MATH35042 - 2007/2008

This course unit has been cancelled for 2007-2008.

General Information

- Title: Special Relativity and Electromagnetic Waves
- Unit code: MATH35042
- Credits: 10
- Prerequisites: MATH20401 or MATH20411
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible:

Specification

Aims

To develop the special theory of relativity from its logical foundations and to apply it to a wide variety of problems.

Brief Description of the unit

This course is mainly devoted to Einstein's **special theory of relativity**, which is introduced from scratch. Relativity is one of the most fascinating subjects in the whole of science and its puzzles and paradoxes are legendary. In particular, the course includes the slowing of moving clocks, the contraction of moving rods, faster-than-light effects, and $E = mc^2$. (It does not include black holes, the Big Bang, or the meaning of life; the first two of these belong to *general* relativity and the third to philosophy!). Also included in the course is a section on the classical theory of **electromagnetic waves** of which microwaves, light and X-rays are examples. This is also developed from scratch. In this section, we will treat a class of problems in which EM waves are reflected/refracted at an interface between two materials. For example, when a beam of light strikes a window pane, how much is reflected and how much passes through? Finally we bring the two parts of the course together by showing that, unlike Newton's laws, the equations of electromagnetic theory are consistent with special relativity.

Future topics requiring this course unit

None.

Syllabus

1. The theory of **special relativity**. Inertial frames and the relativity principle, the Lorentz transformation (derived *without* Einstein's second postulate), the clock and rod paradoxes, relativistic kinematics, relativistic optics and relativistic mechanics.
2. The theory of **electromagnetic waves**, starting from Maxwell's equations. The propagation of plane EM waves in free space or in a dielectric medium, plane, circular and elliptical polarisation, reflection and refraction at a plane interface, reflection and transmission by a dielectric slab, and reflection by a conductor (the skin effect).
3. The **relativistic formulation** of electromagnetic theory. The 4-current, the 4-potential, the electromagnetic tensor, and the covariant form of Maxwell's equations. Applications include the aberration of starlight, the Doppler effect, the reflection of light by a moving mirror (the radar trap), and the fields due to a moving charge.

Textbooks

Any of the several books on relativity by Wofgang Rindler. The library has many copies.

Teaching and learning methods

Two lectures and one examples class each week. In addition students should expect to spend at least four hours each week on private study for this course unit.

Assessment

End of semester examination: two hours weighting 100%

Arrangements