TCM304 Mathematical Methods of Physics IIIa (2020-2023)

HUOM! OPINTOJAKSOJEN TIETOJEN TÄYTTÄMISTÄ KOORDINOIVAT KOULUTUSSUUNNITTELIJAT HANNA-MARI PEURALA JA TIINA HASARI

1. Course title

Fysiikan matemaattiset menetelmät IIIa
Fysikens matematiska metoder IIIa
Mathematical Methods of Physics IIIa

2. Course code

TCM304

Aikaisemmat leikkaavat opintojaksot 53713 Fysiikan matemaattiset menetelmät III, 10 op.

3. Course status: compulsory or optional

-Which degree programme is responsible for the course?
Master's Programme in Theoretical and Computational Methods

-Which module does the course belong to?
TCM300 Theoretical and Computational Methods, Advanced Studies
PAP3002 Particle Physics and Cosmology, Advanced Studies

-Is the course available to students from other degree programmes?
Yes

4. Course level (first-, second-, third-cycle/EQF levels 6, 7 and 8)

Master's level, degree programmes in medicine, dentistry and veterinary medicine = secondcycle degree/EQF level 7
Doctoral level = third-cycle (doctoral) degree/EQF level 8

-Does the course belong to basic, intermediate or advanced studies (cf. Government Decree on University Degrees)?
Advanced studies

5. Recommended time/stage of studies for completion

-The recommended (but not compulsory) time for having completed the course would be by the end the first year of the master programme.

6. Term/teaching period when the course will be offered

-The course may be offered in the autumn or spring term or both, during the first period of the term.

7. Scope of the course in credits

5 cr

8. Teacher coordinating the course

Esko Keski-Vakkuri

9. Course learning outcomes

After the course, the student will be familiar with basic concepts of group theory, group representation theory, and topology. The student can identify different common groups, study if their representations are reducible, irreducible or not, and knows why the theory of groups and their unitary representations is important in quantum physics of systems with various symmetries. The student also understands distinctions between nonhomeomorphic topological spaces and understands the use of topological invariants (such as homotopy groups) in their classification.

- See the competence map (https://flamma.helsinki.fi/content/res/pri/HY350274).

10. Course completion methods

The course is lectured as contact teaching, but it is also possible to pass the course by studying it independently (e.g. by a final exam), if so agreed with the lecturer. In the course form, the completion is based on a final exam and weekly homework performance.

11. Prerequisites

-Description of the courses or modules that must be completed before taking this course or
what other prior learning is required

There are no formal prerequisites for this course, but it is recommended to be familiar with linear algebra, differential and integral calculus, and (partial) differential equations. It is also helpful to know basic physics such as classical mechanics, electrodynamics, some quantum mechanics, and theory of special relativity.

12. Recommended optional studies

-What other courses are recommended to be taken in addition to this course?
-Which other courses support the further development of the competence provided by this
course?

13. Course content

-Description of the course content

Group theory: finite groups, continous groups, conjugacy classes, cosets, quotient groups

Representation theory of groups: complex vector spaces and representations, symmetry tranformations in quantum mechanics, reducible and irreducible representations, characters

Topology: topological spaces, topological invariants, homotopy, homotopy groups

14. Recommended and required literature

The course follows "Mathematical methods of physics III", lecture notes by E. Keski-Vakkuri, C. Montonen and M. Panero. Supplementary reading is listed in the lecture notes. The students are encouraged to actively search for additional supplementary material from the Web (e.g., from Wikipedia and other such pages.)

15. Activities and teaching methods in support of learning

-See the competence map (https://flamma.helsinki.fi/content/res/pri/HY350274).
-Student activities
-Description of how the teacher’s activities are documented

Weekly contact lectures, independent work of the student including solving weekly homework problem sets. The

solutions to the problem sets will be submitted weekly, graded by the teaching assistant and discussed in weekly exercise sessions. In these sessions the students may also discuss and get tutoring for

next week's homework.

16. Assessment practices and criteria, grading scale

-See the competence map (https://flamma.helsinki.fi/content/res/pri/HY350274).
-The assessment practices used are directly linked to the learning outcomes and teaching methods of the course.

The grade is determined in a way agreed in the beginning of the course.

17. Teaching language

The course is lectured in English.