



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	Galician			
Department				
Coordinator	López Ardao, José Carlos			
Lecturers	López Ardao, José Carlos Rodríguez Pérez, Miguel Rodríguez Rubio, Raúl Fernando Sousa Vieira, Estrella			
E-mail	jardao@det.uvigo.es			
Web	http://www.socialwire.es			
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
Master Session	26	39	65
Troubleshooting and / or exercises	10	15	25
Autonomous practices through ICT	6	21	27
Integrated methodologies	0	10	10
Practice in computer rooms	10	9	19

Long answer tests and development	2	0	2
Long answer tests and development	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
Master Session	Exposition of ideas, concepts, techniques and algorithms that shape every lecture. With this methodology students should acquire competencies CT2, CT3, CG3, CG4, CE11, CE17, CE18 & CE19.
Troubleshooting and / or exercises	Resolution by part of the students of problems and exercises of some of the lessons, and resolution by the teacher in the classroom. With this methodology students should acquire competencies CG3, CG4, CE11, CE17, CE18 & CE19.
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. With this methodology students should acquire competencies CG1, CG6, CG9, CE11, CE17 & CE19.
Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course . With this methodology students should acquire competencies CG4, CG6, CG9, CE17, CE18, CE19, CT2, CT3, CT4
Practice in computer rooms	Practices in the computers of the computer classroom, guided by the professor. With this methodology students should acquire competencies CG1, CG9, CE17 & CE19.

Personalized attention

Methodologies	Description
Master Session	Individual tuition will be dispensed to the students in the office hours announced at the beginning of the term.

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.	20	B1	C11	
			B6	C17	
			B9	C19	
Integrated methodologies	Participation in on-line activities (autoevaluation tests and tasks previous to the laboratory sessions) to be proposed along the course.	10	B4	C17	D2
			B6	C18	D3
			B9	C19	D4
Long answer tests and development	Final exam covering all the contents	50	B3	C11	D2
			B4	C17	
				C18	
				C19	
Long answer tests and development	Two partial exams of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade	20	B3	C11	D2
			B4	C17	
				C18	
				C19	

Other comments on the Evaluation

The students can choose the method of evaluation, continuous or single.

Continuous Evaluation (CE) consist of 4 previous tests plus a final exam:

- Two partial exams, PE1 and PE2, of short duration (one hour) in the 7th week (between February 26 and March 2) and 13th week (between April 9 and 13), covering units 1 to 4, and 5 to 8, respectively. Each partial exam has a weight of 10% on the final grade.
- The development of a network program (NP). The last day of practical classes must be delivered by the deadline. Compliance with the requirements and quality of software will determine the qualification of this test. **This program must be made and delivered compulsorily on an individual basis.** The PR will represent 20% of the Final Grade (FG), being necessary to reach 3.5 points out of 10 in this test to be able to surpass the subject.
- Participation in online activities (OA), which represent 10% of the Final Grade (FG). Throughout the course will be proposed 8 activities to be delivered in the virtual classroom of the subject. These activities will consist of small tasks to be done before or after the practical classes, and self-assessment tests will also be done. In each activity the student will get a certain amount of accumulated points of play throughout the course. In the tests can be obtained

between 0 and 10 game points, depending on the number of hits achieved. In the tasks will always have a minimum of points of play by the simple delivery of the task in time and form, and optionally an additional amount can be assigned to perform the task in a satisfactory or correct way. In addition to these 8 activities, teachers will be able to allocate additional points to students for having participated prominently in the class or for actively participating in virtual classroom forums to try to resolve peer doubts. In any case, the maximum mark in this section (10% of the total of the subject) will be obtained by every student who correctly delivers and answers the 8 activities. Students who obtain a score equivalent to twice the average or the median, the lowest of them, will also receive the maximum score. The rest of the students will receive a grade proportional to the minimum between: the score equivalent to the delivery of the 8 tasks, twice the median and twice the average.

- A final exam (**FE**) written on all the contents of the subject, which has a weight of 50% on the Final Grade (FG) and where it is necessary to reach 3.5 points out of 10 to be able to surpass the subject.

FG-CE = $0.1 \times PE1 + 0.1 \times PE2 + 0.1 \times OA + 0.2 \times NP + 0.5 \times FE$ if FE and NP >= 3.5

In case of not reaching in the FE the minimum grade of 3.5, the final grade will be that obtained in FE ==> FG-CE = FE

In case of not reaching in the NP the minimum grade of 3.5 (but in the FE), the final grade will that obtained in the NP ==> FG-CE = NP

It is considered that a student choose CE when presenting to any partial exam, PE1 or PE2, choice that is maintained until end of course. Failure to submit a continuous assessment test involves a qualification of "0" on that test.

Students who do not take part in any partial exam are obliged to take the Single Evaluation (SE). **Single Evaluation (SE)**

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

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, $FG-SE = (0.4 + 0.6 \times NP) \times FE$
Second Evaluation (june/july) There will be a second evaluation with a new FE and it will also be allowed to deliver a new NP consisting of a modified version of the program of the first evaluation, and whose specifications will be published with at least 4 weeks with respect to the deadline of the Final Exam. Any students, regardless of having opted for CE or SE, will be able to do this FE and present a new NP. *Those students that passed the subject in the first evaluation that want to attend the second one will have to present a signed letter asking the subject coordinator to assign them a "Not Presented" mark in the minutes of the first evaluation. The last day to present this letter is the day of the revision of the first evaluation exam.*

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

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

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

Those students who had chosen CE but they want to change to SE for this second call, they must communicate it to the coordinator of the subject before the review of the examination of the first call. 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 SE, being therefore obligatory the delivery of a new PR with the specifications of this second call.

All students that assists to any of the written tests will be considered for evaluation in this subject. The grades of all written tests, partial or final, programs and activities will only take effect in the academic year in which they are proposed.

In case of detection of plagiarism in any of the works/test/exams, the final qualification will be Suspense (0) and this case will be communicated to the academic authorities.

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. Leon-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

Programming II/V05G300V01302

Other comments

Though advisable, it is not necessary prior exposure to computer programming.
