# REVIEW
## of the official reviewer for the dissertation work of
## Mashurov Farukh Arkinovich on the topic «Special Tortkara algebras and assosymmetric algebras»,
## submitted for the degree of Doctor of Philosophy (PhD) in the specialty "8D06103 - Mathematical and computer modeling".

| № p/p | Criteria | Compliance with the criteria (you must mark one of the answer options) | Justification of the official reviewer's position |
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| 1. | The topic of the dissertation (as of the date of its approval) corresponds to the directions of development of science and / or state programs | 1.1 Compliance with priority areas for the development of science or government programs: | Fundamental and applied research in mathematics and physics |
| | | 1) The dissertation was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program) 2) The dissertation was completed within the framework of another state program (indicate the name of the program) **3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)** | The presented dissertation corresponds to the priority direction of science development, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in the direction of personnel "8D061 - Information and Communication Technologies" (specialty "8D06103 - Mathematical and Computer Modeling"). |
| 2. | Importance for science | The work **makes** / does not make a significant contribution to science, and its importance is well disclosed / not disclosed | The work makes a significant contribution to science, and its significance is well disclosed, as evidenced by the relevance and scientific novelty of the tasks outlined in work. The dissertation work contributes significantly to the solution of the relevant tasks posed in the dissertation. |
| 3. | The principle of independence | Self-reliance level: 1) **High;** 2) Medium; 3) Low; 4) There is no independence | The presented dissertation work has a high level of independence, which is also reflected in the results of the doctoral candidate's publication. There are publications in high-ranking journals where the applicant is the first author |

| | | | | and the author for correspondence. Level of independence: high. |
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| 4. | The principle of internal unity | 4.1 Rationale for the relevance of the dissertation: <br> 1) **Justified;** <br> 2) Partially justified; <br> 3) Not substantiated. | | The relevance of the work is well substantiated. The author of the dissertation demonstrates the practical possibility of implementing the obtained algorithm in the classification theory of finite-dimensional nilpotent algebras. |
| | | 4.2 The content of the dissertation reflects the topic of the dissertation: <br> 1) **reflects;** <br> 2) partially reflects; <br> 3) does not reflect | | The topic of the dissertation is reflected in the content and gives a complete understanding of the meaning of the dissertation |
| | | 4.3. The purpose and objectives correspond to the topic of the dissertation: <br> 1) **correspond;** <br> 2) partially correspond; <br> 3) do not correspond | | The goals and objectives set out in the dissertation work are closely related to the research topic, and the author effectively shows the achievement of these goals by diligently performing all related tasks. |
| | | 4.4 All sections and provisions of the dissertation are logically interconnected: <br> 1) **are fully interconnected;** <br> 2) the relationship is partial; <br> 3) there is no relationship | | The dissertation exhibits a highly organized and well-structured format, wherein all chapters are interrelated and systematically present an elaborate account of the research results. |
| | | 4.5 The new solutions proposed by the author (principles, methods) are argued and evaluated in comparison with the known solutions: <br> 1) **there is a critical analysis;** <br> 2) partial analysis; <br> 3) the analysis is not one's own opinions, but quotes from other authors | | The author presented accurate, logically verified substantiations of the main provisions of the dissertation submitted for defense. |
| 5. | The principle of scientific novelty | 5.1 Are scientific results and provisions new? <br> 1) **completely new;** <br> 2) partially new (25-75% are new); <br> 3) not new (less than 25% are new) | | The results obtained in the dissertation work are completely new. |
| | | 5.2 Are the conclusions of the dissertation new? <br> 1) **completely new;** <br> 2) partially new (25-75% are new); <br> 3) not new (less than 25% are new) | | The conclusions presented by the author are completely new because they represent a new solution to emerging |

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| | | | problems in the theory of Tortkara and assosymmetric algebras. |
| | | 5.3 Technical, technological, economic or managerial decisions are new and justified:<br>1) **completely new;**<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new) | The results obtained are mostly fundamental and theoretically new. By virtue of the consistent formulation and demonstration of the proofs of lemmas and theorems that allow one to obtain the necessary expressions explicitly. |
| 6. | Validity of the main conclusions | All key findings are **based**/not based on scientifically sound evidence, or reasonably well-founded (for qualitative research and arts and humanities courses) | The main conclusions of the thesis are fully justified. Lemmas and theorems are proved in detail, consistently and clearly stated. |
| 7. | Basic provisions for defense | The following questions need to be answered for each position separately:<br>7.1 Is the position proven?<br>1) **proven;**<br>2) rather proven;<br>3) rather unproven;<br>4) not proven<br>7.2 Is it trivial?<br>1) yes;<br>2) **no**<br>7.3 Is it new?<br>1) **yes;**<br>2) no<br>7.4 Level to apply:<br>1) narrow;<br>2) medium;<br>3) **wide**<br>7.5 Is it proven in the article?<br>1) **yes;**<br>2) no | 7.1 All results are fully proven.<br>7.2 All the main results are non-trivial.<br>7.3 The main results presented for defence are new.<br>7.4 The main results presented for defence expand the class of problems that can be considered in non-associative algebras. Also, the application of Tortkara algebras is closely related to the signature of iterated integrals (area of areas).<br>7.5 The main results of the study were obtained and proved in articles published in journals included in the Scopus and Web of Science databases. |
| 8. | The principle of certainty Reliability of sources and | 8.1 The choice of methodology is justified or the methodology is described in sufficient detail<br>1) **yes;**<br>2) no | The author makes good use of the proven methods of the theory of nonassociative algebras. |

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| | information provided | 8.2 The results of the dissertation work were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies:<br>1) **yes;**<br>2) no | The results of the dissertation work are obtained using modern methods of the scientific research with the use of computer technology. |
| | | 8.3 Theoretical conclusions, models, identified relationships and patterns are proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results are proven on the basis of a pedagogical experiment):<br>1) **yes;**<br>2) no | Experimental studies are not needed to confirm the theoretical conclusions presented in the dissertation, since the reliability of the study is supported by rigorous proofs. |
| | | 8.4 Important statements are **supported** / partially confirmed / not supported by references to relevant and reliable scientific literature | The results of the work are consistent with the published works. Exact references to related sources are provided. |
| | | 8.5 Used literature sources are **sufficient** / not sufficient for a literature review | The literature sources used are sufficient. |
| 9 | Principle of practical value | 9.1 The dissertation has a theoretical value:<br>1) **yes;**<br>2) no | The dissertation has high theoretical value. |
| | | 9.2 The dissertation is of practical importance and there is a high probability of applying the results obtained in practice:<br>1) **yes;**<br>2) no | The dissertation can find application in their usefulness for solving problems related to the field of the theory of non-associative algebra. |
| | | 9.3 Are the practice suggestions new?<br>1) **completely new;**<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new) | Suggestions are new. |
| 10. | Quality of writing and design | Quality of academic writing:<br>1) **high;**<br>2) medium<br>3) below medium;<br>4) low. | The style of the dissertation is high. |

**Conclusion:**

The dissertation work of Mashurov Farukh on the topic "Special Tortkara algebras and assosymmetric algebras" submitted for the degree of Doctor of Philosophy (PhD) meets all the qualification requirements of the Rules for awarding degrees, presented for doctoral (PhD) dissertations. The dissertation of Mashurov Farukh Arkinovich as a whole has the character of completed research and fully complies with all the requirements and standards for a PhD dissertation (Doctor of Philosophy) in the specialty "8D06103 - Mathematical and computer modeling" and deserves to be awarded the degree of Doctor of Philosophy (PhD).

**Official reviewer:**
Department of Mathematics,
University of Porto (Portugal),
PhD, researcher.

M. Khrypchenko