



IDENTIFYING DATA

Computer Networks

Subject	Computer Networks			
Code	V05G300V01403			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish Galician			
Department	Telematics Engineering			
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella Suárez González, Andrés			
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General description	Operating principles, architecture, technology and norms of computer networks, especially of Internet. Design-oriented course, complemented by practical skills			

Competencies

Code	
B1	CG1: The ability to write, develop and sign projects in the field of Telecommunication Engineering, according to the knowledge acquired as considered in section 5 of this Law, the conception and development or operation of networks, services and applications of Telecommunication and Electronics.
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
B9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
C11	CE11/T6: The ability to conceive, deploy, organize and manage networks, systems, services and Telecommunication infrastructures in residential (home, city, digital communities), business and institutional environments, being responsible for launching of projects and continuous improvement like knowing their social and economical impact.
C17	CE17/T12: The knowledge and usage of concepts of communication network architecture, protocols and interfaces.
C18	CE18/T13: The ability to differentiate the concepts of access and transport networks, packet and circuit switched networks, mobile and fixed networks, as well as distributed network application and systems, voice, data, video, audio, interactive and multimedia services.
C19	CE19/T14: The knowledge of methods of networking and routing, as well as the fundamentals of planning and network evaluation based on traffic parameters.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes

Expected results from this subject	Training and Learning Results
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Comprise the general organization and the basic aspects of operation of communication networks, and particularly of computer networks	B3	C17	D2
Identify and know employ the concepts of switching, access and transport networks and wired and wireless networks	B3	C18	
Comprise the principles and the organization of distributed applications and services, either data or media oriented	B3	C17	
Comprise and know how to analyze the operation of the Internet: the architecture, the service model, the data transport, the routing methods and inter-networking, error control and congestion control	B3 B6	C11 C17 C19	D2 D3
Dominate the technical standards and the fundamental protocols of the Internet	B3 B4 B6	C17 C18 C19	
Practical capacity to design, handle and configure computer networks, from the point of view of data switching and transport	B1 B9	C11	D4

Contents

Topic

1. Introduction	a) Network Infrastructure: Nodes, links and networks b) Circuit and Packet Switching c) Communications Architecture: Layers, encapsulating, models
2. Packet Networks. Internet	a) Performance: Throughput, delays, losses b) The Internet ecosystem
3. Links and subnetworks	a) Concept of link and subnetwork b) Interconnection of networks at level 2: Bridges
4. Ethernet and WiFi	a) Ethernet Switching. b) VLANs and trunking c) Spanning Tree d) WiFi networks
5. Internet and IP	a) Interconnection of subnetworks. Routers b) IP Addressing c) IP datagram format d) Fragmentation e) The ICMP protocol
6. IP Forwarding	a) IP Forwarding mechanism b) Connected and Next-Hop Routes c) The DHCP protocol
7. Name and address translation	a) ARP b) DNS c) NAT
8. Routing	a) Graph theory. Shortest distance paths b) Link state: Dijkstra's algorithm c) Distance vector: Bellman-Ford d) Broadcast routing
9. Internet routing	a) Routing hierarchy b) Intradomain routing: RIP, OSPF c) Interdomain routing: BGP
10. Transport protocols	a) Service model b) TCP & UDP c) Transport connections: establishment, retransmissions, flow control
11. Congestion control	a) Network model b) Dynamics, fairness and stability c) TCP Reno, Vegas, FAST
12. Network security	a) Vulnerabilities. Protection b) Secure network and transport layers c) Denial of service. Spoofing d) Fundamentals of cryptography e) Digital signatures

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	26	52
Problem solving	11	22	33
Autonomous practices through ICT	7	18	25
Autonomous problem solving	0	15	15
Discussion Forum	0	5	5

Computer practices	8	8	16
Essay questions exam	2	0	2
Objective questions exam	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Lecturing	Exposition of the ideas, concepts, technics and algorithms related to the thematic units of the course. With this methodology we will work the competences CT2, CT3, CG3, CG4, CE11, CE17, CE18 and CE19.
Problem solving	Resolution in the classroom by the professor of problems and exercises related with the contents of the master lessons. With this methodology students work the competences CG3, CG4, CE11, CE17, CE18 and CE19.
Autonomous practices through ICT	Students have to develop a network program in an autonomous and individual way. There will be several classroom sessions to explain related programming concepts (sockets, threads), to explain with all detail the program and his implementation, to solve doubts with the professor, and to test and debug the program in the laboratory where this will be tested and evaluated. With this methodology work the competences CG1, CG6, CG9, CE11, CE17 and CE19.
Autonomous problem solving	Resolution of assignments, exercises, questions and self-assessment tests in the virtual classroom in a individual, autonomous way. These activities have a global weight of 10% in the case of continuous evaluation. With this methodology we will work the competences CG4, CG6, CG9, CE11, CE17, CE18, CE19, CT2, CT3, CT4
Discussion Forum	The discussion forums will be necessarily the way to request remote attention for doubts and questions related to the contents of the subject. This discussion and collaborative help will be promoted in the virtual classroom. With this methodology we will work the competences CT3 and CT4
Computer practices	Practices and resolution of practical problems in the computers, guided by the professor. With this methodology students should acquire competences CG1, CG9, CE17 & CE19.

Personalized attention	
Methodologies	Description
Lecturing	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Problem solving	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Computer practices	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Autonomous practices through ICT	Individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended. Please, in this case, contact your practice professor
Autonomous problem solving	In the case of tasks, the detailed solution will be provided in the virtual classroom. In the case of self-assesment tests, suitable feedback for the wrong questions will be provided to the student. In any case, individually personalized face-to-face attention will be dispensed. The tutorial schedule will be announced at the beginning of the course. Reservation in the virtual platform is recommended
Discussion Forum	In addition to individually personalized face-to-face attention, the professor will be monitor the discussions in the forums making suitable answers when necessary or explaining the answers of the students. The discussion forums are the way to request remote attention for doubts and questions related to the contents of the subject. Private attention about contents by means of messaging or e-mail is not available.

Assessment			
	Description	Qualification	Training and Learning Results
Autonomous practices through ICT	The students must develop a network program individually. There will be several presential sessions for tutoring with the professor and for developing, testing and debugging the program in the laboratory where this will be tested and evaluated. It has a weight of 20% but a minimum qualification of 3.5 points is required	20	B1 C11 B6 C17 B9 C19

Autonomous problem solving	During the course, with a roughly weekly periodicity, different tasks, activities, exercises, self-assessment tests must be made in the virtual classroom in an individual and autonomous way. These activities have a global weight of 10%	10	B4 B6 B9 C11 C17 C18 C19 D2 D3 D4
Essay questions exam	Final exam covering all the lessons. It has a weight of 50% but a minimum qualification of 3.5 points is required	50	B3 B4 C11 C17 C18 C19 D2
Objective questions exam	Two control tests will be done. The first one will cover lessons 1 to 4 and the second one lessons 5 to 8. Each control test has a 10% weight.	20	B3 B4 C11 C17 C18 C19 D2

Other comments on the Evaluation

The students can choose the method of Assessment, continuous or eventual.

Continuous Assessment (CA)

It consists of:

- Two midterm control tests (**C1 and C2**) covering, respectively, the contents of the lessons 1 to 4, and 5 to 8. Each control test has a 10% weight in the Final Grade (**FG**). The schedule of the midterm/intermediate exams will be approved in the Comisión
- Académica de Grado (CAG) and will be available at the beginning of each academic semester.
- The development of a network program (**PR**). The deadline will be published together with the specifications, but it will always be between the last practical class and the day of the final exam in May. Compliance with the prescriptions and the quality of the software will determine the qualification of this program. Together with the specifications, an assessment guide will be published. This program must be done and delivered individually. The **PR** will represent 20% of the Final Grade (**FG**), and it is required to reach 3.5 points in this program to be able to pass the subject.
- The participation in the online activities in the virtual environment, that represents 10% of the Final Grade (**FG**). During the course, tasks, activities, exercises, and self-assessment tests will be proposed with a weekly periodicity in the virtual classroom. These activities must be done by all students in an autonomous and individual way. The realization of these activities allows obtaining "merit points" (**MP**) up to a maximum of 100 points (in case of all activities are evaluated with the maximum grade). The grade of this section will be equal to the amount of **MP divided by 100**. In order to facilitate the achievement of the maximum amount of points, additional optional tasks will be proposed throughout the course.
- The virtual classroom includes a **gamification** system based in other types of points and several gamification elements and mechanisms to motivate students to make the activities and participate in a meaningful way in forums of doubts and discussions. This system allows students to get **rewards** to be used in exams and assignments.
- A final exam (**FE**) covering all contents, with a weight of 50% of the Final Grade (**FG**). A minimum qualification of 3.5 points on 10 is required

$$FG-CA = 0.1 \times C1 + 0.1 \times C2 + PM/100 + 0.2 \times NP + 0.5 \times FE \text{ if } FE \text{ and } NP \geq 3.5$$

$$\text{Otherwise, } FG-CA = \min(4.9, FE)$$

It is considered that a student chooses CA when taking any midterm control test (C1 or C2). If any of these control tests are not made, the grade will be "0". These control tests will be not recoverable.

Eventual Assessment (EA)

It will consist on the realization of the same FE at the end of the term, and on the delivery of the same proposed network program (NP) for those who go through the CE. The delivery dates will also be the same.

Students who do not take any midterm control test, compulsorily opt for the Eventual Assessment.

The grade of NP in this case is simply APT (with a numeric value 1), if the qualification of this program is equal or greater than 5.0, or NOT APT (with a numeric value 0) if the qualification is less than 5.0 or if the NP is not delivered, in which case the final grade will be 40% of the FE. That is,

$$FG-EA = (0.4 + 0.6 \times NP) \times FE$$

Second call

In the official dates, a new final exam (FE) will be done only for students not passing in the first call. Students will also be allowed to deliver a new NP consisting of a modified version of the program of the first call, and whose specifications will be published with at least 4 weeks with respect to the deadline, that it will never be later than this second final exam.

For students who chose CA, these FE and NP represent an opportunity to improve the grade in these with respect to the first call, and so the calculation of the final grade considers the best grade obtained.

For students who chose EA, the FE and the NP are considered joint and inseparable, that is,

$$\mathbf{FG-EA} = \mathbf{Max}\{(\mathbf{0.4} + \mathbf{0.6 \times NP-1st}) \times \mathbf{FE-1st}, (\mathbf{0.4} + \mathbf{0.6 NP-2nd}) \times \mathbf{FE-2nd}\}$$

Those students who have failed in the first call by going through Continuous Assessment and wish to renounce it in order to choose the Eventual Assessment, will have to request it in writing to the coordinator before the review date of the first final exam. In this case, the conditions to approve the subject are exactly the same as those of the rest of the students that are presented by EA, being therefore obligatory the delivery of a new PR with the specifications of this second call. In this case, any reward obtained by the CA activities in the virtual classroom is also waived.

Extraordinary call

Students presenting to this extraordinary call must approve the **FE**, to be done at the officially established dates and obtain an APT grade in the practice NP, that must be delivered before the date of this **FE**. The specifications of this practice are the same as those of the second call. It is mandatory to deliver this practice on time, although it has already been delivered in the second call.

The final grade of this call will be that of the **EF** if the **NP** is APT, and 40% of the **EF** if the **NP** is NOT APT

Other comments

All students presenting to any of the exams, **C1**, **C2**, **EF** or **PR** are considered to be presented to the subject. The grades for all exams, partial or final, and activities will affect only the actual academic year.

The virtual classroom platform has tools to detect possible anomalous and dishonest behaviors in self-assessment tests (tests carried out among several people, previously known answers, etc.), as well as to detect plagiarism in written works or in software programs.

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the works/test/exams, including the activities on the virtual platform, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

In case of any contradiction that may occur between the different versions of the guide, due to some error in the translation, the version that will prevail is the Galician language version.

Sources of information

Basic Bibliography

J.F. Kurose, K.W. Ross, **Computer networking: a top-down approach featuring the Internet**, 7,
L. Peterson, B. Davie, **Computer networks: a systems approach**, 5,

Complementary Bibliography

A. León-García, I. Widjaja, **Communication networks: fundamental concepts and key architectures**, 2,
C. López, M. Rodríguez, S. Herrería, M. Fernández, **Cuestiones de redes de datos: principios y protocolos**, 1,

Recommendations

Subjects that continue the syllabus

Data Networks: Technology and Architecture/V05G300V01542
Multimedia Networks/V05G300V01643
Network Security/V05G300V01543
Internet Services/V05G300V01501
Network and Switching Theory/V05G300V01642

Subjects that are recommended to be taken simultaneously

Data Communication/V05G300V01301

Subjects that it is recommended to have taken before

Mathematics: Calculus 1/V05G300V01105
Mathematics: Probability and Statistics/V05G300V01204

Other comments

To take the course, in order to carry out the network program, it is very important to have a certain programming skills in an object-oriented language such as Java (or C ++). The skill level obtained after passing the Programming II course is enough.
