

R E V I E W

on the competition for academic position „associate professor“ in the field of higher education 4. “Natural sciences, mathematics and informatics”, professional direction 4.5. “Mathematics”, by scientific speciality “Mathematical modelling and application of the mathematics”, noticed in SG 14/10.02.2023 for the necessities of the Institute of mathematics and informatics- Bulgarian Academy of Sciences, with sole applicant: chief assist. professor PhD Milen Kolev Borisov

Member of the scientific jury: full professor DSc Svetoslav G. Nikolov, Institute of mechanics-BAS

1. General state and biographic data

The competition for academic position (AP) „associate professor“ by scientific speciality “Mathematical modelling and application of the mathematics” is noticed in SG 14/10.02.2023 and it is published in the official website of the Institute of mathematics and informatics, Bulgarian Academy of Sciences (IMI-BAS).

In legitimate date in the IMI-BAS secretariat only the documents on the competition of chief assist. professor PhD Milen Kolev Borisov are submitted. Now, he is a chief assist. professor at the IMI-BAS, section “Mathematical modelling and numerical analysis”.

Chief assist. professor Borisov obtained his master degree from Sofia University “St. Kliment Ohridski” since 2008 year, speciality “Informatics”, master degree program “Bio and medical informatics”. Since 2013, he defended his PhD thesis named “Stability and bifurcations of equilibrium points in mathematical models of bioprocesses” at the IMI-BAS, and he obtained PhD degree by scientific speciality “Mathematical modelling and mathematical applications”.

In the past 11 years the academic career of chief assist. professor M. Borisov is connected with his work as assist. professor (2012-2020) and chief assist. professor (2020-till now) at the IMI-BAS.

2. General description of the submitted documents for the competition

For the competition, senior assist. professor Milen Borisov 11 publications for review is presented, as all from them are connected with the subject of the competition. Seven papers are with IF (one in Q1, five in Q2 and one in Q3), two are with SJR, and the rest two papers are published in journals, which are not indexed in SCOPUS and Web of Science. Three papers (with numbers [2], [8] and [11]) are included in a habilitation work. The information for scientific papers included in PhD thesis (4 papers – 1 with IF and 1 with SJR), as two papers with SJR for the chief assist. professor competition are presented. Can be noted that an information and evidence materials for additional activities not included in the minimal national rules are also presented – practical lecturer of masters and bachelors in Mathematical modelling in biology for the period 2018-2022 year, Sofia University “St. Kliment Ohridski”, and a member of scientific teams in 1 external fro IMI-BAS project and two internal for IMI-BAS projects.

It is seen from the Table below, in which the presented documents by the competition and minimal rules written in the law on the Development of the Academic Staff in the Republic of Bulgaria and its implementation in the Institute of mathematics and informatics, Bulgarian Academy of Sciences for occupation of AP “assoc. professor” in the professional

direction 4.5. “Mathematics” (the candidate must to have at least seven publications with IF or SJR, as for professional direction 4.5 they are 4 publications with IF) are compared, and they are fully implemented.

Group	Needed minimal number points	Sum of points for a group
A	50	50
B	100	100
Г	220	232
Д	70	192
E	20	63.6

Group A – 50 p. ESD “doctor”, Diplom № 000294/10.10.2013. A list for 4 publications connected with dissertation are presented;

Group B – 100 p. The presented paper with the numbers [2] (Q2, 40 p.), [8] (Q2, 40 p.) and [11] (SJR 20 p.) are included in a habilitation work named “Reaction networks and applications in the biomathematics”. The first paper is with five co-authors (the candidate is second one), and the second and the third papers are with two co-authors (the candidate is the first author);

Group Г – 232 p. For the competition 8 publications are presented. All of them are in the topic of the competition and can be distributed as follows:

Г7- scientific publications in publishers refereed and indexed in world well-known base of data (Scopus, Web of Science, Zentralblatt, MathSciNet, ACM Digital Library, IEEE Xplore u AIS eLibrary), which are not included in the habilitation work with scientific information – 7 n. (with 3 co-authors, as the candidate is the first author) – the sum from 232 p. (12+40+20+50+30+40+40)

Г8- scientific publications in un-refereed journals with scientific review or in refereed group works – 1 n. [7] – in collaboration with 3 coauthors (the candidate is the first author). The paper is published in Ecological Engineering and Environment Protection, 1, National Society of Ecological Engineering and Environment Protection (ISSN: 1311-8668)– the sum is 0 p.

The papers in Г7 are published in the following journals: [1] Serdica Journal of Computing (ISSN: 1312-6555), [3] Buletin of Mathematical Biology (ISSN: 0092-8240), [4] Lecture Notes in Computer Science (ISSN: 0302-9743), [5] Int. J. of Robust and Nonlinear Control (ISSN: 1049-8923), [6] and [10] Processes-MDPI (ISSN: 2227-9717), [9] Water-MDPI (ISSN: 2073-4441). In the documents for the competition missing dividing protocols and because of that I accept equal contribution of all co-authors. Thus, the points sum in this group exceed the minimal one.

Group Д – 192 p. for the competition senior assist. professor PhD Milen Borisov 32 n. citations of his publications is presented. All are in papers from WoS or Scopus. The points sum for this group is **192** (32x6 p.), which is more than the minimal normative one;

Group E – 63.6 p. For this group the candidate is included in two scientific or educational projects (2x10 p.). He is leader of two scientific or educational projects (2x20 p.), as 18000 lv. are drawn (**3.6 p.**).

Summarize the all information for the implementation of the minimal regulations in the different groups for the academic position „associate professor“ in the IMI-BAS, field of higher education 4. “Natural sciences, mathematics and informatics”, and this for the further activities from the minimal national one proofs us that the candidate has the necessary

qualification and abilities to work alone or in a group to do research in the science and in the practice.

3. General characterization of the scientific research activities of the candidate

The scientific research activities of chief assist. professor PhD Milen Borisov are mainly in the following topics:

1. Mathematical modelling of continuous bio-reactors [1], [4-7], [9] and [10];
2. Reaction networks and applications in the biomathematics [2], [8] и [11], which are included in a habilitation work;
3. Mathematical epidemiology.

In dependence from the modelling object (the type of the bioreactor), the first topic can be separated of: 1.1) Models of continues bioreactors for production of methane (bio-gas) [1],[4] and [5]; 1.2) Models of continues bioreactors for production of methane and hydrogen [6] and [7], and 1.3) Models of continues bioreactors for purification of waste waters [9] and [10].

In 1.1) two mathematical models of continues bioreactors for production of methane (bio-gas) are investigated. The first one (in [1]) has four nonlinear ordinary differential equations (ODE) with two discrete time-delays τ_1 and τ_2 (which remarked the delays in the conversion of the used substrate in biomass) and one algebraic equation for velocity of the separation (production) of biogas (methane) Q . From the qualitative analysis of this multi-parametric model the existence of local stable non-trivial equilibrium points and restriction of the solutions is obtained. It is proved the global asymptotic stability about a given fixed point. The second one (in [4]) has two nonlinear ODE with one discrete time-delay τ (for the delay between the initial measures and the reaction of the system) which is included in the stabilized the model feedback for the methane production (the exit of the process). After the replacement of the dilute velocity u with feedback, which has a lower u^- and an upper u^+ boundaries, a closed system is obtained. From the analysis of the last one it is clear that it has a non-trivial asymptotic stable equilibrium point. In dependence from the τ value (which is accepted for a bifurcation parameter) the sustained (self-oscillations) oscillations take place after a Hopf bifurcation. In contrast to [4], in [5] for the same model (when the piece-wise constant feedback is used), a global stability of the model is proved. For the numerical results in [1], [4] and [5], iteration numerical algorithms for an extremum prospecting are used. They are in software platform SmoWeb (<http://platform.sysmoltd.com/BioReactors/ChemostatESAView>).

In 1.2) a new mathematical model of biotechnological process in two continuously connected bioreactors with double-phase anaerobic biodegradation is presented. For the first phase the model has ten ODEs, and for the second one two ODEs. It is accepted (in [7]) that in the first bioreactor butyrate also can be produced, and in the second one a cytogenesis is possible. Thus, the model from [6] is modified and has 13 ODEs for the first phase, and 7 ODEs for the second phase. For these two models equilibrium points are found, as its local stability is investigated. For the numerical simulations, special applications are used, which are included in the platform SmoWeb. The obtained results are used for the design of a laboratory bioreactor in the Institute of microbiology "Stefan Angelov"-BAS.

In 1.3) two mathematical models with three nonlinear ODEs with and without time-delay are investigated. In the first one, time-delay τ (for first time in the scientific literature) is the delay from the processes of production of the consummated substrate to the biomass. For the two models the equilibrium points are obtained and a local qualitative analysis is made. Noted, that of the second model a global analysis is also made. The theoretical investigations are illustrated with numerical simulations.

In the second scientific topic (habilitation work), the problem for modelling of biological processes with reaction networks is considered. The basic goal here is to

understood the biochemical properties of the Gompertz model and the (growth-) decay models from the Gompertz's type, as two new auto-catastrophic reactionary networks VM and VSM- modifications of the Verhulst logistic model, are investigated. A detailed analysis of the character of the model solutions is made. It is shown that the new G-SIR model and classical SIR model have one and the same basic reproduction number, i.e. $R_0^{G-SIR} = R_0^{SIR}$. The basic contributions of senior assist. professor PhD Milen Borisov are in the elaboration of the reaction networks, numerical algorithms in the application "Biochemical reactions" in SmoWeb and in the analysis of the dynamical systems.

In the third scientific topic a new mathematical model of immune response for Dengue viruses in the humans for two types of infection is obtained – primary infection (8 ODEs) and secondary Dengue viruses infection (11 ODEs). The basic reproduction number for the two scenarios is calculated, as in many numerical simulations the immune response is investigated.

4. Primary scientific and scientific-applied contributions

In principle, I accept the suggested contributions from senior assist. professor Milen Borisov which are given in the reference on the base of the achievements in the habilitation work and the publications for the competition. The primary contributions are: 1) creation of new mathematical models, algorithms and classifications, and 2) receipt of a new form of the existed important for the biotechnologies, ecology and the life sciences scientific problems with the help of well-known and unstudied theories.

4.1. In the habilitation work (papers [2], [8] and [11])

scientific

- a Gompertz property is defined for the (growth-) decay models, as it is proved that the growth Gompertz model, VM and VSM have this property;
- it is proved that the G-SIR model is a borderline step between the SIR and the 2SED epidemiological models;

scientific-applied

- many diagrams are obtained as numerical calculations on the base of algorithms of the smallest squares method are made for epidemiological data in numerical (exact) and interval (inexact) form. These algorithms can be used in the nuclear medicine, population dynamics, pharmacokinetics and et al.

4.2. In the publications

scientific

- a basic mathematical model of the anaerobic biodegradation is modified;
- local stable nontrivial equilibrium points of a mathematical model of biotechnical process for purification of waste waters with production of biogas (methane) are found. It is proved that the solutions of this model are global asymptotically stable for a given equilibrium point;
- a mathematical model of bioreactor (for biological open up of organic waste) with time-delay feedback is modified. It is proved that the nontrivial equilibrium point of the modified model is asymptotically stable. Also, it is proved that self-oscillations (after a Hopf bifurcation) take place, when the time-delay crossing a critical (bifurcation one) value;
- a mathematical model of a bioreactor with piece-wise constant feedback is modified; Its global stability is proved.

scientific-applied

- for the models in the papers [1], [4] and [5], a numerical algorithm for searching of an extremum which maximise the methane production in real time is proposed;

- for the models in the papers [6] and [7] is shown that a maximum of the enter-exit static data exist, as it is obtained a relation between the volumes of the bioreactors. The last one is used for the construction of a laboratory bioreactor producing hydrogen and methane;
- few applications in the platform SmoWeb are developed;

5. Critical remarks and recommendations

I haven't some critical remarks about the presented documents for the competition from the senior assist. professor Milen Borisov. My remarks are connected with the bad technical shape of the competition documents and the bad formulations of the contributions.

6. Personal impressions

I know chief assist. professor PhD Milen Borisov as PhD-student at the IMI-BAS and also from his presentations in different scientific forums. My impressions are that he is a person in a responsible position and a honoured colleagues.

7. Conclusion

From the above mentioned, and also from the complete scientific activity of the candidate ***I suggest*** to do a formal proposal to the Scientific Council of the Institute of mathematics and informatics-BAS, on the academic position "assoc. professor" by scientific speciality "Mathematical modelling and application of the mathematics" (Mathematical biology), noticed for the necessities of the section "Mathematical modelling and numerical analysis", ***to be selected*** chief assist. professor PhD Milen Kolev Borisov.

Reviewer:
/Prof. DSc Svetoslav G. Nikolov /

Sofia
22.05.2023