Tárgytematika / Course Description
Optical telecommunications

GKNM_TATA028

Tárgyfelelős neve / Teacher's name: dr. Nagy Szilvia
Félév / Semester: 2023/24/2
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 4/0/0
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The goal of the subject is to get familiar with the physical background, regulations, and practice of optical telecommunications

TANTÁRGY TARTALMA / DESCRIPTION

Optical modeling, geometry of optical fibers: Description of light, Maxwell's equations and the wave equation, photons, geometrical optics. Total reflection. Structure of optical fibers, refractive indices, half-acceptance angle, numerical aperture, refractive index profiles: graded and step-index fibers.

Description of light propagating in fibers: History and theory of light-conducting, waveguides, solutions of the wave equation in waveguides, propagating modes. Mode space diameter. Single and multimode fibers, cutoff wavelength.

Attenuation in optical fibers, absorption, scattering, leakage: absorption diagram and its characteristics, wavelength dependence of scattering, complete attenuation diagram. Bending losses, the effects of the environment.

Dispersion. Mode dispersion, chromatic dispersion, polarization mode dispersion, dispersion curves, fibers with compensated dispersion. Dispersion and signal rate. Measurement of dispersion. Nonlinear effects in optical fibers.

Fiber production, special fibers, cables: Special optical fibers: doped fibers with a special geometry or refractive index distribution. Production of optical fibers. Cabling. Welding, fittings, assembly.

Physics of signal generation: lasers and LEDs. Operation of the semiconductor laser, solid state physics background, band structure, population inversion, laser effect. Fundamentals of material technology, epitaxy, contacts, light output. Thermal engineering problems. Construction of VCSELs, the role of quantum valleys. Lasers made of doped optical fibers.

Signal generation tools: Laser light spectrum, polarization, coherence length. Coupling light into optical fibers. Transmitter modules, regulation, coupling, impedance.

Amplification and regeneration: Amplification and regeneration in optical networks. Electro-optical regeneration, amplification with erbium-doped optical fibers, pumping of optical amplifiers.

Receivers: The receiver diodes. Materials and constructions. Noise and sensitivity. Customer types.

Laboratory: Measurement of attenuation, OTDR measurements, dispersion

Path of the signal: Overview of the physics of passive devices needed to influence the path of the signal, grouping of devices. Switches, multiplexers, filters, polarizers, attenuators. Electro-optical, magneto-optical, acousto-optical phenomena, liquid crystals, MEMS

Laboratory: Presentation of network measurements, filtering, welding, assembly, connectors

Optical networks, standards: Structure of an optical ring, data traffic on optical rings. The role of optical systems in communication, international and national optical backbone network, internal network of primary districts, local networks.

Fiber optic sensors, sensors with internal sensing: Grouping of fiber optic sensors, physics of sensing of sensors with internal sensing, areas of use (Fiber optic sensors: externally sensing sensors.)

Project presentations, Construction and use of externally sensing sensors

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

The students take part in a project, they study and make a presentation on a topic related to the subject to get a signature, and take part in oral exam with previously given larger questions.

If the project is complex enough, and demonstrates deep knowledge on optical telecommunication or sensing, maybe contains practical or standard-related parts, and performed in a group of 2 to 4 people with clear distincion of the tasks, a final mark may be offered based on the project work.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

Lajta György, Szép Iván: Fénytávközlő rendszerek és elemeik (1987, Akadémiai Kiadó)

Hecht, Jeff: Understanding Fiber Optics (2006 Pearson)

Brückner, Volkmar: Elements of Optical Networking (2011 Springer Verlag)

Becker, P. C., Olsson, N. A., Simpson, J. R.: Erbium-Doped Fiber Amplifiers, Fundamentals and Technology (1999 Academic Press)

Bass, M (editor): Fiber Optic Handbook, Fiber, Devices, and Systems for Optical Communications (2002 McGraw.Hill)

Pollock, C. R.: Fundamentals of Optoelectronics (1995 Irwin)

Singh, J: Optoelectronics An introduction to Materials and devices (1996 McGraw.Hill)

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL

Becker, P. C., Olsson, N. A., Simpson, J. R.: Erbium-Doped Fiber Amplifiers, Fundamentals and Technology (1999 Academic Press)

Bass, M (editor): Fiber Optic Handbook, Fiber, Devices, and Systems for Optical Communications (2002 McGraw.Hill)

Pollock, C. R.: Fundamentals of Optoelectronics (1995 Irwin)

Singh, J: Optoelectronics An introduction to Materials and devices (1996 McGraw.Hill)