13934 – 745 (8) Laser Technology (1.5L, 1.5P)

2022

Course summary:

Introduction to lasers, laser rate equations, population inversion, threshold gain and saturation; laser output calculations by means of the uniform field approach, multi- and single-mode oscillations, mode locking, laser resonator theory, introduction to non-linear optics.

Laser media: solid state, gas and dye lasers. Excitation techniques. Resonator types and designs. Q-switching, gain switching, mode locking, single-mode operation, wavelength tuning. Current laser systems. Applications: Scientific, industrial, communications, medical, military.

Module relevance in programme:

This module builds on the undergraduate modules in quantum mechanics, electrodynamics and statistical physics. The module is linked to and prepare the student for modules in electrodynamics 711, Optics 772, Laser spectroscopy 744, molecular physics 747, and atomic physics 716. The module introduces basics of lasers and prepares the student for project work in the laser programme (741).

Outcomes of course:

The course will skill the student in the fundamentals of lasers and non-linear optical processes.

Lecturers:

Dr GW Bosman (4th Term)
Telephone number: (021) 808-2525
E-mail address: gwb@sun.ac.za.
Office: Room number 1046 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 Philip Southey southey@sun.ac.za

Course content:

Formal lectures

The following topics are covered during formal lectures:
Time dependent Schroedinger equation, Two state quantum systems in electromagnetic field, Rabi oscillations, density matrix, Stimulated emission and absorption, introduction to lasers, rate equations, population inversion, threshold and saturation, calculation of laser output through uniform field approximation, single and multimode oscillations, modelocking and introduction to non-linear optics. Laser media: solid state, gas and dye lasers. Excitation techniques: optical, discharge, chemical. Resonator types and designs. Q-switching, gain switching, mode locking, single-mode operation, wavelength tuning. Current laser systems: solid-state lasers, gas lasers, diode lasers, fibre lasers, ultra-short pulse lasers, high-intensity laser systems. Applications: Scientific, industrial, communications, medical, military.

Laboratory work

Practical (Tutorials):

There are informal tutorial sessions, during which students have the opportunity to solve problems related to the course work with the assistance of the lecturer.

Study material:

Prescribed textbooks:
"Lasers" *(J Wiley) by Milonni and Eberly.*
"Laser Physics" *(J Wiley) by Milonni and Eberly.*

Learning opportunities:

Lectures and tutorials as indicated on time table

Assessment:

Methods of Assessments
Homework assignments
Class tests:
Test 1,
Test 2,

Venue and time of assessment opportunities
Details will be communicated to students at start of module.

Availability of marks:
As soon as possible after test

Calculation of final mark for the module:
Homework assignments (typically 6 tasks) 40%
Test 1 30%
Test 2 30%