10445-711(8) Electromagnetism (11/2L,11/2P)

2022

Course summary:

This module focuses on more advanced applications of Maxwell's equations. The main topics are: radiation, scattering and plasmas.

Outcomes of course:

This course builds on the undergraduate courses in electromagnetism and aims at exposing the student to a deeper and more advanced understanding of Maxwell's equations, their physical consequences and applications. Firstly it consolidates the student's knowledge and skills base through a brief review of undergraduate material. It then proceeds to more advanced applications of Maxwell's equations with the eventual aim of equipping the student with the necessary knowledge and skills base to apply Maxwell's equations in a variety of physical systems and to appreciate the physical consequences of these equations.

Lecturer:

Prof FG Scholtz
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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 P Southey (southey@sun.ac.za)

Course content:

1. **Revision**
   - Maxwell equations
     - Free space
     - With sources
   - Relativity
     - Lorentz transformations
     - Covariant and contravariant tensors
     - Maxwell equations in covariant form
     - Transformation of electric and magnetic fields
     - Potential formulation of Maxwell's equations

2. **Potentials and fields**
   - Retarded potentials
   - Lienard-Wiechert potentials
   - Fields of a moving point charge

3. **Radiation**

- Radiation from an arbitrary source
- Radiation from a moving point charge

4. **Scattering**
   - Thomson scattering and Rayleigh's law
   - Explanation of the blue sky

5. **Magnetohydrodynamics and plasmas**
   - Magnetohydrodynamic equations
   - Magnetic diffusion, viscosity and pressure
   - Debye screening

6. **Dynamics of relativistic particles and fields**
   - Lagrangian and Hamiltonian of relativistic charged particle in external electromagnetic fields

Study material:

A study guide will be made available to students in the Sunlearn portal of the module. For more details they can consult the following textbooks:
Introduction to Electrodynamics, D J Griffiths (Prentice Hall, 1999).
Classical Electrodynamics, JD Jackson (John Wiley & Sons, 1980).
Classical Electrodynamics, HC Ohanian (Allyn & Bacon, 1988).

Contact:

Lectures will be face-to face in the slots allocated on the the time table (please consult it). Scheduled tutorials should be used by students to complete the week's homework assignments. Tutorials may also be used for face-to-face feedback sessions as required. Apart from possible face-to-face feedback sessions, the lecturer will also be available during tutorials for consultation in his office (room 1041) or online, depending on the circumstances.

Assignments will be made available on a weekly basis in the Sunlearn portal of the module. It will be graded and the marks will weigh as set out under assessment. The graded assignments will be returned to the students and a memo will be made available for each assignment. It is expected from the student to work through the memo and marked assignment to identify shortcomings in his/her understanding or technical skills.

Assessment:

Evaluation will take place on a continuous basis. Assignments and tests will carry the following weights:

1. Weekly assignments will contribute roughly 10% to 15% of the final mark and are compulsory.
2. There will be one main test at the end of the module, contributing roughly 50 % to the final mark. This test will be open book.

This division of marks may be altered in consultation with the students and head of department. Exceptions may be made for students who are repeating the module.