



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Interazione Luce Materia

2122-3-E3002Q029

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#### Aims

The aim of the course is to describe the different processes through which light interacts with atoms, molecules and bulk materials. Starting from the phenomena that can be described simply on the basis of Maxwell's equations, we will then move on to the illustration of those that require a more sophisticated approach up to the photophysics of vision.

#### Contents

1. WAVE-PARTICLE DUALITY (hints) and MATHEMATICAL REPRESENTATION OF WAVES: Real representation and complex representation of waves; Phase and phase velocity of a wave; Scalar and vector waves; Polarized plane waves.
  2. ELECTROMAGNETIC WAVES: Maxwell's equations (review); Wave equation: propagation of electromagnetic waves in vacuum and in materials; Complex refractive index and complex dielectric function; Dispersion and attenuation of electromagnetic waves in materials; Lorentz and Drude models.
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## Detailed program

1) Wave-particle duality. (Notes from Prof. Tavazzi)

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11) Colorimetry. (Both Sears and Nassau are suitable. Perhaps it is easier to study it on the former)

12) Color by refraction / dispersion. (Nassau chap. 10 up to page 226, but not Appendix F. Additional details on: <http://hyperphysics.phy-astr.gsu.edu/hbase/atmos/rainbowcon.html#c1>)

13) Color by interference and diffraction. (Sears for the basic theory + <http://hep.fi.infn.it/FOC/didattica/beniculturali/fisica2/lez24.pdf>. Nassau chap. 12, plus the paragraph on interference in a thin film of appendix F, but not the paragraph "Diffraction from a layer grating" of the same appendix)

14) Diffusion of light. (Nassau chapter 11 up to page 241 + [http://www2.mater.unimib.it/utenti/meinardi/Integration\\_Raman.doc](http://www2.mater.unimib.it/utenti/meinardi/Integration_Raman.doc))

15) Elements of atomic physics. (Nassau appendix C + Chapter 3 up to page 56 + <http://hyperphysics.phy-astr.gsu.edu/hbase/atomic/hund.html> and <http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/hydfin.html#c2> for Hund's rules + <http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/schr.html#c3> for energy calculation)

16) Color in organic molecules. (<https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/intro3.htm#strc8c> only chapter orbitals + [http://www2.mater.unimib.it/utenti/meinardi/Integration\\_Organiche.docx](http://www2.mater.unimib.it/utenti/meinardi/Integration_Organiche.docx) + Nassau chapter 6 up to

## Polyene Colorants)

17) Vision. (Nassau chap. 14 up to Human color vision +  
<http://www.chemistry.wustl.edu/~edudev/LabTutorials/Vision/Vision.html> +  
<http://www.sciencemag.org/content/254/5030/412.full.pdf>)

18) Emission of black body (hints). (Nassau chapter 2 up to page 45 + appendix B for Laws of Stefan and Wien +  
[http://www.lucevirtuale.net/percorsi/b1/corpo\\_nero.html](http://www.lucevirtuale.net/percorsi/b1/corpo_nero.html))

19) Color in metals and semiconductors. (Nassau chapter 8 up to LEDS and semiconductor lasers (excluded) +  
appendix E)

20) Laser: general theory plus operation of a specific laser among those discussed at the student's choice.  
([http://www2.mater.unimib.it/utenti/meinardi/Integration\\_Laser.doc](http://www2.mater.unimib.it/utenti/meinardi/Integration_Laser.doc))

## Prerequisites

It is assumed that the students already have a good knowledge of the main contents of the courses of Physics 2, Mathematics 1 and 2, and Geometric Optics. In particular, the following notions are taken for known and are absolutely essential:

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## Teaching form

Lectures (in Italian). Textbooks and additional materials may be in both Italian and English.

## Textbook and teaching resource

F.W. Sears, *Ottica*, Ed. CEA

K. Nassau, "The Physics and chemistry of colors", J. Wiley & Sons, Inc.

Prof.ssa Tavazzi's notes (can be downloaded here:  
<https://drive.google.com/drive/folders/1vVCSgW9Vbk89tuiHYTEJ4a5P1zvcuRm0?usp=sharing>. Please note that these notes can complement but not replace textbooks.

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## Semester

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## Assessment method

Written test and oral exam. There are no ongoing tests.

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## Office hours

Every day by appointment.

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