL: INTERCONNECTING NETWORKS

8.1 Basic functions: routing

8.2 Services Network

8.2.1 Model mode network of virtual circuits

8.2.2 Model datagram mode network

8.2.3 Network Service oriented and connection-oriented

8.3 Routing in the Internet. The IP protocol

8.3.1 IPv4

8.3.1.1 The IP header

8.3.1.2 IPv4 Addressing

8.3.1.3 Masks and Subnets

8.3.1.4 Types of IP datagrams

8.3.1.5 The future of IPv4

8.3.2 IPv6

8.3.2.1 Motivation

8.3.2.2 IPv6 Header

8.3.2.3 Problems of migration to IPv6

8.3.2.4 Mechanisms to assist the transition

8.4 Supporting IP Protocols

8.4.1 ICMP 8.4.2 ARP 8.4.3 NDP

8.4.4 BOOTP

8.4.5 DHCP

8.4.6 DNS

8.5 Routing algorithms and mechanisms

8.6 Internet routing protocols

PART VI. THE TRANSPORT LAYER

UNIT 9. PROTOCOLS TRANSPORT LAYER

9.1 UDP (User Datagram Protocol)

- 9.2 TCP (Transmission Control Protocol)
 - 9.2.1 TCP Segment Format
 - 9.2.2 Establishing the connection
 - 9.2.3 Terminating the connection

9.2.4 TCP State Diagram

9.2.5 Transfer of information via TCP

PART VII. THE APPLICATION LAYER

UNIT 10. INTERNET APPLICATIONS

10.1 Client / Server Model

10.2 DNS (Domain Name System)

10.3 Basic Services

10.3.1 Virtual Terminal: The Telnet protocol

10.3.2 Secure connections: SSH protocol

10.4 File Transfer

10.4.1 FTP (File Transfer Protocol)

10.4.2 SSH FTP under

10.5 Email

10.5.1 Transfer of messages: SMTP (Simple Mail Transfer Protocol)

10.5.2 Simple access to mailbox: POP3 (Post Office Protocol)

10.5.3 Full access to mailbox: IMAP (Internet Message Access Protocol)

10.6 Service hypermedia: WWW (World Wide Web) 10.6.1 Hypermedia documents 10.6.2 Transfer hypermedia: the HTTP 10.6.3 Intermediaries: proxies and gateways 10.7 Instant messaging 10.8 Multimedia 10.8.1 Radio over IP 10.8.2 Voice over IP 10.8.3 Video over IP

5.3. Practices/Laboratory sessions program

CNS laboratory sessions

Five lab sessions (2 hours each) will be realized in order to that students become familiar with the underlying technologies in most current networks and communications services and, also, they are able to use the most common equipment and tools (hardware and software) common in the design and operation of telecommunication networks and services.

These five lab sessions will have sufficient complexity to be followed without difficulty while reinforcing the knowledge acquired in the lectures / problems. The sessions will use a local network consisting of various types of computers: PCs with Windows and Linux operating systems, and different physical devices to interconnect LAN (hub, switch, router, etc.). Also, free software is used for analysis and monitoring of frames and packets, and other software applications for network design and configuration. As a complement, oscilloscopes and other measuring instruments can be used during the lab sessions.

6. TEACHING METHODOLOGY

| 6.1. Learning activities | | | | | | | | | | |
|--------------------------|--|---|------|--|--|--|--|--|--|--|
| Activity | Lecturer role | Student Role | ECTS | | | | | | | |
| | 1 | H | | | | | | | | |
| | | Attendance: | 1,40 | | | | | | | |
| Lectures | Oral lecture. Resolution of questions/doubts. | Class attendance | - | | | | | | | |
| | | <u>Non-allendance</u> . Personal study | 1,20 | | | | | | | |
| | | | | | | | | | | |
| | | Attendance: | | | | | | | | |
| | Oral lecture. Approach to problems of | Class attendance | 0,60 | | | | | | | |
| Classes | increasing difficulty. Group work. Finally, | Non-attendance: | | | | | | | | |
| | solving problems in public. | Solving problems during | 0,80 | | | | | | | |
| | | personal study | | | | | | | | |
| | | · · · · · · · · · | | | | | | | | |
| Practices | Practical class. Resolution by students of different collections of problems guided stop | Attendance: Individual work or | | | | | | | | |
| (lab cossions) | by step through the lecturer. Use of | laboratory under lecturer | 0,40 | | | | | | | |
| (Lab Sessions) | computers and network equipments. | supervision. | | | | | | | | |
| | · · · | <u> </u> | | | | | | | | |
| Continuous | Evaluation tasts for each teaching unit to | Non attendance: Doing chart | | | | | | | | |
| assessment | perform individually through the virtual | evaluation tests using the | 0.40 | | | | | | | |
| (Virtual tasts) | classroom. | virtual classroom. | 0,40 | | | | | | | |
| (VIItual tests) | | | | | | | | | | |
| | A cominar/vicit where professionals in the | | | | | | | | | |
| | A seminaryvisit where professionals in the | | | | | | | | | |
| Seminar/Visit | (ICT) can show the student different | Attendance: | 0.10 | | | | | | | |
| | systems/communication networks applicable | Attendance to the seminar/visit | ŕ | | | | | | | |
| | in industry and/or defense sector. | | | | | | | | | |
| | 1 |)/ | | | | | | | | |
| End of course | Final ovam following the current regulation | Attendance: | 0 10 | | | | | | | |
| assessment | Final examinonowing the current regulation. | Written test | 0,10 | | | | | | | |
| <u> </u> | • | <u>, </u> | | | | | | | | |
| | An end of course work on a case study of a | Attendance: | | | | | | | | |
| | telecommunications system/service/network | Oral exposition (in English) | 0,10 | | | | | | | |
| Research project | in the field of security and defense. | | | | | | | | | |
| ····· | Depending on the scope of work, it may be | <u>Non-attendance</u> : Development | 0.00 | | | | | | | |
| | students. | Finglish). | 0,90 | | | | | | | |
| | | | | | | | | | | |

TOTAL

6

12

7. ASSESSMENT

| 7.1. Assessment system | | | | | | | | | | | |
|--|--|---|--|-----|--|--------------------------------|--|--|--|--|--|
| Methods | Criteria | Criteria Weighting | | | | riteria Generic Competences | | | | | |
| Individual written official exam (50 %) | It will consist of a battery of short questions and multiple choice. Its aim is to evaluate the knowledge acquired in the different teaching units. | Up to 5 points. It is required a minimum rating of 4 out of 10 on this test to pass the course. | T1.1, T1.3, T1.7, E2.8 | All | | | | | | | |
| Virtual exams (20%) | For each teaching unit, the student must take a test with different short and multiple choice questions of similar complexity to solve in the literature and in class. These seven tests will be conducted through the virtual classroom after each teaching unit. | Up to 1/7 × 2 points for each exam The average scores for the seven tests average 20% in the final exam grade if that operation favors the final grade. Otherwise, the test score will mean 70% of the final grade for the course. | T1.1, T1.3, T1.7, E2.8 | All | | | | | | | |
| Laboratory work (10%) | For each lab session, a short lab report must be submitted. | $1/5 \times 1$ point for each submitted report | T1.1, T1.3, T1.7, T2.2, T3.1, T3.2, T3.7, E2.8 | All | | | | | | | |
| Research project (20%) | A number of topics and cases of studies will be proposed in order to that students will analyze and orally present a telecommunication Up to 2 points. network/system/service in the context of industry and/or defense. Students can also | | T1.1, T1.3, T1.7, T2.2, T3.1, T3.2, T3.7, E2.8 | All | | | | | | | |

IMPORTANT: *To pass the course you must achieve a final score equal to or greater than 5,* taking into account all the criteria and evaluation tests of the assessment system.

7.2. Learning process monitoring

The learning process monitoring will be made through the following activities:

- Results of the interim assessment tests.
- Monitoring of student work in lab sessions.
- Statistics from the use of documentary material placed in the Virtual Classroom.
- Individual and group tutorials

8. RESULTS, LEARNING ACTIVITIES AND ASSESSMENT

Learning Objectives (4.4)

1. Knowing the historical evolution of networks and communication systems, allowing you to contextualize the current state of technology

2. Learning the basic principles of communication systems, the main types of existing networks and the two models most widespread network architecture: OSI and TCP / IP.

3. Understanding the basics of signaling and data in the time domain and frequency, along with the different types of analog and digital transmission.

4. Knowing the different transmission media-guided and unguided, which are present in most networks and communications systems.

5. Learning the basic principles of design and installation of a structured cabling system.

| Lectures | Classes | Laboratory Sessions | Continuous assessment | Seminary/Visit | Research Project | Individual work |
|----------|---------|---------------------|-----------------------|----------------|------------------|-----------------|
| ■ | | | | | ■ | ■ |
| | | | | | | ■ |
| | | | | | | ■ |
| ■ | ■ | ■ | ■ | | ■ | ■ |
| • | ■ | ■ | ■ | | ■ | ■ |

| Learning Objectives (4.4) | Lectures | Classes | Laboratory Sessions | Continuous assessment |
|--|----------|---------|---------------------|-----------------------|
| 6. Knowing the services offered by the link-level protocols and their relationship with local area networks, both wired and wireless. | • | • | | |
| 7. Understanding the basic mechanisms of the protocol for interconnecting IP networks, IPv4 and IPv6 extension, supported protocols and the main IP routing algorithms and routing Internet. | • | • | | |
| 8. Understanding the basics of different types of communication equipment, such as hubs (hubs), bridges (switches) and routers (routers). | • | | | |
| 9. Learning the operation of the transport protocols UDP and TCP. | • | • | • | • |
| 10. Learn more application protocols currently used, such as remote login, file transfer, e-mail, the Web, instant messaging and multimedia applications (Radio, Voice and Video over IP). | | | | |

Research Project

Individual work

Seminary/Visit

15

9. ECTS ALLOCATION

| COURSE | | ATTEND | DANCE | CONVEN ATTEN | ITIONAL DANCE | NC CONVEN ATTEN | DN- NTIONAL DANCE | NON- ATTENDANCE | | | |
|---------|----------------|--------|-------|-----------------|------------------|-----------------------|-------------------------|--------------------|-----|--|--|
| CREDITS | TOTAL HOURS | AC | АН | CAC | САН | NCAC | NCAH | NAC | NAH | | |
| 6 | 150 | 2,72 | 68 | 2,40 | 60 | 0,32 | 8 | 3,28 | 82 | | |

AC: ATTENDANCE CREDITS CAC: CONVENTIONAL ATTENDANCE CREDITS NCAC: NON-CONVENTIONAL ATTENDANCE CREDITS NAC: NON-ATTENDANCE CREDITS

AH: ATTENDANCE HOURS CAH: CONVENTIONAL ATTENDANCE HOURS NCAH: NON-CONVENTIONAL ATTENDANCE HOURS NAH: NON-ATTENDANCE HOURS

10. SCHEDULE

| | | | | Attendance Activities | | | | | | | | | | | |
|------|--|----------|---------|-----------------------|-----------------|---------|-------|-----------|------------|--------------------------|----------------|---------------|------------------|-----------|-------------|
| | Conventional | | | | No Conventional | | | | | Attendance Activities | | | | P | |
| Week | Units or activities | Lectures | Classes | Lab sessions | Total CAH | Seminar | Visit | Tutorials | Final Exam | Total NCAH | Personal study | Virtual exams | Research project | Total NAH | TOTAL HOURS |
| 1 | Overview of the course + Unit 1 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 5 |
| 2 | Unit 2 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 7 |
| 3 | Unit 2 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 7 |
| 4 | Unit 3 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 7 |
| 5 | Unit 4 + Lab Session 1 | 2 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 7 |
| 6 | Unit 5 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 7 |
| 7 | Unit 6 (I) + Lab Session 2 | 2 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 6 |
| 8 | Unit 6 (II) + Unit 7 (I) | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 4 | 8 |
| 9 | Unit 7 (II) + Unit 8 (I) | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 4 | 8 |
| 10 | Unit 8 (II) | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 5 | 9 |
| 11 | Unit 8 (III) + Lab Session 3 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 4 | 9 | 13 |
| 12 | Unit 9 + Lab Session 4 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 4 | 9 | 13 |
| 13 | Unit 10 + Lab Session 5 | 2 | 0 | 2 | 4 | 0 | 0 | 1 | 0 | 1 | 4 | 1 | 4 | 9 | 14 |
| 14 | Seminar + Visit + Research Project | 2 | 2 | 0 | 4 | 1 | 1 | 1 | 0 | 3 | 4 | 0 | 4 | 8 | 15 |
| 15 | Research Project (Oral Exposition -English-) | 0 | 4 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 4 | 0 | 4 | 8 | 13 |
| | Exams | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 8 | 0 | 0 | 8 | 11 |
| | Others | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL HOURS | 35 | 15 | 10 | 60 | 1 | 1 | 4 | 2 | 8 | 50 | 10 | 22 | 82 | 150 |

11. REFERENCES

11.1. Main References

- *Comunicaciones y Redes de Computadores (6^ª edición)*. William Stallings. Prentice Hall, 2003.
- *Redes de Computadoras (4ª edición).* Andrew S. Tanenbaum. Prentice Hall, 2003.
- Transmisión de datos y redes de comunicaciones (4º Edición). B. Forouzan. Mc-Graw Hill, 2007.
- *Redes de Computadores: Un Enfoque Descendente Basado en Internet (5ª edición).* James F. Kurose, Keith W. Ross. Addison-Wesley, 2010.
- Redes de Computadores. José María Barceló Ordinas, Jordi Íñigo Griera, Ramón Martí Escalé, Enric Peig Olivé, Xavier Perramon Tornil. Universitat Oberta de Catalunya, 2004. (Libre acceso: http://cv.uoc.es/cdocent/W2YEM0UV3EI0G3E91A0X.pdf)

11.2. Additional References

Recommended books:

- Academia de Networking de Cisco Systems: Guía del primer año CCNA 1 y 2.
 3º Edición. Cisco Press, Madrid, 2008.
- Academia de Networking de Cisco Systems: Guía del segundo año CCNA 3 y 4.
 3º Edición. Cisco Press, Madrid, 2008.
- Redes de Area Local (2ª edición). Francisco J. Molina, Editorial Ra-Ma, 2005.
- Redes y Servicios de Telecomunicaciones (4ª edición). José Manuel Huidobro. Thomson – Paraninfo, 2006.

More books:

- Introducción a las redes locales. José Félix Rábago, Editorial Anaya, 1995.
- *Modern Electronic Communication (6^ª edición)*. Gary M. Miller. Prentice Hall, 1999.
- Electronic Communication Systems: A complete course (3ª edición). William Schweber, Prentice Hall, 1999.

11.3. Network resources

All material used during the development of this course is available in Virtual Classroom:

http://moodle.upct.es/course/view.php?id=511103014