

# ATTITUDE OF REVIEWER

**for Assist. Prof. Milen Kolev Borisov, PhD  
on a competition for the academic position "Associate Professor"  
at the Institute of Mathematics and Informatics - BAS  
in the field of higher education 4. Natural sciences, mathematics and informatics,  
professional direction 4.5. Mathematics, scientific specialty "Mathematical Modeling and  
Application of Mathematics" (Mathematical Biology), announced in Newspaper of State,  
No. 14 of February 10, 2023**

Prepared by: Prof. Dr. Nikolay Veselinov Kyurkchiev

By order No.184/07.04.2023 of the Director of IMI-BAN, I am designated as a member of the Scientific Jury in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.5. Mathematics, science specialty "Mathematical Modeling and Application of Mathematics" (Mathematical Biology).

To participate in the announced competition for "Associate Professor", the Assist. Prof. Dr. Milen Kolev Borisov from the "Mathematical Modeling and Numerical Analysis" section of IMI-BAN has submitted his documents.

The required documents for participation in the competition have been submitted in an orderly form.

The candidate - Assist. Prof. Milen Borisov, PhD, presents himself in the competition for "Associate Professor" with 11 scientific publications.

The works presented were published as follows: 7 in journals with an Impact Factor (total IF=18.487 – based on Web of Science) of which 1 article with grade – Q1; 5 articles with grade – Q2 and 1 article with grade – Q3; 2 in journals with SJR (total SJR= 0.705); 1 article in an indexed edition and 1 article in a non-indexed edition.

The publications submitted have not been used to obtain the educational and scientific degree "Doctor" as five of the publications with IF or SJR were published after acquiring the academic position "Assist. Prof." from the candidate, which satisfies the requirements in the sense of the ZRASRB, the Regulations for the implementation of the ZRASRB and the Regulations of IMI-BAN for the implementation of the ZRASRB.

## **Main scientific and applied-scientific results of the candidate:**

The candidate has conditionally grouped the scientific publications presented in the competition into several thematic areas, as follows:

- Mathematical modeling of continuous bioreactors
- Reaction networks and applications in biomathematics
- Mathematical epidemiology

Publications [1], [4–7], [9–10] are devoted on the first thematic area; [2], [8] and [11] – on the second, and [3] – on the third.

I will explicitly note that in the **1st thematic area**, the research is strongly influenced by Prof. Neli Dimitrova - the scientific supervisor of the candidate. Here, the main contributions are in the area of:  
- *Mathematical modeling of continuous bioreactors for wastewater treatment:*

a time delay is introduced into the differential equation of the biomass. The equilibrium points of the newly model are determined, their local asymptotic stability as well as the occurrence of local Hopf bifurcations are studied in dependence on the delay parameter  $\tau$ . A proof for the existence and uniqueness

of positive solutions of the model is applied, as well as the global stabilizability of the model dynamics is proved for certain values of the delay [9]. In [10] is studied a mathematical model for biodegradation of a mixture from phenol and sodium salicylate in wastewater. The model is described by a system of three nonlinear ordinary differential equations and it is similar to the model from [9]. The difference is that the model in [10] has competitive inhibition between the two pollutants (substrates), and no time delay is introduced into the biomass equation. A precise proof of the existence and uniqueness of positive solutions of the model, as well as global asymptotic stabilizability of its dynamics, is given. The performed theoretical analysis and computer simulations can be successfully used to better understand the biodegradation dynamics of the chemical compounds in the bioreactor and to predict and control the system behavior in real life conditions.

- *Mathematical modeling of continuous bioreactors for methane (biogas) production:*

the considered non-trivial differential model (introducing discrete time delays), to represent the delay in the conversion of the consumed substrate to viable biomass; a precise proof of existence and local stability of nontrivial (no washout of biomass) equilibrium points; existence and boundedness of the model solutions as well as global stabilizability towards an admissible equilibrium point [1]; the considered asymptotic stabilizability of the mathematical model of a bioreactor for biological degradation of organic wastes with methane production [4]; the proof of the existence of an attracting and invariant region around the equilibrium point such that all trajectories enter this region and remain there in finite time for some values of the delay; the applied mathematical analysis for investigation of asymptotic stability of the closed-loop system, which is obtained after replacing the dilution rate  $u$  with the feedback  $\chi$  in the model from [4], and the proof of its global asymptotic stabilization towards the previously chosen non-trivial equilibrium (target) point [5].

- *Mathematical modeling of continuous bioreactors for methane and hydrogen production:*

the proposed new mathematical model in [6], describing a biotechnological two-phase anaerobic digestion process, carried out in two connected continuously stirred bioreactors, of simultaneous production of hydrogen (produced during the first phase in the first bioreactor) and methane (produced during the second phase in the second bioreactor); the proposed model in [6] is further developed in [7], under assumptions that as a result of hydrolysis and acidogenesis in the first bioreactor, not only acetate is obtained, but also butyrate, propionate and valerate; and in addition to methanogenesis in the second bioreactor, acetogenesis also occurs, in which the obtained propionate, butyrate and valerate in the first bioreactor are transformed by the corresponding microorganisms into acetate, which is transformed by the methanogenic microorganisms into methane.

**I give a very high assessment of the candidate's work in the 1st applied-scientific thematic area.**

**In the 2<sup>nd</sup> thematic area:**

- the study of two new autocatalytic reaction networks and their corresponding Gompertz-type growing models; the conclusions that they are suitable for modeling biological growth processes that grow more slowly at the beginning and at the end, and where the growth process depends on more than one resource; the presented numerical computations and visualized using some appropriate software tools [2];

- the investigate dynamical system induced by the two-step exponential (growth-)decay (2SED) reaction network involving and the precise analysis of studying the properties of its solutions such as monotonicity, asymptotes, extremums, inflection points, etc.; the performed comparative analysis of the proposed new epidemiological model (called G-SIR), which is obtained from the replacement of the logistic contact mechanism (of type one-to-one contacts between individuals) with Gompertz type catalytic contact mechanism in the classical SIR model, and the made conclusion that the G-SIR model is

suitable to model epidemic outbreaks related to diseases for which the spread pattern occurs simultaneously in both ways: communicative and non-communicative [8].

- the simulations of epidemiological data (involving uncertainties) using the 2SED model [11]. I will explicitly note that until now I have not met in the literature such a precise analysis of the cumulative function of the Gompertz probability distribution (or shifted Gompertz distribution).

**In the 3<sup>rd</sup> thematic area:**

- the development of the mathematical models of immune response in dengue fever for the two infection scenarios: a model of primary infection when there is a lack of antibodies in the human body, described by 8 ODEs, and a model of secondary dengue infection, when the existed antibodies can interact with the immature virions in which severe form of the disease is observed, described by 11 ODEs;

- the precise estimates of the basic reproductive number for the two infection scenarios, which are contributions to the field of vector-borne disease modeling [3].

I will explicitly note that part of the analyzed results in [8] and [11] (from the 2<sup>nd</sup> thematic area) are also related to the 3<sup>rd</sup> thematic area.

I have not ascertained “plagiarism” in the candidate’s scientific works within the meaning of the law for the Development of Academic Staff Act in the Republic of Bulgaria.

### **The citations, impact factor and resonance of the publications of Assist. Prof. Dr. Milen Borisov.**

The candidate's scientific works have national and international recognition.

This is what the presented 32 citations only in Web of Science and Scopus (see List of citations for participation in the competition). The candidate has also submitted a complete list of works cited - 50 pieces.

**Note.** In the process of preparing the opinion, I found that the list of citations is longer. For example, the publication No. 3 from the presented list of publications for participation in the contest is also cited in the following articles

- Rohit Goel, RC Mittal, and Neha Ahlawat, B-Splines Collocation Approach to Simulate Secondary Dengue Virus (DENV) Infection Model with Diffusion, In: RK Sharma et al. (eds.), *Frontiers in Industrial and Applied Mathematics, Springer Proceedings in Mathematics & Statistics* 410, [https://doi.org/10.1007/978-981-19-7272-0\\_16](https://doi.org/10.1007/978-981-19-7272-0_16) (2023); SJR:=0.204
- S. Rashid, F. Jarad, SAA El-Marouf, SK Elagan. "Global dynamics of deterministic-stochastic dengue infection model including multi specific receptors via crossover effects". *AIMS Mathematics*. 8(3): 6466-6503, 2023; IF:=2. 739.

The publication No. 4 from the presented list of publications for participation in the competition is also cited in the following article

- Tingting Yu and Sanling Yuan, Dynamics of a stochastic turbidostat model with sampled and delayed measurements, *Math. Biosciences and Engineering*, 20(4), 6215-61236 (2023); IF:=2.194.

The publication No. 6 from the presented list of publications for participation in the contest is also cited in the following article:

- Abilmazhinov, Y.; Shakerkhan, K.; Meshechkin, V.; Shayakhmetov, Y.; Nurgaliyev, N.; Suychinov, A. *Mathematical Modeling for Evaluating the Sustainability of Biogas Generation through Anaerobic Digestion of Livestock Waste. Sustainability* 2023, 15, 5707, 2023; IF:= 3.899.

The publication under No. 6 from the presented list of publications for participation in the contest is also cited in the following article:

- Prodanov, D., "Asymptotic Analysis of the SIR Model and the Gompertz Distribution." Journal of Computational and Applied Mathematics, vol. 422, Elsevier BV, Apr. 2023, p. 114901. <https://doi.org/10.1016/j.cam.2022.114901>, 2023; IF:=2.872.

With this update, the actual IF of the citations is quite a bit higher. Everything that has been said up to this point shows that the minimum requirements for this criterion have been significantly exceeded.

The candidate presented his author's reference in an impeccable form and after the analysis, I found that the required number of points by groups of indicators for occupying the academic position "Associate Professor" were covered. Dr. Milen Borisov participated in 4 National Research Projects: 1 with FNI; 1 under the National Program "ICT in NES"; 2 projects, as the head of the program to support young scientists at the BAS. Participated in over 30 national and international seminars and conferences. He led exercises on the elective discipline "Mathematical Modeling in Biology" for students from FMI of SU in the period 2018-2022. The additional requirements of IMI-BAS for acquiring the academic position of "Associate Professor" were also fulfilled.

## **CONCLUSION.**

From everything that has been said so far about the candidate's works presented in the competition it is clear that in them are received sufficient scientific contributions in terms of quantity and quality.

I am fully convinced that Assist. Prof. Milen Kolev Borisov, PhD, meets the requirements of the ZRASRB, the Regulations for the implementation of the ZRASRB, the Regulations of IMI-BAN for the implementation of the ZRASRB for the occupation of the academic position "Associate Professor".

Therefore, my conclusion for filling the academic position "Associate Professor" announced by the competition from Assist. Prof. Dr. Milen Borisov is strictly **POSITIVE**.

**I propose to the honorable scientific jury to unanimously propose to the NS of IMI-BAN to elect the candidate Assist. Prof. Milen Kolev Borisov, PhD, for the academic position "Associate Professor" in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.5. Mathematics, scientific specialty "Mathematical modeling and application of mathematics" (Mathematical Biology).**

**May 20, 2023**

**Signature: .....**

**/prof. Dr. Nikolay Kyurkchiev/**