**Degree competences to which the subject contributes**

**Specific:**
- CTI1.1. To demonstrate understanding the environment of an organization and its needs in the field of the information and communication technologies.
- CTI1.2. To select, design, deploy, integrate and manage communication networks and infrastructures in an organization.
- CTI2.1. To manage, plan and coordinate the management of the computers infrastructure: hardware, software, networks and communications.
- CTI2.3. To demonstrate comprehension, apply and manage the reliability and security of the computer systems (CEI C6).
- CTI3.1. To conceive systems, applications and services based on network technologies, taking into account Internet, web, electronic commerce, multimedia, interactive services and ubiquitous computation.
- CTI3.3. To design, establish and configure networks and services.
- CT6.1. To demonstrate knowledge and capacity to manage and maintain computer systems, services and applications.
- CT6.4. To demonstrate knowledge and capacity to apply the characteristics, functionalities and structure of the Distributed Systems and Computer and Internet Networks guaranteeing its use and management, as well as the design and implementation of application based on them.
- CT7.1. To demonstrate knowledge about metrics of quality and be able to use them.
- CT7.3. To determine the factors that affect negatively the security and reliability of a hardware/software system, and minimize its effects.

**Generical:**
- G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.
Teaching methodology

The proposed teaching methodology is based on programming centered learning, cooperative learning, and the Virtual Campus.

1. Programming focuses on learning. Activities in the class session: a) Meeting of temporary groups (for physical proximity in class) to share the doubts last week. Following the interaction of students by the teacher indicating the questionable concepts. b) The teacher will explain the concepts that apply to the program. c) Indication of the studio work outside the classroom. Every two weeks there will be an hour session where problems will be solved by reducing the theory class to 1 hour.

2. Cooperative learning. Students exercise their capabilities in cooperative work developing a technical working in group-based (Technical Report)

3. Campus Atenea. Used in developing the subject in the following aspects: treatment group, documentation class, workshops, document delivery, monitoring of compliance with delivery dates, forum for exchanging opinions, questions and assignments, resolution surveys.

Learning objectives of the subject

1. Applying international regulation and standardization in computer networking technology
2. Designing systems interconnection networks modeled by TCP / IP
3. Calculate the transmission capacity of a channel in the presence of noise and noiseless
4. Apply and understand the various methods of synchronization levels 1, 2 and 3 of computer networks
5. Identify the applications of TDM multiplexing systems
6. Determine the requirements of the asynchronous transmission of packets over synchronous transmission networks
7. Design of link layer protocols
8. Differentiate the use of several existing broadcast media and calculate bandwidth
9. Calculate the efficiency and capabilities of PDH and SDH transmission systems
10. Differentiating digital modulation types (QAM) specifying their use in the networks
11. Calculate the efficiency of packet transmission networks (Frame Relay)
12. Designing networks with virtual circuits (FR) with different types of terminals and Internet access
13. Calculate the parameters of the algorithms for managing access to networks with traffic contract (CIR)
14. Designing ATM packet networks differing routes and the use of virtual channel and calculating the routing tables and delays
15. Identify mechanisms for managing network packet traffic (ATM) and design their applications with GCRA algorithms
16. Identify and analyze the protocols applied to levels 1, 2 and 3 in DSL access networks
17. Calculate the performance and delays in DSL networks, using the management model of quality of service, and calculating the efficiency loss caused by the redundancy
18. Explain the technological elements that are involved in an HFC network access methods and interpret the return channel
19. Compare features and performance between DSL and HFC networks
20. Calculate efficiency of the PON network with voice / data / image services
21. Designing networks with MPLS routing with / without MPLS domain
22. Programming capabilities and scale cellular networks with GPRS and UMTS
23. Apply the use of Carrier Ethernet and Gigabit standards in the design of backbone networks
24. Designing IP WAN networks with IP switches (routers), links of different technologies (SDH, FR, ATM, GigabitETH) and access and wireless
## Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Duration</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 150h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theory classes:</td>
<td>52h 30m</td>
<td>35.00%</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>7h 30m</td>
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<td>Laboratory classes:</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>6h</td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>84h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Introduction

**Degree competences to which the content contributes:**

**Description:**
Regulation of international computer networks and their involvement in technology. Analysis of the importance of IP networks on network technology.

## Technological elements of Internet and data transmission.

**Degree competences to which the content contributes:**

**Description:**
Architectural model of the Internet, network architecture and protocol stack studying the protocol HDLC and PPP. Broadcast media, network topologies and transmission systems including Fourier analysis, Shannon channel, channel coding and digitization of voice. TDM multiplexing systems (PDH/SDH) and WDM. Switching circuits and packet.

## Core networks

**Degree competences to which the content contributes:**

**Description:**
Technologies used for backbone switching networks. Switching frames (Frame Relay), cell (ATM and packet over SDH), labels (MPLS) and Ethernet (Carrier Ethernet).

## Networks with wired access

**Degree competences to which the content contributes:**

**Description:**
Access Technologies using networks with wired transmission media like telephone wire (xDSL), coaxial cable (HFC) and optical fibers (FTTX, PON and WDM-EP2P). Regulations and related protocols.

## Wireless access networks

**Degree competences to which the content contributes:**

**Description:**
Cellular technology and network design for mobile Internet access. GSM / GPRS and UMTS / HSPA technologies. Study of related protocols. LTE technology.
| Development Topic 1: Introduction | Hours: 3h  
Theory classes: 2h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 1h |
|-------------------------------|------------------|
| Description:  
Attendance for the comprehension of regulations on computer networking technologies. |
| Specific objectives: | 1 |

| Development Topic 2: Technological elements of Internet and data transmission. | Hours: 31h  
Theory classes: 16h 30m  
Practical classes: 2h 30m  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 12h |
|----------------------------------------|------------------|
| Description:  
Attendance for the acquisition of knowledge about the architectural model TCP / IP, broadcast media, digital modulation, and circuit and packet switching networks and link protocols. |
| Specific objectives: | 2, 3, 4, 5, 6, 7, 8, 9, 10 |

| Technical Report review 1 | Hours: 1h 30m  
Guided activities: 1h 30m  
Self study: 0h |
|---------------------------|------------------|
| Description:  
Review of the index work |
| Specific objectives: | 24 |

| Development Topic 3: Core Networks | Hours: 23h  
Theory classes: 10h  
Practical classes: 2h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 11h |
|------------------------------------|------------------|
| Description:  
Attendance for the acquisition of knowledge about switching techniques in computer networks. |
### First Test

**Description:**
Assessment test that includes the resolution of exercises and test questions. You can not use books or notes.

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

**Hours:** 4h  
Guided activities: 2h  
Self study: 2h

### Development Topic 4: Networks with wired access

**Description:**
Attendance for the acquisition of knowledge about network access technologies USING wireless transmission media like telephone wire (xDSL), coaxial cable (HFC) and fiber optics (FTTX, PON and WDM-EP2P). Regulations and related protocols.

**Specific objectives:**
16, 17, 18, 19, 20, 24

**Hours:** 20h 30m  
Theory classes: 10h 30m  
Practical classes: 1h 30m  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 8h 30m

### Development Topic 5: Wireless Access Networks

**Description:**
Attendance for the acquisition of knowledge about technology and design of cellular networks for mobile Internet access. GSM / GPRS and UMTS / HSPA. Study of related protocols. LTE technology.

**Specific objectives:**
22, 24

**Hours:** 19h  
Theory classes: 9h 30m  
Practical classes: 1h 30m  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 8h

### Review 2 of Technical report

**Hours:** 1h 30m  
Guided activities: 1h 30m  
Self study: 0h
## Description:
Review the content of the work before final submission

## Specific objectives:
24

### Second test

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>Assessment test that includes the resolution of exercises and test questions. You can not use books or notes.</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>16, 17, 18, 19, 20, 21, 22, 23, 24</td>
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<table>
<thead>
<tr>
<th>Hours:</th>
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<tbody>
<tr>
<td>Guided activities:</td>
<td>2h</td>
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<tr>
<td>Self study:</td>
<td>2h</td>
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### Workshops

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<tr>
<td>Workshops are individual activities with assessment among group members and consist of exercises related to the subject through the virtual campus Athena. Students must solve the exercises and exchange them, a task that makes the Virtual Campus automatically with fellow group basis with deadline for comments.</td>
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<table>
<thead>
<tr>
<th>Specific objectives:</th>
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<tbody>
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<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24</td>
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<td>Laboratory classes:</td>
<td>0h</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
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<tr>
<td>Self study:</td>
<td>18h</td>
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### Final work (Technical report)

<table>
<thead>
<tr>
<th>Description:</th>
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<tr>
<td>The Technical Report is a group activity. Students should develop during the course technical work (Technical Report) in groups of up to three people who gave it to the end of the course. The goal is that students develop the skills of the subject, considering it as a complement to the program itself. Each group chooses the item from the list submitted by the teacher or submit your own theme with the sole condition that it is a complement to the official program and therefore not recorded in the documentation of the course or in any case be a deepening of the topics covered in class. There is an evaluation section that allows students to have a preliminary assessment framework. To facilitate the drafting groups work, Atenea offers to students through Web 2.0 a tool called Wiki to use it as a common repository of documents that are prepared and that will allow them to work remotely. The work also serves to assess the competence G9.3 Critical capacity, assessment capacity.</td>
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<table>
<thead>
<tr>
<th>Hours:</th>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
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<tr>
<td>Self study:</td>
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Final exam

<table>
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<tr>
<th>Description:</th>
<th>Hours:</th>
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<tbody>
<tr>
<td>Students may voluntarily make a final exam to replace the average of the controls in the final mark</td>
<td>3h</td>
</tr>
<tr>
<td>Guided activities: 3h</td>
<td></td>
</tr>
<tr>
<td>Self study: 0h</td>
<td></td>
</tr>
</tbody>
</table>

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

Qualification system

The evaluation of students and their use of the course will follow the following criteria:
AC: Class attendance: 10%. Includes physical presence in all activities specified as classes and tests. Minimum of 75% attendance is required. Otherwise the score will be zero in this section.
PA: Participation: 10%. Includes evaluations of workshops.
CO1 and CO2: Tests: 70%. The average between the first and second test will be assessed.
TR: Technical Report: 10%. Following a framework, the grade will be based on the quality of content, the contributed bibliography, format required, notes added, clarity, conciseness and capacity of criticism and evaluation.
G9.3 skill assessment is depending on test average: A >=8, B >=6, C >=4, D <4
The final mark NF = 0.1*AC + 0.1*PA + 0.7*(CO1 + CO2)/2 + 0.1*TR.
Students who do not pass the 5 of the tests (CO1+CO2)/2 must do the final exam. In this case, the mark of this exam will replace the average of the tests in the final mark.
Books and notes can be used for tests.
Bibliography

Basic:
- Data communications, computer networks and open systems. 4th ed. Addison-Wesley, 1995. ISBN 020142293X.

Complementary:

Others resources:
- Hyperlink
  - http://www.itu.int/
  - http://www.ieee.org/
  - https://www.cnmc.es/ambitos-de-actuacion/telecomunicaciones