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

2016

Course summary:

Electrostatics and applications to boundary value problems; electric multipoles and electric fields in media. Similar topics for magnetostatics. Time-dependent fields, gauge transformations. Electromagnetic waves, their absorption in and transition between different media. Relativity and electromagnetism. Theory of radiation.

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:

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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 Prof HC Eggers eggers@physics.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. **Guided waves**

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

4. **Radiation**
   - Electric dipole radiation
   - Magnetic dipole radiation
   - Radiation from an arbitrary source
   - Radiation from a moving point charge

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

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

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

Practical (Tutorials):

Tutorials are replaced by weekly homework assignments. A weekly consultation session is available in which the homework assignments or any other course related issues can be discussed with lecturer. If the need arises, these sessions may be converted to formal tutorial 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.