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

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	María Teresa Martínez Inglés		
Department	Department of Engineering and Applied Technologies		
Knowledge area	Telecommunications		
Office location	Office 2 @ CUD building		
Telephone	+34 968 189 916	**Fax**	+34 968188780
email	mteresa.martinez@cud.upct.es		
URL / WEB	Aula Virtual UPCT		
Office hours	Tuesday and Thursday at 12:50-14:25 (after prior appointment by email)		
Location	Office 2 @ CUD building		

Qualification/Degree	Doctor of Telecommunication Engineering, Field Telecommunications. Associate Professor of Telecommunications.
Academic rank at CUD-UPCT	Assistant Professor at an associated center
Year of admission in CUD-UPCT	2016
Number of five-year periods (*quinquenios*) if applicable	-
Research lines (if applicable)	Characterization and Modeling of the radio channels for systems with large bandwidth in the millimeter frequency band Experimental study of multiple Diffraction phenomenon in the millimeter band
Number of six-year periods (*sexenios*) if applicable	
Professional experience (if applicable)	3 years AQUILINE: Software engineer UPCT: Engineer. Studies about the viability of cognitive systems
Other topics of interest	

Lecturer	Fernando Pereñíguez García		
Department	Department of Sciences and Informatics		
Knowledge area	Telematics		
Office location	Office 38 – CUD Administrative Building		
Telephone	+34 968 189 946	**Fax**	+34 968 188 780
email	fernando.pereniguez@cud.upct.es		
URL / WEB	Aula Virtual UPCT		
Office hours	Tuesday and Thursday at 12:50-14:35 (after prior appointment by email)		
Location	Office 38 – CUD Administrative Building		

Qualification/Degree	Computer Science Engineer; Master in Advanced Information and Telematic Technologies; PhD in Computer Engineering. ANECA Accreditation of Associate Professor, Telematic Engineering Area.
Academic rank at CUD-UPCT	Assistant Professor at an associated center
Year of admission in CUD-UPCT	2017
Number of five-year periods (*quinquenios*) if applicable	-
Research lines (if applicable)	Network Access control and key distribution models in mobile networks. Seamless handoffs in heterogeneous networks. Federation and Single-Sign-On (SSO) access for application services. Security in communication networks.
Number of six-year periods (*sexenios*) if applicable	One six-year period accredited by CENAI (2008-2013)
Professional experience (if applicable)	- University of Murcia, 2011-2013, researcher in national and European R+D projects. - University of Murcia, 2012-2013, part time lecturer. - Catholic University of Murcia, 2013-2017 (2013-14 Assistant Professor, 2015-17 Associate Professor)
Other topics of interest	Cyber defense and cyber security.

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. Despite there is no any prerequisite associated with this subject, it is recommended that the student has completed the course "Computer Science" (1st year), since the student will be required to employ the binary and hexadecimal numbering representation systems, both learning goals of 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

The student must be familiar with the binary and hexadecimal numbering representation systems, as well as be able to perform conversions between these and decimal representation.

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

KC3. Students must have the ability to collect and interpret important data (normally within their area of study) in order to make judgments considering relevant social, scientific or ethical issues.

4.2. General curricular competences related to the subject

GC2. Application of general technologies and fundamental subjects in the industrial domain for the solving of engineering problems.

4.3. Specific curricular competences related to the subject

SC30. Analyze topics applied to engineering and aircraft systems operations.

4.4. Transversal curricular competences related to the subject

CCC4. Effective use of information resources

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 THE LINK LAYER
UNIT 7. THE LINK LAYER IN THE LOCAL AREA NETWORKS

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

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

PART VII. THE APPLICATION LAYER
UNIT 10. INTERNET APPLICATIONS

PART VIII. NETWORK SECURITY
UNIT 11. SECURITY IN COMMUNICATION NETWORKS

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

Five lab sessions will be realized with the aim of allowing students to become familiar with the underlying technologies used in most current networks and communications services. More precisely, these lab sessions will provide students with the necessary skills for configuring network equipment (i.e. hardware) as well as using management tools (i.e. software) common in the design and operation of telecommunication networks and services.

Session 1. Introduction to the laboratory. Transmission media: Cables and connectors.
Session 2. TCP/IP set-up in Windows and Linux
Session 3. Switch set-up in Local Area Networks
Session 4. Router configuration for inter-networking

These four laboratory sessions will reinforce the knowledge acquired in theory classes / problems.
In the sessions will be made use of a local network formed by different types of equipment: PCs with Windows and Linux operating systems, and different physical devices of interconnection for LANs (hub, switch, router, etc.). Likewise, free software will be used for the analysis and monitoring of frames and packages, as well as other software applications for the design and configuration of networks.
The completion of each laboratory practice will be evaluated by means of tests (for more information see section 7).

Risk prevention

Promoting the continuous improvement of working and study conditions of the entire university community is one the basic principles and goals of the Universidad Politécnica de Cartagena.

Such commitment to prevention and the responsibilities arising from it concern all realms of the university: governing bodies, management team, teaching and research staff, administrative and service staff and students.

The UPCT Service of Occupational Hazards (*Servicio de Prevención de Riesgos Laborales de la UPCT*) has published a "Risk Prevention Manual for new students" (*Manual de acogida al estudiante en materia de prevención de riesgos*), which may be downloaded from the e-learning platform ("Aula Virtual"), with instructions and recommendations on how to act properly, from the point of view of prevention (safety, ergonomics, etc.), when developing any type of activity at the University. You will also find recommendations on how to proceed in an emergency or if an incident occurs.

Particularly when carrying out training practices in laboratories, workshops or field work, you must follow all your teacher's instructions, because he/she is the person responsible for your safety and health during practice performance. Feel free to ask any questions you may have and do not put your safety or that of your classmates at risk.

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) 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 SSH.
- Explain the basic mechanisms of protocols for file transfer.
- Know how email.

- Understand the operation of basic network services such as DNS or DHCP.
- Describe the fundamentals of hypermedia access service (WWW, HTTP, ...).

UD VIII. 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**
Problem solving Classes	Solving problems in the classroom and/or presenting case studies. Teamwork.	In-class: Active attendance. Questions and problem solving.	**15**
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**
Tutoring (individual/group)	Tutoring sessions will be carried out in an individual or groups basis, and they will serve to solve doubts/questions.	In-class: Active participation in resolution of questions/doubts.	**1**
		Self-study: Preparation of questions for face-to-face tutoring.	**1**
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**
Individual study/work	Lecture notes covering all course topics will be made available to the students to ease individual study.	Self-study: Individual study. Problem solving.	**50**
Work/Report preparation	It will be proposed the completion of a Final Work where the students, in groups, will put into practice the knowledge acquired in the subject on the design, configuration and deployment of a network on a real case study. The work will be evaluated both by means of a report that includes the proposed resolution, as well as through an oral exposition that justifies the decisions taken.	In-class: Oral exposition of the Final Work.	**1**
		Self-study: Development and preparation of reports and work.	**23**
Realization of summative and formative course assessment activities	Multiple choice quizzes for each teaching unit to be performed individually through the Virtual Classroom, in order to each student check his/her level of knowledge acquired after giving a 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 considers appropriate) 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: Realization of self-evaluation tests using the e-learning tool (Virtual Classroom).	**6**
End of course assessment	Final exam(s) following the current regulation	In-class: Written exam(s).	**4**
			150

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

	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	
Problem solving classes		x	x	x			x	x			
Laboratory sessions				x	x		x	x	x	X	
Tutoring (individual/group)	x	x	x	x	x	x	x	x	x	X	x
Seminar/Visit											x
Individual study/work	x	x	x	x	x	x	x	x	x	X	
Work/Report preparation		x	x	x	x	x	x	x	x	X	
Realization of summative and formative course assessment activities	x	x	x	x	x	x	x	x	x	X	
End of course assessment	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)
	Summative	Formative			
Midterm Exam	x	x	Theoretical questions (battery of short questions and multiple choice), problems and exercises of complexity similar to those solved in the bibliography and in class. The written test will focus on Units 1-5	35%(*)	1-5
Final Exam B1 (IWE_B1)	x		Theoretical questions (battery of short questions and multiple choice), problems and exercises of complexity similar to those solved in the bibliography and in class. The written test will focus on Units 1-5	35%(*)	1-5
Final Exam B2 (IWE_B2)	x		Theoretical questions (battery of short questions and multiple choice), problems and exercises of complexity similar to those solved in the bibliography and in class. The written test will focus on Units 6-11	45%(*)	6-10
Final project	x	x	A final work will be proposed, where each student will have to apply the different knowledge acquired in the subject. The evaluation of the work will be done through a report and an oral presentation. The evaluation of the work will be done by using a rubric.(**)	10%	2-10
Laboratory work	x		The assimilation of practical knowledge will be evaluated by means of test tests.	10%	4-5, 7-10

(*) There will be an *Individual Written Examination* (IWE) Midterm Exam that will focus on Units I, II and III. It must be passed with a total grade equal to or greater than 4.0 out of 10 to eliminate this part of the course for the final exam.

The final exam will consist of two IWEs. The IWE corresponding to the Units I, II and III (**IWE_B1**) will be carried out for those students who did not pass the IWE Midterm Exam or by students wishing to improve upon their Midterm grades. It is worth mentioning that students taking IWE_B1 to obtain a higher mark on that part, permanently renounce the grade received on the corresponding IWE Midterm Exam, irrespective of the result they obtain on the final exam. The other IWE corresponding to Units IV, V, VI, VII and VIII (**IWE_B2**).

The IWEs will follow the characteristics set in the call. To pass the subject is necessary, but not enough, to obtain a minimum 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 grade that the student will obtain in this situation 4.0. To clarify this point,

let's suppose that a student gets the following grades: IWE_B1 = 3.0, IWE_B2 = 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.

Additional considerations on IWEs:

- If the student's handwriting is illegible, the student will fail the IWE with a maximum qualification of 3.9.
- 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.
- Additional considerations can be made on particular IWEs calls.

IMPORTANT:

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

$$N = 0.35 \times (IWE\_B1) + 0.45 \times (IWE\_B2) + 0.1 \times (FP) + 0.1 \times (PS)$$

where

- **IWE _B1**: qualification of Final Exam B1 (rated from 0 to 10).
- **IWE_B2**: qualification of Final Exam B2 (rated from 0 to 10).
- **FP**: qualification of the Final Project (rated from 0 to 10).
- **PS**: qualification of the Laboratory Sessions (rated from 0 to 10).

To pass the subject it is necessary to obtain a minimum of 4.0 in part IWE_B1, a minimum of 4.0 in part IWE_B2, and that the final grade of the subject N is equal to or greater than 5.0

(**) The Final Work of the subject will be delivered and defended in the dates indicated by the professors within the semester to which the subject belongs. The mark obtained in this work will be maintained until the next call for the exam

As set forth in article 5.4 of the *Reglamento de las pruebas de evaluación de los títulos oficiales de grado y de máster con atribuciones profesionales (UPCT)*, students in the special circumstances listed in the article 5.4 are entitled to a comprehensive assessment test, upon justified request which must be granted by the Department. This does not exempt them from carrying out compulsory tasks included in the teacher's guide of the subject (official syllabus).

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