Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: - Jose Luis Ruiz Muñoz (jose.luis.ruiz@upc.edu)

Prior skills
The student should:
(a) know the logarithm function and its properties,
(b) basic properties of finite probability distributions and random variables,
(c) know the ring of modular integers and perform calculations;
(d) know the basics of vector spaces: systems of linear equation, linear dependence and independence, basis and dimension, matrix operations (suns, products) and compute inverse;
(e) know the basic properties of polynomials and know how to operate with them.

Requirements
- Prerequisite M2
- Prerequisite M1
- Prerequisite FM

Degree competences to which the subject contributes
Specific:
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.
CTI3.3. To design, establish and configure networks and services.

General:
G6. SOLVENT USE OF THE INFORMATION RESOURCES: To manage the acquisition, structuring, analysis and visualization of data and information of the field of the informatics engineering, and value in a critical way the results of this management.

Teaching methodology
In theoretical sessions the professor explains the theoretical issues giving examples and solving problems. It combines both the master methodology, in which the professor presents, explains and illustrates the concepts of the subject, and the interaction with students.

In the lab sessions, and during the hours of personal study, students should try to solve problems from a collection. The teacher supports the student with the difficulties that may raise. It is intended that students take the initiative in solving problems, evaluating solutions and learn from their mistakes.

Learning objectives of the subject
1. To learn the concepts of information of an event and the entropy of a probability distribution. To learn the concepts of information source and communication channel. To learn the concepts of source coding (data compression) and channel coding (error-detection and error-correction) and Shannon’s theorems.

2. To learn the basic concepts of block codes: their parameters and their relationship to the error-detecting and error-correcting abilities. To learn the main applications of modular arithmetic to the construction of block codes. To learn the protocols of error-detection and error-correction used in communication networks.

3. To learn the basic structure of finite fields, mainly those of characteristic 2. To learn the finite dimensional vector spaces over a finite field. To learn the ways of defining a linear code, determining its parameters and decoding using the algorithm based on syndromes. To learn the particularities of some specific linear codes (specially the perfect codes) and their corresponding error-correction algorithms.

4. To learn the general structure of cyclic codes and Meggit’s algorithm. To learn CRC technique: cyclic codes used for detection purposes in communication networks. To learn the binary BCH codes and their error-correction algorithms. To learn Reed-Solomon codes and their application to compact disks.

**Study load**

<table>
<thead>
<tr>
<th><strong>Total learning time:</strong> 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0 h</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15 h</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>6 h</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>84 h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>56.00%</td>
</tr>
</tbody>
</table>
# Content

## Information and entropy.

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

**Description:**
Mathematical definition of the amount of information. Entropy of a probability distribution and mutual information of two random variables.

## Source coding and channel coding

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

**Description:**

## Error-detection and error-correction with block codes.

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

**Description:**

## Finite fields

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

**Description:**
Construction of finite fields, specially those of characteristic 2. Elementary properties and effective computations in finite fields.

## Linear codes

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

**Description:**

## Cyclic codes and CRC

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

### Binary BCH codes

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

**Description:**

### Reed-Solomon codes

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

**Description:**
Reed-solomon codes as cyclic codes. The finite Fourier transform. Algorithm for error-correction. Application: coding of the audio compact disc.
# Planning of activities

| Information and entropy                                      | Hours: 9h 30m  
|                                                          | Theory classes: 3h  
|                                                          | Practical classes: 0h  
|                                                          | Laboratory classes: 1h  
|                                                          | Guided activities: 0h  
|                                                          | Self study: 5h 30m  |

**Description:**
Developing the subject "Information and entropy"

**Specific objectives:**
1

| Developing the subject "Source coding and channel coding" | Hours: 13h 30m  
|                                                           | Theory classes: 6h  
|                                                           | Practical classes: 0h  
|                                                           | Laboratory classes: 1h  
|                                                           | Guided activities: 0h  
|                                                           | Self study: 6h 30m  |

**Description:**
Developing the subject "Source coding and channel coding"

**Specific objectives:**
1

| Partial exam | Hours: 9h  
|             | Guided activities: 2h  
|             | Self study: 7h  |

**Description:**
Partial exam on subjects 1, 2 and 3

**Specific objectives:**
1, 2

| Developing the subject "Error-detection and error-correction with block codes" | Hours: 9h  
|                                                                             | Theory classes: 4h  
|                                                                             | Practical classes: 0h  
|                                                                             | Laboratory classes: 1h  
|                                                                             | Guided activities: 0h  
|                                                                             | Self study: 4h  |

**Description:**
Developing the subject "Error-detection and error-correction with block codes"

**Specific objectives:**
2
### Solving problems 1

**Description:**
Troughout the course the student has to work on at least two problems.

**Specific objectives:**
1, 2

**Hours:** 2h 42m
- Guided activities: 0h 30m
- Self study: 2h 12m

### Developing the subject "Finite fields"

**Description:**
Developing the subject "Finite fields"

**Specific objectives:**
3

**Hours:** 13h
- Theory classes: 6h
- Practical classes: 0h
- Laboratory classes: 2h
- Guided activities: 0h
- Self study: 5h

### Developing the subject "Linear codes"

**Description:**
Developing the subject "Linear codes"

**Specific objectives:**
3

**Hours:** 13h
- Theory classes: 5h
- Practical classes: 0h
- Laboratory classes: 2h
- Guided activities: 0h
- Self study: 6h

### Developing the subject "Cyclic codes and CRC"

**Description:**
Developing the subject "Cyclic codes and CRC"

**Hours:** 15h
- Theory classes: 6h
- Practical classes: 0h
- Laboratory classes: 3h
- Guided activities: 0h
- Self study: 6h
## Specific objectives:

4

| Developing the subject "Binary BCH codes" | Hours: 16h  
Theory classes: 6h  
Practical classes: 0h  
Laboratory classes: 3h  
Guided activities: 0h  
Self study: 7h |
|------------------------------------------|--------------------------------------------------|
| **Description:**  
Developing the subject "Binary BCH codes" | **Specific objectives:**  
4 |

| Developing the subject "Reed-Solomon codes" | Hours: 11h  
Theory classes: 6h  
Practical classes: 0h  
Laboratory classes: 1h  
Guided activities: 0h  
Self study: 4h |
|---------------------------------------------|--------------------------------------------------|
| **Description:**  
Developing the subject "Reed-Solomon codes" | **Specific objectives:**  
4 |

| Solving problems 2 | Hours: 2h 48m  
Guided activities: 0h 30m  
Self study: 2h 18m |
|-------------------|--------------------------------------------------|
| **Description:**  
Throughout the course the student has to work on at least two problems. | **Specific objectives:**  
3, 4 |

| Report on a subject related to the course | Hours: 11h  
Guided activities: 1h  
Self study: 10h |
|-------------------------------------------|--------------------------------------------------|
| **Description:**  
Report on a subject related to the course where both the contents and the use of reliable information resources will be assessed. |
270128 - TCI - Information Transmission and Encoding

Specific objectives:
1, 2, 3, 4

<table>
<thead>
<tr>
<th>Final exam</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: Final exam on subjects from 4 to 8</td>
<td>20h</td>
</tr>
<tr>
<td>Specific objectives: 3, 4</td>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 17h</td>
</tr>
</tbody>
</table>

Qualification system

(1) Students have to write a report on a topic related to course. The report's content and the use of reliable information resources will be assessed separately.

The mark of the report represents the 15% of the course mark (1a).

Rating: Tr

The grade for the cross-competition "Using reliable information resources" is gotten directly from the use of the bibliography in the report (1b).

(2) There is a mid-term exam in class time (20%), about the sixth week of the course on the contents 1, 2 and 3. These subjects will not be further requested.

Rating: Pa

(3) There is a final exam not in class-time (50%) on the contents 4, 5, 6, 7 and 8.

Rating: F

(4) Personal work and the achievement of objectives will be taken into account by writing the solution to some problems (15%).

Rating: Pr

(5) The final mark of the course is computed as:

0.15 * Tr + 0.20 * Pa + 0.15 * Pr + 0.50 * F

(6) The grade of cross-competition "Using reliable information resources" is 100% of (1b).
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

http://www.sagemath.org