STATEMENT

by the competition for an academic position **Associate Professor**,
Area of higher education: 5. "Technical Sciences",
Professional Field 5.2. "Electrical engineering, electronics and automation",
Scientific specialty „Application of the principles and methods of cybernetics in different fields of science (biomedicine)", for the needs of the department „Analysis and processing of biomedical signals and data" in the Institute of Biophysics and Biomedical Engineering (IBPhBME) – Bulgarian Academy of Sciences (BAS),
announced in the State Gazette (issue no. 69/16.08.2024).

The only candidate for the competition is **Tatyana Dimitrova Dobreva**, PhD, Chief Assistant Professor in the same department.

Internal member of the scientific jury, appointed by order of the director of IBPhBME-BAS (no: 1351/14.10.2024) is **Prof. Vessela Tzvetanova Krasteva PhD, MSEE**.

1. General characteristic of the scientific and applied research of the candidate

For participation in the announced competition, the candidate Chief Assist. Prof. Tatyana Dobreva has submitted the necessary documents for scientific research, which fully comply with the minimum national requirements under Art. 26, para. 1 in the Regulation for application of the "Law for the Development of the Academic Staff in Republic of Bulgaria", under the scientific area 5. "Technical sciences", as well as with the rules for holding academic positions at the IBPhBME-BAS, gathering a total number of 730 points, which exceed about 1.8 times the required minimum of 400 points, according to the summary table below.

Indica-tor	Minimal number of points	Candidate's number of points	Number of points by main indicators in the group
A	50	50	**A.1.** PhD thesis: Diploma no./ issue date: № 28538/26.06.2003, Scientific specialty: 02.21.07 "Automated systems for information processing and management in medicine", Commission No. 5, protocol No. 6/14.04.2003 to the Higher Attestation Commission.
B	100	189	**B.4.** Habilitation work – peer-reviewed scientific publications (at least 10), which are referenced and indexed in recognized international databases with scientific information. 10 publications indexed in Web of Science (8 items with impact factor) and Scopus (2 items with SJR-Scopus Journal Rank).
G	200	311	**G.7.** Peer-reviewed scientific publication, which is referenced and indexed in recognized international databases with scientific information. 10 publications indexed in Scopus, of which 4 have SJR. **G.8.** Peer-reviewed scientific publication in not referenced sources or in peer-reviewed collective volumes. 18 publications
D	50	100	**D.12.** Citations or reviews in scientific publications referenced and indexed in recognized international databases with scientific information or in monographs and collective volumes. 10 citations
E	-	80	**E.26.** Published application for patent or useful model. 2 patents
A-E	400	730	**Sum of all indicators**

Regarding the points in **Indicator A**, it should be noted that these are fulfilled by the PhD thesis (2003) of Chief Assist. Prof. Tatyana Dobreva. Her dissertation, titled 'Rapid Recovery of an Electrocardiographic Amplifier After a Defibrillation Pulse,' is of significant scientific and practical value, focusing on the development of automated systems for information processing and control in medicine. Dobreva's contributions to the department for which the competition is announced date back to this period. Over the course of more than 20 years, including her doctoral and postdoctoral studies, she has gained extensive research experience in the field of technical sciences and biomedical engineering.

In **Indicator B.4** Chief Assist. Prof. Tatyana Dobreva has presented 10 publications indexed in globally recognized scientific databases, including 8 with an Impact Factor (IF-Web of Science) and 2 with an SJR (Scopus Journal Rank). These publication earn 189 points, exceeding the required minimum of 100 points. Among these, 2 papers were presented at the international scientific conference *Computing in Cardiology* (published by IEEE) and indexed by Scopus (SJR=0.191). Particular recognition is due to 8 publications in Impact Factor journals, ranked in the highest quartiles (Q1 and Q2) across various scientific fields:

- 1 publication (2021) in *IEEE Sensors Journal* (IF=4.325, Q1 quartile).
- 4 publications (2005, 2008, 2017, 2022) in *Medical and Biological Engineering and Computing* (IF ranging from 1.484 to 3.079, Q2 quartile).
- 1 publication (2022) in *Applied Sciences* (IF=2.838, Q2 quartile).
- 2 publications (2008, 2018) in *Physiological Measurement* (IF=2.246, Q2 quartile).

The candidate has submitted additional 28 publications in **Indicator G**, including 10 indexed publications (G.7) and 18 non-indexed publications (G.8), earing 111 points above the minimum requirement of 200 points. Notably, three of these publications, from 2009, 2018 and 2020, were published in the *International Journal of Bioautomation* (SJR since 2012, Q3 quartile). The remaining publications were published in the Proceedings of the *International Scientific Conference Electronics - ET* (2005 to 2022), organized by the Faculty of Electronic Engineering and Technology at the Technical University – Sofia. Since 2015, the reports have been published by IEEE Publishing and indexed in Scopus.

Out of 38 scientific publications presented according to indicators B and G, Assist. Prof. Tatyana Dobreva has a leading contribution as the first author in 8 publications (21%) and as the second author in 26 publications (68%). While she has no single-author publications, it is notable that 17 of her works (44%) involve collaborations with just one other researcher, reflecting her strong commitment to the topics she develops. Importantly, the articles submitted for the 'Associate Professor' competition (published between 2005 and 2022) do not overlap with the studies included in her PhD thesis (published prior to 2002).

Chief Assist. Prof. Tatyana Dobreva reports 10 citations in Scopus for a single publication submitted in the current competition, which is more than sufficient to earn 100 points, exceeding the minimum requirement of 50 points in **indicator D.12**. It is worth noting that the total number of citations for all her publications included in the competition is significantly higher, reaching 223.

Inr **Indicator E** (80 points), the report highlights additional activities, with Chief Assist. Prof. Tatyana Dobreva serving as the leading inventor for two patents registered with the Patent Office of the Republic of Bulgaria. These patents are:BG67325/31.05.2021 ("Method and device for correlated multiple sampling with high-order noise generation"), and BG67598/29.12.2023 ("Method and device for registering and synchronous filtering of biosignals"), held by IBPhBME-BAS, the organizer of the current competition for Associate Professor. These patents underscore the innovative scientific and applied nature of Dobreva's contributions, particularly in biomedical engineering, a core focus of the Institute. Specifically, they address the challenge of improving the quality of recorded weak biosignals in noisy environments—an issue faced daily by diagnostic and therapeutic medical devices in multi-electrode and multi-modal configurations.

2. Main scientific and applied scientific contributions

In the publications under indicators "B", "G" and "E", I can distinguish significant scientific-applied and applied contributions of Chief Assist. Prof. Tatyana Dobreva, as follows:

Scientific-applied contributions:

I. **Development of schematic solutions for biosignal measurement transducers** [B4.1, B4.2, G8.1, G8.2, G8.3, B4.3, G7.1, G8.4, G7.2, E26.1], including:
   a. **Differential and non-differential amplifiers without a reference electrode,** applicable for two-electrode recording of ECG signals in defibrillators, ambulatory monitors, etc.
   b. **Amplifiers with current input control**, designed to improve the quality of the recorded signals of cardiac activity (ECG) and respiratory activity (bioimpedance).
   c. **Measurement transducers of biosignals from sensors with capacitive output impedances**, whose active negative feedback allows adjustment of the operating point and cut-off frequency. They are applicable for recording ECG signals in a diagnostic frequency bandwidth through capacitive electrodes or other biosignals from piezoelectric sensors.
   d. **Phototransducer for recording peripheral pulse from the forehead area**, which can be used as an additional sensor for monitoring cardiac activity in portable automatic external defibrillators.
   e. **Patented method and device for Correlated Multiple Sampling** - a technique that processes a large number of input samples to significantly improve the suppression of the offset and low-frequency (flicker) noise of the measuring transducer.

II. **Development of digital filters for suppressing electromyographic (EMG) noise in electrocardiograms,** designed to adaptively adjust bandwidth and minimize distortions of essential ECG components [B4.5, G7.3, G7.4, B4.6, G7.5], including:
   a. **Adaptive low-pass filter based on the Savitzky-Golay approximation procedure**, with dynamic adjustment of the cut-off frequency, depending on the frequency spectrum of the ECG waves. For example, the cutoff frequency ranges from 14 to 40 Hz for the low-frequency components (P and T-waves, PQ, ST, and TP-intervals) and from 100 to 500 Hz for the high-frequency components (QRS complexes). The filter has been validated and implemented in series production of the high-end ECG device CS-200Excellence of Schiller AG, Switzerland, according to the implementation certificate.
   b. **Locally adaptive algorithms for 'Myriad' filters with an adaptive linearity parameter,** demonstrating improved integral and local performance metrics compared to the advanced nonlinear locally adaptive algorithms.

III. **Design of digital filters for suppression of the power-line interference in ECG signals**, including:
   a. **Comb filters** [G8.7, G8.8, G8.9, G8.10, G8.11, G8.12, G7.6], including designs that use positive feedback to adjust the quality factor and others that adapt to powerline frequency deviations by shifting their frequency response in arbitrary fractional steps (referred to as fractional-adaptive filters). A major advantage of all proposed comb filters is their simple structure, enabling real-time implementation in conventional microcontrollers.
   b. **Filters synchronized with the power-line frequency** [B4.8, B4.9, B4.10, G7.7, G7.8, G8.13, G8.14, G8.15, G8.16, E26.2], for which several innovative solutions have been proposed:
      - **A mixed analog-digital design for automatic balancing of the impedance bridge** formed by the electrode impedances and the amplifier's input impedances;
      - **Digital demodulation and remodulation of the powerline interference** through synchronous processing of the differential and common-mode signals. The method has been patented in Bulgaria [E26.2];

- **A software phase-locked loop (PLL),** generating a reference signal synchronized with the common-mode powerline interference;
- **Software-based automatic gain control**, with and without feedback, designed to generate a reference powerline interference signal with constant amplitude, extracted from the common-mode signal.

The presented algorithms for synchronous filtering enable flexible adjustments for recording various biopotentials using surface electrodes (ECG, electroencephalogram, electromyogram, electrooculogram, etc.). They could find broad application in a range of diagnostic and therapeutic medical devices.

Applied contributions:

I. **Development of prototypes for high-resolution ECG signal recording and generation** [B4.4, G8.5, G8.6], including:
   a. **A device for recording 16-channel electrocardiograms**, digitized with high resolution (24-bit) and a high sampling rate (2 kHz). This unique measurement equipment is designed for scientific research, enabling experimental and clinical recordings of ECG databases. It supports a large number of channels, DC potentials, and requires no pre-filtering, with a special focus on high-frequency components critical for ECG biometrics, late potential studies, etc.
   b. **An ECG signal simulator** capable of generating up to 16 channels with high resolution (286 nV/bit, 2 kHz) via direct digital-to-analog conversion of data from a computer. The system, which includes a hardware module and specialized user-interface software (Visual-C), allows interactive real-time data control. This unique equipment serves as a tester for ECG devices with adjustable parameters, supporting both standardized and clinical ECG databases.

3. Significance of the contributions to the science and practice

The presented contributions stand out with their innovative scientific and applied nature in the field of biomedical engineering, focusing primarily on facilitating and improving the quality of input measurements of biosignals. These studies integrate interdisciplinary knowledge on the interaction between electronic sensors and biological tissues to extract multimodal information about the functions of the cardiovascular and respiratory systems. This is achieved through the recording of weak biosignals such as electrocardiograms, impedance plethysmograms, photoplethysmograms, and others, which are often accompanied by various types of noise. Ensuring high-quality biosignals remains a daily challenge for both medical personnel and the equipment used. It is a key factor for performing accurate manual or automated measurements – a necessary condition for proper diagnostic and therapeutic decisions.

The presented developments are based on innovative engineering solutions that integrate knowledge and technologies in analog circuit design, multi-channel amplifiers, analog and digital filters, analog-to-digital and digital-to-analog converters, microprocessor control and real-time operation, digital signal processing algorithms, and the development of computer-based applications and user interfaces. The applied contributions include a certificate for the implementation of a digital filter, as well as the development of two hardware prototypes: a multi-channel generator and a measurement system for high-resolution ECG signals. These devices serve as fundamental components in any research and testing setup, providing high precision and multi-functionality in measurements. These developments highlight the extensive experience acquired by Chief Assist. Prof. Tatyana Dobreva during her postdoctoral work in the field of biomedical engineering. The significance of her contributions is supported by 38 scientific publications, co-authorship in 2 patents, and over 250 citations of her work, which is a clear indicator of their high scientific value and impact.

4. **Remarks and recommendations**

I have no criticisms of the candidate's materials submitted in the competition for Associate Professor.

In the author's reference (item 1.4), two implementations are cited. However, in the description of the main contributions (item 2) and the supporting materials, only one implementation certificate is included. This certificate pertains to an adaptive low-pass filter based on the Savitzky-Golay approximation procedure, which was implemented in the series production of the high-end ECG device CS-200Excellence by Schiller AG, Switzerland. My question is: *What is the second implementation, and why is it not included in the submissions for the current competition for Associate Professor?*

The author's reference related to the competition does not specify any participation in national or international scientific projects, which could serve as additional evidence of the scientific significance and application of the presented developments, as well as demonstrate the acquisition of relevant research experience by the candidate.

Considering the innovative nature of the methods presented in the conference papers, I believe there is significant potential for some of them to be further developed, summarized and published as original articles in journals with an impact factor. I highly recommend that Chief Assist. Prof. Tatyana Dobreva adopts this practice for future developments in order to enhance the quality and impact of her scientific career.

CONCLUSION

The materials submitted for the competitive selection procedure meet the requirements of the Regulation for application of the "Law for the Development of the Academic Staff in Republic of Bulgaria", as well as the rules for holding of academic positions at the Institute of Biophysics and Biomedical Engineering – Bulgarian Academy of Sciences. They allow for an objective and multifaceted assessment of the candidate's qualities. Chief Assistant Professor Tatyana Dimitrova Dobreva is a scientist with proven potential in the field of biomedical engineering.

In essence, the submitted materials show that the requirements according to the national and institutional criteria for holding the academic position of "Associate Professor" are exceeded by all criteria. This gives me reason to confidently propose that Chief Assistant Professor Tatyana Dimitrova Dobreva is awarded the academic rank of "Associate Professor" in Area of higher education: 5. "Technical Sciences", Professional Field 5.2. "Electrical engineering, electronics and automation", Scientific Speciality „Application of the principles and methods of cybernetics in different fields of science (biomedicine)".

18.11.2024 Member of the scientific jury:

Sofia /Prof. Vessela Krasteva, PhD/