Optics I

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Course description

Properties of light, Geometrical optics, Optical instruments, Matrix method in paraxial optics, Wave and oscillations, Wave optics, Interference, Coherence, Fraunhofer and Fresnel diffraction, Polarisation, Holography

References and recommended books

- **F. L. Pedrotti, L. M. Pedrotti and L. S. Pedrotti, Introduction to optics**
- **E. Hecht, Optics**
- **Jurgen R. Meyer-Arendt, Introduction to Classical and Modern Optics**
- **Ian R. Kenyon, The light fantastic: A modern introduction to classical and quantum optics**

Time table with detailed outline (1.5 hours per day: total 45 hours)

day 1 **Introduction** Brief overview on the subject, outline the course and lay down an agreement (markings, homeworks, quizzes, exams etc). Particle vs wave descriptions. Geometrical and physical optics.

day 2-6 **Geometrical optics** Geometrical optics limit, Shadow, Path length, Fermat's principle, Reflection and refraction, Mirror, Thin lenses.

day 7 **Optical instruments** Stops and pupils. Prisms: angular deviation, dispersion. Prism spectrometers. Reflecting Prisms. Cameras. Microscopes. Telescopes.

day 8-9 **Matrix methods in paraxial optics** Thick lenses and lens systems. Matrix analysis of lenses. Matrix analysis of mirrors.

day 10-11 **Aberrations** Ray tracing method, Monochromatic, spherical, chromatic aberrations, Coma, Distortion.

day 12-13 **Wave and oscillations** 1D wave, wave equation, harmonic waves, phase velocity, the superposition principle, complex representation, plane waves, spherical waves, cylindrical waves

day 14-15 **Electromagnetic wave** Maxwell's equations and electromagnetic wave. The Poynting vector, irradiance, inverse square law. Radiation, light emission. Light interactions in matter, scattering and absorption, dispersion. The spectrum of light.

– Midterm examination–

day 16-19 **Interference** Two-beam interference. Young's double-slit experiment. Double-slit interference with virtual sources. Interference in dielectric films. Fringes in equal thickness. Newton's rings. Film-thickness measurement by interference. Stoke's relations. Multiple-beam interference in a parallel plate. The Michelson interferometer. The Fabry-Perot interferometer. Gravitational wave detectors.

day 20-21 **Fourier transform and Coherence** Fourier analysis. Temporal coherence and line width. Partial coherence. Spatial coherence. Spatial coherence width.

day 22-25 **Fraunhofer diffraction** Single-slit diffraction: Beam spreading, Rectangular and circular apertures. Resolution. Double-slit diffraction. Many-slit diffraction. Grating: grating equation

day 25-28 **Fresnel diffraction** Fresnel-Kirchhoff diffraction integral. Criterion for Fresnel diffraction. The obliquity factor. Fresnel diffraction from circular apertures. Phase shift of the diffracted light. The Fresnel zone plate. Fresnel diffraction from rectangular apertures. The Cornu spiral. Babinet's principle.

day 29 **Polarisation** Polarisation by selective absorption. Polarisation by reflection from dielectric surfaces. Polarisation by scattering. Birefringence.

day 30 **Holography** Hologram of a point source. Hologram of an extended object.

Grading

- Homeworks 20 points
- Midterm exam paper 40 points
- Final exam paper 40 points