270121 - PI - Internet Protocols

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 701 - DAC - Department of Computer Architecture
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: - Jose María Barceló Ordinas (joseb@ac.upc.edu)
Others: - Llorenç Cerdà Alabern (llorenc@ac.upc.edu)

Prior skills
Have completed the signing XC

Requirements
- Prerequisite XC

Degree competences to which the subject contributes

Specific:
CT1.1. To demonstrate understanding the environment of an organization and its needs in the field of the information and communication technologies.
CT1.4. 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.
CT2.1. To manage, plan and coordinate the management of the computers infrastructure: hardware, software, networks and communications.
CT2.3. To demonstrate comprehension, apply and manage the reliability and security of the computer systems (CEI C6).
CT3.3. To design, establish and configure networks and services.
CT4. 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.
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.

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

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

In addition, students must make an oral presentation, in teams of about 3 students, 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. The presentation must involve 3 the
students of the group.

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 &\#8203;&\#8203;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.
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## Study load

<table>
<thead>
<tr>
<th></th>
<th>Total learning time: 150h</th>
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<tbody>
<tr>
<td></td>
<td>Hours large group:</td>
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<tr>
<td></td>
<td>45h</td>
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<td>Hours medium group:</td>
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<td>Hours small group:</td>
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<td>Guided activities:</td>
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<td>6h</td>
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<td></td>
<td>Self study:</td>
</tr>
<tr>
<td></td>
<td>84h</td>
</tr>
<tr>
<td>Content</td>
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<td>------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Internet Architecture and Addressing.</strong></td>
<td></td>
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<tr>
<td><strong>Degree competences to which the content contributes:</strong></td>
<td></td>
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<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>Internet Architecture: ISP’s, corporate networks and access networks.</td>
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<tr>
<td>Organizations that manage the operation of businesses on the Internet:</td>
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</tr>
<tr>
<td>RIR (Regional Internet Registers), LIR (Local Internet Registries).</td>
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<tr>
<td>An Introduction to Content Distribution Networks (CDN).</td>
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<tr>
<td>Exchange Points.</td>
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<tr>
<td>Addressing Internet. IPv6.</td>
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<tr>
<td><strong>Corporate Network: switching blocks.</strong></td>
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<tr>
<td><strong>Degree competences to which the content contributes:</strong></td>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Ethernet switching.</td>
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<tr>
<td>Virtual Networks (VLANs, IEEE 802.1Q) and aggregation (IEEE 802.3ad).</td>
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<tr>
<td>Reliability level 2: Spanning Tree Protocol (IEEE 802.1D).</td>
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<tr>
<td>Reliability Level 3: VRRP.</td>
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<tr>
<td>Design of the switching block. Data Processing Centre (CPD): design</td>
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<tr>
<td>and basic concepts.</td>
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<tr>
<td><strong>Intra-domain Routing</strong></td>
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<tr>
<td><strong>Degree competences to which the content contributes:</strong></td>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Basics for routing.</td>
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<tr>
<td>Link state routing.</td>
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<tr>
<td>Dijkstra algorithm.</td>
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<tr>
<td>OSPF.</td>
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<tr>
<td><strong>Inter-domain Routing.</strong></td>
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<tr>
<td><strong>Degree competences to which the content contributes:</strong></td>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Autonomous systems.</td>
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<tr>
<td>BGP (internal/external), attributes, multi-homing, load balancing.</td>
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<tr>
<td>Scalability in BGP: route reflectors and confederations.</td>
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<tr>
<td>Design of an ISP: intra-domain/inter-domain.</td>
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<tr>
<td><strong>Corporative Networks II: Virtual Private Networks</strong></td>
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<tr>
<td><strong>Degree competences to which the content contributes:</strong></td>
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</tbody>
</table>
**Description:**
Traffic parameters and QoS parameters
Virtual Private Networks.
MPLs-BGP.
Metro-Ethernet.

**Applications and Services**

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

**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.
### Planning of activities

| Theme Development "Internet Architecture and Addressing" | Hours: 12h  
Theory classes: 9h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 3h |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>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.</td>
<td>Specific objectives: 1, 3, 7</td>
</tr>
</tbody>
</table>

| Development of the "Intra-domain Routing" contents | Hours: 10h  
Theory classes: 6h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 4h |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>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.</td>
<td>Specific objectives: 1, 3, 4, 7</td>
</tr>
</tbody>
</table>

| Development topic "Inter-domain Routing" | Hours: 14h  
Theory classes: 8h  
Practical classes: 0h  
Laboratory classes: 0h  
Guided activities: 0h  
Self study: 6h |
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>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.</td>
<td>Specific objectives: 1, 3, 5, 7</td>
</tr>
</tbody>
</table>
### 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

<table>
<thead>
<tr>
<th>Hours</th>
<th>Theory classes</th>
<th>Practical classes</th>
<th>Laboratory classes</th>
<th>Guided activities</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>17h</td>
<td>9h</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
<td>8h</td>
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</table>

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

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

**Specific objectives:**
4, 7, 8

<table>
<thead>
<tr>
<th>Hours</th>
<th>Theory classes</th>
<th>Practical classes</th>
<th>Laboratory classes</th>
<th>Guided activities</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>7h</td>
<td>4h</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
<td>3h</td>
</tr>
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</table>

### 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

<table>
<thead>
<tr>
<th>Hours</th>
<th>Theory classes</th>
<th>Practical classes</th>
<th>Laboratory classes</th>
<th>Guided activities</th>
<th>Self study</th>
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<tbody>
<tr>
<td>11h</td>
<td>6h</td>
<td>0h</td>
<td>0h</td>
<td>0h</td>
<td>5h</td>
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### Laboratory Internal Routing

<table>
<thead>
<tr>
<th>Hours</th>
<th>Theory classes</th>
<th>Practical classes</th>
<th>Laboratory classes</th>
<th>Guided activities</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>2h 30m</td>
<td>0h</td>
<td>0h</td>
<td>2h</td>
<td>0h</td>
<td>0h 30m</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
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<tbody>
<tr>
<td>Development of a practice on OSPF routers.</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Specific objectives:</strong></th>
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</thead>
<tbody>
<tr>
<td>4, 6, 7, 9, 10</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Laboratory Inter-domain Routing and Multihoming</strong></th>
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<tbody>
<tr>
<td><strong>Hours:</strong> 8h</td>
</tr>
<tr>
<td>Theory classes: 0h</td>
</tr>
<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 7h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Self study: 1h</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
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<tbody>
<tr>
<td>Laboratories which develop the design of an ISP, load balancing techniques and use of communities.</td>
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<table>
<thead>
<tr>
<th><strong>Specific objectives:</strong></th>
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<tbody>
<tr>
<td>1, 4, 5, 9, 10</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Switching Laboratories</strong></th>
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<tbody>
<tr>
<td><strong>Hours:</strong> 4h 30m</td>
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<tr>
<td>Theory classes: 0h</td>
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<tr>
<td>Practical classes: 0h</td>
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<tr>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 0h 30m</td>
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<thead>
<tr>
<th><strong>Description:</strong></th>
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<tbody>
<tr>
<td>Laboratories where are implemented techniques for the design of corporate networks, both in the switching unit as in the CPD.</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Specific objectives:</strong></th>
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<tbody>
<tr>
<td>1, 6, 7, 8, 9, 10</td>
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<table>
<thead>
<tr>
<th><strong>Midle exam</strong></th>
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<tbody>
<tr>
<td><strong>Hours:</strong> 10h</td>
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<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 10h</td>
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<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
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<tbody>
<tr>
<td>Review of theory about week 10.</td>
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<table>
<thead>
<tr>
<th><strong>Specific objectives:</strong></th>
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<tbody>
<tr>
<td>1, 2, 3, 4, 5</td>
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</tbody>
</table>
### control 1

**Hours:** 2h 30m  
- Theory classes: 0h  
- Practical classes: 0h  
- Laboratory classes: 0h  
- Guided activities: 2h 30m  
- Self study: 0h

**Description:**  
Control theory on topics 1, 2, 3 and 4.

**Specific Objectives:** 1, 2, 3, 4, 5

### Oral presentation

**Hours:** 3h  
- Guided activities: 3h  
- Self study: 0h

**Specific Objectives:** 1, 2, 3, 4, 5, 6, 7, 8

### Oral Presentation

**Hours:** 10h  
- Theory classes: 0h  
- Practical classes: 0h  
- Laboratory classes: 0h  
- Guided activities: 0h  
- Self study: 10h

**Description:**  
Presentation of work proposed by the teacher to student groups. The presentation will be 10 minutes per group.

**Specific Objectives:** 1, 2, 3, 4, 5, 6, 7, 9, 10

### Lab Exam

**Hours:** 7h  
- Guided activities: 2h  
- Self study: 5h

**Description:**  
Review choice of 6 laboratories made during the course.

**Specific Objectives:** 2, 3, 4, 5, 6, 9, 10
## Final Exam

<table>
<thead>
<tr>
<th>Specific objectives:</th>
<th>Hours: 28h 30m</th>
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<tbody>
<tr>
<td>1, 2, 3, 4, 5, 6, 8</td>
<td>Guided activities: 0h</td>
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<tr>
<td></td>
<td>Self study: 28h 30m</td>
</tr>
</tbody>
</table>

## Final Exam

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 3h</th>
</tr>
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<tbody>
<tr>
<td>Final Exam</td>
<td>Theory classes: 0h</td>
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<tr>
<td></td>
<td>Practical classes: 0h</td>
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<tr>
<td></td>
<td>Laboratory classes: 0h</td>
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<tr>
<td></td>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 0h</td>
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</tbody>
</table>

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8
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Qualification system

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:

If continuous evaluation:
NF = 0.20 * NL + 0.10*PO + 0.35 * C1 + 0.35 * C2

If NO continuous evaluation:
NF = 0.20 * NL + 0.10*PO + 0.7 * EF

where:

NF = Mark at the end of the course.
C1 = Mark of partial exam (aprox. en semana 10), topics 1 to 3.
C2 = Mark of partial exam (el dia del examen final), topics 4 to 6.
EF = Mark of Final exam (topic 1 to topic 6)
PO = oral presentation (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

Basic: