Wave optics

1. Fermat’s principle - derivation of refraction and reflection law; surfaces forming a perfect image
2. Refractive index of glass, dispersion of light in optical materials, Abbe number; positive and negative connotations of dispersion
3. Propagation of light in metals: definition of refractive index, reflectivity of air/metal boundary with respect to angle of incidence and wavelength; thin metal films applications
4. Interference conditions, visibility of fringes, interference for various degrees of mutual coherence
5. Coherence of light: temporal, spatial; coherence length
6. Shape and pitch of interference fringes; wavefront and intensity splitting
7. Diffraction of light at rectangular and circular aperture: shape of diffraction pattern, type of function describing the energy distribution, angular distance of first diffraction minimum
8. Diffraction at double slit, Young’s experiment: description of diffraction pattern, effect of slit width and slits’ pitch
9. Diffraction at a grating, grating equation, spectral orders, resolving power of a grating
10. Grating types, blaze grating, echelle grating
11. Resolving power of optical instruments (telescope, microscope), Rayleigh criterion
12. Fundamental parts of spectrometer – their function, effect on resolving power, conditions for a correct function of the dispersing element; main characteristics of spectral instrument; spectrum forming
13. Prism spectrometer: angular dispersion, resolving power of a prism, linear dispersion; examples of dispersion prisms
14. Grating spectrometer: angular dispersion, resolving power of a grating, linear dispersion, free spectral range; optical layout of a spectrometer with plane grating (example)
15. Michelson and Mach-Zehnder interferometers: optical layout, optical paths in reference and test arms, application example
16. Thin film on glass: principle of function, design methodology, effect of angle of incidence, wavelength and polarization to the film performance
17. Anti-reflective thin film systems: film materials, system of their combinations, reasons for the use of multilayer systems; application examples
18. Applications of multilayer systems: beam splitters, filters, mirrors (also dichroic)
19. Polarization of light: mathematical description of polarized wave for individual polarizations, effect of polarization on the behaviour of light at a boundary
20. Microscope: standard and Abbe type – optical layout, magnification, resolving power
21. Contrast enhancing techniques in microscopy: dark field, polarization, DIC, fluorescence.
22. Refractive telescopes: Keplerian, Galilean. Magnification, resolving power. Focusing.
23. Astronomical telescopes: common designs – their pros and cons; correction plates; primary mirrors’ designs, segmented mirrors
24. Camera – principle, magnification, resolving power, depth of field, A-stop; fundamental parts, shutter types, autofocus principles