

## Course guide

### 240IBI32 - 240IBI32 - Medical Images

**Last modified:** 13/03/2025

**Unit in charge:** Barcelona School of Industrial Engineering  
**Teaching unit:** 723 - CS - Department of Computer Science.

**Degree:** MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).  
MASTER'S DEGREE IN NEUROENGINEERING AND REHABILITATION (Syllabus 2020). (Compulsory subject).

**Academic year:** 2025    **ECTS Credits:** 4.5    **Languages:** English

#### LECTURER

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**Coordinating lecturer:** DANIELA TOST PARDELL

**Others:** Tost Pardell, Daniela

#### PRIOR SKILLS

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Capacity of searching bibliography  
Initiative to carry on projects  
Skills in ICT  
Hability to schedule and plan work

#### REQUIREMENTS

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Skills in computer science, specifically programming (python)

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

CEMEI16. Ability for the research management, development and technological innovation.  
CEEAUT4. Apply vision techniques by computer, shape recognition and merging of multi-sensorial data in automated production systems.  
CEEBIO3. Identify and extract information of interest in the biomedical signs.  
CEEBIO4. Know how to apply the main methods which most of the treatment projects offer, analysis and visualization of medical images.

#### TEACHING METHODOLOGY

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In this subject, a strong component of personal work is expected from students. In the theoretical sessions, the teacher will expose the needed concepts, give bibliographic references and present the corresponding works. In the lab sessions students will develop their requested work.

## LEARNING OBJECTIVES OF THE SUBJECT

To introduce students into the representation, visualisation and analysis of 2D and 3D biomedical images: images characteristics, representation models image file formats, visualisation through surface extraction and direct volume visualization, and image analysis and processing.

At the end of the course, we expect students to be able to construct a volumetric model, to visualise it, to extract and visualise selected iso-surfaces and to apply analysis methodologies. Therefore, they have to learn images characteristics and file formats; the fundamentals of volume visualization including the ray-tracing method as well as to edit transfer functions in order to obtain illustrative images; methods for surface extraction as Marching Cubes and for visualising the corresponding surfaces.

Students are also expected to work with existing applications such as Slicer and/or Paraview and also to devise their own applications using VTK and ITK libraries.

## STUDY LOAD

Type	Hours	Percentage
Self study	72,0	64.00
Hours large group	27,0	24.00
Hours small group	13,5	12.00

**Total learning time:** 112.5 h

## CONTENTS

### Introduction

#### Description:

- 1) Origins
- 2) Acquisition methods
- 3) Perspective
- 4) 2D images
- 5) 3D images
- 6) Data and applications

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

Theory classes: 3h

### Graphical interfaces

#### Description:

Introduction to graphical user interfaces. Graphic area, menu, panel.

#### Related activities:

Implementation of the project's GUI

**Full-or-part-time:** 26h

Theory classes: 5h

Laboratory classes: 3h

Self study : 18h

### Medical Images

**Description:**

Medical Image Representation  
Creacion of a medical image  
Reading of a medical image  
Filtering  
processing  
Analysis  
Segmentation

**Specific objectives:**

Learn to create a medical image, read it and know how to interpret its content  
Know the basics of image processing and know how to apply filtering techniques using high-level libraries and applications  
Know the basics of image analysis and know how to apply segmentation techniques using high-level libraries and applications

**Full-or-part-time:** 25h 30m

Theory classes: 5h

Laboratory classes: 3h 30m

Self study : 17h

### Volume models

**Description:**

- 1) Voxel model
- 2) Alternative models

**Full-or-part-time:** 8h

Theory classes: 2h

Laboratory classes: 1h

Self study : 5h

### Direct volume rendering (DVR)

**Description:**

- 1) Ray-tracing method
- 2) Shading and depth composition
- 3) Transfer functions

**Full-or-part-time:** 25h

Theory classes: 6h

Laboratory classes: 3h

Self study : 16h

### Indirect volume rendering

**Description:**

- 1) Surface extraction and reconstruction
- 2) Methodologies/models: block-form/cuberile, beveled form/Marching Cubes
- 3) Triangle mesh representation. STL format
- 4) Surface processing

**Full-or-part-time:** 25h

Theory classes: 6h

Laboratory classes: 3h

Self study : 16h

## GRADING SYSTEM

Throughout the course there will be 2 tests (T1 and T2) during a face-to-face session and 2 laboratory practices will be delivered (L1 and L2). The final grade of the course will be calculated as:

$$NF = \max(NAC + NLab, NLab + NEF * 0.4)$$

with:

NAC = Continuous assessment grade =  $T1 * 0.2 + T2 * 0.2$  (value from 0 to 4)

NLab = Lab Grade =  $L1 * 0.30 + L3 * 0.30$  (value from 0 to 6)

NEF = Final exam grade (value from 1 to 10)

## BIBLIOGRAPHY

**Complementary:**

- Lichtenbelt, Barthold; Crane, Randy; Naqvi, S. Mahmood. Introduction to volume rendering. Upper Saddle River: Prentice Hall, cop. 1998. ISBN 0138616833.
- Engel, Klaus. Real-time volume graphics [on line]. Wellesley: A K Peters, cop. 2006 [Consultation: 21/03/2025]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1633501>. ISBN 1568812663.
- Schroeder, Will; Martin, Ken; Lorensen, Bill. The Visualization Toolkit : an object-oriented approach to 3D graphics. 4th ed. Clifton park: Kitware, cop. 2006. ISBN 193093419X.
- González, Rafael C ; Woods, Richard E. Digital image processing [on line]. 4th ed. New York: Pearson, 2018 [Consultation: 19/10/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5573669>. ISBN 9781292223049.



## RESOURCES

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### Audiovisual material:

- Nom recurs. Resource

### Other resources:

Papers of the following journals (to specify):

- IEEE Transactions on Visualization and Computer Graphics
- ACM Computer Graphics
- Computer Graphics Forum
- Computers & Graphics

Computer applications:

- 3D Slicer: [www.slicer.org/](http://www.slicer.org/)
- itk: [www.itk.org](http://www.itk.org)
- vtk: [www.vtk.org](http://www.vtk.org)