



## Course guide

### 270121 - PI - Internet Protocols

**Last modified:** 30/01/2024

**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:** 2023    **ECTS Credits:** 6.0    **Languages:** Catalan, Spanish, English

#### LECTURER

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**Coordinating lecturer:** JOSE MARIA BARCELÓ ORDINAS

**Others:** Primer quadrimestre:  
JOSE MARIA BARCELÓ ORDINAS - 11, 12  
LLORENÇ CERDÀ ALABERN - 11, 12

Segon quadrimestre:  
JOSE MARIA BARCELÓ ORDINAS - 10

#### PRIOR SKILLS

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Have completed the signing XC

#### REQUIREMENTS

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- Prerequisite XC

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

- CT3.6. To demonstrate knowledge about the ethical dimension of the company: in general, the social and corporative responsibility and, concretely, the civil and professional responsibilities of the informatics engineer.
- 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.
- CT7.2. To evaluate hardware/software systems in function of a determined criteria of quality.
- CT7.3. To determine the factors that affect negatively the security and reliability of a hardware/software system, and minimize its effects.
- CT8.1. To identify current and emerging technologies and evaluate if they are applicable, to satisfy the users needs.
- CT8.4. To elaborate the list of technical conditions for a computers installation fulfilling all the current standards and normative.
- CTI1.1. To demonstrate understanding the environment of an organization and its needs in the field of the information and communication technologies.
- CTI1.4. To select, design, deploy, integrate, evaluate, build, manage, exploit and maintain the hardware, software and network technologies, according to the adequate cost and quality parameters.
- 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).
- CTI3.3. To design, establish and configure networks and services.
- CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

### General:

G8. APPROPRIATE ATTITUDE TOWARDS WORK: to have motivation to be professional and to face new challenges, have a width vision of the possibilities of the career in the field of informatics engineering. To feel motivated for the quality and the continuous improvement, and behave rigorously in the professional development. Capacity to adapt oneself to organizational or technological changes. Capacity to work in situations with information shortage and/or time and/or resources restrictions.

## TEACHING METHODOLOGY

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The course consists of lectures combined with exercises where students learn the theoretical foundations of the subject.

In addition, students must make a written work an issue will be proposed at the beginning of the course. Students should seek information on the topic and defend the chosen topic, presenting the relevant technological aspect, systems integration, adaptability and other aspects.

There will be 6 laboratories that complement the theory. These laboratories are generally solved in groups of 10/20 students depending on the practice. They will solve a modular network. Every 2 students design and program a part of the network so that in the end, all modules are to form a whole that works. Are encouraged to work on one side in teams of 2, to solve your module, and coordinate with the other modules to work on everything. Each of the 6 Labs, is an aspect of the topics covered in class. It is essential the understanding of the theory (works responsibilities) for the lab work.

At the end of the Lab, students do a mini-control 10-minute test that assesses the knowledge acquired during the Lab's. The average of teh mini controls represents 25% of the final mark of Lab

At the end of this course the student takes a final test that includes questions of all lab values and where global knowledge of a large network in all modules.



## LEARNING OBJECTIVES OF THE SUBJECT

1. Being able to understand the architecture and structure of the Internet, identifying the various elements that form that architecture and structure.
2. Be able to understand, assess and manage multimedia services.
3. Know the services offered by an Internet Service Provider
4. Being able to design and dimension the intra-domain routing of a corporate network and an Internet Service Provider
5. Being able to design and dimension the inter-domain routing in Internet Service Providers, as well as business relationships with each other.
6. Being able to design and dimensioning of switching blocs that are part of a corporate network
7. Being able to design and configure corporate networks and ISPs from the information provided.
8. Being able to understand the technologies that allow the interconnection between its headquarters and a remote corporate network
9. Capability of adaptation in front of situations with lack of information and/or changes in the initial requirements.
10. Have a positive attitude for the quality and continuous improvement.

## STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	84,0	56.00
Guided activities	6,0	4.00
Hours large group	45,0	30.00

Total learning time: 150 h

## CONTENTS

### Internet Architecture and Addressing.

**Description:**

Internet Architecture: ISP's, corporate networks and access networks,  
Organizations that manage the operation of businesses on the Internet: RIR (Regional Internet Registers), LIR (Local Internet Registries),  
An Introduction to Content Distribution Networks (CDN),  
Exchange Points.  
Addressing Internet. IPv6.

### Corporate Network: switching blocks.

**Description:**

Ethernet switching.  
Virtual Networks (VLANs, IEEE 802.1Q) and aggregation (IEEE 802.3ad).  
Reliability level 2: Spanning Tree Protocol (IEEE 802.1D).  
Reliability Level 3: VRRP.  
Design of the switching block. Data Processing Centre (CPD): design and basic concepts.

### Intra-domain Routing

**Description:**

Basics for routing,  
Link state routing,  
Dijkstra algorithm,  
OSPF.



### Inter-domain Routing.

**Description:**

Autonomous systems.  
BGP (internal/external), attributes, multi-homing, load balancing.  
Scalability in BGP: route reflectors and confederations.  
Design of an ISP: intra-domain/inter-domain.

### Corporate Networks II: Virtual Private Networks

**Description:**

Traffic parameters and QoS parameters,  
Virtual Private Networks,  
MPLS-BGP,  
Metro-Ethernet.

### Applications and Services

**Description:**

An introduction to Multimedia Services.  
Compression in Multimedia: Spatial Compression and Temporal Compression  
Quality of Service on the Internet: IntServ versus DifServ  
Encapsulation and Signaling Protocols in Multimedia.

## ACTIVITIES

### Theme Development "Internet Architecture and Addressing"

**Description:**

During this activity the student will learn the architecture of the Internet, the basic components that architecture, addressing the problems of the Internet and its impact on different elements.

**Specific objectives:**

1, 3, 7

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 20h

Theory classes: 10h

Self study: 10h



### Development of the "Intra-domain Routing" contents

**Description:**

During this activity students will learn the basic theories behind the routing protocols to link state, OSPF student as a representative of this class of protocols. Also learn the applications and their use in corporate networks and ISPs.

**Specific objectives:**

1, 3, 4, 7

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 10h

Theory classes: 6h

Self study: 4h

### Development topic "Inter-domain Routing"

**Description:**

In this activity the students will study BGPv4 as a representative of the routing between Autonomous Systems. Learn to design an ISP, relating to the external service routing. In addition, the work load balancing through multihoming techniques.

**Specific objectives:**

1, 3, 5, 7

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 10h

Theory classes: 6h

Self study: 4h

### Theme Development "Corporate Networks: Switching blocks"

**Description:**

During this activity students will study these techniques and protocols to design a corporate network and a Data Processing Centre (DPC).

**Specific objectives:**

1, 3, 6, 7, 8

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 20h

Theory classes: 10h

Self study: 10h



### Development of the "Corporative Networks II: Virtual Private Networks"

**Description:**

During this activity you will learn the theoretical foundations behind virtual private networks.

**Specific objectives:**

4, 7, 8

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 5h

Theory classes: 3h

Self study: 2h

### Development "Applications and Services item"

**Description:**

During this activity, services provided by Internet service providers (ISPs) will be studied, as well as multimedia applications, and a brief introduction to Internet quality of service and multimedia signalling protocols.

**Specific objectives:**

1, 2, 3, 7

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 10h

Theory classes: 6h

Self study: 4h

### Laboratory Internal Routing

**Description:**

Development of a practice on OSPF routers.

**Specific objectives:**

4, 6, 7, 9, 10

**Related competencies :**

G8. APPROPRIATE ATTITUDE TOWARDS WORK: to have motivation to be professional and to face new challenges, have a wide vision of the possibilities of the career in the field of informatics engineering. To feel motivated for the quality and the continuous improvement, and behave rigorously in the professional development. Capacity to adapt oneself to organizational or technological changes. Capacity to work in situations with information shortage and/or time and/or resources restrictions.

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

Laboratory classes: 2h

Self study: 1h



### Laboratory Inter-domain Routing and Multihoming

**Description:**

Laboratories which develop the design of an ISP, load balancing techniques and use of communities.

**Specific objectives:**

1, 4, 5, 9, 10

**Related competencies :**

G8. APPROPRIATE ATTITUDE TOWARDS WORK: to have motivation to be professional and to face new challenges, have a width vision of the possibilities of the career in the field of informatics engineering. To feel motivated for the quality and the continuous improvement, and behave rigorously in the professional development. Capacity to adapt oneself to organizational or technological changes. Capacity to work in situations with information shortage and/or time and/or resources restrictions.

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 10h

Laboratory classes: 7h

Self study: 3h

### Switching Laboratories

**Description:**

Laboratories where are implemented techniques for the design of corporate networks, both in the switching unit as in the CPD.

**Specific objectives:**

1, 6, 7, 8, 9, 10

**Related competencies :**

G8. APPROPRIATE ATTITUDE TOWARDS WORK: to have motivation to be professional and to face new challenges, have a width vision of the possibilities of the career in the field of informatics engineering. To feel motivated for the quality and the continuous improvement, and behave rigorously in the professional development. Capacity to adapt oneself to organizational or technological changes. Capacity to work in situations with information shortage and/or time and/or resources restrictions.

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 6h

Laboratory classes: 4h

Self study: 2h

### Exam 1

**Description:**

Review of theory about week 8.

**Specific objectives:**

1, 2, 3, 4, 5

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 15h

Guided activities: 2h

Self study: 13h



### Written work

**Specific objectives:**

1, 2, 3, 4, 5, 6, 7, 8

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 16h

Self study: 16h

### Lab Exam

**Description:**

Review choice of 6 laboratories made during the course.

**Specific objectives:**

2, 3, 4, 5, 6, 9, 10

**Related competencies :**

G8. APPROPRIATE ATTITUDE TOWARDS WORK: to have motivation to be professional and to face new challenges, have a wide vision of the possibilities of the career in the field of informatics engineering. To feel motivated for the quality and the continuous improvement, and behave rigorously in the professional development. Capacity to adapt oneself to organizational or technological changes. Capacity to work in situations with information shortage and/or time and/or resources restrictions.

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 10h

Guided activities: 2h

Self study: 8h

### Exam 2

**Specific objectives:**

1, 2, 3, 4, 5, 6, 8

**Related competencies :**

CTI4. To use methodologies centred on the user and the organization to develop, evaluate and manage applications and systems based on the information technologies which ensure the accessibility, ergonomics and usability of the systems.

**Full-or-part-time:** 15h

Guided activities: 2h

Self study: 13h

## GRADING SYSTEM

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The course consists of lectures and laboratory. In the lectures it will be explained the concepts and issues. The student will have a collection of exercises to be solved in class.

The laboratory is an important part of the course. At the end of each session there will be a mini-exam or presentation.

The student must prepare a topic related to the theory and will defend it orally in public.

Grading of technical skills:

$$NF = 0.20 * NL + 0.10 * PO + 0.35 * C1 + 0.35 * C2$$

where:

NF = Mark at the end of the course.

C1 = Mark of partial exam (approx. in week 7-8), topics 1 and 2.

C2 = Mark of partial exam (in period of final exams), topics 3 to 6.

EF = Mark of Final exam (topic 1 to topic 6)

PO = oral presentation or written work (maxim in groups of 3 students).

NL = Final Laboratory mark. Will be calculated based on the average of the practices (25%) and grade the final exam laboratory (75%).

Grading of transversal skills:

$$NCT = 0.4 * PO + 0.3 * Actividad\_Lab + 0.3 * NL.$$

where:

NCT= Transversal Skills mark

PO = oral presentation (the previous one).

Actividad\_Lab= activity/participation of the student in the lab

NL = Final Lab mark.

To be normalized to A, B, C or D (where A corresponds to an excellent standard, B corresponds to a desired level, C corresponds to a sufficient level and D corresponds to a level not exceeded).

## BIBLIOGRAPHY

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### Basic:

- Huitema, C. Routing in the internet. 2nd ed. Prentice Hall PTR, 2000. ISBN 0130226475.
- Stewart III, J.W. BGP4: inter-domain routing in the Internet. Addison-Wesley, 1999. ISBN 0201379511.
- Perlman, R. Interconnections: bridges, routers, switches, and internetworking protocols. 2nd ed. Addison-Wesley, 2000. ISBN 0201634481.