12546 – 744 (8) Laser spectroscopy (1.5L, 1.5P)

2019

Course summary:

Optical spectroscopic diagnostic instrumentation and techniques. Laser spectroscopy techniques for atoms, molecules and plasmas. High-frequency and time-resolved spectroscopy and related diagnostic instrumentation and methods. Examples of applications of spectroscopic techniques.

Module relevance in programme:

This module builds on the undergraduate modules in quantum mechanics. The module is linked to modules in quantum mechanics 714, Quantum Optics and laser technology 745, molecular physics 747, and atomic physics 716. The module introduces basic techniques for atomics and molecular spectroscopy and prepares the student for project work in the laser programme (741).

Outcomes of course:

To skill students at an advanced level in the concepts, techniques, methods and apparatus needed in laser spectroscopy research.

Lecturer:

Dr GW Bosman
Telephone number: (021) 808 2525
E-mail address: gwb@sun.ac.za
Office: Room number 1028 in the Merensky Physics Building

Dr PH Neethling
Telephone number: 021 808 3365
E-mail address: pietern@sun.ac.za
Office: Room 1042 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:

RADIATION PARAMETERS:
a) Einstein A and B transition probabilities,
b) Relationship with line-strength an oscillator strength,
c) Intensity, radiance, radiation density.

POPULATION OF ENERGY LEVELS:

a) Radiational excitation and decay,
b) Dissociation of molecules,
c) Ionisation.

SPECTRAL LINE PROFILES:
a) Natural broadening - Lorentz profile,
b) Thermal motion, Doppler broadening and Gauss profiles,
c) Convolution of line profiles,
d) Line broadening mechanisms.

SPECTROSCOPIC INSTRUMENTATION:
a) Laboratory radiation sources,
b) Spectrometer configurations,
c) Radiation detectors and measurement systems.

SPECTROSCOPIC TECHNIQUES:
a) Atomic emission,
b) Atomic absorption,
c) Atomic fluorescence.

LASER SPECTROSCOPY TECHNIQUES:
a) Laser induced fluorescence
b) Non-linear laser spectroscopy
c) Raman and IR spectroscopy
d) femto- and attosecond spectroscopy
e) x-ray spectroscopy and Free Electron Laser Physics

Study material:

Laser Spectroscopy by W Demtroeder, Third Edition, Springer
Molecular physics and elements of quantum chemistry by Haken and Wolf, Springer.

Learning opportunities:

Class discussions and tutorial problems.

Assessment:

Methods of Assessments
Tutorial problems, assignments and test contribute to the continuous assessment.

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