# Module: Specialization I

**Module No.:** physics610

# Course: Laser Physics and Nonlinear Optics

**Course No.:** physics614

| Category | Type | Language | Teaching hours | CP | Semester |
|---|---|---|---|---|---|
| Elective | Lecture with exercises | English | 3+1 | 6 | WT |

**Requirements:**

**Preparation:**

**Form of Testing and Examination:**
Requirements for the examination (written or oral): successful work with the exercises

**Length of Course:**
1 semester

**Aims of the Course:**
To make the students understand laser physics and nonlinear optics and enable them to practically apply their knowledge in research and development.
Pivotal experiments will be shown during the lecture. The acquired knowledge will be dealt with in depth in the exercise groups. An additional offer: interested students may build and investigate a nitrogen laser device.

**Contents of the Course:**
Laser physics: advanced geometric optics and wave optics (ABCDmatrix, Gauss rays, wave guides). Light-matter interaction (spontaneous/ excited processes, inversion, light intensification). Principle of the laser; mode of operation and properties of lasers (standing wave-/ring laser, mode condition, hole burning). Continuous wave laser (gas, solid states), pulsed laser (Q-switching, mode coupling), optical properties of semiconductors, semiconductor laser; dynamic properties of laser light (Schawlow-Townes line width, chaotic laser radiation). Petawatt laser, white light laser, free electron laser, laser application in telecommunications, metrology and material processing;
Nonlinear Optics: Frequency doubling, sum-, difference frequency generation, parametric oscillators, phase matching (critical, non-critical, quasi), photorefraction, nonlinear Kerr effect, 4-wave mixing.

**Recommended Literature:**
D. Meschede; Optik, Licht und Laser (Teubner, Wiesbaden 2. überarb. Aufl. 2005)
F. K. Kneubühl; Laser (Teubner, Wiesbaden 6th edition 2005)
J. Eichler, H.J. Eichler; Laser (Springer, Heidelberg 5th edition 2003)
R. Boyd; Nonlinear Optics (Academic Press 2003)
R. Menzel; Photonics (Springer, Berlin 2001)
Y.-R. Shen; The principles of nonlinear optics (Wiley, New York (u.a.) 1984)