Lund University

Faculty of Science

ASTM25, Astronomy: Stellar Structure and Evolution, 7.5 credits

Astronomi: Stjärnornas struktur och utveckling, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2019-12-13. The syllabus comes into effect 2019-12-13 and is valid from the autumn semester 2020.

General information

This course is a compulsory course for second-cycle studies for a Degree of Master of Science (120 credits) in astrophysics.

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements
Astrophysics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

This course aims to give the student knowledge of the structure and evolution of stars and an understanding of the physical processes governing them, as well as skills of analysing complex astrophysical problems.

References to aims target the intended learning outcomes in the programme syllabus of Degree of Master in Astrophysics at Lund University,as given in the table below:

Course aim in this course plan	Learning outcomes in programme syllabus

1-7	1a.I
5	1b
8	2
8 and 9	3.I
10	6.I

Knowledge and understanding

On completion of the course, the student shall be able to:

1. Use physical reasoning to derive the basic equations that describe the internal structures of stars, and apply them to calculate pressures and temperatures inside stars.

2. Account for the transport of energy inside stars by radiation and convection.

3. Describe the nuclear reactions that take place in stars and calculate the rates at which they occur.

4. Use mathematical tools including polytropic models, homology relations and Eddington's quartic to determine how the initial masses of stars govern their evolution and final states

Competence and skills

On completion of the course, the student shall be able to:

5. Apply the Hertzsprung-Russell diagram as a tool for classifying stars and calculating stellar radii.

6. Calculate observable properties of stars, including e.g. their magnitudes, using analytic stellar models and homology.

7. Apply Schwarzschild's formula to determine which energy transport mechanism dominates in a given star.

8. Analyse a complex astrophysical problem by breaking it down into its component parts and solving them separately.

9. Demonstrate the ability to work as part of a group to solve a complex astrophysical problem.

Judgement and approach

On completion of the course, the student shall be able to:

10. Evaluate when and how it is appropriate to reference the work of others.

Course content

The course contains the following parts:

- An overview of the different phases of the evolution of a star.
- The magnitude system and using it for stellar astronomy.
- The initial mass function.
- The equations of stellar structure.
- The virial theorem.
- Nuclear reactions in stars.
- Energy transport via radiation and convection.
- The equation of state in stellar conditions.

- Calculations using polytropic stellar models and homology.
- Stellar evolution using analytic stellar models.
- Detailed evolution of high- and low-mass stars from numerical models.
- Supernovae and the formation of heavy elements in the Universe.

Course design

Teaching consists of lectures, problem-based learning sessions, group work and self-study. Compulsory participation is required in

- The introduction to astronomical information systems and referencing
- The problem-based learning sessions

Assessment

Assessment is based on the performance of students in:

- The final written examination, which assesses intended learning outcomes 1-7
- Written reports from the problem-based learning sessions, which assess intended learning outcomes 8 and 9
- A written report from the introduction to astronomical information systems and referencing, which assesses intended learning outcome 10.

Students who do not pass an assessment will be offered another opportunity for assessment soon thereafter.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
The grading scale for the report from the introduction to astronomical information systems and referencing is Fail and Pass. The grading scale for the final written examination and the written reports from the problem-based learning exercises are Fail, Pass and Pass with distinction.

For a grade of pass on the whole course, the student must have passed the written report on the introduction to astronomical information systems and referencing, each of the three written reports on the problem-based learning sessions, and the final written examination.

The final grade is specified by the aggregated results of the different assessed components. The pass mark is 50% and the mark for a pass with distinction is 75%.

When calculating the aggregated result, the second and third problem-based learning sessions are weighted 10% each. The final examination is weighted 80%.

Entry requirements

To be admitted to the course, as well as having English 6/B and meeting the general entry requirements, students must have 75 credits in Physics and 45 credits in Mathematics, or a Bachelor of Science in Physics, in both cases including knowledge corresponding to FYSC11 Atomic and Molecular Physics, 7.5 credits, and FYSC12 Nuclear Physics and Reactors, 7.5 credits.

Further information

This course may not be included in a degree together with ASTM14 The structure and evolution of stars, 7.5 credits.