



Department of Physical and Chemical Sciences

BACHELOR DEGREE IN CHEMICAL AND MATERIALS SCIENCES AND TECHNOLOGIES

PROGRAMME OF “PHYSICS OF MATTER AND LABORATORY”

A.A. 2018-2019

Teacher: Prof. Luca Lozzi; **ECTF:** 9

- **Elements of electromagnetism**
 - o Electric and Magnetic fields
 - o Maxwell equations
 - o Electromagnetic waves
 - o Interference and Diffraction
- **Special Theory of Relativity**
 - o The Galilean transformation
 - o The Michelson-Morley experiment
 - o Einstein's postulates
 - o The Lorentz transformation
 - o Relativistic dynamics
- **The crisis in Classical Physics: Particle-like properties of electromagnetic waves**
 - o Black-body radiation, stationary waves, Rayleigh-Jeans law.
 - o Quantisation of Energy and Planck theory
 - o The photoelectric effect
 - o The Compton effect
- **The structure of the atom**
 - o The Thomson's model
 - o The Rutherford's model
- **The electronic structure of the atoms**
 - o The Bohr's model, quantisation of the states, correspondence principle
 - o The Franck-Hertz experiment
- **Wave-like properties of particles**
 - o The de Broglie wavelength
 - o The wave packets
 - o Wave superposition and beats
 - o Bohr quantisation rules and de Broglie theory
 - o The Heisenberg principle of uncertainty

- Wave functions and probability amplitude
- Dual nature of particles and waves
- **The Schrodinger equation**
 - The Schrodinger equation and the time independent Schrodinger equation
 - Properties of the Schrodinger equation: eigenfunctions and eigenvalues
 - Operators in quantum mechanics
 - Examples of Schrodinger equations:
 - The free particle
 - Particle in 1-D box
 - Energy quantisation
 - 2-D and 3-D potential wells
 - The simple harmonic oscillator
 - The step potential
 - Barrier potential
 - The tunneling process
- **The hydrogen atom**
 - The Schrodinger equation for one-electron atoms
 - The Schrodinger equation in spherical coordinates
 - Solutions of the Schrodinger equation for one-electron atoms.
 - Radial and angular probability densities
 - The angular momentum operators
 - Magnetic dipole for the hydrogen atom
 - Magnetic dipole-magnetic field interaction, angular momentum precessing
 - The Stern-Gerlach experiment: the electron spin
 - Transition selection rules (outlines)
 - The Zeeman effect
 - The spin-orbit interaction (outlines)

Laboratory sessions:

- Determination of the prism refractory index using the Cauchy's law
- Determination of the Rydberg constant using a prism and a diffraction grating
- Determination of the electron e/m ratio
- The Stefan law on black body using an I-V circuit
- The photoelectric effect: determination of the Planck constant
- The Franck-Hertz experiment

Reading list:

1. K. Krane, Modern Physics, John Wiley & Sons (main text)
2. P.A. Tipler, Modern Physics, W.H. Freeman (same level of the main text)
3. F. Ciccacci, Fondamenti di Fisica Atomica e Quantistica, EdiSES (for some insights, only in Italian)
4. R. Eisberg, Fundamentals of Modern Physics, John Wiley & Sons (for some insights)
5. S. Gasiorowicz, Quantum Physics, John Wiley & Sons (only for students that want to study in depth quantum mechanics)
6. L. Colombo, Elementi di Struttura della Materia, Hoepli (only in Italian)

Assessment methods: written and oral examination