Statement report

under the procedure for acquisition of the educational and scientific degree "Doctor"
by candidate **Boyan Stefanov,**
of the PhD Thesis entitled: "Optimal Control Problems under Uncertainty ",
In the Scientific field: **4. Natural Sciences, Mathematics and Informatics**
Professional field: **4.5. Mathematics**

Doctoral program "Operations Research", Department „ Probability Operations Research and Statistics",
Faculty of Mathematics and Informatics (FMI), **Sofia University "St. Kliment Ohridski" (SU),**

The review has been prepared by: **Prof. Dr. Sci. Ognyan Kounchev**,
(academic position, scientific degree, given names, surname - place of work)
as a member of the scientific jury for the defense of this PhD thesis according to Order №129/ 1.3.2024 of the Rector of the Sofia University.

1. **General characteristics of the dissertation thesis and the presented materials**

The dissertation comprises 72 pages and is structured into an introduction and three additional chapters presenting the author's contributions, followed by a brief concluding chapter. The bibliography includes 53 items.

2. **Short CV and personal impressions of the candidate**

I have known the doctoral candidate since 2021 when he was a PhD student under Professor Mikhail Krastanov advisory, actively engaged in an interesting new field of Optimal Control and Game Theory. I have attended his presentations at the IMI-ORPS section seminars where he presented the dissertation findings. I was impressed by the depth of his understanding of these areas and the novel results they have achieved, as well as his adequat responses to questions raised.

3. **Content analysis of the scientific and applied achievements of the candidate, contained in the presented PhD thesis and the publications to it, included in the procedure**

In his dissertation, BS presents new original results, which have been published or are in the process of being published, totalling four articles. One of the articles has been published in the renowned journal "Dynamic Games and Applications." These articles are joint works with Professor M. Krastanov and/or Dr. Rosen Rozenov.

Overall, the dissertation is dedicated to problems in Optimal Control under Uncertainty. This is a topic that is highly relevant in various fields of applied mathematics in today's world.

In Chapter 1 of the dissertation, a sufficient optimality condition is derived for a linear-quadratic differential game with an infinite horizon, subject to constraints imposed on the

control of one of the players. The novelty here lies in the difficulty arising from the infinite horizon and the imposed control constraints. This is a new result that has not been published before. The proof technique is based on breaking down the game into two phases and applying standard techniques to each of them. This approach leverages the fact (proved in the dissertation) that there exists a neighborhood of zero in the phase space where the constraints are not active, allowing us to use standard techniques for finding optimal strategies.

In a similar manner, the results in Chapter 2 were obtained, where the discrete case of the same linear-quadratic game with an infinite horizon and constraints on control was examined.

The results in Chapter 3 of the dissertation have been published in two articles. The first result establishes a necessary optimality condition for a discrete game with an infinite horizon in a general form. Its proof crucially relies on defining the adjoint variable explicitly, a definition borrowed from a recent paper by Aseev and co-authors. The second result in the chapter presents a sufficient optimality condition for the Optimal Control problem with discrete time. The proof technique is related to the proof technique of the first result under suitable assumptions.

4. Approbation of the results

The scientific metrics of these articles significantly surpass the minimum requirements for obtaining the educational and scientific degree of "doctor" in the respective scientific field and professional direction, as defined in Regulation No. 26 of February 13, 2019. The scientific publications fall into Group G7 and accumulate a total of 105 points, exceeding the minimum requirements of 30 points for the respective field. The first publication is classified as Q3 and is rated at 45 points, while the second and third are classified as SJR and are rated at 30 points each. The obtained 105 points substantially exceed the minimum requirements for a doctoral degree.

It is clearly stated that:

a) the scientific works meet the minimum national requirements (under Art. 2b, para. 2 and 3 of ADASRB*) and respectively to the additional requirements of Sofia University “St. Kliment Ohridski” for acquiring the educational and scientific degree “Doctor” in the scientific field and professional field of the procedure;
b) the results presented by the candidate in the dissertation work and scientific works to it do not repeat such from previous procedures for acquiring a scientific title and academic position;
c) there is no plagiarism proven in the legally established order in the submitted dissertation work and scientific papers under this procedure.

5. Qualities of the abstract

The abstract contains 39 pages and meets all technical requirements. The presentation of the results in the abstract is adequate to the content of the dissertation.

6. Critical notes and recommendations

In principle, I do not have critical remarks, just a technical one – the bibliography has to be numbered.

7. Conclusion

Having become acquainted with the PhD thesis presented in the procedure and the accompanying scientific papers and on the basis of the analysis of their importance and the scientific and applied contributions contained therein, **I confirm** that the presented PhD thesis and the scientific publications to it, as well as the quality and originality of the results and achievements presented in them, meet the requirements of the ADAS in the Republic of Bulgaria, the Rules for its Implementation and the corresponding Rules at the Sofia University "St. Kliment Ohridski" (FMI-SU) for acquisition by the candidate of educational and scientific degree "Doctor" in the Scientific field 4. Natural sciences, mathematics and informatics, Professional field Mathematics. In particular, the candidate meets the minimal national requirements in the professional field and no plagiarism has been detected in the scientific papers submitted for the competition.

Based on the above, **I strongly recommend** the scientific jury to award to Boyan Stefanov, the educational and scientific degree "Doctor" in the Scientific field 4. Natural sciences, mathematics and informatics, Professional field 4.5. Mathematics.

Date: 7.5.2024 Reviewer: . .....

/Prof. Dr. Sci. Ognyan Kounchev/

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