2EL5120 – Smart Photonics Systems

Instructors: Delphine Wolfersberger
Department: CAMPUS DE METZ
Language of instruction: ANGLAIS
Campus: CAMPUS DE METZ
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Fundamental Sciences
Advanced level : No

Description

In the context of new technologies, light is increasingly used as a support for calculating, transporting or storing information. The objective of this course is to present recent developments in "photonics", including lasers and their applications in different fields: ultra-fast optics, telecommunications, all optical information processing.

After a few notions of wave physics, the different types of laser sources will be discussed as well as the different components of a typical optical information transmission channel: from emitters (LEDs and laser diodes) to receivers (photodiodes) . A practical experiment on the transmission of sound will be set-up to validate the course. We will then discuss about different applications that we carry out in our laboratories using light: chaos in lasers, random numbers generation, holography for storing light, slow light... Some visits of labs will be organized to allow students to discover the world of research and innovation.

Quarter number
SG8

Prerequisites (in terms of CS courses)
none

Syllabus

Physical properties of lasers:

Laser basics principles, Fabry-Pérot cavity, threshold conditions, laser dynamics, modulation bandwidth.

Ultra-Fast Optics:

Generation of ultra-short pulses: femto-second lasers (Laser Ti: Sapphir), Optical Parametric Oscillator (OPO), Pulse measurement (auto-correlation).

Telecommunications basics

Network structure: access, transport, popular models – Traffic regulation: guided and free space propagation – Resources accessibility: TDMA, FDMA, CDMA – Different ways of communications: concurrency or complementarities.

Guided propagation, optical fibers

Guided wave theory: geometrical and wave approach of the optical fibers, attenuation and dispersion – Temporal Multiplexing – Wavelength Division Multiplexing: WDM, DWDM – Interconnects.

Components and optoelectronic interfaces

Light emitters: Electro luminescent diodes (DEL), Laser diodes, Emitting optical interface (modulation, noise, coupling, laser-fiber) – Photo detectors: PIN photodiodes, Avalanche photodiode, Reception optical interface.

Non-linear Optical Components

Non-linear propagation and solitons: non-linear Schrödinger equation, stability – Electro-optic effect – Optical parametric amplification.

Towards all optical network

Multiplexing – Amplification – Optical routing and commutation: micro-mirrors, liquid crystals, and spatial solitons.

Class components (lecture, labs, etc.)

30,5h lecture, 3h00 practical laboratory work

Grading

Oral evaluation (1h30) at the end of the course based on an oral presentation of 2-3 students : the mark will be individual.

Course support, bibliography

Les Composants Optoélectroniques, François Cerf, Hermes Science Publications, Paris 2000.

Fundamentals of photonics, E.A. Saleh, M.C. Teich (ISBN : 978-0-471-35832-9).

Resources

Educational team : Delphine Wolfersberger - Nicolas Marsal

Learning outcomes covered on the course

At the end of the course, the students will be able to:

- understand basics of lasers and their applications: holography, laser-based cryptography, optical buffering, optical memories ...
- understand the physical phenomena that are at the origin of lasers emission: threshold, resonance, ...
- become familiar with the ultra-fast optics: femto-second laser, optical parametric oscillator
- design and realize practically an optical communication for optical video/sound transmission
- understand notions of nonlinear optics used for the development of novel optoelectronic components.

Description of the skills acquired at the end of the course

C1 Analyze, design, and build complex systems with scientific, technological, human, and economic components

C2 Develop in depth skills in an engineering domain and a family of professions
C7 Know how to convince