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# Photonic components and devices A

## Finalità

The course provides theoretical basis for the study of the electromagnetic propagation at optical frequencies in dielectric guiding structures like waveguides and optical fibers, mandatory for the comprehension of modern optical telecommunication systems. Fundamental devices, like lasers, optical amplifiers and photodiodes, will be analysed in detail.

## Programma

- Introduction. Remind on wave propagation and dielectric media.
- Integrated optics. Dielectric waveguides. Slab isotropic, anisotropic and non-symmetric waveguide. Passive optical components; various type of guides, channel, rib, edge, diffused; directional couplers, junctions, curves.
- Notes about numerical methods for light propagation analysis; Goell's, Marcanti's and effective index methods.
- Optical fiber. Constitutive parameters and fabrication technology. Step fiber and HE, EH, TE and TM modes; weakly guiding fiber; LP modes.
- Dispersion phenomena in optical fiber; chromatic dispersion, polarization mode dispersion. Compensation techniques.
- Attenuation. Rayleigh scattering. Sellmeier equation.
- Open dielectric cavity; cavity modes. Oscillation and stability.
- Semiconductor lasers; device physics, geometry and functioning.
- Single mode semiconductor laser, DFB and DBR lasers, tunable lasers.
- Vertical emission lasers, GCSEL and VCSEL. Comparison with traditional ones. Characteristics, performances and applications.
- Optical amplification mechanisms. Population rate equations; two, three and four level systems; Propagation equations, gain and absorption coefficient. Line broadening.
- Doped fiber optical amplifiers; configurations and schemes, pumping techniques, gain, band, noise figure. Signals and pump behaviour.
- Amplification in C, L, S and S+ band. Effect of different hosting matrix. Fiber laser.
- Photodetection. Absorption and transparency. Materials and their characteristics.
- Different types of photodiodes. Performances, noise, bias circuit.

## Attività d'esercitazione

Students will attend experimental lab activities on characterization and performance analysis of optical amplifiers as well as numerical ones on light propagation in dielectric waveguides and optical fibers.

## Modalità d'esame

Oral test

## Propedeuticità

Propagazione Guidata, Antenne A.

## Testi consigliati

- B. E. A. Saleh, M. C. Teich "Fundamental of Photonics" Wiley Interscience, 1991.  
P. Bassi, G. Bellanca, G. Tartarini "Propagazione ottica libera e guidata" Clueb, 1999.