KTH Teknikvetenskap

SF2729 GROUPS AND RINGS
COURSE PM
2010

1. Course Plan

1.1. **Goals.** After the course, the student shall be able to pursue abstract reasoning about algebraic structures. The student shall be trained in logical thinking and in constructions of mathematical proofs. Algebraic structures appear in many disciplines within Science and Technology. The student shall be able to recognize and use such structures in his or her forthcoming work. Concretely, this means that the student shall be able to:

- Identify and describe fundamental algebraic structures such as groups, rings and fields,
- Identify algebraic substructures such as subgroups, subrings and ideals,
- Identify and describe relations between algebraic structures, such as homomorphisms and group actions,
- Define and use bijective functions between algebraic structures, with special attention to permutations,
- Use classical results in basic group theory and ring theory, such as Lagrange's theorem or Cauchy's theorem, to describe the structure of the group or the ring,
- Explain relations using mathematical proofs and logical reasoning,
- Formulate certain practical problems by means of algebraic structures.

1.2. **Content.** Groups, permutations, homomorphisms, group actions, rings, ideals, modules, fields and field extensions.

1.3. **Eligibility.** SF1604 Linear algebra and SF1204 Discrete mathematics or corresponding courses are required prerequisites.

1.4. **Examination.** One written exam which can partly be replaced by homework assignments and one mid term exam.[1] Grade scale A, B , C, D, E, Fx, F.

1.5. **Literature.** *A First Course on Abstract Algebra, 7th Edition* by John B. Fraleigh.

Date: 2010-01-25.

[1] Details about this in Section 3.

2. ACTIVITIES

The course is running for the whole semester with one lecture and one exercise session every week. During the lectures we will discuss the theoretical material and examples and the exercise sessions will be used for problem solving. Apart from this, it is important that the students have time to study the material on their own and to practise problem solving.

3. EXAMINATION

3.1. **Mid term exam, homework assignments and final exam.** Part of the final exam can be replaced by two optional homework assignments which are to be handed in on February 16 and on April 20. The homework corresponds to the first problem of each section of the exam. The first part of the final exam can be replaced by an optional mid term exam on March 15, 09.00-11.00.

In order to take part in the mid term exam, students have to sign up by sending an email to Mats Boij (boij@kth.se) no later than on March 8.

Registration for the final exam, which will take place on May 26 at 08.00-12.00, should be made no later than on May 12. Location for the final exam will be communicated one week before the exam.

The final exam consists of two sections, one on groups and one on rings. Each part will have three problems which can give up to 6 credits. In order to pass the exam, a minimum of 18 credits is required with no less than 8 credits on either of the two sections. Failing two of these conditions will give the grade F, but failing only one of them will give the grade Fx, which can be upgraded to E through an oral exam. On each part that corresponds to a homework assignment or a mid term exam, the maximum of the obtained results is counted.

The minimum requirements for the various grades are according to the following table:

Grade	**A**	**B**	**C**	**D**	**E**
Total credit	30	27	24	21	18
From part I	13	12	11	9	8
From part II	13	12	11	9	8

3.2. **Reexamination.** There will be a possiblility to retake the final exam in August. Information about the date and location will be available before the end of the course. Deadline for registration for this exam will be two weeks before the exam.

3.3. **Allowed aids.** In the final exam as well as in the mid term exam no aids are allowed. The homework assignments should be made by the student who hands them in. No copying from other students or from other sources is allowed. Collaborations should be clearly stated.

3.4. **Rules at exams and homework assignments.** In all examination the KTH rules for examination apply (cf. www.kth.se).

3.5. **Written presentation.** In the grading of all written examination, including the written exams and the homework assignments, weight will be given on how well presented the solutions are, in particular regarding explanatory text.

4. ADMINISTRATION

4.1. **Contact information.** The following teachers and administrative personnel are involved in the course:

	Name	**email**	**telephone**
Lecturer and Examiner	Mats Boij	boij@kth.se	08-790 66 48
Lecturer	Sandra Di Rocco	dirocco@kth.se	08-790 71 68
Exercise Session Teacher	Stephanie Yang	stpyang@kth.se	08-790 65 89
Course secretary	Rose-Marie Jansson	jansson@math.kth.se	08-790 72 01

Observe that the course secretary only deals with questions regarding registration and reporting of results.

4.2. **Course web page.** On the web page of the course, all relevant information about the course will be found.

URL. http://www.math.kth.se/math/GRU/2009.2010/SF2729/CTFYS

4.3. **Course evaluation.** In the middle of the course we will post a web questionnaire for course evaluation. At the end of the course there will be a summative course evaluation and the examiner will write a course analysis. We welcome any students interested in taking part in a course evaluation group together with the lecturers.

5. TIME BUDGET

The course corresponds to a workload of 7,5 ECTS credits which means 10 hours a week during the whole semester. In total, about 160 hours. We have lectures and exercise sessions using 60 of these hours, leaving 100 hours for studies.

6. SCHEDULE

	Part I - Groups	
Jan 27	Groups	I 1-4
Jan 28	Exercises	
Feb 2	Subgroups, cyclic groups and Cayley digraphs	I 5-7
Feb 4	Exercises	
Feb 9	Permutations	II 8-9
Feb 11	Exercises	
Feb 16	Lagrange's Theorem and finitely generated abelian groups	II 10-12
Feb 18	Exercises	
Feb 23	Homomorphisms and factor groups	III 13-15
Feb 25	Exercises	
Mar 2	Group actions	III 16-17.
Mar 4	Exercises	
Mar 9	Free groups and group presentations	VII 34, 38-40
Mar 11	Exercises	
	Part II - Rings	
Mar 23	Rings and fields, integral domains and Fermat's theorem	IV 18-20
Mar 25	Exercises	
Mar 30	Fields of quotients and rings of polynomials	IV 21-23
Apr 1	Exercises	
Apr 13	Factor rings and ideals	V 26-27
Apr 20	Gröbner bases	V 28
Apr 22	Exercises	
Apr 27	Unique factorization domains and Euclidean domains	IX 45-47
Apr 29	Exercises	
May 4	Exercises	
May 6	Vector spaces and algebraic extensions	VII 29-31
May 11	Exercises	
May 18	Finite fields	VII 32-33
May 20	Exercises	