

# 10445-711 (8) Electromagnetism (1½l, 1½p)

2019

## 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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Office: Room number 1041 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](mailto:cmsteen@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

## Practical (Tutorials):

Tutorials will serve as a weekly consultation session in which the homework assignments or any other course related issues can be discussed with the lecturer. Some tutorial sessions may also be used as supplementary evaluation sessions.

## Study material:

A study guide will be made available to the students. For more details they need to 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).

## Assessment:

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

1. Homework assignments will be handed out on a weekly basis. The aim here is not to generate marks, but rather to facilitate hands-on exposure to the work. Homeworks, 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.
3. The remaining marks will be made up of tutorial tests or oral examinations, in agreement with students.

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.

**Subminimum:** a subminimum of 40% is required for the main test in order to pass the module.