Course guides
270125 - TXC - Computer Network Technology

Unit in charge: Barcelona School of Informatics
Teaching unit: 701 - DAC - Department of Computer Architecture.
Degree: BACHELOR’S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Optional subject).
Academic year: 2021 ECTS Credits: 6.0 Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: - German Santos Boada (german@ac.upc.edu)
Others: - Jordi Domingo Pascual (jordi.domingo@ac.upc.edu) - Josep Sole Pareta (pareta@ac.upc.edu)

PRIOR SKILLS

Least to read English technical documentation, manuals and standards. Basic knowledge on computer networks. Basic knowledge of operating systems.

REQUIREMENTS

- Pre-Corequisite XC

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.
CTI6.1. To demonstrate knowledge and capacity to manage and maintain computer systems, services and applications.
CTI6.4. 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.
CTI7.1. To demonstrate knowledge about metrics of quality and be able to use them.
CTI7.3. 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 transmission capacities of synchronous transmission systems
10. Differentiating digital modulation types (QAM) specifying their use in the networks
11. Calculate the efficiency of packet transmission networks
12. Designing networks with virtual circuits with different types of terminals and Internet access
13. Calculate the parameters of the algorithms for managing access to networks with traffic contract
14. Designing packet networks calculating the routing tables and delays
15. Identify mechanisms for managing network packet traffic and design their applications
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 and SDN routing
22. Programming and sizing the capabilities of cellular networks with different technologies
23. Apply the use of Ethernet and Gigabit standards in the design of backbone networks
24. Design WAN-type IP networks with IP switches (routers), links of different technologies and access with and without mobility

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>54,0</td>
<td>36.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
<tr>
<td>Guided activities</td>
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<td>4.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>6,0</td>
<td>4.00</td>
</tr>
</tbody>
</table>

**Total learning time:** 150 h
## CONTENTS

### Introduction

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

### Technological elements of Internet and data transmission.

**Description:**
Level 2 error control and flux control protocols. Broadcast media, network topologies and transmission systems including Fourier analysis, Shannon channel, channel coding and digitization of voice. TDM multiplexing systems and WDM. Switching circuits and packet.

### Core networks

**Description:**
Technologies used for backbone switching networks. Virtual circuits and switching frames, cells and packet over SDH), labels MPLS), SDN and Ethernet (Carrier Ethernet), and congestion control.

### Networks with wired access

**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

**Description:**
Cellular technology and network design for mobile Internet access. GSM / GPRS and UMTS / HSPA technologies. Study of related protocols. LTE technology and 4G, and 5G

## ACTIVITIES

### Development Topic 1: Introduction

**Description:**
Attendance for the comprehension of regulations on computer networking technologies.

**Specific objectives:**
1

**Full-or-part-time:** 3h
- Theory classes: 2h
- Self study: 1h
Development Topic 2: Technological elements of Internet and data transmission.

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

Full-or-part-time: 31h
Theory classes: 16h 30m
Practical classes: 2h 30m
Self study: 12h

Technical Report review

Description:
Review of the work

Specific objectives:
24

Related competencies:
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.

Full-or-part-time: 1h 30m
Guided activities: 1h 30m

Development Topic 3: Core Networks

Description:
Attendance for the acquisition of knowledge about switching techniques in computer networks.

Specific objectives:
11, 12, 13, 14, 15, 21, 23, 24

Related competencies:
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.

Full-or-part-time: 23h
Theory classes: 10h
Practical classes: 2h
Self study: 11h
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

Full-or-part-time: 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

Related competencies:
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.

Full-or-part-time: 20h 30m
Theory classes: 10h 30m
Practical classes: 1h 30m
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

Related competencies:
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.

Full-or-part-time: 19h
Theory classes: 9h 30m
Practical classes: 1h 30m
Self study: 8h
**Review of Technical report**

**Description:**
Review the content of the work before final submission

**Specific objectives:**
24

**Related competencies:**
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.

**Full-or-part-time:** 1h 30m  
Guided activities: 1h 30m

**Second test**

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

**Specific objectives:**
16, 17, 18, 19, 20, 21, 22, 23, 24

**Related competencies:**
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.

**Full-or-part-time:** 4h  
Guided activities: 2h  
Self study: 2h

**Workshops**

**Description:**
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.

**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

**Related competencies:**
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.

**Full-or-part-time:** 18h  
Self study: 18h
Final work (Technical report)

**Description:**
The group of students must submit a report, following a template, of the work done. After the first control, the groups are assigned and the work begins. The teacher follows up as a directed activity. The delivery of the work is before the second control. The evaluation is individual and includes the quality of the memory, the individual participation in the WIKI created for this purpose and the completion of an individual test about the work.

**Specific objectives:**
1, 2, 24

**Related competencies:**
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.

**Full-or-part-time:** 21h 30m
Self study: 21h 30m

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Final exam

**Description:**
The student take a final exam of all the content of the subject according to the evaluation method

**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

**Related competencies:**
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.

**Full-or-part-time:** 3h
Guided activities: 3h

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**GRADING SYSTEM**
The evaluation of students and their use of the course will follow the following criteria:

**TA:** Workshops: 15%. Includes evaluations of workshops.
**CO1 and CO2:** Tests: 70%. The average between the first test C1 and second test CO2 will be assessed. If this mark don't allow to pass the course a Final Test will be required and the mark obtained will replace the CO1-Co2 mark average.
**TR:** Technical Report-Lab: 15%. The grade will be based on a test and the quality of content.
G9.3 skill assessment is depending on test average over10 of ((CO1+CO2)/2 being : A >=8, B >=6, C >=4, D <4

The final mark NF = 0.15*TA + 0.70*(CO1 + CO2)/2 + 0.15*TR.

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**BIBLIOGRAPHY**

**Basic:**

**Complementary:**

**RESOURCES**

**Hyperlink:**
- http://www.ieee.org/
- http://www.itu.int/
- https://www.cnmc.es/ambitos-de-actuacion/telecomunicaciones
- https://www.gns3.com/