COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCES		
ACADEMIC UNIT	DEPARTMENT OF MATHEMATICS		
LEVEL OF STUDIES	UNDERGRADUATE PROGRAM		
COURSE CODE		**SEMESTER**	**D**
COURSE TITLE	ALGEBRA		
INSTRUCTOR	Constantinos Kofinas		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
	6	9

COURSE TYPE	General background
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.math.aegean.gr/index.php/en/academics/undergraduate-programs

(2) LEARNING OUTCOMES

Learning outcomes

Understanding of the notions of operations and groups. Ability to provide examples. Understanding of subgps and quotient groups. Examples. Cyclic gps and permutation gps, examples. Acquaintance with structures with two operations. Examples of rings and fields. Understanding of Ideals and quotient rings.

General Competences

Working independently. Team working. Working in an interdisciplinary environment.

(3) SYLLABUS

Setheoretic principles. Union, intersection, difference and complement. 1-1 and onto maps. Inverse map, composition of maps. The sets N, N^*, Z, Z^*, R, R^*, R^+, C. Quantifiers $\forall, \exists$. The meaning of counterexample. Proof by contradiction. Principle of good ordering. Division algorithm in Z. Greatest common divisor. Least common multiple. Prime numbers. Theorem of unique factorization in Z.

Equivalence relations. Equivalence classes. Examples. Operations, associative and commutative operations. Identity element and inverse elements. Definition of semigroup, monoid and group. Examples

Definition of abelian groups. Klein group. Cancelations in groups. Equivalence of the definition of a group with the solutions of the equations a.x=b and y.a=b. Examples. Definition of subgroup. When a subset of a group is a subgroup. Examples.

Cyclic groups. Generators of cyclic groups. Order of an element, order of a group. Examples of elements and groups of infinite order. Definition of group nZ, Z_n. Equations over groups Z_n. Examples of calculations of remainders of “big” numbers.

Definition of left and right cosets of a subgroup of a group. Properties of cosets. Relation between left and right cosets. Coset representative systems. Index of a subgroup. Lagrange’s Theorem. Consequences for finite groups. Definition of group homomorphism. Definitions of monomorphisms, epimorphisms, isomorphisms, automorphisms.

Permutation groups: definition of a permutation. Definition of a k-cycle. 2-cycles. Definition of S_n. Permutations as products of cycles. Cycles as products of 2-cycles. Proof of uniqueness of the decomposition of a permutation as a product of 2-cycles. The group A_n. Proof that the index of A_n in S_n is 2. Cayley's Theorem. Direct product of groups. Direct products of abelian groups. When is Z_n x Z_m isomorphic to Z_{mn}? Kernel and Image of a homomorphism. Normal subgroups. Quotient groups. Normality as a non-transitive property. Natural epimorphism G -> G/K. First Isomorphism Theorem. Consequences, examples. Definition of a ring. Properties. Definition of a field. Subrings. Ring homomorphisms. Kernel and Image of ring homomorphism. Ideals. Ideals as kernels. Quotient rings. First Isomorphism Theorem for rings. Examples. Principal ideal. Integral domain. Characteristic of a ring. Properties. Characteristic of an integral domain. Prime and maximal ideals. Connection between prime ideals and integral domains. Connection between maximal ideals and simple rings. Units of rings. Euclidian Domains. Polynomial rings: definition as sequences of elements of a ring. Operations. Connection with the classical definition. Monic and irreducible polynomials, factorization and primitive polynomials. Polynomial map. Kernel of $f_c : R[x] \to S, R \leq S$. Algebraic and transcendental elements. Examples. Roots of polynomials. Multiplicity. n-th roots of unity. Maximal common divisors. Theorem of unique factorization. Polynomials over Z. Gauss' Theorem (factorization in Q implies factorization in Z). Eisenstein's criterion. Applications.

TEACHING MATERIAL DISTRIBUTION	The teaching material of the course is uniformly distributed during the semester.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Face-to-face lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Communication with students via e-mail
TEACHING METHODS	
COURSE COMMITMENTS	Attending course and tutorial sessions is not obligatory.
STUDENT PERFORMANCE EVALUATION	Student's evaluation is done in Greek through a written examination which includes short-answers questions and problem solving. For students with disabilities, evaluation takes place via oral exams.

Activity	*Semester workload*
Lectures	52
Tutorials	26
Independent study	147
Course total (25 per ECTS)	***225***

(5) ATTACHED BIBLIOGRAPHY

1. Μια Εισαγωγή στην Άλγεβρα, Βάρσος Δημήτρης, Δεριζιώτης Δημήτρης, Εμμανουήλ Γιάννης, Μαλιάκας Μιχάλης, Ταλέλλη Ολυμπία, Εκδ. ΣΟΦΙΑ, 2012.
2. Εισαγωγή στην Άλγεβρα, Fraleigh John, Πανεπιστημιακές Εκδόσεις Κρήτης, 2010.