Universidad Politécnica de Cartagena

Centro Universitario de la Defensa

General Air Force Academy

Course unit description:

Redes y Servicios de Comunicación

(Communication Networks & Services)

Degree/s: Industrial Organization Engineering

Course: 2016-2017

1. Subject data

Name	Communication Networks & Services				
Subject area	Communication Networks & Services				
Module	Optional courses *(Esp. Defensa y control Aéreo)*				
Code	511103013				
Degree programme	Grado en Ingeniería de Organización Industrial				
Curriculum	2009 (Decreto 269/2009 de 31 de julio)				
Centre	University Centre of Defence at the Spanish Air Force Academy				
Type	Optional				
Length of subject	Four-month course	**Semester**	2nd	**Course**	3rd
Language	Spanish/English				
ECTS	6	**Hours / ECTS**	25	**Total workload (hours)**	150

2. Lecturer data

Lecturer in charge	José Santa Lozano		
Department	Department of Sciences and Informatics		
Knowledge area	Telematics		
Office location	Office 37, CUD Administrative Building		
Telephone	+34 968 189943	**Fax**	+34 968 189970
email	jose.santa@cud.upct.es		
URL / WEB	UPCT eLearning application (Aula Virtual)		
Office hours (for supervisions)	Prior email notice. Tuesday and Thursday (12:35-14:35)		
Office hours location (for supervisions)	Office 37, CUD Administrative Building		

Teaching and research profile	PhD in Computer Engineering. Accreditation of Associate Professor
Teaching experience	7 years in Computer Engineering Degree in University of Murcia; 5 years in MSc on New Technologies in Computer Science in University of Murcia; 1 year in Degree in Tourism; 3 year in CUD San Javier. Previous subjects: Embedded Systems, Microprocessor-Based Design, Electronic Distribution in the Tourism Sector, Physical Fundaments of Computers, Wireless Networks, Mobility-Supporting Services.
Research lines	Mobile Networks, Ubiquitous Services, Intelligent Buildings and Home Automation, Vehicular Networks, GNSS Navigation, Intelligent Transportation Systems, Vehicular Telematics.
Work experience	5 years. Project Manager in R+D and Network Engineer at University of Murcia, Department of Information and Communication Engineering.
Other	Tele-monitoring of infrastructures and automation.

3. Subject description

3.1. General description

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 nine 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. How the subject contributes to a professional career

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 an efficient, responsible and secure 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.

3.3. Relationship with other subjects in the programme

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.

Due to the fact that this course belongs to Information & Communication Technologies (ITC), it extends the basic notions analyzed in the course “Security and Defense Technology” (3rd year) and complements the course "Electromagnetic Exploration Systems" (4th year). Furthermore, although indirectly and to a lesser extent, this subject is also related with other courses as "Computer Science" (1st year), "Electrical Technology" or "Electronic Automation and Instrumentation" (2nd year).

3.4. Incompatibilities defined in the programme

None.

3.5. Recommendations to do the subject

None.

3.6. Special provisions

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 and learning outcomes

4.1. Basic curricular competences related to the subject

BC1. Students must know and understand a field of study that has its basis in secondary education for which advanced textbooks are used. In addition, students must also be acquainted with avant-garde knowledge of their field of study.

BC2 Students must know how to professionally apply their knowledge to their work or vocation and have the skills to make and defend arguments and solve problems in their field of study.

BC3 Students must have the ability to collect and interpret important data (normally within their area of study) in order to make judgements considering relevant social, scientific or ethical issues.

BC4. Students must be able to transmit information, convey ideas, and describe problems and solutions to a specialised and non-specialised audience.

BC5. Students must have developed the learning abilities needed to undertake subsequent studies with a high degree of autonomy.

4.2. General curricular competences related to the subject

Ability of organization and management of companies and institutions, evaluating the aspects of organizational behavior and management of resources, all in a secure legal environment provided for their expertise in legal matters.

4.3. Specific curricular competences related to the subject

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. Transversal curricular competences related to the subject

T1.1	Analytical and summary skills
T1.3	Oral and written communication skills in their mother tongue
T1.7	Problem solving skills
T2.2	Teamwork
T3.1	Ability to apply theory to practice
T3.2	Learning ability
T3.7	Ability to work autonomously

4.5. Subject learning outcomes

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).

11. Learning the basics of network security, and knowing the new concepts of ciberdefence and cibersecurity.

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. Curricular contents related to the subject

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

5.2. Theory syllabus (teaching modules and units)

PART I: OVERVIEW OF COMMUNICATIONS
UNIT 1. INTRODUCTION

PART II. SIGNALS AND DATA COMMUNICATIONS
UNIT 2. SIGNALS AND DATA TRANSMISSION
UNIT 3. ANALOG AND DIGITAL TRANSMISSION

PART III. THE PHYSICAL LAYER
UNIT 4. TRANSMISSION MEDIA
UNIT 5. STRUCTURED CABLING SYSTEMS

PART IV. THE LINK LAYER
UNIT 6. INTRODUCTION TO LEVEL LINK
UNIT 7. LINK LEVEL IN THE LOCAL AREA NETWORKS

PART V. THE NETWORK LAYER
UNIT 8. NETWORK LEVEL: INTERCONNECTING NETWORKS

PART VI. THE TRANSPORT LAYER
UNIT 9. PROTOCOLS TRANSPORT LAYER

PART VII. THE APPLICATION LAYER
UNIT 10. INTERNET APPLICATIONS

PART VIII. ACCESS NETWORK
UNIT 11. ACCESS NETWORK TECHNOLOGIES TO HIGH-SPEED INTERNET SERVICES

PART IX. NETWORK SECURITY
UNIT 12. SECURITY IN COMMUNICATION NETWORKS

5.3. Practice syllabus (name and description of every practical)

Six 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.

Session 1. Introduction to the laboratory and structured cabling.
Session 2. Introduction to the TCP/IP stack
Session 3. TCP/IP set-up in Windows and Linux
Session 4. Switch set-up in local area networks
Session 5. Router configuration for inter-networking
Session 6. Transport and application-level services in networks.

5.4. Theory syllabus in english (teaching modules and units)

See Section 5.2.

5.5. Detailed description of learning goals for every teaching module

UD I. OVERVIEW OF COMMUNICATIONS.

- Know the technological evolution of telecommunications, from the first telephone networks to the existing telecommunications systems.
- Describe the main modules / components of a communications system.
- Describe the different types of existing networks by connecting, physical topology, geographic scale, scope of data and the establishment of communication.
- Know the main network switching modes (circuit switching and packet switching).
- Explain the two main models of network architectures (OSI and TCP IP models /) and its operation.
- Describe the main regulations governing communications networks and services.

UD II. SIGNAL AND DATA COMMUNICATIONS.

- Know the main concepts and terms of signals and data transmissions.
- Be able to understand the differences between the time and frequency representation of signals / data.
- Know the basics of time domain and frequency domain.
- Distinguish between different types of disturbances that exist in the transmission of signals and data.
- Know the different modes of transmission (asynchronous / synchronous serial / parallel, simplex / half-duplex / full-duplex).
- Differentiate between analog and digital transmission.
- Understand principles of modulation and coding signals and analog and digital data.

UD III. THE PHYSICAL LAYER.

- List the differences between means of transmission guided and unguided.
- Know the basics of the main means of transmission led (twisted pair, coaxial cable, optical fiber).
- Know the basics of the main means of transmission unguided (radio waves, microwaves, infrared).
- Identify the different topologies in existing structured cabling systems.
- Explain the different subsystems that make up a structured cabling system.
- Know the rules existing in structured cabling systems.
- Know the main communications equipment in structured cabling systems.

UD IV. THE LINK LAYER.

- Know the different services provided at the link level.
- Distinguish between different types of links (point-to-point and broadcast).

- To understand the importance of the link layer in context.
- Know the different protocols multiple media access (TDM, FDM, CDMA, dynamic access random access).
- Know the address used in the link layer.
- Know the Ethernet protocols for wired and wireless networks.
- Explain the operation of a switch (switch).

UD V. THE NETWORK LAYER.

- Distinguish between networks as virtual circuit and datagram mode.
- Be able to understand network services oriented and connectionless.
- Know the main aspects of the IP protocol (IPv4 and IPv6 versions).
- Know the Internet addressing scheme.
- Be able to apply private and public schemes addressing.
- Know the main protocols support IP protocol (ICMP, ARP, NDP, BOOTP, DHCP, DNS, ...) and its foundations.
- Explain the operation of a router (router).
- To understand the algorithms, mechanisms and existing routing protocols today.

UD VI. THE TRANSPORT LAYER.

- List the differences between the two main protocols of the transport layer (TCP and UDP).
- Know how the TCP protocol.
- Know how the UDP protocol.

UD VII. THE APPLICATION LAYER.

- Explain the client / server model.
- List the major Internet applications.
- Define the characteristics and operation of the access protocols via Telnet and SSH.
- Explain the basic mechanisms of protocols for file transfer.
- Know how email.
- Describe the fundamentals of hypermedia access service (WWW, HTTP, ...).
- List the main characteristics of instant messaging services.
- To understand the concepts of radio transmission, voice and video on the Internet.

UD VIII. ACCESS NETWORK.

- Define the main existing technologies of access network to high-speed internet services.
- Understand the basic notions concepts of these technologies, which include –among others- xDSL, HFC, FTTH, WiFi-WiMAX and 3G/4G.

UD IX. NETWORK SECURITY.

- Define the main procedures of security and defense in the different layers that make up the architecture of a network or communications system.
- Understand the concepts of cyber security and defense.

6. Teaching method

6.1. Teaching method

Teaching activity	Teaching techniques	Student workload	Hours
Lectures	Presentation and explanation of the course material. Resolving doubts. Special emphasis will be made on the fundamental and more complex theoretical aspects of the course.	In-class: Active attendance and class participation. Taking notes. Questions.	**35**
		Self-study: Individual study.	**25**
Problem solving classes	Solving problems in the classroom and/or presenting case studies. Teamwork.	In-class: Active attendance. Questions and problem solving	**15**
		Self-study: Individual study. Problem solving.	**25**
Laboratory sessions	Explaining the laboratory exercises. Supervising and leading the laboratory classes. Evaluating student knowledge and participation.	In-class: Individual and/or cooperative work in the laboratory under lecturer supervision. Active participation.	**12**
Self-learning virtual tests	Multiple choice quizzes for each teaching unit to perform individually through the virtual classroom, in order to each student check his/her level of knowledge acquired after giving this teaching unit. The nature of these self-learning activities is completely optional (to be done using the e-learning tool at the time that each student sees fit) and it is not evaluable for the final qualification, as their unique purpose is to guide the student about his/her level of acquired knowledge.	Self-study: Doing short self-learning tests using the e-learning tool (virtual classroom).	**7**
Tutoring (individual/group)	Tutoring sessions will be carried out in an individual or groups basis, and they will serve to solve doubts/questions.	This activity will be face-to-face or remotely, through e-mail.	**2**
Seminar/Visit	A seminar/visit where professionals in the Information Technology and communications (ICT) can show the student different systems/communication networks applicable in industry and/or defense sector.	In-class: Attendance to the seminar/visit	**2**
End of course assessment	Final exam(s) following the current regulation	In-class: Written exam(s).	**3**
Research project	An end of course work on a case study of a telecommunications system/service/network.	In-class: Oral exposition (in English)	**1**
		Self-study: Development of research project (written in English).	**23**
			150

6.2. Learning outcomes (4.5) / teaching activities (6.1) (optional)

	Learning outcomes (4.5)										
Teaching activities (6.1)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Lectures	x	x	x	x	x	x	x	x	x	x	x
Problem solving classes			x	x	x	x	x	x	x	x	
Laboratory sessions				x	x	x	x	x	x	x	
Self-learning virtual tests	x	x	x	x	x	x	x	x	x	x	
Tutoring	x	x	x	x	x	x	x	x	x	x	x
Seminar/Visit											x
Research project	x	x	x	x	x	x	x	x	x	x	x

7. Assessment method

7.1 Assessment method

Assesment activity	Type		Assessment methods and criteria	Percentage (%)	Assessed learning outcomes (4.5)
	Sumative	Formative			
Individual Written Examination, IWEs[(1)] (80%)	x		**Theoretical and theoretical-practical questions.** 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. It should be note that the exam may include issues related to laboratory sessions.	60% of the IWE (48% of the total)	1-11
			Problems. It will consist of several medium-long duration problems/exercises. Mainly, the practical application of the acquired knowledge and the analysis capacity are evaluated.	40 % of the IWE (32% of the total)	3-10
Research project (20%)	x	x	A number of topics and cases of studies will be proposed in order to that students will analyze and orally present a telecommunication network, system or service in the context of industry and/or defense. Students can also make their own proposals. Exposure / defense will be in English during the last weeks of class, as directed by the teacher responsible for the course. The evaluation of the work will be done by using a rubric.	20% of the total	1-11

(1) For making easier the continuous assessment, and according to the head of the course, a partial Individual Written Examination (IWE) may take place in mid-term, which will focus on the first part of the course (Teaching Units I, II and III). If this test is performed, it must overcome with total equal to or greater than 4.5 on 10 to eliminate this part of the course for the final exam. This partial IWA is completely optional and it is done on a unique date fixed by the head of the course. Those students who do not perform or do not pass this partial IWA have to pass a final exam that will cover all the teaching units that make up this course.

The final exam consists of two IWEs. First, all students will do the IWE2 corresponding Teaching Units IV, V, VI, VII and VIII. After a break, the IWE1 corresponding to the first part will be done by those students who did not rid such material in the partial IWE1, or those wishing to obtain a higher mark on that part. All students can do this second IWE1, but, those who rid the contents in the partial IWE1, if they give this part to the teacher, will renounce to the mark obtained in the partial IWE1.

The IWEs will follow the specifications previously detailed. To pass the course it is necessary but not enough to obtain a minimum mark of 4.0 at each of the IWEs. If this condition is not satisfied, the student will not pass the whole course, being the maximum mark in this situation 4.0. To clarify this point, let's suppose that a student gets the following marks: IWE1 = 3.0, IWE2 = 10.0, the average mark is IWE = 6.5, but as long as IWE1 is lower than 4.0, the final mark of the student will be 4.0.

Additionally considerations on IWEs:

a. If the student's handwriting is illegible, the student will fail the IWE with a maximum qualification of 3.9.
b. If the student doesn't write correctly his name in every sheet he gives to the teacher, the student will fail the IWE with a maximum qualification of 3.9.
c. Additional considerations can be made on particular IWEs calls.

IMPORTANT:

The score of the course (*N*) is calculated using the following expression:

$$If \quad \left.\begin{matrix} IWE_1 \geq 4.0 \\ IWE_2 \geq 4.0 \end{matrix}\right\} \rightarrow IWE = \frac{IWE_1 + IWE_2}{2} \begin{cases} 0 \leq IWE < 4.5 \rightarrow & N = IWE \\ 4.5 \leq IWE \leq 10 \rightarrow & N = 0.8 \times IWE + 0.2 \times RP \end{cases}$$

$$Otherwise, \quad N = \min(4.0, IWE)$$

where

IWE = arithmetic average of the individual written examinations (rated from 0 to 10).
RP = obtained score in the Research Project (rated from 0 to 10).

To pass the course it must be N ≥ 5.0.

7.2. Control and monitoring methods (optional)

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 e-learning tool.
- Individual and group tutorials

8. Bibliography and resources

8.1. Basic bibliography

- *Comunicaciones y Redes de Computadores (6ª 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/W2YEM0UV3EIOG3E91A0X.pdf)

8.2. Supplementary bibliography

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 (6ª edición)*. Gary M. Miller. Prentice Hall, 1999.
- *Electronic Communication Systems: A complete course (3ª edición)*. William Schweber, Prentice Hall, 1999.

8.3. On-line resources and others

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

https://aulavirtual.upct.es/course/view.php?id=222