Title: Medical optics			
Credits: 4 **Semester: 1** **Compulsory: Yes**			
Format	Lectures 30 hrs	Guided project - Laboratory - Tutorials -	Private study 30 hrs
Lecturer(s): prof. dr hab. inż. Krzysztof Patorski			

Objectives:

The aim of this course is to present fundamentals of light interaction with biological tissues, low and high energy laser therapy methods, and optical imaging techniques for diagnostic purposes using light propagation properties in scattering and absorbing media (photon sorting methods, incoherent and coherent optical gating, opto(photo)acoustics).

Contents:

1. Light in medicine – historical overview. Main parameters characterizing optical radiation. Laser operation fundamentals. Basic classification of lasers for medical applications. Preliminary examples of laser applications in medicine.
2. Light interaction with biotissue. Penetration depth and absorption for selected tissues as a function of light wavelength. Photochemical, thermal, photoablative and electromechanical interactions. Laser light dosing. Exemplary therapeutic devices.
3. Selected applications of laser therapy. Low light level therapy (LLLT) – biostimulation. Energetic laser applications, including: photodynamic therapy (PDT), gastroenterology, blood vessel recanalization, ophthalmology, coronary artery diseases – angioplasty and mioplasty.
4. Novel imaging modalities in biomedicine. Why optical imaging? Light propagation in highly turbid media. Photon sorting (gating) techniques and their exemplary implementations: LTPS (Light Transmission Photoscanning - confocal gating), Kerr cell method - incoherent gating, OCT (Optical Coherence Tomography – coherent interference gating).
5. Opto(photo)acoustics. Light to ultrasound signal conversion. Laser optoacoustic imaging. Experiments with phantoms and clinical applications *in vivo*: imaging of cancer stages, skin disorders, brain vasculature, retinal vessels and pigment distribution in the RPE layer (photoacoustic ophthalmo-scopy). Real-time photoacoustic system for small animals.
6. Optical coherence tomography. Detection of back-scattered ballistic photons using polychromatic light interference. Implementations: time and spectral/Fourier domain data acquisitions (hardware and software issues). Applications in weakly scattering tissues: high resolution studies of human retina and subretinal layers (diagnosis of diabetic retinopathy, glaucoma, cystoid macular edema, age-related macular degeneration); imaging optimization using different light wavelengths, polarized light (for visualization of anisotropic structures of anterior chamber and retina, including retinal pigment epithelium), compensation of dispersion and eye lens aberrations; ultra high speed imaging systems. Applications in highly scattering tissues: gastrointestinal system examination, intravascular OCT, investigations of developing embryonic morphology, intraoperative assessment of micro-surgery, human oviduct imaging, normal and osteoarthritic cartilage imaging, bladder cancer diagnosis, dentistry, dermatology (3D skin and skin thermal damage polarization imaging).

Abilities:

The students will understand basic phenomena of light interaction with tissues and laser radiation and their application for diagnosis and therapy purposes in medicine. Selection of modern optical imaging techniques and equipment for monitoring and treatment of diseases in modern industrialized societies.

Assessment: 100% exam (but positive laboratory assessment required)

Practical work: -

Recommended texts:

1. V.V. Tuchin, *Optical Biomedical Diagnostics*, SPIE Press, Bellingham, 2002
2. L.V. Wang, H. Wu, *Biomedical Optics*, John Wiley & Sons, Hoboken New Jersey, 2007

Further readings:

1. B. Bouma, G. Tearney, eds., *Handbook of Optical Coherence Tomography*, Marcel Dekker, Inc., New York, 2002
2. W. Drexler, J.G. Fujimoto, eds., *Optical Coherence Tomography*, Springer-Verlag, Berlin, 2008

Prerequisites: Fundamentals of Optics (Physics Course)