EC562: ENGINEERING OPTICS
Instructor: Prof. Luca Dal Negro
Fall 2017 - Course Syllabus

28 lectures – 14 weeks course duration

1. Fundamentals

1.1. *The mathematics of waves and wave equations*
1.2. *Special functions used in engineering optics*
1.3. *What is Fourier Optics and why is it useful?*
1.4. *Spatial frequency and Fourier transforms in engineering*
1.5. *Review of linear systems and analytic functions*

2. Ray optics in non-homogeneous media

2.1. *Waves in non-homogeneous media and the geometric-optics approximation*
2.2. *Path of light in non-homogeneous media*
2.3. *How to describe the path of light*
2.4. *Variational principles and Lagrangian optics*
2.5. *Spherically and cylindrically symmetric media*
2.6. *Engineering applications to self-focusing fibers and lenses*
2.7. *Introduction to transformation optics*

3. Basic diffraction theory

3.1. *From vector to scalar diffraction*
3.2. *Kirchohoff diffraction*
3.3. *Fresnel-Kirchoff's diffraction*
3.4. *The Rayleigh-Sommerfeld formulation*
3.5. *The angular spectrum of plane waves*
3.6. *Engineering applications to diffractive optics and antenna theory*

4. Linear optical Systems

4.1. *Analysis of optical systems in spatial frequency domain*
4.2. *Coherent and incoherent optical systems*
4.3. *Image formation*
4.4. *Aberration and effects on frequency response*
4.5. *Optical resolution*
4.6. *Coherent and modulation transfer functions*
4.7. *Imaging beyond classical diffraction*

5. Fourier analysis of engineering instruments

5.1. *Lens-based systems (e.g., microscopes, telescopes, transformation optics)*
5.2. *Diffractive gratings and Fresnel optical elements*
5.3. *Microscopy, optical and infrared imaging cameras*
5.4. *Optical super-resolution*

5.5. *Wavefront modulation*

6. Holography & 3D imaging

6.1. *The principles of holography*
6.2. *Computer-generated holograms*
6.3. *White-light holograms*
6.4. *Speckle patterns*
6.5. *Engineering applications of holography*
6.6. *Physiological factors of 3D vision*
6.7. *Stereoscopes*
6.8. *3D displays*
6.9. *3D movies*
6.10. *Integral photography*

Textbook
Engineering Optics, by K. Iizuka (Springer-Verlag, 3rd edition, 2007)

Other references
Diffraction, Fourier optics and imaging, by Okan K. Ersoy (John Wiley, 2007)
Computational Fourier optics, by D. Voelz (SPIE Press, 2011)
Introduction to Fourier optics, by J.W. Goodman (Roberts & Company, 3rd edition)
Numerical simulation of optical wave propagation, by J. D. Schmidt (SPIE Press 2010)