WARSAW UNIVERSITY OF TECHNOLOGY
DEVELOPMENT PROGRAMME

Title: Diffraction and Fourier optics			
Credits: 4 Semester: 1 Compulsory: Yes			
Format	Lectures 30	Guided project Laboratory Tutorials	Private study 30
Lecturer(s): Tomasz Kozacki			

Objectives:

The course gives theoretical knowledge of Fourier Optics, with theoretical treatment of EM wave and its interaction with medium and optical elements. Gaining knowledge of the fundamentals of wave optics based numerical analysis of optical systems including microoptics.

Contents:

1. Linear systems. Fourier Transform. Fourier Transform Theorems. Discrete Fourier Transform (DFT).
2. Optical wave propagation - fundamentals. Electromagnetic wave. Maxwell equations. Wave equation in source free medium. Plane wave.
3. Scalar diffraction theory - rigorous and approximate methods. Helmholtz equation. Plane Wave Spectrum Decomposition (PWS). Rayleigh-Sommerfeld Diffraction (RS). Fresnel wave equation. Fresnel diffraction. Fraunhofer diffraction. Plane wave spectrums: slit, diffraction grating (phase and amplitude). Numerical methods of optical wave propagation in free-space with usage of DFT (PWS, RS, Fresnel diffraction).
4. Coherent and incoherent imaging of optical systems. Thin optical elements, thin lens. Frequency analysis of coherent optical systems. Imaging as 2D filtering operation, effect of limited aperture in optical systems. Optical Transfer Function (OTF). Frequency response of incoherent diffraction limited optical system. Modulation Transfer Function (MTF). Coherent and incoherent imaging. Imaging with resolution exceeding diffraction limitation.
5. Wigner Distribution. Space - Spatial Frequency analysis of optical wave and optical systems.
6. Diffractive optical elements - DOE. Depth function. Synthetic holograms. Methods of design of synthetic holograms (iterative methods). Subwavelength structures. Microlenses, its analysis.
7. Numerical methods of rigorous diffraction theory. Analysis of wave guiding structures(*Beam Propagation Method* - BPM). Numerical solution of Maxwell equations (*Finite Difference Time Domain Method - FDTD*).

Abilities:

The course gives theoretical knowledge of Fourier Optics. Students will gain knowledge of wave optics based numerical analysis of optical systems including microoptics.

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HUMAN – BEST INVESTMENT!
EUROPEAN UNION
EUROPEAN SOCIAL FUND

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Literature: J. W. Goodman: *Introduction to Fourier Optics*, 2nd ed., McGraw-Hill, New York 1996 O. K. Ersoy: *Diffraction, Fourier Optics and Imaging*, John Wiley & Sons, Hoboken 2007 M. Born, E. Wolf: *Principles of Optics*, 7-th (expanded) ed., Cambridge University Press, New York 1999 B.E.A. Saleh, M.C. Teich: *Fundamentals of Photonics*, 2nd ed., John Wiley & Sons, New York 2007 R. Jóźwicki: *Podstawy Inżynierii Fotonicznej*, Oficyna Wydawnicza PW, Warszawa 2006.
Prerequisites: Fundamentals of Photonics, Fundamentals of geometrical optics.