GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Magnetohydrodynamics of Plasmas (E026260)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 2)	English	Gent	lecture

Lecturers in academic year 2023-2024

Jaspers, Roger	TW17	lecturer-in-charge

Offered in the following programmes in 2023-2024	**crdts**	**offering**
European Master of Science in Nuclear Fusion and Engineering Physics	6	A

Teaching languages

English

Keywords

magnetohydrodynamics (MHD), fluid dynamics, electromagnetism, Maxwell equations, magnetic Reynolds number, dynamo, sun, fusion reactors

Position of the course

To describe the behavior of a conducting fluid or a plasma in a magnetic field, the theory of magnetohydrodynamics (MHD for short) has proven to be a very successful tool. With MHD, many diverse phenomena can be understood, ranging from the generation of magnetic fields in planetary cores, to the behaviour of solar flares and the confinement of the fuel in a nuclear fusion reactor. Instabilities, waves, and turbulence in all these systems and in many engineering applications like liquid metals, find their origin in the MHD behaviour.
In this course the basic MHD framework is introduced. The focus is on the conceptual understanding and the application to well-known physical phenomena, instead of on a rigorous derivation. Practical examples, exercises and working with state-of-the-art computational tools are part of the course.

Contents

- Demonstration of MHD effects, Maxwell's equations
- From fluid dynamics to MHD
- Incompressible MHD
- Evenwichten en instabiliteiten
- Astrophysics
- MHD in fusion
- Computational MHD
- MHD in engineering

Initial competences

Vector calculus, electrodynamics, basic fluid mechanics

Final competences

1 Derive and understand the MHD equations, and apply them to simple problems.
2 Know the conditions under which the MHD theory is valid and applicable.
3 Discuss the basic MHD phenomena like the dynamo effect and MHD waves.
4 Identify different instability mechanisms, link the kink or sausage instability.
5 Understand the confinement of a fusion plasma and understand how the stability limits its performance
6 Use state-of-the-art computational tools to solve a practical MHD problem.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Independent work

Extra information on the teaching methods

Each session will consist of a mix of plenary lectures, quizzes, coached exercises and guided self-study. In addition the students will work in groups of 3 on a small project and present this in the final week.

Learning materials and price

The lectures will not follow any particular textbook, but the material (lecture notes, lecture slides) will be made available to teh students. This contains many references to different textbooks, such as:
- Introduction to Magnetohydrodynamics, by P.A. Davidson, 2e editie, 2016 (not required)
- Principles of Magnetohydrodynamics, by J.P. Goedbloed, 2010 (not required)
- Plasma Physics en Fusion Energy, by J. Freidberg, 2008 (not required)

References

- P.A. Davidson, Introduction to Magnetohydrodynamics, 2nd edition, Cambridge University Press, 2016
- J.P. Goedbloed and S. Poedts, Principles of Magnetohydrodynamics, Cambridge University Press, 2010

Course content-related study coaching

The instructor can be contacted after the lectures, or by appointment.
Interactive support via the electronic learning platform.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment

Examination methods in case of periodic assessment during the second examination period

Written assessment

Examination methods in case of permanent assessment

Oral assessment, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Extra information on the examination methods

80% on written exam 20 % on report/ presentation of project

Calculation of the examination mark