# UNIVERSITA' DEGLI STUDI DI MILANO
# PROGRAMME DESCRIPTION - ACADEMIC YEAR 2022/23
# BACHELOR
# Physics (Classe L-30)
# Enrolled from 2012/2013 Academic Year

## *HEADING*

| | |
|---|---|
| **Degree classification - Denomination and code:** | L-30 Physics |
| **Degree title:** | Dottore |
| **Length of course:** | 3 years |
| **Total number of credits required to complete programme:** | 180 |
| **Years of course currently available:** | 1st , 2nd |
| **Access procedures:** | Open, subject to completion of self-assessment test prior to enrolment |
| **Course code:** | F63 |

## *PERSONS/ROLES*

**Head of Study Programme**
Prof.ssa Alessandra Guglielmetti

**Degree Course Coordinator**
Prof. Stefano Olivares

**Tutors - Faculty**
Tutor per l'orientamento (Academic guidance tutor)
F. Camera, S. Cialdi, G. Colò, S. D'Auria, L. Gariboldi, A. Guglielmetti, G. Lodato, N. Manini, L.G. Molinari, S. Olivares, M. Paris, P. Piseri, P.M. Pizzochero, M. Sorbi, D. Tamascelli, A. Vicini

Tutor per i piani di studio (Study plan tutor)
A. Guglielmetti, S. Olivares

Tutor per la mobilità internazionale e l'Erasmus (Erasmus and International mobility)
N. Piovella

Tutor per stage e tirocini (Internship tutor)
N. Piovella, A. Guglielmetti

Tutor per laboratori e altre attività (Laboratory Classes)
R. Vecchi

**Tutors - Students**
Davide ABRIOLA
Irene CARRARA
Tommaso COLOMBO
Clara IAQUINTA
Fabiana LAURO
ilberto NARDI
Giovanni PELLEGRINI
Andrea SALA
Raffaele SALIONI
Irene SPONGANO
Nicola TESSITORE

**Degree Course website**
https://fisica.cdl.unimi.it/it

**Dissertation and Final Exam**

I. Veronese (Presidente), C. Benedetti, S. Carrazza, F. Crespi, V. Liberali, D. Maino,

**Laboratory Security**

M. Potenza

**Matriculation**

https://www.unimi.it/it/node/183

**Outreach**

https://unimibox.unimi.it/index.php/s/d3z27gH8KLosixk

**PLS Program Chair**

M. Giliberti

**Program Transfer**

G. Bertin, M. Di Vece, M. Fanti, G. Maero Email: commissione.ammissione@fisica.unimi.it

**Schedule of Classes**

M. Gherardi, A. Guglielmetti, M. Zaro, F. Cordani

**Scientific English**

A. Guglielmetti, A. Podestà, A. Pullia

**Specific Learning Disabilities**

L. Carminati

**Statistical Data**

G. Colò, A. Guglielmetti, F. Ragusa

**Student Registrar**

Phone 0250325032 https://www.unimi.it/it/studiare/servizi-gli-studenti/segreterie-informastudenti

**Study Program Office**

Via Celoria, 16 - 20133 Milano Phone 02.503.17401 Email: cl.fisica@unimi.it

**TOLC test coordinator**

L. Gariboldi

## *CHARACTERISTICS OF DEGREE PROGRAMME*

**General and specific learning objectives**

The Bachelor's Degree program in Physics aims to enable the student to continue with higher studies or to start a professional activity. The program gives students the methodological, experimental, theoretical, mathematical basis on which Physics is based. Knowledge will be acquired of classical, relativistic and quantum Physics, as focused on phenomenological and theoretical aspects as well as on their mathematical formalization.

**Expected learning outcomes**

1) MATHEMATICS AREA

By virtue of in-depth studies in the mathematics area, graduates will acquire:

- knowledge of mathematical analysis;
- knowledge of linear algebra and geometry;
- knowledge of elements of functional analysis.

On the basis of the consolidation of mathematical skills, graduates will be able to:

- use mathematics in the study of statistics and therefore in the classification and interpretation of experimental data;
- use mathematics in the study of topics in the physical and application area;
- use mathematical models to describe and predict the trends of physical phenomena.

The above knowledge and understanding and the ability to apply this knowledge are mainly achieved through the participation of students in lectures and classroom exercises (or in the virtual classroom if necessary) and through individual study. Verification takes place through written and/or oral exams. These exams can take advantage of ongoing written tests.

2) PHYSICS AREA

By virtue of the teachings in the Physics area, graduates will acquire:

- Knowledge of classical Physics: mechanics, thermodynamics, electromagnetism, optics and wave propagation, fluid dynamics, analytical mechanics.
- Knowledge of modern Physics: quantum mechanics, quantum theory of matter, nuclear Physics, Physics of elementary particles, restricted relativity, general relativity (introductory level)

On the basis of the consolidation of skills in the Physics area, graduates will be able to:

- use the scientific method in the representation and modeling of physical phenomena;

- apply their knowledge in the physical area to solve qualitative and quantitative problems in countless application and/or theoretical areas.

The above knowledge and understanding and the ability to apply this knowledge are mainly achieved through the participation of students in classroom lectures and exercises (or in the virtual classroom if necessary), and through individual study. Verification takes place through written and/or oral exams. These exams can take advantage of ongoing written tests.

3) APPLICATION AND COMPUTER AREA

By virtue of the courses in the application, computer science and chemistry area, graduates will acquire:

- Knowledge of the working modes and proper use of laboratory instruments for carrying out physical measurements
- Computer skills: procedural programming and object-oriented programming, solving problems with numerical techniques, computer networks, instrumentation control and data acquisition.
- Electronics knowledge: use of oscilloscopes, function generators, power supplies. Analysis and sizing of simple and electronic devices, including physical signal sensors and amplifiers.
- Chemistry knowledge: periodic properties of elements, covalent, ionic bonds, Arrhenius' law, electrochemical potentials.

By virtue of the consolidation of skills in the application, computer science and chemistry area, graduates will be able to:

- use laboratory equipment efficiently and safely;
- manage measurement systems and procedures;
- use software and IT tools for data collection;
- elaborate the experimental data with statistical methods and IT tools
- design and use simple electrical and electronic circuits;
- use the skills of chemistry in the most varied applications;
- work in a group in a synergistic and efficient way.

The above knowledge and understanding and the ability to apply this knowledge are achieved through the participation of students in lessons, practical exercises and/or in the laboratory. A distance teaching method could also be proposed for practical exercises if the health emergency prevented the provision of didactic activities in the presence.

The verification takes place through exams, which may include written or oral tests or the presentation of laboratory reports with multimedia instruments.

**Professional profile and employment opportunities**

The study program is structured in such a way as to stimulate attitudes to physical-mathematical modeling and enhance the ability to use adequate methods and tools to face and solve different problems. The given skills are useful also for work activities not directly connected with Physics such as, for example, the economy, health, finance, public administration, security. The graduates can be employed in different sectors of the world of work, industry, and science education.

**Initial knowledge required**

Admission requirements

Qualifications and knowledge required for admission

Applicants to the Bachelor's degree programme in Physics must hold an upper secondary-school diploma or an equivalent qualification obtained abroad.

Admission to the programme is open, subject to a mandatory, non-selective assessment test before enrolment. The test is aimed at ascertaining the candidate's educational background, in terms of baseline knowledge and understanding of scientific disciplines, especially mathematics and elementary logic. The test syllabus is available at:
https://www.cisiaonline.it/area-tematica-tolc-scienze/struttura-della-prova-e-syllabus/

Admission assessment

Candidates are usually assessed through the TOLC CISIA Online Test, to be taken at the University of Milan or any other universities belonging to the Consortium of Inter-University Integrated Access Systems (CISIA). You can register for the TOLC test on the CISIA website (www.cisiaonline.it).

Admission of transfer or graduate students

Transfer students from a degree programme of the University of Milan, or another university, and graduate students will be waived from the test requirement only if they are admitted to years subsequent to the first.

To this end, they will have to submit a specific request for prior assessment of their academic career using the online service as shown in the call for applications.

These candidates must provide a full transcript of records (listing exams, subject areas, credits, grades) and attach the course syllabi. For more details, please refer to the call for applications.

The request for career assessment must be submitted by 30 June 2022.

The outcome will be notified via e-mail by 15 July 2022.

Students admitted to the first year will be required to take the test.

The TOLC tests providing access to the degree programme in Physics are TOLC-S and TOLC-I.

Only after taking one of these tests, will you be able to enrol, WHATEVER THE RESULT:

- TOLC-S, divided into 4 sections: Basic mathematics (20 questions - 50 minutes), Reasoning and problems (10 questions - 20 minutes), Reading comprehension (10 questions - 20 minutes), Basic sciences (chemistry, physics and geology - 10 questions - 20 minutes)
- TOLC-I, divided into 4 sections: Mathematics (20 questions - 50 minutes), Logic (10 questions - 20 minutes), Science (10 questions - 20 minutes), Verbal comprehension (10 questions - 20 minutes).

Each question has 5 answer options, of which only one is correct.
Score: +1 for a correct answer, -0.25 for a wrong answer, 0 for a no answer.

Each TOLC test includes an additional English section, consisting of 30 questions to be answered in 15 minutes. It does not replace the for-credit English proficiency assessment required by the degree programme (see "Language assessments" in the programme description), but it is a self-assessment for the student.

Other equivalent tests may be accepted on a case-by-case basis, with the prior approval of the Academic Board.

Additional learning requirements (OFA) and remedial activities
First-year students who have not achieved at least 10 points in the Basic mathematics module will have to fulfil additional learning requirements (OFA) for this subject within the first year of the programme.
Remedial activities and tests: Students with additional learning requirements will have to carry out remedial activities in the period October-December, and then take a test to prove they have filled their gaps. Otherwise, they may not take any second-year exams before passing the Mechanics exam (https://fisica.cdl.unimi.it/it/studiare/le-matricole).

Test topics, registration procedures, dates, deadlines and other information are specified in the call for applications:
https://www.unimi.it/en/study/enrolment
https://fisica.cdl.unimi.it/it/iscriversi

**Compulsory attendance**

Attendance is compulsory and will be monitored in each class for laboratory courses

**Degree programme final exams**

To obtain their degree, the student must have earned 180 credits, possibly also before the end of the three-year period.
The paper consists of an individual work carried out by the student under the guidance of a supervisor.
It is also possible to work on the final paper in external public or private entities, under the guidance of both an external and an internal supervisor.

Before starting thesis work, the student is required to submit an application (with a tentative thesis title) to the Degree Board for approval. The board will grant any applications that are consistent with the study programme, and assign each student their supervisor(s) and co-supervisor(s).
Following a resolution of the Academic Board, students enrolled in the second year in 2021/2022 or in subsequent years are required to pass the electromagnetism exam before they are assigned a thesis.

The official thesis assignment is a MANDATORY step to be taken before starting thesis work. Thesis supervisors and co-supervisors thereby take responsibility for and are required to check all formal aspects, including for insurance purposes. The thesis application must be submitted online at https://registrazione.fisica.unimi.it/richiesta-tesi/login

To be admitted to the final exam, the student must have earned 172 CFU. Moreover, there must be consistency between academic records and the last approved study plan.
Thesis defense marks the completion of the study programme, and the graduate can enter the world of work or enrol on a Master's degree programme

**Campus**

Academic offices for the Bachelor's degree programme in Physics: Department of Physics, Via Celoria 16
Course venue: courses are held in the classrooms of the Physics Department, via Celoria 16, or in the teaching facilities, Via Celoria 20

**Laboratories**

The degree programme mainly uses the laboratories at the Physics Department.

**Notes**

In order to obtain their degree, students must be proficient in English at a B1 level under the Common European Framework of Reference for Languages (CEFR). This proficiency level may be certified as follows:
- Through a language certificate, earned within three years prior to the date of submission, at a B1 level or higher. For the list of language certificates recognised by the University, please review: https://www.unimi.it/en/node/297/. The certificate must be uploaded during the enrolment procedure, or subsequently to the portal http://studente.unimi.it/uploadCertificazioniLingue;
- Through a Placement Test, which is delivered by the University Language Centre (SLAM) during year I only, from October to December. Students who fail the test will be required to take a SLAM course.
The Placement Test is mandatory for all students who do not hold a valid certificate.
Those who do not sit the Placement Test by December, or who fail to pass the end-of-course test within six attempts, must obtain a paid certificate by graduation.

As a further requirement for graduation, the student's proficiency in scientific English language (English Language 2) will be assessed in one of the following ways:

1. the delivery of a written Laboratory Report in English
2. carrying out and passing one of the curricular examinations in English
3. attending a course delivered in the English language
4. training activities related to the final thesis executed in the English Language

## *EXPERIENCE OF STUDY ABROAD AS PART OF THE TRAINING PROGRAM*

The University of Milan supports international mobility by providing its students with the opportunity to spend study and internship periods abroad. It is a unique chance to enrich your educational path in a new exciting environment.

The agreements entered into by the University with over 300 universities from the 27 EU member countries and other Extra-EU countries under the European Erasmus+ programme allow regularly enrolled students to carry out part of their studies at one of the partner universities or to undertake internships at companies, training and research centres and other organizations.

Similar international mobility opportunities are provided outside Europe, through agreements with a number of prestigious institutions.

**Study and internships abroad**

The thesis work may be occasionally carried out in prestigious research centers like CERN or GSI, or important Universities worldwide, in the frame of international collaborations and research programs.

**How to participate in Erasmus mobility programs**

How to participate in Erasmus+ mobility programmes

The students of the University of Milan can participate in mobility programmes, through a public selection procedure.
Ad hoc commissions will evaluate:
• Academic career
• the candidate's proposed study programme abroad
• his/her foreign language proficiency
• the reasons behind his/her application

Call for applications and informative meetings
The public selection for Erasmus+ mobility for study generally begins around February each year with the publication of a call for applications specifying destinations and requirements. Regarding the Erasmus+ Mobility for Traineeship, the University of Milan usually publishes two calls a year enabling students to choose a destination defined by an inter-institutional agreement or to find a traineeship position on their own.

The University organizes informative meetings to illustrate mobility opportunities and rules for participation.

Erasmus+ scholarship
The European Union grants the winners of the Erasmus+ programme selection a scholarship to contribute to their mobility costs, which may be supplemented by the University funding for disadvantaged students.

Language courses
Students who pass the selections for mobility programmes can benefit from intensive foreign language courses offered each year by the University.

Learn more at https://www.unimi.it/en/international/study-abroad/studying-abroad-erasmus

For assistance, please contact:
International Mobility Office
Via Santa Sofia 9 (second floor)
Tel. 02 503 13501-12589-13495-13502
Contacts: InformaStudenti; mobility.out@unimi.it
Student Desk booking through InformaStudenti

### *1st COURSE YEAR Core/compulsory courses/activities common*

| Learning activity | Ects | Sector |
|---|---|---|
| COMPUTER SCIENCE | 6 | INF/01 |
| English assessment B1 (2 ECTS) | 2 | ND |
| GEOMETRY 1 | 7 | MAT/03 |
| MATHEMATICAL ANALYSIS 1 | 8 | MAT/05 |
| MATHEMATICAL ANALYSIS 2 | 8 | MAT/05 |

| | | | |
|---|---|---|---|
| MECHANICS | | 8 | FIS/01 |
| PHYSICS LABORATORY WITH INTRODUCTION TO STATISTICS | | 10 | FIS/01 |
| WAVES AND OSCILLATIONS | | 7 | FIS/01 |
| | Total compulsory credits | 56 | |

## *2nd COURSE YEAR Core/compulsory courses/activities common*

| Learning activity | | Ects | Sector |
|---|---|---|---|
| CLASSICAL MECHANICS | | 7 | MAT/07 |
| ELECTROMAGNETISM | | 15 | FIS/07, FIS/01 |
| EXPERIMENTAL DATA PROCESSING LABORATORY | | 6 | FIS/01 |
| MATHEMATICAL ANALYSIS 3 | | 6 | MAT/05 |
| MATHEMATICAL METHODS IN PHYSICS | | 7 | FIS/02 |
| OPTICS,ELECTRONICS AND MODERN PHYSICS LABORATORY | | 10 | FIS/01 |
| QUANTUM PHISYCS 1 | | 7 | FIS/02 |
| THERMODYNAMICS | | 6 | FIS/07, FIS/01 |
| | Total compulsory credits | 64 | |

## *3rd COURSE YEAR (available as of academic year 2023/24) Core/compulsory courses/activities common*

| Learning activity | | Ects | Sector |
|---|---|---|---|
| CHEMISTRY 1 | | 6 | CHIM/03 |
| INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS | | 9 | FIS/04 |
| QUANTUM PHISYCS 2 | | 8 | FIS/02 |
| STRUCTURE OF MATTER 1 | | 9 | FIS/03 |
| | Total compulsory credits | 32 | |

## *Elective courses*

**The student must also complete another 12 credits freely choosing from all the courses activated by the University, provided that they are culturally coherent with his/her educational path and cannot be superimposed, in content, to the fundamental and optional teachings already used in the study plan.**

| | | |
|---|---|---|
| ASTRONOMY LAB | 6 | FIS/05, FIS/01 |
| COMPUTATIONAL PHYSICS LABORATORY | 6 | FIS/08, FIS/07, FIS/06, FIS/05, FIS/04, FIS/03, FIS/02, FIS/01 |
| CONDENSED MATTER PHYSICS LABORATORY | 6 | FIS/03, FIS/01 |
| EARTH PHYSICS LABORATORY | 6 | FIS/07, FIS/06, FIS/01 |
| ELECTRONICS 1 | 6 | ING-INF/01, FIS/01 |
| ELECTRONICS LABORATORY | 6 | ING-INF/01, FIS/01 |
| ENVIRONMENTAL PHYSICS LABORATORY | 6 | FIS/07, FIS/06, FIS/01 |
| GAMMA SPECTROSCOPY LABORATORY | 6 | FIS/04, FIS/01 |
| INTRODUCTION TO ASTROPHYSICS | 6 | FIS/05 |
| INTRODUCTION TO GENERAL RELATIVITY | 6 | FIS/02 |
| INTRODUCTION TO HEALTH AND MEDICAL PHYSICS | 6 | FIS/07 |
| INTRODUCTION TO STATISTICAL PHYSICS | 6 | FIS/03, FIS/02 |
| NUCLEAR PHYSICS LABORATORY | 6 | FIS/04, FIS/01 |
| NUMERICAL SIMULATION LABORATORY | 6 | FIS/08, FIS/07, FIS/06, FIS/05, FIS/04, FIS/03, FIS/02, FIS/01 |
| OPTICS LABORATORY | 6 | FIS/03, FIS/01 |

## *COURSE YEAR UNDEFINED Core/compulsory courses/activities common*

| Learning activity | | Ects | Sector |
|---|---|---|---|
| ENGLISH 2 | | 2 | L-LIN/12 |
| | Total compulsory credits | 2 | |

## *End of course requirements*

| | | | |
|---|---|---|---|
| FINAL EXAM | | 8 | NA |
| | Total compulsory credits | 8 | |

## *COURSE PROGRESSION REQUIREMENTS*

***The course contains the following obligatory or advised prerequisites***

| Learning activity | Prescribed foundation courses | O/S |
|---|---|---|
| MATHEMATICAL ANALYSIS 3 | MATHEMATICAL ANALYSIS 1 | Core/compulsory |
| | MATHEMATICAL ANALYSIS 2 | Core/compulsory |
| MATHEMATICAL ANALYSIS 2 | MATHEMATICAL ANALYSIS 1 | Core/compulsory |
| ELECTROMAGNETISM | MECHANICS | Core/compulsory |
| THERMODYNAMICS | MECHANICS | Core/compulsory |