Faculty of Science

FYTN08, Theoretical Physics: General Relativity, 7.5 credits

Teoretisk fysik: Allmän relativitetsteori, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2008-01-24 to be valid from 2008-01-25, autumn semester 2008.

General Information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) with a specialisation in physics.

Language of instruction: English and Swedish
If needed the course is given in English.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The aim of the course is to give the student an introduction to Einstein's theory of general relativity. The course includes the basic physical ideas, the necessary mathematics and a number of applications, for example bending of light, planetary motion, black holes, gravitational waves and cosmology.

The aims of the course are that, upon completion of the course, the student shall have acquired the following knowledge and skills:

- Theory of Special Relativity and flat space-time: The student understands the concept of space-time and the geometry of space-time and can handle the flat space-time of special relativity.
- Tensors: The student understands and can apply the concept of tensors.
- The equivalence principle: The student can explain the equivalence principle and how it leads to a curved space-time.

- Curved space-time: The student can show, how the mathematics of a curved space-time can be built up with minimal modifications of flat space-time. The student can explain the new concepts that are needed, especially metric, parallel transport and the Riemann tensor.
- Einstein's equations: The student can write down Einstein's equations and from physical principles explain the origin of the different terms.
- The weak field approximation: The student can formulate Einstein's equations in the weak field approximation and use these to derive Newton's law of gravity as well as gravitational waves.
- Strong symmetric and/or static space-time: The student can simplify the metric of a strong symmetric and/or static space-time and solve Einstein's equations in these cases. The student can describe astronomical and cosmological applications, for example black holes and the expansion of the universe.
- Geodesics: The student can explain the concept of geodesics and understands its importance.
- Conservation laws: The student can explain the concept of conserved quantities and apply conserved quantities to analyse possible orbits in a given curved space-time.
- Experimental tests: The student can describe the most important experiments to test general relativity.

Examples of problems that the student should be able to solve upon completion of the course:

- Given a metric, show whether it represents a flat or curved space-time, state conserved quantities and calculate the Christoffel symbols and the Riemann tensor.
- Given the metric of a symmetric space-time, analyse possible orbits and examine whether the space-time contains horizons.

Course content

The course consists of the elements described above for a total of 7.5 credits.

Course design

The teaching consists of lectures and exercises.

Assessment

The examination consists of written hand-in assignments, an oral seminar assignment and an oral test. Students who do not pass the regular exam are offered a new possibility shortly after the regular exam.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
To pass the entire course, a passed oral test as well as passed written hand-in assignments and passed seminar assignment is required.
The final grade is determined by combining the results of the different parts of the examination.

Entry requirements

The prerequisites required for admission to the course are: English B and general entry requirements as well as knowledge equivalent to 90 credits in physics and 30 credits in mathematics.

Further information

The course may not be credited towards a degree together with FYS229.

Subcourses in FYTN08, Theoretical Physics: General Relativity

Applies from V08

0801 General Relativity, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction