Universida_de_Vigo

IDENTIFYING DATA
Computer Networks

Subject	Computer Networks
Code	V05G306V01210
Study programme	Degree in Telecommunications Technologies Engineering

Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd

Teaching language	English
Department	
Coordinator	López Ardao, José Carlos Rodríguez Pérez, Miguel
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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 newtwork 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

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
Specify common telecommunications infrastructures and structured cabling in buildings	B1 B6	C11	

Contents

Topic	
1. Introduction	1.1. Network elements, types of links, services and protocols 1.2. Switching techniques: circuits, messages and packets 1.3. Reference models and service modes
2. Packet switching (I): Link Transmission	2.1. Packet framing and Frame transmission 2.2. Forwarding techniques. 2.3. Generalized forwarding. Correspondence and action 2.4. Statistical multiplexing 2.5. ARQ Techniques 2.6. Flow control
3. Packet switching (II): Path Transmission	3.1. Fundamental performance: delay, losses, equivalent capacity 3.2. Reliability (hop-by-hop vs. end-to-end)
4. The data plane (I): IEEE 802.x networks	4.1. Flat architecture of the data plane 4.2. Bridges and switches 4.3. Forwarding tables 4.4. Frame Formats 4.5. Practical limits
5. The data plane (II): IP networks	5.1. Hierarchical architecture of the data plane 5.2. Structure of IP addresses 5.3. Routers and forwarding tables 5.4. Correspondence in IP (longest prefix match) 5.5. The IP protocol. IPv4 and IPv6 5.6. Addressing scopes. Private networks 5.7. NAT
6. Interconnection of link networks	6.1. IP as interconnection network 6.2. Routers vs. switches 6.3. Translation between link and network addresses: ND/ARP 6.4. Fragmentation
7. The control plane (I): Distributed control	7.1. Flat Networks (Bridged IEEE 802.1 LANs): Backward Learning and STP 7.2. Hierarchical networks (IP): RIB, IGPs, ASs, BGP
8. The control plane (II): Centralized control	8.1. Programmable switches 8.2. Software Defined Networks (SDN)
9. The Transport Layer	9.1. Multiplexing, reliability and transmission modes 9.2. Transport protocols 9.3. UDP 9.4. TCP: Connection management. Ordered delivery. ARQ and flow control in TCP
10. Congestion control	10.1. The AIMD algorithm 10.2. Classic implementations: Tahoe, Reno 10.3. Delay-based mechanisms. Vegas
11. Internet Security	11.1. Secure communication systems 11.2. Confidentiality. Symmetric and asymmetric cryptography 11.3. Authenticity and integrity. Hash functions. Digital signatures 11.4. Availability. DDoS Attacks 11.5. Secure Transport: TLS over TCP

Planning

	Class hours	Hours outside the classroom	Total hours

Lecturing	28	28	56
Problem solving	10	15	25
Autonomous practices through ICT	6	24	30
Autonomous problem solving	0	15	15
Discussion Forum	0	4	4
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
	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	Completion and delivery, more or less weekly, of online activities. These are self-evaluation tests and small tasks or problems to be carried out before or after the practical classes. It also includes the delivery of a small basic network program, as a training for the final network program. With this methodology we will work the competencies 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	Instructor-led practices on computer labs, using various network tools and utilities (GNS3, WireShark, ping, traceroute, dig, etc.) to reinforce the content presented in the master classes. CG1, CG9, CE17 and CE19 competencies are worked with this methodology.

Personalized assistance

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-assesmemt 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 student must develop a network program. This program must be made and delivered individually. There will be several classroom sessions for the explanation of the practice, tutoring with the teacher and for the development, testing and debugging of the program in the laboratory, where it will be tested and evaluated. It supposes a weight of 20% but a minimum mark of 3.5 points is required to pass the subject.	20	B1 C11 B6 C17 B9 C19	
Autonomous problem solving	During the course, with an approximately weekly periodicity, tasks, resolution of exercises, questions and self-evaluation tests will be proposed in the virtual classroom that must be carried out by the students individually, autonomously and not presencially, always with a deadline. These tasks have an overall weight of 10% for the student who chooses option B of continuous assessment. Those who choose option A of continuous assessment can do the tasks but the score does not count for the final mark, being only indicative for their self-assessment.	0-10	B4 C11 D2 B6 C17 D3 B9 C18 D4 C19	
Essay questions exam	Final exam covering the whole subject. It has a weight of 50% but a minimum mark of 3.5 out of 10 is required to pass the subject.	50	B3 C11 D2 B4 C17 C18 C19	
Objective questions exam	Two intermediate one-hour multiple-choice tests will be carried out to check the progress of the subject. Each control test has a weight of 10% for the students who choose option B of continuous evaluation and 15% for the students who choose option A.	30-20	B3 C11 D2 B4 C17 C18 C19	

Other comments on the Evaluation

Students can choose the method of Assessment: **Continuous or Exam-Only Assessment.**

Continuous Assessment (CA)

There will be two possible ways or options to go through Continuous Assessment, which we call A and B. Student must choose the option in the subject virtual classroom during first month. The deadline for making the choice will be communicated sufficiently in advance in the official News Forum of the virtual classroom. After this deadline, the chosen continuous assessment option cannot be changed. Students who do not make any explicit choice follow the exam-only assessment.

Given the necessary collaborative and social character of option B, groups that do not reach a minimum of 30 students, will only have option A for continuous assessment.

Continuous Assessment consists of four types of activities or tests:

- **Qualifying activities in the virtual classroom**. During the course, with an approximately weekly periodicity, tasks, resolution of exercises, questions and self-evaluation tests will be proposed in the virtual classroom for the students to carry out after school hours individually, autonomously. All activities will have a strict deadline. The completion of these activities allows students to obtain ⬚merit points⬚ (**MP**) up to a maximum of 100 points (in the case of the correct completion of all of them). **The mark in this part will be calculated as the amount of MP divided by 100**. In order to facilitate to get the maximum number of points, there will be additional optional tasks will proposed throughout the course.

  The Merit Points only count for students who have chosen option B of continuous assessment. Those who chose option A of continuous assessment can also do the tasks and tests, but the MP obtained do not count for the final mark, being only indicative of their self-assessment.

  A gamification system will be employed in the virtual classroom using other types of points, mechanics and elements of gamification to motivate the completion of the activities and the meaningful participation in forums for help, doubts and discussions. This will allow students to earn rewards for use in the subject exams and homework.

- **Two intermediate one-hour multiple-choice tests to assess the progress of the subject (C1 and C2)**. Each control test has a weight of 15% on the final mark (FG) for students who chose option A of continuous assessment and 10% for those who opt for option B. The schedule of the different intermediate evaluation tests will be approved by the Comisión Académica de Grado (CAG) and will be available at the beginning of the term.

- **The development of a network program (NP)**. The deadline will be published together with its specifications. Compliance with the prescriptions and software quality will determine the qualification of this program. An

assessment guide will be published along with the program specifications. This program must be coded and submitted individually. The NP will account for 20% of the Final Grade (FG), and it is required to reach 3.5 points to be able to pass the subject.

- **A final exam (FE) covering all contents,** has a weight of 50% of the Final Grade (FG). A minimum qualification of 3.5 points over 10 is required

FG-CA-A = 0.15 × (C1+C2) + 0.2 · NP + 0.5 × FE, if FE ≥ 3,5 and NP ≥ 3.5

FG-CA-A = 0.1 × (C1+C2) + MP/100 + 0.2 × NP + 0. 5 · FE, if FE ≥ 3,5 and NP ≥ 3.5

If either FE or NP does not reach the minimum mark of 3.5 => FG-CA-A =FG-CA-B = min(3.5, FE)

As said above, it is mandatory to choose the CA option, A or B, in the established period, that will be until the day before the C1 control test. Students that do not make any explicit choice will be subjected to exam-only assessment (EA).

Failure to take any of the control tests, C1 or C2, implies a mark of "0" on the test. These tests are not recoverable.

Exam-Only Assessment (EA)

Students who do not made any choice of continuous assessment within the stipulated time period are required to take the Exam-Only Assessment (EA)

The Exam-Only Assessment will consist of the same FE at the end of the term, and the submission of the same network program (NP) proposed for those going through CA. The submission deadlines will also be the same.

The grade of the NP in this case will be simply APPT (with an equivalent numeric value of "1"), if the qualification obtained in the NP is equal to or greater than 5, or NOT APPT (with a numeric value of "'0") if it is less than 5 or not delivered. In this case the final mark will correspond to the 40% of the FE. That is to say,

FG-EA = (0.4 + 0.6 · NP) × FE

Second call

In the official dates, a new final exam (FE) will be done only for students that failed 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 3 weeks of advance with respect to the deadline. This deadline will never be later than this second final exam.

For students who chose CA, these FE and NP represent an opportunity to improve the mark 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,

FG-EA = Max{(0.4 + 0.6 × NP-1st) × FE-1st, (0.4 + 0.6 × NP-2nd) × 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 subject coordinator before the review date of the first final exam. In this case, the conditions to pass the subject are exactly the same as those of the rest of the students that have chosen EA, being therefore compulsory the delivery of a new NP with the second call specifications. In this case, any reward obtained by the CA activities in the virtual classroom is also waived.

End-of-program call

Students participating in the extraordinary call must pass the FE, to be carried out at the officially established dates and obtain an APT grade in the NP, that must be delivered before the date of this FE. The specifications of this program are the same as those of the second call. It is mandatory to deliver this program on time, even if it has already been delivered in the second call.

The final mark 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 FE are considered to be presented to the subject. The marks for all exams, intermediate or final, and activities will only have effects on the current 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 virtual platform activities, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

All the official communications of the Subject will be published in the News Forum of the virtual classroom, to which all the students are necessarily subscribed by email. It is assumed that all students reads these messages and are properly informed of their content.

In the event of any contradiction that may have occurred between the different versions of this guide, due to any error in the translation, the prevailing version will be the Galician language version, with the exception of the English teaching group, for which the English version of the Guide will be considered.

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-Garcia, 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

Programming II/V05G300V01302

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.