R E V I E W

On the competition for the occupation of academic position "Professor"

In the Scientific field: 4. Natural Sciences, Mathematics and Informatics,

Professional field: 4.5. Mathematics,

Scientific specialty: „Algebra and Number Theory (Transformation Semigroups)

for the needs of the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Announced in State Gazette no. 84 / 21.10.2022 г.

I.General description of the applicant and submitted documents

1. Candidate data and documentation

Only one candidate has submitted documents for the announced competition – Assoc. Prof. Dr. Jörg Kopitz, IMI, BAS. Jörg Kopitz was born on 07.09.1966 in Halle, Germany. In 1989, he graduated as a mathematics and physics teacher. In 1993 г. he defended his doctoral dissertation (doctorrerum naturalium) on the topic "Semigroups with a v-semidistributive lattice of subsemigroups" at the University of Potsdam. At present he is an associate professor at the Institute of Mathematics and Informatics, BAS.

The documents submitted by the candidate fully comply with the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Rules for Implementation of the ADAS in the Republic of Bulgaria (RIADAS in the RB) and the Rules on the Terms and Requirements for Acquisition of Scientific Degrees and Occupation of Academic Positions at Intitute of Mathematics and Informatics. With a minimum requirement of 660 points, the candidate has submitted evidence for 839 points;

The scientific papers presented by the candidate do not repeat those from previous procedures for acquiring a scientific title or academic position.

2. General characteristics of the applicant's scientific work and achievements

Dr. Kopitz's scientific interests are in the algebraic theory of semigroups, and he is the author of 83 publications in refereed journals, 13 publications in scientific conference proceedings and one textbook.

17 scientific publications are submitted for participation in the competition, all of which are in journals with an impact factor. The applicant declares that the participation of the co-authors in the presented articles is equal. Ten of the articles have one co-author, five - with two co-authors and two - with three co-authors.

The scientific works of Prof. Dr. Kopitz have been cited 102 times, and the articles submitted for participation in the competition have been cited 26 times.

3. Characterization and evaluation of teaching, work on projects and other activities

The candidate has given lectures and exercises on Algebra, Linear Algebra, Number Theory, Arithmetic, Semigroup Theory, Analysis, Graph Theory, etc. for students majoring in Mathematics, Informatics, Geography at the University of Potsdam – Germany (2001 – 2022). He has lectured at other universities: Brno University of Technology, University of Szeged, South-West University Blagoevgrad, Universidade Nova de Lisboa, Luhansk Traras Shevchenko National University. He was the supervisor of 8 successfully defended doctoral students in "Algebra" (7 at the Institute of Mathematics of the University of Potsdam - Germany and 1 at the University of Khon Kaen - Thailand). He is currently the scientific supervisor of a doctoral student.

He has been a member of organizing or program committees of 7 conferences. He is a member of the scientific editorial board of the journals "Discussiones Mathematicae" and "Asian-European Journal of Mathematics". He has participated in 5 scientific projects, in one of which as a leader.

4. Content analysis of the applicant's scientific and scientific-applied achievements, contained in the materials for participation in the competition

The scientific achievements of the candidate can be classified in 4 directions.

Transformation semigroups – papers 1, 2, 3, 4, 7, 9, 14, 15

Any semigroup can be embedded isomorphically into a semigroup of transformations of suitable set. In this group of papers, properties of semigroups of complete or partial transformations with certain properties are studied. The semigroups of order-preserving transformations of a finite chain (i.e., a linearly ordered set) have been intensively studied.

In particular, the so-called zig-zag ordering is considered, and the corresponding partially ordered set is called a fence. In articles [1, 15], the rank of the semigroup FIn of all partial automorphisms of an n-element fence preserving the zig-zag order is determined. In [15] a description of the Green's relations of this inverse semigroup is given. В статия [1], която обобщава резултатите от [15] е изследван рангът на моноида FIn при нечетно n. In article [1], which generalizes the results of [15], the rank of the monoid FIn for odd n is studied. In [14], results related to the zig-zag order in the set of natural numbers N are obtained. In paper [9], complete transformations preserving the zig-zag order are studied. In [2] a formula for the relative rank of T(X,Y) modulo OP(X,Y) is presented and all relative generating sets of T(X,Y) modulo OP(X,Y) with a minimal number elements are characterized.

In [3] the remaining cases for the set X are considered and it is shown that the relative rank of OP(X) modulo O(X) is equal to one.

In [4] and [7] problems from algebraic graph theory are considered. In [7], the rank and power of monoids of all endomorphisms of Pn and the monoid of all weak endomorphisms of Pn are calculated.

Doppelsemigroups – papers 8, 10, 11

Doppelsemigroups were introduced by B. Richter in [R,97]. A doppelsemigroup is an algebraic structure of a nonempty set and two binary associative operations satisfying two additional axioms. In [8], rectangular doppel-semigroups were studied by constructing the free rectangular doppel-semigroup of arbitrary rank. In paper [10] it is proved that any doppelsemigroup can be embedded isomorphically into an ordered doppelsemigroup of binary relations of a suitable set. In [11] the free product of arbitrary n-ary semigroups are considered and the free commutative n-ary semigroup of arbitrary rank are constructed.

Semigroups under point of view of Universal Algebra – papers 5, 6, 13, 16, 17

Certain subsets of the symmetric semigroup T(X,Y) have an important interpretation in automata theory and thus in a broader sense also in theoretical informatics, namely the semigroups of nondeterministic transformations. A nondeterministic mapping from X to Y is a mapping of X into the set of all nonempty subsets of Y.

Algebraically, a non-deterministic transformation can be viewed as a set of transformations, i.e. as an element of the set TP(X,Y) of all nonempty subsets of T(X,Y). In a canonical way, one can define an associative operation in TP(X,Y). The semigroup of nondeterministic operations on X with domain in some nonempty subset of the set of all subsets of Y can be nested into the semigroup TP(X,Y). This motivates the study of the semigroup TP(X,Y). Some properties and isomorphic semigroups of TP(X,Y) are already known (see for example [S,17]). In [6, 13, 16] we limited ourselves to the case where Y is a two-element set.

This is an interesting case, since if Y has two elements, then the semigroup of nondeterministic Boolean operations can be embedded in TP(X,Y). Essential to the study of TP(X,Y) is the structure of the monoid T(X,Y). We assume that T(X,Y) is the so-called 4-part semigroup. Since TP(X,Y) is not regular, it is important to study Green's relations. This question is solved in [13]. In [13], the largest congruence that is contained in the corresponding Green's relation is defined. This gives important information about the congruence structure of the semigroup, such as the monoid of endomorphisms.

In [6] all ideals as well as all principal ideals of TP(X,Y) are characterized. In [16] regular elements and idempotents were studied, finding all maximal regular subgroups of TP(X,Y). In [5] the idempotents and regular elements in the monoid of all generalized hypersubstitutions of algebraic systems are characterized. In [17] all stable varieties of semigroups are characterized, showing that there are exactly 10 stable varieties of semigroups which are at the bottom of the lattice of all varieties of semigroups.

Semihypergroups – paper 12

In article [12], semihypergroups are studied from a certain point of view. This article makes the argument that the study of hyperstructures is not necessary in every case. It is proved that every semihypergroup can be considered as a semigroup. All second-order semihypergroups are characterized, finding 17 of them.

5. Critical notes and recommendations

I have no critical notes or recommendations.

6. Conclusion on the application

Based on the materials submitted for participation in the competition by Assoc. Prof. Kopitz, I believe that his scientific achievements meet the requirements of the ADAS in the Republic of Bulgaria, the Rules for its Implementation and the corresponding Rules of the Institute of Mathematics and Informatics for occupation of the academic position of "professor" in the scientific field and professional direction at the contest. The candidate satisfies the minimum national requirements in the professional field. I give my positive assessment to the application.

II. General conclusion

Based on the above, I strongly recommend that the Scientific Jury propose to the Scientific Council of IMI-BAS to award Assoc. Dr. Jörg Kopitz the title of "Professor" in the field of higher education: 4. Natural Sciences, Mathematics and Informatics, professional field 4.5 Mathematics, scientific specialty "Algebra and number theory" (Semigroups of transformations).

Date: 19.03.2023 г.   Signature:

(Prof. Emil Kolev)