# [MMD102] DIGITAL IMAGE PROCESSING

## GENERAL INFORMATION

| | | | | | |
|---|---|---|---|---|---|
| **Studies** | MASTER'S DEGREE IN BIOMEDICAL TECHNOLOGIES | | | **Subject** | ? |
| **Semester** | 1 | **Course** | 1 | **Mention / Field of specialisation** | |
| **Character** | COMPULSORY | | | | |
| **Plan** | 2023 | **Modality** | Face-to-face | **Language** | ENGLISH |
| **Credits** | 4,5 | **Hours/week** | 3.84 | **Total hours** | 69.2 class hours + 43.3 non-class hours = **112.5 total hours** |

## PROFESSORS

MENDICUTE ERRASTI, MIKEL

## REQUIRED PREVIOUS KNOWLEDGE

| Subjects | Knowledge |
|---|---|
| SIGNAL AND BIOMEDICAL IMAGES PROCESSING | *(No previous knowledge required)* |
| [!] *Procesamiento de señales biomédicas* | |
| [!] *Procesamiento de imagen biomédica* | |

## LEARNING RESULTS

| LEARNING RESULTS | KC | SK | AB | ECTS |
|---|---|---|---|---|
| **MMRA11** - To develop image processing systems applied to biomedical engineering | | | *x* | 3,16 |
| **MMRA26** - 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* | | 1,08 |
| **MMRA28** - To communicate your conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way | | *x* | | 0,26 |
| | | | **Total:** | **4,5** |

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

## SECONDARY LEARNING RESULTS

**RMM123** **[!]** ***Dominar las técnicas de mejora digital de las imágenes biomédicas necesarias para su post-procesado.***

| 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 | 4,5 h. | 3,5 h. | 8 h. |
| Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints | 2 h. | 1 h. | 3 h. |
| Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects | 5 h. | 2,5 h. | 7,5 h. |

| EVALUATION SYSTEM | W |
|---|---|
| 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 | 70% |
| Individual written and/or oral tests or individual coding/programming tests | 30% |

**Comments:** If the score of the exam is lower than 4, this evaluation item will be evaluated in its entirety (%100) with the score of the exam.

**MAKE-UP MECHANISMS**

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

**CH - Class hours:** 11,5 h.
**NCH - Non-class hours:** 7 h.
**TH - Total hours:** 18,5 h.

**RMM124** **[!]** ***Seleccionar las técnicas de segmentación y extracción de características idóneas para el diagnóstico de imágenes biomédicas.***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints | 4 h. | 2 h. | 6 h. |
| Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams | 10 h. | 6 h. | 16 h. |
| Carrying out exercises and solving problems individually and/or in teams | 5 h. | 3,5 h. | 8,5 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 70% |
| Individual written and/or oral tests or individual coding/programming tests | 30% |

**Comments:** If the score of the exam is lower than 4, this evaluation item will be evaluated in its entirety (%100) with the score of the exam.

| MAKE-UP MECHANISMS |
|---|
| Individual written and/or oral tests or individual coding/programming tests |

**CH - Class hours:** 19 h.
**NCH - Non-class hours:** 11,5 h.
**TH - Total hours:** 30,5 h.

**RMM125** **[!]** ***Especificar y aplicar correctamente algoritmos para la reconstrucción de imágenes.***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams | 3 h. | 3 h. | 6 h. |
| Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects | 4 h. | 2 h. | 6 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 70% |
| Individual written and/or oral tests or individual coding/programming tests | 30% |

**Comments:** If the score of the exam is lower than 4, this evaluation item will be evaluated in its entirety (%100) with the score of the exam.

| MAKE-UP MECHANISMS |
|---|
| Individual written and/or oral tests or individual coding/programming tests |

**CH - Class hours:** 7 h.
**NCH - Non-class hours:** 5 h.
**TH - Total hours:** 12 h.

**RMM126** **[!]** ***Especificar y seleccionar adecuadamente los algoritmos de procesado de imágenes necesarios en un proyecto real***

| 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 | 4 h. | 3 h. | 7 h. |
| Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams | 7 h. | 4 h. | 11 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems | 70% |
| Individual written and/or oral tests or individual coding/programming tests | 30% |

**Comments:** If the score of the exam is lower than 4, this evaluation item will be evaluated in its entirety (%100) with the score

| MAKE-UP MECHANISMS |
|---|
| Individual written and/or oral tests or individual coding/programming tests |

of the exam.

**CH - Class hours:** 11 h.
**NCH - Non-class hours:** 7 h.
**TH - Total hours:** 18 h.

**RMM144** **[!]** ***Analiza las variables intervinientes en la solución de los problemas y plantea acciones para lograr una situación estable asumiendo responsabilidades en el equipo de trabajo, afrontando contingencias y organizando y planificando tareas.***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams | 8,5 h. | 5 h. | 13,5 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Individual written and/or oral tests or individual coding/programming tests | 40% |
| Co-assessment | 5% |
| Prototype / Product | 55% |

**Comments:** If the score of the defense is lower than 5, this evaluation item will be evaluated in its entirety (%100) with the score of the defense. A co-evaluation system will be implemented to adjust the score of the student based on his or her participation in the Project.

**MAKE-UP MECHANISMS**
Observation (technical capacity, attitude and participation)

**CH - Class hours:** 8,5 h.
**NCH - Non-class hours:** 5 h.
**TH - Total hours:** 13,5 h.

**RMM145** **[!]** ***Conoce y es capaz de aplicar las herramientas de resolución de problemas en el campo de la Ingeniería Biomédica con iniciativa, toma de decisiones, creatividad y razonamiento crítico.***

| LEARNING ACTIVITIES | CH | NCH | TH |
|---|---|---|---|
| Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams | 8 h. | 5,5 h. | 13,5 h. |

| EVALUATION SYSTEM | W |
|---|---|
| Individual written and/or oral tests or individual coding/programming tests | 40% |
| Co-assessment | 5% |
| Prototype / Product | 55% |

**Comments:** :If the score of the defense is lower than 5, this evaluation item will be evaluated in its entirety (%100) with the score of the defense. A co-evaluation system will be implemented to adjust the score of the student based on his or her participation in the Project.

**MAKE-UP MECHANISMS**
Observation (technical capacity, attitude and participation)

**CH - Class hours:** 8 h.
**NCH - Non-class hours:** 5,5 h.
**TH - Total hours:** 13,5 h.

**RMM146** **[!]** ***Define el problema, el desarrollo de la solución, así como las conclusiones de manera eficaz, argumentando y justificando cada una de ellas, y haciendo un uso correcto del lenguaje, por escrito y de manera oral.***

| 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 | 2,2 h. | 1,3 h. | 3,5 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 | 50% | Observation (technical capacity, attitude and participation) |
| 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 | 50% | |

**CH - Class hours:** 2,2 h.
**NCH - Non-class hours:** 1,3 h.
**TH - Total hours:** 3,5 h.

**RMM147** **[!]** ***Define los objetivos, realiza la planificación para su consecución y su seguimiento sistemático coordinando su trabajo con los demás miembros del equipo.***

| 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 | 2 h. | 1 h. | 3 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 | 50% | Observation (technical capacity, attitude and participation) |
| 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 | 50% | |

**CH - Class hours:** 2 h.
**NCH - Non-class hours:** 1 h.
**TH - Total hours:** 3 h.

## CONTENTS

1. Morphological processing

1.1 Erosion and dilation

1.2 Opening and closing

1.3 Hit and Miss

1.4 Complex morphological operations

1.5 Grayscale morphological operations

2. Image segmentation

2.1 Point, line and border detection

2.2 Gradients and Laplacians

2.3. Canny

2.4. Contour following

3.- Image restoration and reconstruction

4.- Complex practice with real images

## LEARNING RESOURCES AND BIBLIOGRAPHY

| Learning resources | Bibliography |
|---|---|
| Technical articles | Bankman, I. N., & Morcovescu, S. (2002). Handbook of Medical Imaging. Processing and Analysis. Medical Physics |
| Slides of the subject | Prince, J. L., & Links, J. M. (2006). Medical imaging signals and systems. Pearson Prentice Hall |
| Moodle Platform | Rangayyan, R. M. (2004). Biomedical image analysis. CRC press. |
| Class presentations | Gonzalez, R.C., & Woods, R.E. (2008). Digital Image Processing. Pearson Prentice Hall |
| | Gonzalez, R.C., Woods, R.E., Eddins, S.L. (2009). Digital Image Processing Using MATLAB. Gatesmark Publishing |