

February 5th, 2019

Институт по информационни и
комуникационни технологии-БАН

Вх. № 138 / 12.02.2019 г.

TO:
PROFESSOR DOCTOR DIMITAR KARASTOYANOV
CHAIR OF A SCIENTIFIC PANEL
set up pursuant to Order № 257 / 28.12.2018
issued by the Director of the Institute of Information and
Communication Technologies – at the Bulgarian Academy of Sciences
Professor Galya Angelova, DSc
Sofia, 'Academic Georgi Bonchev' Street, building 2

Your Protocol № 1 / 04.01.2019 (date of the 1-st session)

Attached hereto:

REVIEW of the procedure for the awarding of Philosophy Doctor's Educational and Scientific Degree
Professional domain 5.2. "ELECTRICAL EQUIPMENT, ELECTRONICS, AND AUTOMATION"
Doctor's program "Application of cybernetics' principles and methods in various scientific areas"
by the PhD student, BISTRA YULIYANOVA ZAHARIEVA;

Thesis on the following subject:

"INTELLIGENT METHODS EMPLOYED IN THE ANALYSIS OF REHABILITATION PROCESSES"

Reviewer:

Professor Doctor Ivet Borisova KOLEVA – Yoshinova, MD, DMedSc;

Professor from the Supreme Attestation Commission under the scientific specialty "Physiotherapy, Health
Resort, and Rehabilitation"

From the University of Medicine of Sofia

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I hereby declare that my participation as a reviewer does not conflict with the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and its regulations.

I hereby declare that I am not a related person within the meaning of Art. 1, item 5, of the supplementary provisions of the Law on the Development of the Academic Staff, and I have no private interest in the candidate within the meaning of Art.1, item 3, of the supplementary provisions of the Law on the Development of the Academic Staff.

The revision has been drafted in compliance with the Law on the Development of the Academic Staff, the Bulgarian Academy of Sciences Act, the Higher Education Act, the Rules for the implementation of the Law on the Development of the Academic Staff, the Statute of the Bulgarian Academy of Sciences, the Regulations on the Terms and Procedure for the Awarding of Academic Degrees and the Holding of Academic Positions in the Bulgarian Academy of Sciences; the requirements, conditions and resolutions of the Scientific Council (SC) in each independent research unit of the Bulgarian Academy of Sciences, and the ones of the Institute of Information and Communication Technologies.

The document titled "Regulations on the Terms and Procedure for the Awarding of Academic Degrees and the Holding of Academic Positions in the Bulgarian Academy of Sciences" was downloaded from the site of the Bulgarian Academy of Sciences on 05.01.2019.

TO: THE CHAIR OF THE SCIENTIFIC PANEL
set up pursuant to Order № 257 / 28.12.2018 issued by the Director of the
Institute of Information and Communication Technologies
At the Bulgarian Academy of Sciences
Professor Doctor G. Angelova, DSc
PROCEDURE FOR THE AWARDING OF PHILOSOPHY DOCTOR'S
EDUCATIONAL AND SCIENTIFIC DEGREE

REVIEW

of

Thesis with the following subject:

**“INTELLIGENT METHODS EMPLOYED IN THE ANALYSIS OF
REHABILITATION PROCESSES”**

by a regular PhD student

Bistra Yuliyanova Zaharieva

Scientific Supervisor:

Professor Lyubka Atanasova Dukovska, Ph.D., D.Sc.

Procedure for the awarding of Philosophy Doctor's Educational and Scientific Degree

Scientific area: 02.00.00. Technical sciences

Professional domain 5.2. “ELECTRICAL EQUIPMENT, ELECTRONICS, AND AUTOMATION”

Doctor's program: 02.21.10. “Application of cybernetics' principles and methods in various scientific areas (technical, medical, bio-cybernetical, legal, etc.)”

by:

Professor Doctor Ivet Borisova KOLEVA – Yoshinova, MD, PhD, DMedSc

Professor in the scientific specialty “Physiotherapy, Health Resort Studies, and Rehabilitation”;

from the University of Medicine of Sofia, Bulgaria

The review was issued in accordance with the requirements of the Regulations on the Terms and Procedure for the Awarding of Academic Degrees and the Holding of Academic Positions in the Bulgarian Academy of Sciences, downloaded from the site of the Bulgarian Academy of Sciences on 05.01.2019.

1.SHORT CV

(according to data, provided by the candidate)

PhD student, Bistra Yuliyanova Zaharieva, was born in 1988. In 2012, she acquired professional qualification “Rehabilitator” (Professional Bachelor's Educational Degree) from the Medical College of the University of Medicine of Sofia, and in 2015 – Kinesitherapist (Physiotherapist - Master's Educational Degree) from the National Sports Academy, Sofia. She has professional experience as a rehabilitator and has worked with outpatients in Sofia medical centres. There is no information about courses and qualifications taken within her main specialty.

Since 2016, she has been assigned as a regular PhD student on the following subject: "Intelligent Systems" – in the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences.

She has acquired computer skills and competences - Microsoft Office.

She uses Italian and English language.

2. ANALYSIS OF THE PROCEDURAL REQUIREMENTS

(according to data and documents supplied by the supervisor and the candidate)

Mrs. Bistra Zaharieva has been assigned as a regular PhD student since 01.01.2016, with a doctorate's term of 3 years. She has completed her PhD studies by covering the following educational program's elements as required by the law and the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences: *basic special educational discipline (40 points); two mandatory additional courses on 'Generalized Nets' and 'Intuitionist Fuzzy Sets' (2 x 20 points); English language course (25 points); and has further participated in three more courses – 'Computer Skills', 'Preparation and Management of Projects Financed by EU Funds', and 'Management of Large Databases and Cloud Services' (3 courses of 25 points each).*

She has reported her results at a scientific workshop held in the Institute of Information and Communication Technologies (2 x 8 points or a total of 16 points), 1 national forum (24 points), and 5 international scientific events (5 x 32 points).

The candidate has attached a list (and full text) including a total of 6 (six) articles published in reference international journals in the area of the regular doctorate. These articles have between 2 and 5 authors; in 4 of them the PhD student is the first author, and in the other two - she is second. According to the report attached hereto, these publications bring to the PhD student a total of *71,33 points*. I have not reviewed the attached publications of the PhD student, but I have accepted the points generated by them since these articles are in the field of technical sciences (electronics and cybernetics), and have been published in the respective scientific journals: two articles appeared in *International Journal Bioautomation* (SCImago Journal Rank - SJR); two in *Notes on Intuitionistic Fuzzy Sets*; one in the journal of the Polish Academy of Sciences – *Issues in Intuitionistic Fuzzy Sets and Generalized Nets*, and one article was included in the data base of *IEEEXplore*.

Attached hereto is a list of two quotes, cited in referred international journals.

The PhD student has presented the thesis work in complete text and has attached to it an author's summary which fully reflects the contents of the thesis. The internal procedure of defense passed successfully.

According to the Attestation Report, the PhD student has a total of 868 points.

The opinion of the Scientific Supervisor is positive.

CONCLUSION ON ITEMS 1 and 2:

The candidate meets the formal requirements of the procedure for the awarding of Philosophy Doctor's Educational and Scientific Degree: she has submitted a full thesis text; she has successfully defended it internally; and during her period of study as a regular PhD student she has acquired the necessary number of points.

3. ON THE STRUCTURE OF THE THESIS WORK AND AUTHOR'S SUMMARY

3.1. Thesis

The structure of the thesis is original. Standards for similar works in the field of medicine and rehabilitation are missing, and namely: Literary Review, Objective and Tasks, Material and Methods, Results and Analysis, Discussion, Conclusions and Assumption. I must point out that the objective and the tasks are formulated in the text of the thesis' preamble (page 6) and in the introduction of the author's summary (page 2).

The volume of the whole work is 148 pages, and it is distributed in the following manner: Contents – 3 pages; Preamble – 4 pages; Chapter One (*Overview of intelligent methods for the analysis of complex processes*) – 30 pages; Chapter Two (*Analysis of the rehabilitation processes in the case of ankylosing spondylitis and chronic degenerative disease of the knee joint*) – 30 pages; Chapter Three (*Experimental results from the application of intelligent methods for the analysis of rehabilitation processes*) – 43 pages; Chapter Four (*Ethical norms in the application of intelligent methods for the analysis of rehabilitation processes*) – 18 pages; *Conclusion* – 2-3 pages; *Summary of results obtained* – 1-2 pages; *Guidelines for future studies* – 1 page; *Related publications* – 1 page; *Declaration of results' originality* – 1 page; *References* – 16 pages.

The work is illustrated with 8 figures and 15 spreadsheets.

The attached list of author's publications on the topic includes 6 titles.

The thesis contains also a Declaration of results' originality.

The reference includes a total of 155 sources – 22 in Cyrillic and 134 in Latin.

3.2. AUTHOR'S SUMMARY

The author's summary covers 30 pages. It contains a synthesis of the performed work and presents the results of the thesis. It also includes a list of relevant publications and a list of results or contributions (according to the author).

4. ON THE THESIS SUBJECT

In recent years both the process of teaching and the clinical practice of medicine and rehabilitation have witnessed the swift introduction and effective application of informatics and contemporaneous information technologies. It is undisputable that the intelligent methods for the analysis and modelling of processes based on mathematical approaches in the field of "artificial intelligence" could be very useful in both the training and the everyday activities of medical specialists (doctors of various specialties) and health professionals (nurses, midwives, rehabilitators, kinesitherapists /physiotherapists/, occupational therapists).

To this end, the thesis topic "Intelligent methods for the analysis of rehabilitation processes" is extremely up-to-date and very promising.

5. THESIS ANALYSIS

5.1. PREAMBLE (INTRODUCTION)

The thesis preamble presents the subject, and includes a brief introduction on the topic, mentioning the main methods used, the publications related to the thesis, the purpose and tasks.

The goal is clearly formulated: *"to develop highly effective intelligent methods for the analysis of rehabilitation processes by employing modern paradigms in the area of intelligent systems"*.

The tasks are arranged in a logical sequence, and they include the following: systematization of the existing intelligent methods for the analysis of the rehabilitation processes; provision of methodology for the analysis of the rehabilitation processes in some socially significant diseases; development of generalized network models of the rehabilitation processes applied to patients with diseases and injuries of the locomotor system: fractures in the proximal part of the shoulder bone, ankylosing spondyloarthritis (Bechterew's disease) and gonarthrosis. The last task is: *"systematization of the legal aspects in the use of data related to the physical condition of patients in hospital environment"*.

5.2. LITERARY REVIEW AND REFERENCES

Chapter One is titled *"Overview of intelligent methods for the analysis of complex processes"*. The purpose of the review is to perform a systematic analysis of the advantages and disadvantages of some of the methods examined in the field of informatics by selecting the intelligent techniques that are most suited for the analysis of the rehabilitation processes. Included in the topics are the following principles: *Knowledge Management; Artificial Intelligence, Computer Intelligence and Intelligent Systems; Mathematical Approaches to the Modelling of Biological and Medical Processes; Theory of Generalized Networks; Intuitionistic*

Fuzzy Sets; Indexed Matrices; Inter-Criterial Analysis Method. The issues in the 'Inter-Criterial Analysis Method' and the 'Theory of Generalized Networks' are considered in detail. The presentation follows a logical order, and the methods' language is clear and accurate. I am not capable of analysing and evaluating the mathematical part of the review (mathematical formulas), for I am competent in another thematic field (medicine).

The review ends with the **hypothesis** that "*the most appropriate methods for the analysis of the rehabilitation processes would be the network methods based on the theory of generalized networks and the methods using intuitionistic fuzzy sets and indexed matrices.*"

As noted hereinabove, the **references** include a total of 155 sources (22 in Cyrillic and 134 in Latin), with nearly half of these sources (78 titles) dating from the last ten years. A large part (87 titles) of the sources in Latin is from Bulgarian authors working in the Bulgarian Academy of Sciences (87 out of 134 titles). Some 94 reference sources (from the total number of quoted titles) are from Bulgarian authors working in the Bulgarian Academy of Sciences (94 out of 155 titles, of which 5 are thesis /dissertation/ studies). The general bibliography includes also the PhD student's own publications on the subject.

Most of the **reference sources** are focused on the main area of the thesis (7 in Cyrillic and 124 in Latin). In the reference report (Latin titles), there are only 17 special sources on the thesis subject written by authors who are not associated with the Bulgarian Academy of Sciences (and another 17 titles by combined team of authors – foreigners and employees of the Bulgarian Academy of Sciences). I am not an expert on artificial intelligence, but I think that the reference report is incomplete, especially in view of the fact that according to the foreword of the author's summary (page 1), in the past few years in the field of intuitionistic fuzzy sets there had been published more than 4000 articles by experts from 40 countries.

The sources from the field of rehabilitation are in total 25, of which 15 are from Bulgarian authors - mainly textbooks and classroom manuals for Rehabilitation and Kinesiotherapy students (9 of these titles are from the last ten years). The other 10 sources in Latin are related to medicine (ankylosing spondylitis and gonarthrosis) - mainly on topics concerning classifications and the application of functional assessment scales. Sources № 109 and № 146 are repeated.

The sources include 3 Internet sites containing popular information about rehabilitation (Framar Pharmacies, Health Navigator, Ortho Centre). The general references do not include the sources of ethics (in particular bioethics) discussed in Chapter 4.

5.3. CONTENTS OF CHAPTERS 2, 3 AND 4

The second chapter is entitled ***“Analysis of the rehabilitation processes in the case of ankylosing spondyloarthritis and chronic degenerative disease of the knee joint”***. The first chapter is related to Bechterew's disease (ankylosing spondyloarthritis), and the second one refers to gonarthrosis. Old and even rejected data (on etiology, pathomorphology, clinical picture, forms, etc.) are cited in both nosological units, which (in my opinion) are not essential elements of the discussed thesis. The kinesiotherapy and massage programs are cited according to the level of competences of the PhD student. The presentation of the physical therapy (pre-formed physical modalities) also suffers from important errors. They, however, do not concern the mathematical and statistical analysis. The construction of the research is correct (concerning the general structure of the diagnostic and rehabilitation processes, functional assessments and analyses - before and after rehabilitation).

The third chapter is titled: ***“Experimental results from the application of intelligent methods for the analysis of rehabilitation processes”***. It includes several sub-chapters, and namely: analysis of the application of intercriteria (interquartile) analysis of patients suffering from Bechterew's disease, of patients with gonarthrosis, of patients with musculoskeletal complaints, and of patients with fracture of the proximal humerus. The obtained clinical results are described, and their processing was carried out applying the newly developed intelligent methods for the analysis of rehabilitation processes with optimum statistical characteristics. Also presented is a model of a generalized network for physical examination before the application of a kinesiotherapeutic program to a patient with musculoskeletal problems, in a generalized version, with unspecified nosology.

The fourth chapter is dedicated to ***“Ethical norms in the application of intelligent methods for the analysis of rehabilitation processes”***. Commented here are legal and ethical issues that normally arise from patients' treatment and rehabilitation (use of personal data – identification data and data from the physical exam). The sections of applied and normative ethics are examined in view of the thesis' goals. I must recall the fact that the term “bioethics” (and not just ethics as seen in the text) has been introduced in medicine and rehabilitation long time ago. Nevertheless, I should point out that the inclusion of these issues is appropriate in view of the general theme of the thesis. Therefore, I don't understand why the sources used are given under line and not included in the general list of references.

5.4. RESULTS AND CONCLUSION. CONTRIBUTIONS.

The methodology created for the application of intelligent methods in the analysis of rehabilitation processes has been successfully applied on patients suffering from three important musculoskeletal disorders – an inflammatory joint disease (Bechterew's disease), a degenerative joint disease (gonarthrosis), and a traumatic injury (fracture of the humeral bone). In each of these groups, the patients were subdivided into control and experimental

groups. Improvement in the quality of life of the patients included in the experimental groups is objectively demonstrated – using the application of the own intelligent method.

Chapter **Conclusion** contains a synthesized overview of the work done in the thesis, and this same text is also included at the end of the author's summary.

In general, I agree (in part) with the first four groups of results, presented by the PhD student, and namely:

- *The existing intelligent methods for the analysis of rehabilitation processes have been systematically presented;*
- *A methodology for the analysis of the rehabilitation processes applied to patients suffering from socially significant diseases and disorders (Bechterew, gonarthrosis, humeral fracture) has been proposed;*
- *Generalized network models of the rehabilitation processes used on patients with the aforementioned diseases and disorders have been developed;*
- *Results have been obtained on the employment of intelligent methods for the analysis of rehabilitation processes for patients with ankylosing spondyloarthritis (Bechterew's disease), gonarthrosis, and fracture of the proximal humerus (the specific diagnosis is not cited, but it is probably a fracture of the humeral neck). I believe that the reported increase in the effectiveness of the treatment techniques used is debatable given the lack of specific comparative information.*

Scientific studies in the field of medical and rehabilitation clinical practice traditionally apply specific statistical methods (for the analysis of parametrical and nonparametrical data) and some modern methods of mathematical modelling. As far as I know, so far there has been no application of the modern methods used in the thesis (method of the generalized networks, intuitionistic fuzzy sets, indexed matrices, etc.) which (undoubtedly) is a novelty of exceptional scientific and scientific-practical significance.

Therefore, I accept the results referred to hereinabove as **contributions** of the thesis in the following thematic field: *Application of cybernetics' principles and methods in the area of medical rehabilitation.*

Since there is no updated terminology and information on this topic, I am not convinced of the correctness of the *Proposal for the Amendment of the General Code of Professional Ethics in Healthcare*, presented by the PhD student in the fourth chapter. In general, however, I accept as correct the standpoint that upon the introduction of intelligent systems, the legal and ethical aspects should also be taken into consideration. Accordingly, the Code of Good Medical Practice should include rules ensuring patients' rights during the application of new and modern methods in the rehabilitation clinical practice, which meet the requirements of bioethics.

SUMMARY OF ITEM 5

The thesis submitted meets the requirements provided for in: the *Law on the Development of the Academic Staff*; the *Law of the Bulgarian Academy of Sciences*; the *Law of the Higher Education*; the *Rules for the Implementation of the Law on the Development of the Academic Staff*; the *Statute of the Bulgarian Academy of Sciences*; the *Regulations on the Terms and Procedure for the Awarding of Academic Degrees and the Holding of Academic Positions in the Bulgarian Academy of Sciences*; the requirements, conditions and resolutions of the *Scientific Council (SC) in each independent research unit of the Bulgarian Academy of Sciences*, and the ones of the *Institute of Information and Communication Technologies*.

No data on candidate's inventions and rationalizations have been presented.

The list of publications, attached to the thesis, lack a distribution protocol, thus making it difficult to evaluate the personal contribution of each author. Yet, I must note that the aforementioned regulations allow for co-authorship in the PhD student's publications on the topic of the thesis.

6. GUIDELINES FOR FUTURE STUDIES.

CRITICAL REMARKS AND RECOMMENDATIONS.

I agree with the PhD student's opinion that "the results referred to in the thesis are applicable to the solving of a wider range of tasks in the description of real biological and rehabilitation processes" and that the employment of respective intelligent methods in the field of medicine and rehabilitation would lead to "the enrichment of the research area".

I however definitely recommend that during these investigations there should be requested the standpoint of a physician, who is an expert in the respective clinical field, and namely: a medical doctor - specialist in rheumatology should be consulted in the clinical analysis of inflammatory joint diseases (Bechterew's disease and rheumatoid arthritis) and degenerative joint diseases (knee joint osteoarthritis - gonarthrosis); a specialist in Orthopaedics and Traumatology - in the case of traumatic injuries (such as a humeral fracture); a specialist in Physical Medicine and Rehabilitation – for rehabilitation processes; and Social Medicine specialist – for the performance of analysis on the bioethical aspects. That would help prevent the existing methodological and terminological inaccuracies, and would contribute to other scientific areas of both medicine and rehabilitation.

Since the thesis is for the awarding of Doctor's Educational and Scientific Degree in *Professional Field "Electrical engineering, electronics and automation"*, I do not consider it necessary to make detailed comments on any medical and rehabilitation inaccuracies or mistakes. I do not have the pleasure of knowing in person the PhD student and the Scientific

Supervisor, but I am delighted by the fact that the author (a rehabilitator by education) has been motivated to go deep into the field of informatics and mathematical modelling.

However, as a reviewer of the thesis, I must at least point out some of the basic inaccuracies and mistakes made by the PhD student, given her level of competence (she is a physiotherapist and not a doctor), for in this particular case we are dealing with scientific work applicable to the field of medicine.

A. Terminological, methodological and methodological inaccuracies: for example, in the thesis (page 52, bottom rows 5-6) it is written "Transcutaneous Electrical Stimulation of the Nerves" instead of "Transcutaneous Electro-Neurostimulation", which is not exact and changes the meaning. Most of the quoted methods with pre-formed physical modalities are inaccurate, with some of them being old and accordingly rejected. The statement on page 57, bottom rows 4-6, saying that "the new laser therapy...combines visible radiation and invisible infrared rays" is also absolutely wrong. The Kinesiotherapy indications mentioned on page 62, bottom rows 11-15, are confused with the goals of Kinesiotherapy (it reads as follows: "Indications for use: Increase in joint mobility; Reduction of joint pain; Reduction of muscle spasm; Maintenance of joint mobility").

B. Medical and rehabilitation (including kinesiological and kinesiotherapeutic) inaccuracies: for example, on page 81 of the thesis, bottom rows 10-11, it is written the following: "the main muscle performing head flexion (m.sternocleidomastoideus)". It is known however that the unilateral contraction of the aforementioned muscle results in the rotation of the cervical spine, and its bilateral contraction helps the flexion - a movement performed *primarily* by the neck's deep muscles (musculus longus colli, m.longus capitis, m.rectus capitis anterior).

On page 89, upper row 9, the "sense of end" described by 'James Kyriax' is quoted, but this author is not mentioned in the references. *Dr James Henry Cyriax* is an English doctor, and he is considered as one of the founders of Orthopaedics and of Manual Medicine. The term established in the Bulgarian scientific and practical rehabilitation literature (including kinesiological analysis, manual therapy and kinesiotherapy) is "*joint's movement utmost limit*" defined as "the resistance between the joint's movement physiological and anatomical volume". [*JH Cyriax. Textbook of orthopedic medicine. - London: Cassell, 1954-1955. (Volume 1 – 692 p.; vol.2 - 373 p.)*].

On this same page 89, bottom row 19, the author talks of the Manual Muscle Testing (MMT) as a method for the assessment of the muscle strength. In rehabilitation (including kinesiotherapy), it is well known that the Manual Muscle Test evaluates the muscular weakness, whereas the muscle strength is measured using the method of dynamometry.

The results from the functional assessment scale, *Health Survey Form (SF-36)*, in patients suffering from Bechterew's disease, are shown on pages 72-73 of the thesis and on page 11 of the author's summary. Yet, when commenting the results of the Figure 3.1, the author claims that it is all about rheumatoid arthritis (thesis – page 72, bottom rows 1 and 5; author's summary – page 11 /upper rows 5 and 8/). Rheumatoid arthritis and ankylosing spondyloarthritis (Bechterew's disease) are *different* nosological entities with a *different* clinical picture (etc.), regardless of the fact that both are inflammatory joint diseases.

B. Grammar and spelling errors: for example, on page 44 of the thesis, bottom row 8, it is written "urine analyses" with orthographical errors. On page 45, upper row 2, it is written "sacroilit" instead of sacro-ileitis, etc. On page 67 of the thesis, upper row 10, it is written "conrol group" instead of 'control group'. There are many grammar errors (for example, page 58, bottom row 1), as well as missing or unnecessary punctuation.

D. Editorial flaws: for example, on page 41 of the thesis, it is written "Pain in the lombo-sacral disease", which I also consider an editorial flaw or oversight. The same flaw can be observed in the author's summary, page 6, upper row 3: "The most typical symptoms of the disease are: pain in the lombo-sacral disease". Reference source № 73 cited in the thesis /page 41/ and related to entesopathy appears as Enteropathy, which I accept as a typing error. On page 107, bottom row 6, it is written 'one of the tuberositis'. Source 145 (page 5, upper row 14 and page 11, upper row 7 - in the author's summary) is mentioned in the thesis as a source of the functional scale, *Health Survey Form (SF-36)*, used in patients suffering from Bechterew's disease, but it turns out that the author has in mind reference sources 146 and 147. Another example of this is page 5 of the author's summary, upper row 5: "The inter-criterial analysis method is introduced in [10]."

SUMMARY OF ITEM 6
In perspective, the intelligent methods could be applied in the rehabilitation of other diseases and injuries of the locomotor system – rheumatological, orthopaedic and traumatic ones; as well as in the neurorehabilitation clinical practice.
The thesis and the author's summary contain the following basic inaccuracies and errors: <i>terminological and methodological; medical and rehabilitation (including kinesiological and kinesiotherapeutic) inaccuracies; grammar and spelling mistakes; editorial flaws.</i>
If these inaccuracies and errors must be avoided in the future, I would recommend a greater precision and a more serious attitude towards the scientific work, as well as consultations with a medical doctor - specialist.
I hope that the specific citation of inaccuracies will serve to improve the quality of the PhD student's future publications.

7. OVERALL ASSESSMENT

The analyzed work of PhD student, Bistra Zaharieva, employs mathematical modelling tools (generalized networks and inter-criterial analysis) for the solution of complex tasks in the rehabilitation process.

Despite the abovementioned critical remarks and recommendations, I believe that the thesis makes several important contributions to the *Scientific area* "Technical Sciences", *Professional domain* "Electrical engineering, electronics and automation"; *Thematic field* "Application of cybernetics' principles and methods in medical rehabilitation", as follows:

- ❖ *Systematization of the existing intelligent methods for the analysis of the rehabilitation processes;*
- ❖ *The work proposes a methodology for analysis of rehabilitation processes – in patients suffering from some socially significant diseases and injuries (Bechterew, gonarthrosis, fracture of the humerus);*
- ❖ *Resolution of generalized network models for rehabilitation processes used in patients suffering from the aforementioned diseases and disorders;*
- ❖ *Obtaining of results from the application of intelligent methods in the analysis of rehabilitation processes for patients with some socially significant diseases and injuries of the locomotor system - ankylosing spondyloarthritis (Bechterew's disease), gonarthrosis and fracture of the humeral neck.*

February 5th, 2019

CONCLUSION:

In view of the aforesaid and regardless my critical notes, I think that regular PhD student, *Bistra Yuliyanova Zaharieva*, meets as a whole the requirements for the awarding of *Philosophy Doctor's Educational and Scientific Degree* on her *scientific thesis* entitled: "INTELLIGENT METHODS EMPLOYED IN THE ANALYSIS OF THE REHABILITATION PROCESSES", with *Scientific Supervisor: Professor Lyubka Atanasova Dukovska, PhD, DSc*; as per the Law on the Development of the Academic Staff, the Rules for the implementation of the Law on the Development of the Academic Staff, the Statute and the Regulations of the Bulgarian Academy of Sciences (*Regulations on the Terms and Procedure for the Awarding of Academic Degrees and the Holding of Academic Positions in the Bulgarian Academy of Sciences*).

I recommend that the honourable members of the Scientific Panel vote on the completion of the awarding procedure and grant the PhD student *Doctor's Educational and Scientific Degree* in Higher Education Area 02.00.00 "Technical Sciences", Professional domain 5.2. "Electrical equipment, electronics, and automation", Doctor's program: 02.21.10. "Application of cybernetics' principles and methods in various scientific areas (technical, medical, bio-cybernetical, legal, etc.)".

I vote YES.

05.02.2019

Reviewer:
Professor Ivet Koleva, MD, DMedSc
University of Medicine of Sofia, Bulgaria