# [MRD104] SIGNAL PROCESSING

## GENERAL INFORMATION

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|---|---|---|---|---|---|
| **Studies** | Master's Degree in ROBOTICS AND CONTROL SYSTEMS | | | **Subject** | ? |
| **Semester** | 2 | **Course** | 1 | **Mention / Field of specialisation** | AUTONOMOUS SYSTEMS - EIT |
| **Character** | OPTIONAL | | | | |
| **Plan** | 2023 | **Modality** | Face-to-face | **Language** | CASTELLANO/EUSKARA |
| **Credits** | 6 | **Hours/week** | 0 | **Total hours** | 54 class hours + 96 non-class hours = **150 total hours** |

## PROFESSORS

MENDICUTE ERRASTI, MIKEL
OLAIZOLA ALBERDI, JON

## REQUIRED PREVIOUS KNOWLEDGE

| Subjects | Knowledge |
|---|---|
| Circuit theory | Laplace transform |
| Fundamentals of mathematics | Mathematics: complex numbers, complex exponentials |

## LEARNING RESULTS

| LEARNING RESULTS | KC | SK | AB | ECTS |
|---|---|---|---|---|
| **M1R216** - [!] *Elegir e implementar algoritmos de procesamiento de señal para la extracción de información relevante* | | x | | 4,4 |
| **M1R223** - [!] *Capacidad de trabajar en equipos multidisciplinares y en un entorno multilingüe y de comunicar, tanto de forma oral como escrita, conocimientos, procedimientos, resultados e ideas relacionadas con los temas afines al máster* | | x | | 0,4 |
| **M1R224** - [!] *Capacidad para ejercer su profesión con actitud cooperativa y participativa, y con responsabilidad social* | | x | | 0,4 |
| **M1R226** - To apply the knowledge acquired and your problem-solving skills in new, little-known or changing environments within broader (or multidisciplinary) contexts related to your area of study | | x | | 0,8 |
| | | | **Total:** | 6 |

*KC: Knowledge or Content / SK: Skills / AB: Abilities*

## SECONDARY LEARNING RESULTS

**RA171** **[!]** ***Identifica los fundamentos matemáticos del procesamiento de señal y los desarrolla en un contexto práctico tanto individualmente como en equipo***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Computer simulation exercises, individually and/or in teams | 6 h. | 6 h. | 12 h. |
| Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects | 6 h. | 10 h. | 16 h. |
| Carrying out exercises and solving problems individually and/or in teams | 6 h. | 6 h. | 12 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 50% |
| Individual written and/or oral tests or individual coding/programming tests | 50% |

**Comments:** All activities (control points, individual and group work, etc.) must have a minimum grade of 5 and an opportunity for recovery (except the PBL). In unapproved training activities (less than 5) the recovery is compulsory and the final grade will be the grade obtained in the recovery. In the activities carried out it is necessary to obtain a minimum mark of 4 to calculate the average mark of the learning result. Otherwise, the note of the learning result will be that of the suspended activity. The system will calculate the final grade with the RA, applying the percentages defined in IKOF.

**MAKE-UP MECHANISMS**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

Individual written and/or oral tests or individual coding/programming tests

**CH - Class hours:** 18 h.
**NCH - Non-class hours:** 22 h.
**TH - Total hours:** 40 h.

**RA172** **[!]** ***Categoriza y evalúa algoritmos de filtrado adaptativo y monitorización de procesos cooperando para obtener la propuesta de manera participativa***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams | 3 h. | 10 h. | 13 h. |
| Computer simulation exercises, individually and/or in teams | 4 h. | 7 h. | 11 h. |
| Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects | 3 h. | 10 h. | 13 h. |
| Carrying out exercises and solving problems individually and/or in teams | 7 h. | 6 h. | 13 h. |

| EVALUATION SYSTEM | W | MAKE-UP MECHANISMS |
|---|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 30% | Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems |
| Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems | 30% | Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems |
| Individual written and/or oral tests or individual coding/programming tests | 40% | Individual written and/or oral tests or individual coding/programming tests |

**Comments:** All activities (control points, individual and group work, etc.) must have a minimum grade of 5 and an opportunity for recovery (except the PBL). In unapproved training activities (less than 5) the recovery is compulsory and the final grade will be the grade obtained in the recovery. In the activities carried out it is necessary to obtain a minimum mark of 4 to calculate the average mark of the learning result. Otherwise, the note of the learning result will be that of the suspended activity. The system will calculate the final grade with the RA, applying the percentages defined in IKOF.

**CH - Class hours:** 17 h.
**NCH - Non-class hours:** 33 h.
**TH - Total hours:** 50 h.

**RA173** **[!]** ***Desarrolla y valida el uso práctico de algoritmos de procesamiento de señal en tiempo real resolviendo los problemas asociados a la solución propuesta en entornos nuevos o poco conocidos***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams | 5 h. | 13 h. | 18 h. |
| Computer simulation exercises, individually and/or in teams | 4 h. | 9 h. | 13 h. |
| Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects | 4 h. | 12 h. | 16 h. |
| Carrying out exercises and solving problems individually and/or in teams | 6 h. | 7 h. | 13 h. |

| EVALUATION SYSTEM | W | MAKE-UP MECHANISMS |
|---|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 30% | Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems |
| Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems | 30% | Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems |
| Individual written and/or oral tests or individual coding/programming tests | 40% | Individual written and/or oral tests or individual coding/programming tests |

**Comments:** All activities (control points, individual and group work, etc.) must have a minimum grade of 5 and an opportunity for recovery (except the PBL). In unapproved training activities (less than 5) the recovery is compulsory and the final grade will be the

grade obtained in the recovery. In the activities carried out it is necessary to obtain a minimum mark of 4 to calculate the average mark of the learning result. Otherwise, the note of the learning result will be that of the suspended activity. The system will calculate the final grade with the RA, applying the percentages defined in IKOF.

**CH - Class hours:** 19 h.
**NCH - Non-class hours:** 41 h.
**TH - Total hours:** 60 h.

## CONTENTS

0. Introduction

1. Mathematical basics of signal processing

1.1 Discrete systems

1.2 Basic operations

1.3 Spectral analysis

1.4 Z transform

2. Signal Processing Systems

2.1 Digital filters

2.2 Adaptive filters and observers

3. Industrial examples of signal processing systems

## LEARNING RESOURCES AND BIBLIOGRAPHY

| Learning resources | Bibliography |
|---|---|
| Moodle Platform<br>Slides of the subject<br>Specific Master Software | Digital Signal Processing: Principles, Algorithms and Applications, 3rd Edition, J.G. Proakis. D. Manolakis, 1996. Pearson. ISBN: 9780133737622. |