17221 - 772 (8) Optics (1.5L, 1.5P)

2020

Course summary:

Geometrical, physical and quantum formalisms, polarisation (Stokes and Jones vectors), reflection, transmission and dispersion (Fresnel, Brewster, total internal reflection, double refraction), geometric-optical description of paraxial optical systems (matrix optics), diffraction and interference (three-dimensional), interferometry. Diffraction theory. Fourier optics, diffractive optics.

Module relevance in programme:

This course offers a comprehensive look at the interaction between light and matter and as such the topics covered allows for eventual specialization in the field of photonics. It is also envisioned that the course permits a seamless transition of concepts to practice which are the requirements of the various laser based research undertaken at the LRI. The module requires prior knowledge in classical electromagnetism as presented in the undergraduate modules 254 and 342 and 711.

Outcomes of course:

The outcomes of the course are to give the student an understanding of a number of the optical techniques that are available in the application of lasers.
The student should:

- understand the physical principles on which the technique relies,
- be able to apply this knowledge to special cases related to experiments in our research projects,
- have knowledge of how these techniques are applied in research and technology.

Lecturer:

Prof EG Rohwer
Telephone number: (021) 808-3372
E-mail address: egr@sun.ac.za
Office: Room number 1003 in the Merensky Physics Building

Ms N Payne
Telephone number: (021) 808-3373
E-mail address: nancy.elizabeth.payne@gmail.com
Office: Room number 0020 in the Merensky Physics Building.

Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is Dr CM Steenkamp cmsteen@sun.ac.za

Course content:

Formal lectures

1. INTRODUCTION: History of optics. Wave motion. Electromagnetic theory. Propagation of light
2. CLASSICAL DISPERSION THEORY: Electron oscillator model. Refractive index and polarisability. Electric dipole radiation. Scattering and polarisation.
3. GEOMETRICAL OPTICS: Lenses, mirrors and prisms. Optical systems. Analytical ray tracing and the matrix formalism. Thick lenses and aberrations.
4. POLARIZATION: Nature of polarised light. Polarisers. Dichroism and birefringence. Stokes and Jones vectors.
5. INTERFERENCE: Addition of waves. Conditions for interference. Interferometers. Multiple beam interference.
6. DIFFRACTION: Fraunhofer diffraction. Fresnel diffraction. Kirchhoff's diffraction theory.
7. FOURIER OPTICS: An Introduction to Fourier imaging

Practical (Tutorials):

No formal tutorials are scheduled. Students are expected to complete tutorial problems and assignments in their own time.

Study material:

Optics, E Hecht (Fourth Edition), Addison - Wesley, Reading, 2002.
Lasers, P W Milonni and J H Eberly, John Wiley, New York, 1988.

Learning opportunities:

Class discussions and tutorial problems.

Assessment:

Methods of Assessments

Homework and tutorial problems
Oral presentations

Written test

Venue and time of assessment opportunities
As determined by lecturer in consultation with students at beginning of semester and the honours time table.

Availability of marks:
Tutorial problems: marks available within 2 weeks.
Examination: marks available within 2 weeks of the examination.

Calculation of final mark for the module:

Test 50%, Oral presentation 25 %, homework 25 %