UNIVERSITÀ DI PISA

PHYSICS OF PHOTONIC DEVICES

ALESSANDRO TREDICUCCI

Academic year	2019/20
Course	PHYSICS
Code	203BB
Credits	9

Modules	Area	Type	Hours	Teacher(s)
FISICA DEI DISPOSITIVI FOTONICI	FIS/03	LEZIONI	54	MARCO POLINI ALESSANDRO TREDICUCCI

Learning outcomes

Knowledge
The student who successfully completes the course will be able to understand the physics underlying the operation of the most common semiconductor / solid-state photonic components; will have the capability to use that knowledge for investigating novel device concepts and materials; will be aware of the current research frontiers in this field.

Assessment criteria of knowledge
The student will be assessed on his/her demonstrated ability to discuss the main course contents using the appropriate terminology. He/ she will be asked to demonstrate the ability to approach a circumscribed new research problem putting into practice, with critical awareness, the concepts and ideas learned during the course.
Methods:

- Final oral exam

Skills
At the end of the course the student will be able to understand the operating concepts of the most important photonic devices; he/she will able to critically examine new ideas and implementations appearing in the scientific literature, will have the necessary physics background to tackle the electromagnetic and electronic simulation of photonic devices as well as sufficient materials knowledge to learn their practical fabrication, will know which parameters, and how, should be tested to assess device performance.

Assessment criteria of skills
The course features an interactive approach in which students are involved in discussions with the teacher, also concerning new results appearing in the scientific literature. Basic exercises / questions are an integral part of the lessons to verify the degree of comprehension.

Behaviors
The student will learn the relevance and impact of physics in the development and applications of photonics devices. He/she should be able to conduct independentely a research project in the field.

Assessment criteria of behaviors
Impressions on the the attendance to the Photonics Conference, discussions on the seminars, choice of the exam topics will be used to verify the level of progress reached.

Prerequisites
A general knowledge of quantum mechanics is required to successfully follow the course. An at least basic exposure to solid state physics (energy bands, phonons, etc.) is highly recommended.

Teaching methods
Delivery: face to face
Learning activities:

- attending lectures
- participation in seminar
- participation in discussions
- individual study
- Bibliography search

Attendance: Advised
Teaching methods:

- Lectures
- Seminar
- Task-based learning/problem-based learning/inquiry-based learning

Syllabus

Brief introduction to the physics of semiconductors and of semiconductor heterostructures. Optical properties of bulk, quantum wells. Gain in semiconductors and semiconductor lasers (configurations, concepts, properties). Mode-locking and frequency combs. Zero-dimensional systems. Non-linear optics: effects and devices. Microcavities and polariton physics. Exciton condensation. Graphene, plasmonics in 2D materials, and photonic applications. Photodetectors.

Bibliography

Recommended reading includes: A. Yariv - Optical Electronics in Modern Communications. Further bibliography will be indicated during the course

Non-attending students info

A series of course notes taken by previous students, together with lesson slides, is available to complement the bibliographical material.

Assessment methods

The exam is oral and is usually constituted by two seminars on recent relevant literature of the field. The two topics of the seminar are typically one on semiconductor devices, the other on solid-state lasers. During the seminar, constant questioning is perfromed to assess the depth of understanding of the reported work and the capability to put it in the context of the course teachings.

Work placement

The possibility to attend the annual national conference of photonics is provided.

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