Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Računska algebra
Course title:	Computational algebra

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Matematika, 3. stopnja		1. ali 2.	1. ali 4.
Mathematics, 3rd Degree		1st or 2nd	1st or 4th

Vrsta predmeta / Course type izbirni/elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30					120	5

Nosilec predmeta / Lecturer: Igor Klep

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski / Slovene
Vaje / Tutorial:	Slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Poznanje osnovnih pojmov iz algebre.

Prerequisits:

Knowledge of basic concepts from algebra.

Vsebina:

Content (Syllabus outline):

- polinomi, polinomski sistemi in Gröbnerjeve baze
- Hilbertov Nullstellensatz, delovanja grup in Hilbertov izrek o končnosti
- končno prezentirane grupe, permutacijske grupe, policiklične grupe in računanje homoloških grup
- načelo Tarskega, eliminacija kvantifikatorjev in cilindrično algebraična dekompozicija

Spodaj navedena literatura praviloma služi le kot osnova in bo nadgrajena z bolj specializiranimi teksti.

- polynomials, polynomial systems and Gröbner bases
- Hilbert's Nullstellensatz, groups actions, and Hilbert's finiteness theorem
- finally presented groups, permutation groups, polycyclic groups and computing homology groups
- Tarski principle, quantifier elimination and cylindrical algebraic decomposition

The literature below in principle serves only as a basis, and will be combined with more specialized texts.

Temeljni literatura in viri / Readings:

- D. Eisenbud: Commutative Algebra with a view toward algebraic geometry, Springer GTM, 1995.
- G.-M. Greuel, G. Pfister: A Singular introduction to commutative algebra, Springer, 2002.
- C.C. Sims: Computation with finitely presented groups, Cambridge, 1994.
- D.F. Holt, B. Eick, E.A. O'Brien: Handbook of computational group theory, Chapman & Hall, 2005.
- The GAP Group, GAP -- Groups, Algorithms, and Programming
- http://www.gap-system.org
- S. Basu, R. Pollack, M.-F. Roy: Algorithms in real algebraic geometry, Springer, 2006.

Cilji in kompetence:

- študenta seznaniti z osnovnimi področji računske algebre
- pripraviti podlago za poglobljeni študij posebnih področij iz algebre;
- razvijati sposobnosti študenta za samostojno reševanje problemov in razumevanje zahtevnejših matematičnih konceptov.

Objectives and competences:

- to get students acquainted with fundamental topics of computational algebra;
- to give students a basis for the advanced study of some special topics in algebra;
- to develop student's skills for solving problems and understanding deeper mathematical concepts.

Predvideni študijski rezultati:

Znanje in razumevanje:

- poznavanje in razumevanje osnovnih rezultatov računske algebre;
- poznavanje algoritmičnih prijemov iz algebre in njihova implementacija..

Prenesljive/ključne spretnosti in drugi atributi:

- podlaga za raziskovalno delo na področju algebre;
- prenos in implementacija znanja iz algebre različna strokovna in znanstvena področja, kjer se uporabljajo algebraične metode.

Intended learning outcomes:

Knowledge and understanding:

- knowledge and understanding of basic results of computational algebra;
- knowledge and understanding of basic algorithmic approaches to algebra and their implementations.

Transferable/Key Skills and other attributes:

- a basis for research in area of algebra;
- implementation and knowledge transfer of statistical methods into different areas dealing with algebraic methods.

Metode poučevanja in učenja:

Learning and teaching methods:

• predavanja; • reševanje praktičnih nalog; • priprava seminarja; • konzultacije; • samostojni študij.	• lectures; • solving concrete problems; • seminar work; • consultations; • self-study.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): • seminarsko predavanje; • rešitve praktičnih nalog; • ustni ali pisni izpit.	**30** **30** **40**	Type (written examination, oral exam, coursework, project): • seminar talk; • solutions of concrete problems; • **oral or written examination.**

Reference nosilca / Lecturer's references:

The Procesi-Schacher conjecture and Hilbert's 17th problem for algebras with involution, J. Algebra, 2010, vol. 324, no. 2, pp. 256-268. (with Thomas Unger).

Constrained polynomial optimization problems with noncommuting variables, SIAM J. Optim., 2012, vol. 22, pp. 363-383. (with Kristijan Cafuta and Janez Povh).

On real one-sided ideals in a free algebra, J. Pure Appl. Algebra, 2014, vol. 218, pp. 269-284. (with Jaka Cimpric, J. William Helton, Scott McCullough and Chris Nelson).

An exact duality theory for semidefinite programming based on sums of squares, Math. Oper. Res., 2013, vol. 38, pp. 569-590. (with Markus Schweighofer).

A local-global principle for linear dependence of noncommutative polynomials, Israel J. Math., 2013, vol. 193, pp. 71-82. (with Matej Brešar).