Linnæus University

Jnr: 2021/180-3.1.2.2

# Course syllabus

Faculty of Technology
Department of Mathematics

## 1MA601 Vågutbredning i atmosfären, växthuseffekten och global uppvärmning, 7,5 högskolepoäng

## Wave propagation in the atmosphere, the greenhouse effect and global warming, 7.5 credits

**Main field of study**
Physics, Mathematics

**Subject Group**
Mathematics

**Level of classification**
First Level

**Progression**
G1N

**Date of Ratification**
Approved 2020-05-18
Revised 2021-01-18 by Faculty of Technology. Prerequisites are revised.
The course syllabus is valid from spring semester 2021

**Prerequisites**
NO VALUE DEFINED

## Objectives

After completing the course, the student should:
Knowledge and understanding

- A.1 Be able to account for the physical causes of the atmospheric absorption, the greenhouse effect and global warming.
- A.2 Be able to account for the wave equation and Schwarzschild's equation in one space dimension.
- A.3 Have good knowledge of the radiation spectrum of the sun, Planck's radiation law, and the absorption spectrum of the greenhouse gases.
- A.4 Understand how Schwarzschild's equation for radiation transport can be applied with given basic data, especially with regard to global warming.

Abilities and skills

- B.1 Be able to solve simple special cases of the wave equation (in space and time) and the Helmholtz equation (in space and frequency) in one space dimension and a homogeneous atmosphere.
- B.2 Be able to solve simple special cases of Schwarzschild's equation for a homogeneous atmosphere.
- B.3 Be able to use and understand a numerical method to solve Schwarzschild's

- equation for an inhomogeneous atmosphere.
- B.4 Independently be able to perform a simple programming task in Matlab based on the given theoretical models.

Judgement and approach

- C.1 Be able to explain something about the established science's view on global warming and its causes.
- C.2 Demonstrate ability to judge the reasonableness of the results of climate models on the basis of given conditions.

## Content

The course gives an overview on wave propagation in the atmosphere, the greenhouse effect and global warming. The focus is on the mathematical description of these phenomena as well as to give examples of the computations that are made in the climate models. The course contains the following parts.

- Information about what the UN Climate Panel is saying about global warming and its causes.
- An overview about which the greenhouse gases are and why they absorb heat radiation.
- Information about where and how the content of greenhouse gases are measured and what the trends are.
- Detailed information about the solar spectrum as well as the absorption spectrum of the greenhouse gases.
- An overview on wave propagation in the atmosphere, the wave equation, scattering and absorption.
- An overview on heat radiation and radiation transport in the atmosphere, Planck's radiation law, Albedo, the transport equation and Schwarzschild's equation.
- The mathematical solution of the wave equation and the Schwarzschild's equation.
- Numerical solution of Schwarzschild's equation for an inhomogeneous atmosphere.
- An overview on available programs and databases.
- Simple calculations and programming in Matlab.
- A few smaller project assignments with programming in Matlab.

## Type of Instruction

The teaching is conducted in the form of lectures and supervision of project assignments.

## Examination

The examination of the course is divided as following:

| Code | Appellation | Grade | Credits |
|---|---|---|---|
| 2101 | Written examination | U/G/VG | 4.00 |
| 2102 | Project assignments | U/G | 3.50 |

The course is assessed with the grades Fail (U), Pass (G) or Pass with Distinction (VG).
The course is examined with a written exam that is assessed with the grades Fail, Pass or Pass with Distinction. An initial re-examination is offered within six semester weeks. The project assignments are compulsory and are assessed with the grades Fail or Pass.

Repeat examination is offered in accordance with Local regulations for courses and examination at the first and second-cycle level at Linnaeus University.

If the university has decided that a student is entitled to special pedagogical support due to a disability, the examiner has the right to give a customised exam or to have the student conduct the exam in an alternative way.

**Objectives achievement**

The examination parts are linked to the learning outcomes as follows:

| **Goal** | 2101 | 2102 |
|---|---|---|
| A.1 | ✓ | |
| A.2 | ✓ | |
| A.3 | ✓ | ✓ |
| A.4 | ✓ | ✓ |
| B.1 | ✓ | |
| B.2 | ✓ | |
| B.3 | | ✓ |
| B.4 | | ✓ |
| C.1 | ✓ | |
| C.2 | | ✓ |

## Course Evaluation

During the implementation of the course or in close conjunction with the course, a course evaluation is to be carried out. Results and analysis of the course evaluation are to be promptly presented as feedback to the students who have completed the course. Students who participate during the next course instance receive feedback at the start of the course. The course evaluation is to be carried out anonymously.

## Required Reading and Additional Study Material

**Wave propagation in the atmosphere**

Kuo-Nan Liou. An introduction to atmospheric radiation. Academic Press, London, UK, 2002. 201 pages of 583 (chapt. 1-4, 6.5 and 8.1-8.2).

Material from the department (approximately 100 pages).