GÖTEBORG UNIVERSITY

Faculty Board of Science

MMA200 Advanced Linear and Multilinear Algebra

7.5 credits

Second Cycle

This syllabus is the binding document.

1. Confirmation

The syllabus was confirmed by the Department of Mathematical Sciences on December 1, 2007 to be valid from December 1, 2007. The syllabus was revised on April 26, 2010 to be valid from July 1, 2010. Field of education: Science. Responsible department: Mathematical Sciences.

2. Position in the educational system

The course Advanced Linear and Multilinear Algebra, 7.5 credits, is one of several single subject courses included in the Masters Program in Mathematical Sciences. The course is also open for eligible students outside the program. It is further one of the courses in the post-graduate program in Mathematics.

3. Entrance qualifications

The prerequisite for the course Advanced Linear and Multilinear Algebra is the equivalent of 90 credits in Mathematics, including the course MMG500 Algebraic structures.

4. Course content

Multilinear algebra centered around the tensorproduct and bilinear forms. Generalizations of this leading to symmetric products as well as alternating ones, the latter involving the wedge product. Relationships between the functors Hom and tensorproducts and duality.

Elementary group theory involving combinatorics and classification of groups of low orders, involving notions such as semidirect products and simple groups.

Theory of modules, especially over principal ideal domains, with applications to canonical forms for linear operators. Examples such as semisimple modules and group algebras.

Quadratic and skewsymmetric forms, and canonical forms of those especially over the complex and real numbers respectively. Clifford algebras.

Classical groups, especially those related to quadratic and skewsymmetric forms. The connection between quaternions and SO(3,R). The rudiments of Lie theory, including the relationship between Lie algebras and Lie groups.

Group representations. Traces, characters, charactertables, irreducible representations, ortho-gonality relations, and the explicit workout of the representations for groups of low orders, as well as finite subgroups of the orthogonal groups. Classification of real representations as real, complex and quaternionic.

5. Learning outcomes

After completing the course, the student should above all have acquired a greater mathematical sophistication and be able to solve more challenging problems involving original thinking.

In particular the student should have a command of tensors and wedge products to

- be able to put quadratic forms in canonical forms and decide when two are equivalent

- be able to classify linear transformations and understand multiple roots of the characteristic equations.

Furthermore the student should

- have a firm grasp of elementary group theory and be able to classify groups of low order

- be able to manage calculations pertaining to group representations, in particular be able to recognize irreducible ones.

- acquire some familiarity with classical groups, being able to determine their dimensions, generating finite subgroups, and parametrizations of them from linear approximations.

6. Required reading

List of required reading enclosed.

7. Assessment

An examination will be given at the end of the course. A student who has failed a test twice has the right to change examiner, unless weighty arguments can be invoked. For this, the student must send a written request to the board of the department.

8. Grading scale

The grades are Fail (U), Pass (G), and Pass with Distinction (VG).

Students who are contractually entitled to ECTS grades should inform the examiner about this no later than one week after the start of the course. Students without such entitlement will not be awarded ECTS grades. Grades will be converted into ECTS terminology according to a standard model approved by the University President.

9. Course evaluation

Oral and/or written course evaluation will be performed. The results of the evaluation will be communicated to the students and will serve as a guide for the development of the course.

10. Additional information

The language of instruction is English unless all involved are Swedish speakers.