# Nonlinear Optics

## Prof. Gabriele Ferrini

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course is intended as an introduction to the fundamental principles of nonlinear optics, mainly those related to the non-linear susceptibility of the second order. At the end of the teaching, the student will be able to understand the principles and the technological aspects related to the nonlinear radiation-matter interaction, and to study the subject independently in specialized literature.

***COURSE CONTENT***

Lorentz model of the susceptibility.

The electromagnetic description of the quadratic nonlinearity and

symmetry constraints.

The coupled wave equations.

Second harmonic generation without pump depletion.

Uniaxial crystals and phase matching, quasiphasematching.

Walk off angle, angular acceptance, phase matching bandwidth.

Second harmonic generation with pump depletion.

Second harmonic generation with gaussian beams.

Parametric interaction in the low conversion limit (OPO/OPA)

Angular tuning curves, amplification bandwidth of OPO/OPA.

Coupled equations considering the group velocity mismatch.

Conservations laws.

Additional topics to be agreed upon with the students.

***BIBLIOGRAPHY***

N. Bloembergen, *Nonlinear Optics*, World Scientific Publishing Company

Y. R. Shen, *The principles of nonlinear optics,* Wiley-Interscience

R. W. Boyd, *Nonlinear optics*, Academic Press;

Yariv, *Quantum electronics*, Wiley

E. Rosencher and B. Vinter, *Optoelectronics,* Cambridge University Press

***TEACHING METHOD***

Lectures, notes handed out in class and seminars. The exercises deal with specific aspects of the theory presented in class, examples and comments.

***ASSESSMENT METHOD AND CRITERIA***

The exam consists in an essay and an oral examination.

The essay will focus on a topic of the course that is of particular interest to the student. The evaluation of the essay will take into account the quality and effectiveness of the presentation and the degree of personal elaboration of concepts by the student.

The oral examination aims to assess the degree of assimilation of the concepts illustrated in the lectures. The student should be able to understand spoken technical questions or problems from the examiners and to give responses, both in words and by writing equations and figures on the blackboard. The questions and/or problems will focus on selected topics of the program, not excluding references to prerequisites or connections between parts of the same. The evaluation of the oral examination will take into account the students’ depth of knowledge and their ability in problem solving.

The final grade takes into account 80% the oral examination and 20% the essay assessment.

***NOTES AND PREREQUISITES***

To effectively understand the material presented in the course, the student must have previously attended courses on classical electromagnetism and optics.

Prof. Ferrini receives in his office every day by appointment.