



Barcelona Institute of
Science and Technology

Dolors Aleu Graduate Centre

Centre affiliated to



Universitat
Pompeu Fabra
Barcelona

mmres.bist.eu | [@_bist](https://twitter.com/_bist)

Master of Multidisciplinary Research in Experimental Sciences



2023/2024
Syllabus



PRESENTATION

The MMRES is a unique, one-of-a-kind programme. The bulk of the curriculum (more than 60%) is spent on experimental research in the laboratory and the nature of that research is highly multidisciplinary. Work is carried out in two different disciplines, in two of the participating centres, and under the supervision of leading national and international researchers.

In addition to a solid research experience, the programme also offers training in transversal skills such as statistics & data analysis, responsible research, and science communication. These provide MMRES students with a holistic view of the challenges that come with a research career. The Seminars on Advanced Research feature lecturers and invited speakers from the world's leading research centres and contribute to the multidisciplinary nature of the programme. They help prepare students to be successful in scientific PhD programmes and other science-related jobs at the most demanding institutions.

The 2023-2024 class forms the seventh edition of the MMRES. More than 135 students have already experienced their first day in the programme before you, but we are confident that your master's experience will be unique. You are now part of a community of 2,500 people and you could start your scientific career surrounded by eminent researchers.

Welcome to the BIST Community!

Enjoy your experience!



OUTLINE

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CALENDARS

Academic year

| SEPTEMBER | | | | | | |
|-----------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | |

| OCTOBER | | | | | | |
|---------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

| NOVEMBER | | | | | | |
|----------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | | | |

| DESEMBER | | | | | | |
|----------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

| JANUARY | | | | | | |
|---------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

| FEBRUARY | | | | | | |
|----------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | | | |

| MARCH | | | | | | |
|-------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

| APRIL | | | | | | |
|-------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | | | | | |

| MAY | | | | | | |
|-----|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | | |

| JUNE | | | | | | |
|------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| JULY | | | | | | |
|------|----|----|----|----|----|----|
| DI | Dt | Dc | Di | Dy | Ds | Dg |
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| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

- Welcome Ceremony
- Initial Training Period
- Research Training Period
- Deadlines
- Training Days
- Winter School
- Thesis Presentations
- Holidays



Initial Training period

| SEPTEMBER | | | | | | |
|-----------------|------|-----------------------------|-----------------|------|----|----|
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | | MMRES Annual Ceremony | SDA Bootcamp | SDA | | |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| SDA Bootcamp | SDA | SDA | SDA Bootcamp | SDA | | |
| SAR | RRSC | SAR | RRSC | RRSC | | |
| 25 | 26 | 27 | 28 | 29 | 30 | |
| Holiday | SDA | SDA | SDA Bootcamp | SDA | | |
| | RRSC | SAR | RRSC | SAR | | |
| OCTOBER | | | | | | |
| | | | | | | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| SDA | SDA | SDA | SDA Bootcamp | SDA | | |
| SAR | RRSC | SAR | RRSC | RRSC | | |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| SDA Bootcamp | SDA | SDA | Holiday | | | |
| SAR | RRSC | SAR | | | | |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| SDA | SDA | SDA | | | | |
| | RRSC | RRSC | | | | |



| | |
|------|--|
| SDA | Statistics & Data Analysis |
| SAR | Seminars in Advanced Research |
| RRSC | Responsible Research and Science Communication |

Training days

| | | | |
|------------|-------------|------------|---------|
| November 6 | December 11 | February 5 | March 4 |
| SAR | SAR | SAR | SAR |
| RRSC | RRSC | RRSC | RRSC |
| March 25 | April 15 | May 6 | June 3 |
| SAR | SAR | SAR | SAR |
| | | RRSC | RRSC |

The dates and location of the Seminars (SAR) and RRSC classes might change during the course to adapt to the centres.

Research training period

| | |
|---------------|---|
| 13-Sep | Master's Annual Ceremony |
| 19-Oct | Start of Major Project |
| 20-Nov | Deadline for Major Project Initial Report |
| 12-Feb | Deadline for Minor Project Assignment |
| 18-Mar | Deadline for Mid-Project Report |
| 2-Jul | Deadline Master Thesis scientific paper |
| 10-jul | Deadline supervisors assessment |
| 17-18-19 July | Oral presentations |

Lab time

- Major Project: From Oct 19, 2023 to July 2, 2024
- Minor Projects: 10 weeks (approx.) between Nov 20, 2023 and Jul 2, 2024
- Master Thesis: From Jul 17 to Jul 19, 2024.



ACADEMIC BOARD

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Robert Sewell

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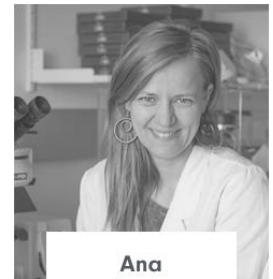
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Janic**
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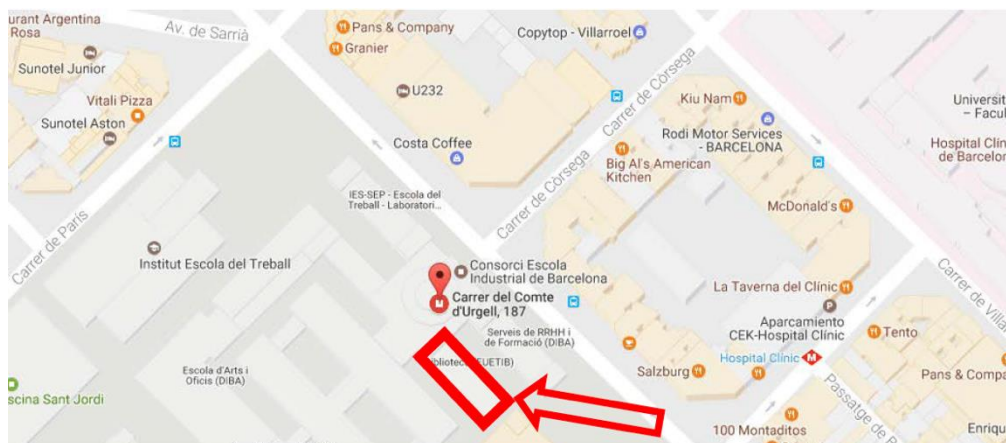


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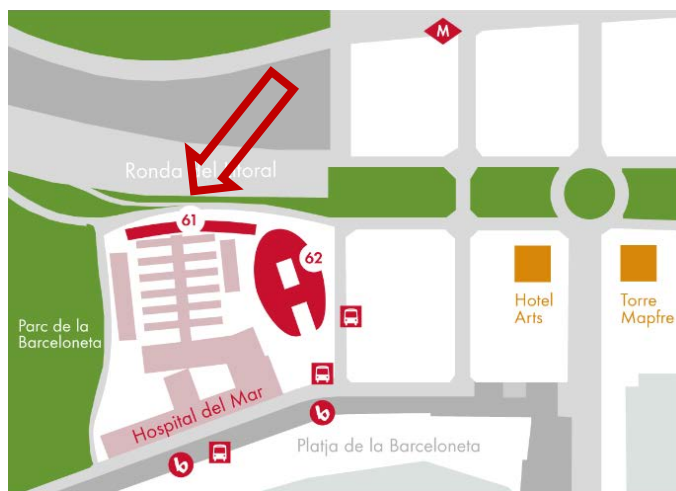
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SYLLABUS

Statistics & Data Analysis (SDA)

Overview

Coordinator: Lidia Mateo (IRB), Míriam Navarro (BIST)

Contact: Lidia Mateo (lidia.mateo@irbbarcelona.org); Míriam Navarro (mnavarro@bist.eu)

Teaching staff: Alejandro Caceres (ISGlobal), Borja Requena (ICFO), Gianluca Arauz (IRB), Lidia Mateo (IRB) and Carles Sánchez (IFAE).

ECTS: 5

Workload: 125 hrs.

Term: 1st

Location: UPF Campus Mar (Dr. Aiguader 80) Edifici docent Aula 61.114.

Comments: Students must bring their laptop for the hands-on sessions

Teaching guide

Presentation of the course

This course focuses on statistical methods to analyse Research data in Experimental Sciences. The course includes a course in the programming tools needed to complete the subject, and an introduction to useful tools for their research projects. The Phyton Bootcamp is a 6-day workshop, modelled on and taking advantage of open-source online materials.

After a general introduction on probability theory and parameters estimation, an emphasis will be made on statistical inference, along with a general introduction to Bayesian statistics. The course comprises 5 ECTS credits, involving approximately 30 hours of plenary lectures, and 20 hours of exercises and hands-on computer classes. The subject is based on the understanding of key methodological concepts and tools and on the application of Python resources to solve statistical analysis. As this is an intensive course, students are advised of the need for strong interaction with the lecturers and of the need to keep the class material up to date.

The subject focuses on practical implementation of different types of tools for statistical inference. Thus, the methods covered are strongly based on a good understanding of basic principles of probability and programming.



Prerequisites in order to follow the itinerary.

Previous programming knowledge and notions of probability are required. A Python Bootcamp is organised for 6 sessions at the beginning of the course to introduce python language to all students.

Information on the teaching

This course will be delivered face to face. The structure of the course is based on:

- Theoretical sessions (Initial training period): Theoretical classes on statistics and programming with exercises and practical examples to understand the content of the subject.
- Bootcamp on Python (Initial training period). Includes 6 sessions on programming tools of Python resources to solve statistical analysis.

Associated competences

General competences

Instrumental:

Proficient reading/writing/listening of scientific English related to the subject.

Interpersonal:

Group work

Ability to solve by yourself a given problem

Systemic:

Analysis and synthesis abilities

Ability to search for information

Specific competences

1. To understand the concept of probability.
2. To understand Bayes' Theorem.
3. To distinguish statistical description from inference.
4. To understand the concept of random variable.
5. To become familiar with central trend and dispersion measures.
6. To understand the concept of probability distribution.
7. To become familiar with the most common kinds of distributions.



8. To understand the implication of large numbers' use and convergence.
9. To understand the concept of confidence intervals and standard error.
10. To understand the concept and application of Monte Carlo techniques.
11. To understand the concept of estimator and its main properties.
12. To master standard techniques for parameter estimation such as least-squares and maximum likelihood fits.
13. To master standard techniques for error propagation.
14. To understand the concept of hypothesis testing.
15. To understand the concept of Type I and II errors.
16. To master the concept of ANOVA and its different designs.
17. To master the concept of contingency tables and the relevant testing procedures.
18. To master the concept of and procedures for Regression and Correlation Analysis.
19. To understand resampling methods.
20. To understand the concepts of multiple regression and correlation.
21. To understand the concept and procedures for Likelihood ratio tests, Linear tests, Non-linear tests and machine learning.
22. To understand the concept of Bayesian Statistics.
23. To master parameter estimation in a Bayesian framework.
24. To master hypothesis testing ("model selection") in a Bayesian framework.
25. To become familiar with Markov chain Monte Carlo and its applications in Bayesian statistics.

Learning aims

To understand and apply algorithms and methods currently used in multidisciplinary research in experimental sciences to perform statistical analysis upon data.

Contents

Module 0 (Lidia Mateo, Gianluca Arauz)

Python Bootcamp

Module 1 (Alejandro Caceres)

Introduction. Descriptive statistics

Basic concepts of probability. Distributions and probability density functions

Sampling distribution. Law of large numbers and convergence

Hypothesis testing: t-student, ANOVA, Regression analysis, Categorical data.



Module 2 (Carles Sánchez)

Bayesian statistics

Module 3 (Borja Requena)

Machine learning

Calendar

| Session | Learnin activity | Format | Lecturer | Date | Time | Location |
|--|---------------------|--------|----------|--------|--------------|----------|
| Bootcamp on Phyton | 1 | P | GL | 14-set | 10:00-12:00 | 61.114 |
| Data description and probability | 2 | T | AC | 15-set | 9:00 - 12:00 | 61.114 |
| Bootcamp on Phyton | 3 | P | GL | 18-set | 10:00-12:00 | 61.114 |
| Random variable, mean and variance, probability mass function | 4 | T | AC | 19-set | 9:00 - 12:00 | 61.114 |
| Uniform, Binomial and Negative binomial distributions. Poisson and Normal distributions | 5 | T | AC | 20-set | 9:00 - 12:00 | 61.114 |
| Bootcamp on Phyton | 6 | P | GL | 21-set | 10:00-12:00 | 61.114 |
| Pont estimators, sampling | 7 | T | AC | 22-set | 9:00 - 12:00 | 61.114 |

| Session | Learning activity | Format | Lecturer | Date | Time | Location |
|--|-------------------|--------|----------|--------|--------------|----------|
| distribution, central limit theorem | | | | | | |
| Group work: Exercises on probability | 8 | P | AC | 26-set | 9:00 - 12:00 | 61.114 |
| Hypothesis testing and errors, interval estimation | 9 | T | AC | 27-set | 9:00 - 12:00 | 61.114 |
| Bootcamp on Phyton | 10 | T/P | LM | 28-set | 10:00-12:00 | 61.114 |
| Maximum likelihood | 11 | T | AC | 29-set | 9:00 - 12:00 | 61.114 |
| Bayesian statistics | 12 | T/P | CS | 2-oct | 9:00 - 12:00 | 61.114 |
| Bayesian statistics | 13 | T | CS | 3-oct | 9:00 - 12:00 | 61.114 |
| Bayesian statistics | 14 | T/P | CS | 4-oct | 9:00 - 12:00 | 61.114 |
| Bootcamp on Phyton | 15 | T/P | LM | 5-oct | 10:00-12:00 | 61.114 |
| Group work: Exercises on hypothesis testing, t-test. | 16 | T | AC | 6-oct | 9:00 - 12:00 | 61.114 |
| Bootcamp on Phyton | 17 | T/P | LM | 9-oct | 10:00-12:00 | 61.114 |
| One-way and Two-way Anova | 18 | T | AC | 10-oct | 9:00 - 12:00 | 61.114 |

| Session | Learnin: activity | Format | Lecturer | Date | Time | Location |
|----------------------------------|----------------------|--------|----------|--------|------------------|----------------|
| Regression and correlation | 19 | P | AC | 11-oct | 9:00 - 11:00 | 61.114 |
| Machine Learning | 20 | T/P | BR | 16-oct | 9:00 - 12:00 | 61.114 |
| Machine Learning | 21 | T/P | BR | 17-oct | 9:00 - 12:00 | 61.114 |
| Machine Learning | 22 | T/P | BR | 18-oct | 9:00 - 12:00 | 61.114 |
| Exam | | | AC | 31-oct | 10:30 - 13:30 | 61.106- 108 |

Assessment

General assessment criteria

The evaluation will consist of three parts:

| Task | Description | Weight |
|----------|--|--------|
| Module 1 | Final exam (60%). Exercises and practicals eventually delivered during the course. (40%) | 64% |
| Module 2 | 2 questions at the final exam (60%), Practical work and eventually exercises delivered during the course (40%) | 18% |
| Module 3 | Take home exam, Practical works and eventually exercises delivered during the course. | 18% |

All assessment and exercises to be delivered are to be individual work, that is, students can and are advised to discuss and work together to resolve assessments, but the final resolution and presentation must be individual. Disciplinary action will be taken against students who not follow the guidelines (e.g. colluding with other students or copying other students' work).



Course Materials

Course materials available on GitHub at <https://github.com/MMRES-PyBootcamp/MMRES-python-bootcamp2023/>

Preliminary Requirements

Students are requested to bring their own laptop with a working installation of Anaconda Python 3.9. Installation instructions and additional resources are given [here](#).

Recommended Installation

Version: [Anaconda Python 3.9](#)

Distribution: [Anaconda](#) with [Jupyter](#) and [Spyder](#) (or another editor)

Packages: [NumPy](#), [SciPy](#), [Matplotlib](#), [Pandas](#), [Seaborn](#), [Scikit-learn](#)

Version Control: [Git](#)

Online Resources

[Learn X in Y minutes where X = Python](#)

[Learn Python](#)

[10 Minutes to Pandas](#)

[Pythonic Perambulations](#)

[Subtleties of Colour](#)

Useful Courses

Software Carpentry - [Programming with Python](#)

Software Carpentry - [Plotting and Programming with Python](#)

Software Carpentry - [Version Control with Git](#)

Software Carpentry - [Instructor Training](#)

Python - [Python Tutorial](#)



Data Carpentry – [Python for Ecologists](#)

AstroEd – [Python for Physics and Astronomy](#)

SciPy – [Lecture Notes](#), particularly the [Statistics in Python](#) chapter

J.R. Johansson – [Scientific Computing with Python](#)

Institute of Space Sciences – [Python for Astronomy and Particle Physicists](#).

Teaching Resources

<https://www.otexts.org/book/biostat>

<http://onlinestatbook.com/>

<http://www.biostathandbook.com/>

Other References

[Best Practices in Scientific Computing](#)

[Good Enough Practices in Scientific Computing](#)

Bibliography

M.L. Samuel, J.A. Witmer, A. Shaffner. Statistics for the Life Sciences.

G. Cowan; "Statistical Data Analysis", 1998, Oxford University Press

Stuart et al., "Kendall's Advanced Theory of Statistics", Vol 2A. Wiley.

F. James, "Monte Carlo Theory and Practice", Rep. Prog. Phys. 43 (1980) 73.

D. Sivia and J. Skilling, "Data Analysis, A Bayesian Tutorial", 2nd ed., 2006, Oxford University Press

E.T. Jaynes, "Probability Theory: The Logic of Science", Cambridge University Press.

W.T. Press et al., "Numerical Recipes: The Art of Scientific Computing", Cambridge University



Responsible Research and Science Communication (RRSC)

Overview

Coordinator: Míriam Navarro (BIST)

Contact: Míriam Navarro (mnavarro@bist.eu)

Teaching Staff: Núria Bayo (BIST); Maruxa Martinez (PRBB), Elena Redondo (BIST); Marta Llorens (BIST), Míriam Navarro (BIST), Zoila Babot (BIST), Àlex Argemí (ICN2), Laura Hernandez (ICIQ), Sebastián Grinschpun (IFAE).

ECTS: 5

Workload: 125 hrs.

Term: 1st 2nd, 3rd

Location: UPF Campus Mar (Dr Aiguader, 80) and BIST Centres

Description of the subject

The course is a developmental training programme which is focused on enhancing the effectiveness of future researchers by providing an opportunity to build their understanding, skills and confidence in basic knowledge of responsible research, project management and effective communication. It also encourages critical discussions and thorough reflection on the wider impact of concrete research and innovation (R&I) aspects and the overall science and technology system.

The course also focuses on different skill sets for scientific communication: how to gather information, and how to communicate science to peers, multidisciplinary peers and to general public. During the course students will learn to gather, manage and summarise scientific information and also, they will develop their abilities in three key channels for traditional scientific communication (poster presentations, scientific articles, and oral presentations) and by designing, performing and evaluating a public engagement activity for the general public.

The course is divided into three different domains:

BLOCK I: RRI and public communication

BLOCK II: Project management

BLOCK III: Scientific communication



Objectives

On completion of this course students will be able to:

- Understand methods to facilitate dialogue on R&I with different actors: multidisciplinary peers, strategic stakeholders (users, consumers, patients, industry representatives, policy makers, CSO representatives), media and the public.
- Develop public communication skills.
- Adapt these methods to their specific R&I process or development.
- Develop attitudes and techniques on effective planning and project management.
- Develop techniques to effectively communicate with thesis supervisor and relevant people for the success of the thesis,
- Develop an individual plan for the coming year and identify the things that need to be done.
- Develop techniques to communicate the outputs of their research projects in different ways: poster, paper and oral presentation.

Methodology

Block I: RRI and public communication

In this course, students will have the opportunity to experience both sides of deliberation activities. Thereby it will be possible for them to reflect on different societal aspects of R&I developments (including issues of sustainability, societal equality, gender, open science, open access etc.) applied to their own research.

Students will get to know and discuss different methods to facilitate dialogues on R&I and related developments. In groups they will prepare and conduct presentations on different related methods suggested by the course instructor. Groups of students supervised by the course instructor will design and implement a dialogue “experiment”. Thus, each student will experience both the side of the facilitator and that of a participant. At the end of the course students will assess their own public engagement activity and present it in an oral presentation.

Block I sessions overview:

| Learning activity | Lecturer | Description |
|--|-----------------|--|
| Overview of the subject. | Míriam Navarro | Introduction to the subject and practical exercises to understand the importance of communication <i>Attendance and participation</i> |
| Exploring participatory science | Míriam Navarro | Theoretical review and practical exercises on responsible research and innovation <i>Attendance and participation</i> |
| Other Shared values | Míriam Navarro | Practical exercises on other shared values (ethics, gender, inclusive science and sustainability) |
| Research integrity and science ethics (I) | Maruxa Martínez | Introduction to research integrity and science ethics. Philosophical reflection and practical experiences from research routine. <i>Evaluative activity inside classroom: attendance and participation</i> |
| Research integrity and science ethics (II) | Maruxa Martínez | Practical tools to keep your research integrity: data management and conflict of interests. <i>Evaluative activity inside classroom: attendance and participation</i> <i>Evaluative activity outside classroom: RI risk assessment</i> |
| Science and society: practical examples. | Zoila Babot | Round table session with experts in science communication and outreach activities. |

| Learning activity | Lecturer | Description |
|--|--|--|
| Public communication skills. Knowing your public. | Marta Llorens | Review and critical assessment of practical examples of the different approaches to conduct a bi-directional public engagement activity based on dialogue with different stakeholders. <i>Attendance and participation</i> |
| Public engagement approach: Designing a participatory activity | Àlex Argemí Sebastián Grinschpun Laura Hernández | Theoretical review on the engaged researcher. Practical exercises to design a participatory activity based on at least one students' major project research. <i>Attendance, participation and an initial report creation.</i> |
| Public engagement - Dialogical approach | Àlex Argemí Sebastián Grinschpun Laura Hernández | Oral presentations of the dialogical approach of each public engagement activity. <i>Evaluative activity inside classroom: attendance and participation</i> |
| Public engagement - How to evaluate | Àlex Argemí Sebastián Grinschpun Laura Hernández | Evaluation methodology to assess each public engagement activity. |
| Public engagement - Final presentations | Àlex Argemí Sebastián Grinschpun Laura Hernández | Final oral presentations of the public engagement carried out mainly focusing on implemented dialogue dynamics and evaluation results. <i>Attendance and participation.</i> <i>Report assessment and oral presentation of the public engagement activity</i> |



Block II: Project Management

The focus of the block is project management techniques which create effective interactions and a well-managed research project implementation. This course will build on your existing skills and can be applied directly to your research.

Research requires a display of initiative, commitment and persistence. Project management compliments those skills by providing process, monitoring, communication and risk response.

On this course, students will develop:

- An understanding of the impact project management skills can have on your research project
- An introduction to foundation project management tools and their application in research projects
- An insight into project management responsibilities in maintaining relationships and communication channels

This training course is full of activity and discussion. The class will be working in small groups and applying project management theory onto a research project.

Block II sessions overview:

| Learning activity | Lecturer | Description |
|---|------------|---|
| Overview of main concepts involved in Project Management. Identifying key elements will impact my research project. | Núria Bayó | Introduction to the subject. Overview on different methodologies. Exercise to understand the classification of projects and the three main constraints linked to each project. Practical exercise to identify what are the key elements when developing your participatory activity. <i>Evaluative activity inside classroom: attendance and participation</i> |

| Learning activity | Lecturer | Description |
|---|------------|--|
| Being a Project Management on Research. Getting tools to manage your research projects (work plan, risk assessments, communication plan and team work). | Núria Bayó | Introduction to main tools used on Project Management adapted to research projects. Practical exercises to identify the impact on using described tools. Practical exercises to use described tools on your participatory activity. <i>Evaluative activity inside classroom: attendance and participation</i> <i>Evaluative activity outside classroom two weeks later to apply knowledge to a given real research project proposal.</i> |

Block III: Science Communication

Throughout this workshop series, the instructor will introduce basic concepts in written and visual communication, as a common theme for scientific communication, and will expand and build upon these in each successive session. As part of the students' learning process, the instructor will reinforce the culture of always considering the Why of each scientific task (Why am I doing this? What do I want to achieve?), rather than just applying a formula for how it 'should' be done. Thus, the students will develop their scientific skills through autonomous thinking, rather than just applying standard practice.

Block III sessions overview:

| Learning activity | Lecturer | Description |
|------------------------------|---------------|---|
| Writing your Master's Thesis | Elena Redondo | To explore the structure of scientific written documents and the process of scientific writing, and to create a writing plan and structural draft of the participants' MSc thesis. <i>Attendance and participation</i> |



| Learning activity | Lecturer | Description |
|--------------------------------|----------------|---|
| Preparing an Oral Presentation | Andreu Gual | To explore key elements of designing and delivering a scientific presentation, and to plan and practice the participants' oral defence of their MSc thesis. <i>Create a draft of the oral thesis presentation, and practice presenting their story to their colleagues</i> |
| Preparing Scientific Posters | Holly Blondin | The role of posters in research communication. How to create an effective poster. Submitting posters to conferences. Working the poster session at an event. <i>Attendance and participation</i> |
| Reading Effectively | Míriam Navarro | Searching for and selecting literature. Reading efficiently. Managing your literature. Integrating your reading into your writing <i>Evaluative activity: Create your reading card</i> |

Calendar

| Session | Learning activity | Format | Lecturer | Date | Time | Location |
|---------|--|-------------|--|-------------|-------------|--------------------------|
| 1 | Overview of the subject. | T/P | Míriam Navarro | 19-sep 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 2 | Exploring participatory science movements: RRI, OS, QH | T/P | Míriam Navarro | 21-sep 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 3 | Other Shared values | T/P | Míriam Navarro | 22-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 3 | Research integrity and science ethics (I) | T/P | Maruxa Martínez | 26-sep 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 4 | Research integrity and science ethics (II) | T/P | Maruxa Martínez | 28-sep 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 5 | Reading effectively | T/P | Míriam Navarro | 3-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 6 | Science and Society: Practical examples | Round Table | Zoila Babot | 5-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 7 | Project Management I | T/P | Núria Bayó | 6-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 8 | Public engagement approach: Introduction and planning a participatory activity | T/P | Sebastián Grinschpun, Àlex Argemí, Laura Hernández | 10-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |

| Session | Learning activity | Format | Lecturer | Date | Time | Location |
|---------|---|--------|--|-------------|-------------|--------------------------|
| 9 | Knowing your Public | T/P | Marta Llorens | 17-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 10 | Project Management II | T/P | Núria Bayó | 18-oct 2023 | 12:30-14:30 | Campus Mar; Room: 61.114 |
| 12 | Public engagement – Dialogical approach | T/P | Sebastián Grinschpun, Àlex Argemí, Laura Hernández | 6-Nov 2023 | 15:00-18:00 | TBD |
| 14 | Preparing Poster | T/P | Holly Blondin | 11-Dec 2023 | 15:00-17:00 | TBD |
| 13 | Public engagement – How to evaluate | T/P | Sebastián Grinschpun, Àlex Argemí, Laura Hernández | 5-Feb 2024 | 15:00-18:00 | TBD |
| 15 | Public engagement – Final presentations | T/P | Sebastián Grinschpun, Àlex Argemí, Laura Hernández | 4-mar 2024 | 15:00-18:00 | TBD |
| 16 | Writing your thesis | T/P | Elena Redondo | 6-may 2024 | 15:00-17:00 | TBD |
| 17 | Preparing Oral presentation | T/P | Andreu Gual | 3-jun 2024 | 15:00-17:00 | TBD |

T/P: Theoretical and practical.

Assessment

| Activity | Weight |
|--|--------|
| Block I – Participatory science and Public Comm. <ul style="list-style-type: none"> ▪ Research Integrity task (5%, individual) ▪ Public Engagement Activity: <ul style="list-style-type: none"> ○ Initial report (5%, group) ○ Teacher evaluation (20%, group) ○ Group members’ evaluation (10%, individual) | 40% |
| Block II – Project Management <ul style="list-style-type: none"> ▪ Practical exercises in class (20%, group) ▪ PE report (10%, individual) | 30% |
| Block III – Scientific Comm. <ul style="list-style-type: none"> ▪ Effectively reading task (10%, individual) ▪ Scientific poster workshop participation (10%, individual) ▪ Oral presentation workshop participation (10%, individual) | 30% |

Attendance and active participation in all sessions will be considered for the final grade. It can modify up to 10% of the final grade.

This course does not have a final exam; the assessment will be done continuously throughout the course. This will be through several deliveries along the three blocks, oral presentations, and self-assessment activities. It is necessary to pass all three blocks (minimum score 5/10) to pass the course.

The assistance is mandatory and can only be justified under special causes (medical issues, PhD interviews, etc.). Students will need to send the justified documents to the subject coordinator.



SYLLABUS

Advanced Techniques in Experimental Sciences (ATES, Winter School)

Overview

Academic Coordinators: Jordi Arbiol (ICREA & ICN2), Maria García-Parajo (ICREA & ICFO)

Course Coordinator: Sara Martí (ICN2)

Contact: Sara Martí (sara.marti@icn2.cat)

Lecturers: Sara Martí-Sánchez (ICN2); Julien Colombelli (IRB); Nadia Halidi (CRG); Teresa Galán (IBEC); Pablo Loza-Alvarez (ICFO); Jordi Arbiol (ICN2), Maria Garcia-Parajo (ICFO); Gabriel Gomila (IBEC); Aitor Mugarza (ICN2); Belén Ballesteros (ICN2); Pablo Merino (ICN2); Christian Neissner (IFAE/PIC); Daniel Kerzberg (IFAE); Marc Botifoll (ICN2); Jordi Fraxedas (ICN2); Jorge Jiménez (IFAE); M. Chiara Spadaro (ICN2); Òscar Blanch (IFAE); Francisco J. Belarre (ICN2); Marcos Rosado (ICN2); Sébastien Tosi (IRB); Anna Lladó (IRB); Lidia Bardia (IRB); Pablo Guerra (IBMB-CSIC); Maria Marsal (ICFO); Gustavo Castro (ICFO), Claudia Valdés (ICFO); Neus Domingo (ORNL, USA); Nikos Giakoumakis (IRBB).

ECTS: 5

Workload: 125 hrs.

Term: 1st and 2nd

Location: BIST Centres

Prerequisites: None

Description of the subject

Intensive winter school combining theoretical courses and hands-on training in microscopy, nanoscopy and imaging analysis. This course will take full advantage of the research and academic facilities at the centres.

The Microscopy & Imaging Science Winter School 2023-2024, will cover the following five topics:

1. Optical microscopy
2. Electron microscopy
3. Scanning probe microscopy
4. Raman imaging and spectroscopy
5. Imaging technology and approaches in astrophysics / cosmology



Objectives

- To acquire knowledge in thematic advanced techniques in experimental science
- To develop the hands-on practical and technical skills in specific experimental and/or theoretical techniques
- To gain experience working in groups

Methodology

Lectures, research seminars, and hands-on training in specific experimental techniques.

Location & Organisation

The theoretical part of the course will be carried out from the 8 to the 12 of January.

The hands-on training of the winter school will be hosted by the BIST research centres, with the location rotating depending on the topic. Practical training will be undertaken at each centre to take advantage of their research and training facilities from 15 to 17 of January. This year the BIST Symposium on Microscopy will be held on February 16 at ICFO, with input from IRB, CRG, ICN2, IBEC and IFAE researchers.

The students will have correlative sessions on February 15 at ICFO, to prepare them for the lectures on the next day at the Symposium.

Assessment

| Task | Description | Weight |
|--------------------|--|--------|
| Participation | Participation in lectures and classes during school | 30% |
| Coursework & Tests | Assessment via oral presentation per groups (techniques review, or case study) | 70% |



SYLLABUS

Seminars in Advanced Research (SAR)

Overview

Coordinator: Robert Sewell (ICFO), Ana Janic (UPF)

Contact: Robert Sewell (robert.sewell@icfo.eu), Ana Janic (ana.janic@upf.edu)

Teaching staff: Robert Sewell and Ana Janic

Total credits: 5 ECTS

Workload: 125 hrs.

Term: 1st, 2nd and 3rd terms

Location: UPF Campus Mar (Dr. Aiguader 80) and BIST Centres + MELIS-UPF

General description of the subject

This course provides broad exposure to multidisciplinary research in experimental sciences. The aim is to give students direct contact with inspirational speakers, introduce cutting-edge challenges in contemporary research, and help prepare students to understand what is involved in pursuing a cutting-edge research career in academia or industry, and specifically for pursuing a PhD at a leading international institution.

There are two main components of the course:

Research Seminars: Designed to complement the hands-on training they will receive in carrying out their research projects. These seminars are presented by PIs from the UPF and BIST research centres during the Initial Training Period and invited external speakers during the Training Days.

Group Discussion Sessions: During the training days, there will be a student-led group discussion session emphasising critical evaluation of scientific literature. These will involve faculty from the UPF and BIST, and the invited external speakers.

Objectives

- Meet researchers from participating institutions, and outstanding international scientists
- Learn about important contemporary research topics
- Discuss topics relevant to becoming a successful scientist
- Learn about and discuss some of the challenges involved in multidisciplinary research



Methodology

Seminars and discussion sessions with BIST/MELIS-UPF PIs and invited external speakers, including student-led presentation and discussion of scientific publications. Students will be required to prepare and lead a discussion session based on a research article on the presented topic, which they must choose and research.

Format

For the 2023-24 academic year, all seminars and discussions for EU speakers will be in-person (if the conditions allow us) and for non-EU speakers will be held online via videoconferencing platform.

Both internal and external seminars will follow the same format. For the internal seminars we ask the speaker to include a few slides to introduce the centre/department, and opportunities for (PhD) students, at the start of their seminar.

Research Seminars

The dates of the external seminars are tentative. The final dates might adapt to the dates of the seminars at the different BIST research centers.

Speakers will be invited to present a seminar, followed by a Q&A about their chosen research topic and general challenges in undertaking multidisciplinary research / pursuing a research career.

There will be 8 lectures from BIST/MELIS PIs, and 8 seminars from invited speakers, with a standard format:

- 15-minute introduction to the research field of the speaker and their corresponding research institute / department
- 45-minute research seminar on a topic of their choice, which might include research that the speaker has led, or an open challenge in the field
- 30-minutes discussion, which may open onto more general topics about pursuing a research career

Note that the order is flexible, and for the external seminars the students will be responsible for leading the introductory discussion via a presentation of a research paper from the invited external speaker.

The research seminars will be open to the BIST community, and publicly announced.



Where possible, we will arrange an informal Q&A session over coffee with the speaker and MSc students.

Group Discussion Sessions

For the student-led discussion of a research paper, the group of students will be required to choose and present a research paper on a topic related to the seminar that day in consultation with the invited external speaker and lead the group in a discussion of the paper and the seminar. A short CV of the speaker and the paper the students are going to present should be uploaded to Aula Virtual one week before the training day in order to share this information with the rest of the classmates.

Students will undertake this task in small groups and they will be assigned to a different field of expertise that their own research project. The assignment of students to each Discussion Session will be defined during the initial training period. The format will be:

- 30-minute student-led introduction and discussion of their chosen research paper
- 30-minutes discussion, which may open onto more general topics about pursuing a research career

Calendar

Initial Training Period - Research Seminars

| Session | Speaker | Affiliation | Date | Time | Location |
|---------|------------------------------------|-------------|--------|-------------|--------------------|
| 1 | Nora Martin & Rosa Martínez-Corral | CRG | 18-Sep | 12:30-14:30 | Campus Mar; 61.114 |
| 2 | Michael Krieg | ICFO | 20-Sep | 12:30-14:30 | Campus Mar; 61.114 |
| 3 | Aurelio Juste | IFAE | 27-Sep | 12:30-14:30 | Campus Mar; 61.114 |
| 4 | TBC | TBC | 29-Sep | 12:30-14:30 | Campus Mar; 61.114 |
| 5 | Emigdio Chavez | ICN2 | 2-Oct | 12:30-14:30 | Campus Mar; 61.114 |
| 6 | TBC | TBC | 4-Oct | 12:30-14:30 | Campus Mar; 61.114 |
| 7 | Benedetta Bolognesi | IBEC | 9-Oct | 12:30-14:30 | Campus Mar; 61.114 |



| | | | | | |
|---|-----|-----|--------|-------------|-----------------------|
| 8 | TBC | TBC | 11-Oct | 12:30-14:30 | Campus Mar; 61.114 |
|---|-----|-----|--------|-------------|-----------------------|

Training Days - Group Discussion Sessions

The speakers will be announced during September. The locations are at the different BIST Centers.

Assessment

Attendance of at least 80% of the seminars and group discussion sessions is required to pass the subject.

Students are responsible to communicate and justify absences and late arrivals.

Students are expected to participate actively in group discussions.

| Task | Description | Weight |
|-----------|---|--------|
| Tests | There will be a short online quiz following each seminar using questions provided by the lecturers | 40% |
| Classwork | Oral presentation summarizing the chosen research article; students must also lead discussion session | 60% |



SYLLABUS

Research Project (Major Project)

Overview

Coordinator: Núria Bayó (BIST) and Míriam Navarro (BIST)

Contact: Núria Bayó (nbayo@bist.eu); Míriam Navarro (mnavarro@bist.eu)

Academic Tutors: Ana Janic (MELIS-UPF), Pau Gorostiza (IBEC), Robert Sewell (ICFO), Thomas Surrey (CRG), Rafel Escribano (IFAE), Mónica Perez Temprano (ICIQ), Arben Merkoçi (ICN2), Roger Gomis (IRB Barcelona)

ECTS: 20

Workload: 500 hrs.

Term: 1st 2nd & 3rd

Location: BIST Centres and DCEXS

Description of the subject

Hands-on, intensive training-through-research. The aim is to provide in-depth training in a specific discipline. The student chooses and develops during five months one of the projects offered by the BIST-DCEXS research groups and re-enforces the training in multidisciplinary science provided in the initial period.

Research Component: Students will join a research team at one of the BIST institutes / MELIS and develop a research project assigned and supervised by a principal investigator. During this time, the student will perform calculations and/or experiments, analyse data, describe and discuss results, research the literature, and other tasks required to successfully carry out a research project. The aim is to acquire key conceptual knowledge and experimental skills, familiarise the student with the organisation and functioning of a research team, and provide the student with first-hand knowledge of life as a researcher, as a first step towards pursuing a future research career.

Training Component: Under the guidance of their supervisor, students will gain a broad understanding of theoretical concepts and standard research techniques in their field, and a deep understanding of the background to their research topic.

Objectives

- To acquire advanced knowledge in a field of the experimental sciences
- To develop the practical and technical skills required for a specific discipline on experimental sciences
- To learn good practices to design, record and discuss experiments.
- To analyse and communicate properly scientific results.

Methodology

Research Component: Students complete a guided research project, with clear goals in terms of acquiring conceptual knowledge and technical skills, as well as expected research outcomes. Progress is monitored through regular structured reports and research group meetings.

Training Component: The methodology combines guided independent learning through reading textbooks and scientific literature, with regular tutorial sessions with supervisor, and hands-on training in the laboratory.

Assessment

| Task | Description | Who evaluates | When | Weight |
|-----------------------|---|----------------------|--------------------------------|--------|
| Initial Report | 2-page initial project plan description including the research goal, concepts and techniques that should be required | Academic Coordinator | 20-Nov | 10% |
| Mid-term Report | 2-page assessment of progress, discussing challenges that may have arisen, and re-evaluating project plan | Academic Coordinator | 18-Mar | 10% |
| Poster presentation | Students should prepare a poster presentation about their projects to be evaluated through oral presentation. | External panel | At the BIST Symposium (16 Feb) | 20% |
| Supervisor Evaluation | <ul style="list-style-type: none"> Oral presentation to the research group: student's understanding of the field, and their performance in learning new concepts and techniques. (40%) Student's performance and attitude in carrying out the research project. (60%) | Research Supervisor | 10-Jul | 60% |



Interdisciplinary Research Training (Minor Project)

Overview

Coordinator: Míriam Navarro (BIST) and Ana Janic (MELIS-UPF)

Contact: Míriam Navarro (mnavarro@bist.eu); Ana Janic (ana.janic@upf.edu)

Academic Tutors: Ana Janic (MELIS-UPF), Pau Gorostiza (IBEC), Robert Sewell (ICFO), Thomas Surrey (CRG), Rafel Escribano (IFAE), Mónica Perez Temprano (ICIQ), Arben Merkoçi (ICN2), Roger Gomis (IRB Barcelona)

ECTS: 10

Workload: 250 hrs.

Term: 1st & 2nd

Location: BIST Centres and MELIS-UPF or External centers

Description of the subject

The aim of this subject is to provide students with complementary training in a different research discipline to that of their major project. Students are required to carry out a 10-week stay in a different research group (the host group). The aim is to gain complementary conceptual knowledge and experimental skills. Students will gain experience working in a different research environment, and an ability to analyse the multidisciplinary component of a research project.

Objectives

- To acquire advanced knowledge in a different field of the experimental sciences to that of the main project.
- To develop the practical and technical skills required for a specific discipline on experimental sciences.
- To train multidisciplinary approaches to a given research topic .

Methodology

Students gain supervised, hands-on training guided by the principal investigator of the host group. Student and supervisor will develop clear goals in terms of acquiring conceptual knowledge and technical skills. Progress is monitored through regular structured reports. Assessment is via these reports, and evaluation by the supervisor and PI of the host group.

Assessment

| Task | Description | Who evaluates | When | Weight |
|-----------------------|---|--------------------------------|---|--------|
| Initial Report | 2-page initial project plan description including the research goal, concepts and techniques that should be required | Academic Coordinator | Within the first two weeks of the project | 20% |
| Supervisor Evaluation | <ul style="list-style-type: none"> Oral presentation to the research group: student's understanding of the field, and their performance in learning new concepts and techniques. (40%) Student's performance and attitude in carrying out the research project. (60%) | Research Supervisor | 12-Jul | 60% |
| Results report | 2- page report that should be included on the Master thesis appendix or main text. | External panel (Master thesis) | 17, 18, 19-Jul | 20% |

The master thesis should include the description of the results obtained in the Interdisciplinary research project in the main text when possible or in the appendix section.



Master's Thesis

Overview

Coordinator: Núria Bayó (BIST), Míriam Navarro (BIST)

Contact: Núria Bayó (nbayo@bist.eu); Míriam Navarro (mnavarro@bist.eu)

Academic Tutors: Ana Janic (MELIS-UPF), Pau Gorostiza (IBEC), Robert Sewell (ICFO), Thomas Surrey (CRG), Rafel Escribano (IFAE), Mónica Pérez Temprano (ICIQ), Arben Merkoçi (ICN2), Roger Gomis (IRB Barcelona)

ECTS: 10

Contact Hours: 250

Term: 3rd

Location: BIST Centres & MELIS-UPF.

Description of the subject

The student will write a research manuscript in the format of a scientific paper, based on the original results obtained by the student during their research training. In addition, the student will make a public oral presentation and defence of this work to an examining committee.

Objectives

- To elaborate a scientific manuscript with the different sections of a scientific article
- To put in practice the knowledge acquired in data analysis in the results section
- To present in the introduction and discussion sections the aspects related to responsible research and multidisciplinary approach derived from the project when possible.
- To practise oral communication of scientific results.
- To include the results of the interdisciplinary project at the appendix part.
- To demonstrate the acquisition of advanced knowledge during the master's in the discipline of the projects performed

Assessment

| Task | Description | Who evaluates | When | Weight |
|-----------------------|--|----------------|-------|--------|
| Scientific manuscript | Written report of project results (including minor and major projects) | External Panel | 2-Jul | 50% |



| | | | | |
|-------------------|---|----------------|----------------|-----|
| Oral presentation | 20-minute presentation of project in front of committee | External Panel | 17, 18, 19-Jul | 30% |
| Oral defence | 10-minute questions by committee | External Panel | 17, 18, 19-Jul | 20% |

Students should attend all the oral presentations within the same evaluation session. The master thesis should include the description of the results obtained in the Interdisciplinary research project in the main text when possible or in the appendix section.



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