1 INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION

1.1 Family name(s)
xxxxxxx

1.2 Given name(s)
xxxxxxx

1.3 Date of birth (day/month/year)
dd/mm/yyyy

1.4 Student identification number or code (if available)
xxxxxx

2 INFORMATION IDENTIFYING THE QUALIFICATION

2.1 Name of the qualification and (if applicable) title conferred (in original language)
Laurea in INGEGNERIA FISICA
Dottore

2.2 Main field(s) of study for the qualification
10 Industrial Engineering

2.3 Name and status of awarding institution (in original language)
Politecnico di Milano (Università statale), Piazza Leonardo da Vinci 32, 20133 Milano
Description of curriculum

CHEMISTRY A

Code: 060003
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
CHIM/07 FOUNDATIONS OF CHEMISTRY FOR TECHNOLOGIES

The programme

EXPERIMENTAL PHYSICS A

Code: 060027
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
FIS/01 EXPERIMENTAL PHYSICS

The programme
Physical quantities and measurements: dimensions, standards and units, International System Kinematics of point-like particles: reference frames; motion in one dimension; freely falling bodies; vectors; periodic motion: harmonic motion and uniform circular motion; relative motion; Galilean and Lorentz (hints) transformation Dynamics: Newton's law of motion: principle of inertia and 2nd principle; mass and (linear) momentum; 3rd principle. Fundamental interactions. Forces: weight, constraints, friction, elastic force, central forces, inertial forces (pseudoforces) Work, power, energy: work; power; work and kinetic energy; conservative forces and potential energyOscillatory motion: harmonic oscillator (free, damped and forced); resonance; composition of harmonic motions System of particles: impulsive forces and collisions; angular and mechanical momentumGravitation: planetary motion and Kepler’s laws; Newton's law of gravitation, potential energy; qualitative discussion of orbits; gravitational field; representation of scalar and vector fields; circulation and flux of a vector field; Gauss's law
MATHEMATICAL ANALYSIS A AND GEOMETRY.

Subject groups
MAT/05 MATHEMATICAL ANALYSIS, MAT/03 GEOMETRY

The programme

Fundamental Theorem of Calculus. Integration methods. Riemann improper integrals and comparison tests.

COMPUTER SCIENCE A

Subject groups
ING-INF/05 DATA PROCESSING SYSTEMS

The programme
## MATHEMATICAL ANALYSIS B

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**Subject groups**

MAT/05 MATHEMATICAL ANALYSIS

**The programme**


## BUSINESS ECONOMICS AND ORGANIZATION D

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**Subject groups**

ING-IND/35 ENGINEERING AND MANAGEMENT

**The programme**

The firm: aims and context. Monitoring, planning and control tools: analysis and interpretation of the balance sheet, balance indexes, cost accounting and costing systems; investment analysis; elements of budgeting and budget variance analysis. Business management: economic value of a firm as a measure of that firm's results; main typologies of markets; business areas; decisional context, competitive differentials and basic competitive strategies. Business processes and functions; customer care process and marketing process; new product and technology development; supply management; operations. Elements of organisational designing; work division, articulation and co-ordination; main typologies of organisation and organisational methodologies.
EXPERIMENTAL PHYSICS B+C

Subject groups
FIS/01 EXPERIMENTAL PHYSICS

The programme

STATISTICS

Subject groups
MAT/06 PROBABILITY AND MATHEMATICAL STATISTICS

The programme

Code: 061203
Credits: 10.00
Grade: nn
Date: dd/mm/yy

Code: 060103
Credits: 5.00
Grade: nn
Date: dd/mm/yy
EXPERIMENTAL PHYSICS D

Code: 061385
Credits: 5.00
Grade: nn
Date: dd/mm/yy

**Subject groups**

FIS/01 EXPERIMENTAL PHYSICS

**The programme**


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ELECTRICAL ENGINEERING

Code: 060115
Credits: 5.00
Grade: nn
Date: dd/mm/yy

**Subject groups**

ING-IND/31 ELECTROTECHNICS

**The programme**

MATHEMATICAL ANALYSIS D

Code: 061217
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
MAT/05 MATHEMATICAL ANALYSIS

The programme

FUNDAMENTALS OF AUTOMATIC CONTROL I

Code: 061146
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
ING-INF/04 AUTOMATICS

The programme
Introduction to control problems: basic concepts and examples; open and closed loop control; the role of feedback. Continuous time dynamic systems: state and input-output representations; movement; equilibrium; stability; linearization; frequency and time domain analysis of time invariant linear systems. Control systems: stability and performance analysis of a control system; outline of the controller design problem; industrial PID controllers.
MATHEMATICAL ANALYSIS C

Code: 061382
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
MAT/05 MATHEMATICAL ANALYSIS

The programme

ELECTRONIC MEASUREMENTS

Code: 061213
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
ING-INF/07 ELECTRIC AND ELECTRONIC MEASUREMENT SYSTEMS

The programme
Metrology: principles of measurements; International System of units (SI); reference standards based on quantum phenomena and natural constants; logarithmic units; graphic representation of experimental data. Analysis of measurement data: probability density function, mean, variance, correlated variables, and measurement uncertainty; compatibility between measurements and weighted mean value. Interpolation and regression of measurement data. Data acquisition systems: sampling and A/D conversion; characteristics and working principles of ADCs (speed, resolution, quantization uncertainty, number of equivalent bits); structure of the most common A/D and D/A converters; properties and use of DAQ systems; use of LabVIEW for automated measurements. Instrumentation: oscilloscopes (analog and digital); power meters (electrical and optical); spectrum analyzers (digital and analog; optical spectrum analyzers); the monochromator; the autocorrelator for measuring optical pulses.
FUNDAMENTALS OF THE PHYSICS OF MATTER

Code: 061386
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
FIS/01 EXPERIMENTAL PHYSICS

The programme
Introduction of the spin and the discussion of the hydrogen atom in the presence of spin (with experimental evidences). The general methods of quantum mechanics: the correspondence between observables and operators, the meaning of the eigenvalues, the expectation values. The identical particles in quantum mechanics. The two electron system: the one dimensional box and the Helium atom with experimental evidences. The atoms with many electrons in the mean field description. The periodic table of the elements. The quantum description of the chemical bond. The hydrogen molecule. Fundamentals on the optical spectroscopy of molecules.

INTRODUCTION TO ELECTRONICS

Code: 070487
Credits: 10.00
Grade: nn
Date: dd/mm/yy

Subject groups
ING-INF/01 ELECTRONICS

The programme
The programme

Fundamentals: systems, states and properties; processes and interactions between systems; first law: internal energy, energy balance; equilibrium and not-equilibrium states; second law: available energy; entropy, highest-entropy principle, entropy balance; conditions for mutual equilibrium between systems: temperature and pressure; U-S graph, quasi-static processes. Properties of substances: enthalpy; specific heats and volumetric coefficients; state equations for homogeneous systems: ideal a gases and incompressible liquids and solids; heterogeneous systems: phases and phase transitions, the phase rule, triple point; critical state; p-T and T-s state diagrams. Engineering thermodynamics: control volume; mass, energy and entropy balances; availability functions; shaft work; analysis of conversion devices: turbines, compressors, pumps, throttles; cycles and processes for power and refrigeration plants: air-standard cycles (Otto, Joule-Brayton); vapor-power cycle (Rankine); vapor-compression cycle. Conduction: heat flux; the Fourier's law; thermal conductivity; the heat diffusion equation; one-dimensional steady-state solutions for plane and cylindrical geometry; electrical analogy and equivalent thermal network; extended surfaces; transient conduction: the lumped capacitance method, dimensionless heat-conduction parameters. Convection: introductory concepts; dimensional analysis and dimensionless parameters; forced convection in internal and external flows; some correlations for heat transfer coefficient and fiction factor; introduction to free convection. Heat exchangers. Electronics cooling. Radiation: thermal radiation; black body radiation; surface absorption, reflection and transmission; the Kirchhoff law; the gray surface; radiation exchange between grey surfaces; selective surfaces.
## PHYSICS OPTICS

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**Subject groups**
FIS/01 EXPERIMENTAL PHYSICS

**The programme**


## QUANTUM MECHANICS

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**Subject groups**
FIS/01 EXPERIMENTAL PHYSICS

**The programme**

The course is aimed to give an overview of all the most relevant experimental methods used in the field of material science, with a special emphasis on its application to nanotechnologies. The guidelines of the course will be the realization of an experiment whose different aspects will be considered. More precisely, the course will cover the following topics: 1) technique for obtaining and maintaining vacuum; 2) thin films deposition techniques; 3) X-rays and electron diffraction; 4) electron spectroscopies for characterizing the chemical composition and the valence electron states; 5) electron microscopy techniques; 6) magnetic properties characterization techniques; 7) computer assiste data acquisition and experiment control.
PRINCIPLES OF LASERS

Code: 061392
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
FIS/03 MATERIAL PHYSICS

The programme

Credits validated for activities carried out during an international exchange period at:

xxxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxx (FRANCIA)
Type of scheme: DOPPIA LAUREA UE
Period: from dd/mm/yyyy to dd/mm/yyyy

Courses
PROJET INNOVATION: MODES DE PROPAGATION
FUNDAMENTALS OF TELECOMMUNICATIONS I

Code: 061388
Credits: 5.00
Grade: nn
Date: dd/mm/yy

Subject groups
ING-INF/03 TELECOMMUNICATIONS

The programme

Credits validated for activities carried out during an international exchange period at:
xxxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxx (FRANCIA)
Type of scheme: DOPPIA LAUREA UE
Period: from dd/mm/yyyy to dd/mm/yyyy

Courses
SYSTEMES D'INFORMATION
SYSTEMES EMBARQUES
### MANUFACTURING

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**Subject groups**

ING-IND/16 PRODUCTION TECHNOLOGIES AND SYSTEMS

**The programme**


Credits validated for activities carried out during an international exchange period at:

xxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxx (FRANCIA)

Type of scheme: DOPPIA LAUREA UE

Period: from dd/mm/yyyy to dd/mm/yyyy

<table>
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DIPLOMA SUPPLEMENT ATTACHMENT

Person code: xxxxxxxx

Document ID: 000000/4

Date of issue: dd/mm/yyyy

Numero registro: xxxxxxxxx
# STRUCTURE OF MATTER

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## Subject groups

FIS/03 MATERIAL PHYSICS

## The programme


Credits validated for activities carried out during an international exchange period at:

xxxxxxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxxx (FRANCIA)

Type of scheme: DOPPIA LAUREA UE

Period: from dd/mm/yyyy to dd/mm/yyyy

## Courses

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MATERIALS SCIENCE AND TECHNOLOGY

Code: 060116
Credits: 10.00
Grade: nn
Date: dd/mm/yy

Subject groups
ING-IND/22 SCIENCE AND TECHNOLOGY OF MATERIALS

The programme

Credits validated for activities carried out during an international exchange period at:

xxxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxx (FRANCIA)
Type of scheme: DOPPIA LAUREA UE
Period: from dd/mm/yyyy to dd/mm/yyyy

Courses
PHYSIQUE DE LA MATIERE
PROBABILITY THEORY

Code: 070489  
Credits: 5.00  
Grade: nn  
Date: dd/mm/yy

Subject groups  
MAT/06 PROBABILITY AND MATHEMATICAL STATISTICS

The programme

Credits validated for activities carried out during an international exchange period at:

xxxxxxxxxxxxxxxxxxxxx - xxxxxxxxxxxxxxxx (FRANCIA)
Type of scheme: DOPPIA LAUREA UE
Period: from dd/mm/yyyy to dd/mm/yyyy

FINAL EXAMINATION

Code: 074089  
Credits: 8.00  
Grade: nn  
Date: dd/mm/yy

Subject groups  
Unavailable

The programme  
Unavailable