Skoltech

Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Ali Mazhar

PhD Program: Engineering Systems

Title of Thesis: Voltage Feasibility Boundaries

Supervisor: Prof. Janusz Bialek

Date of Thesis Defense: 09 December 2019

Name of the Reviewer: Henni Ouerdane

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:** **Date: 20-11-2019**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- **Brief evaluation of the thesis quality and overall structure of the dissertation.**

The doctoral thesis *Voltage feasibility boundaries*, presented by Mr. Mazhar Ali compiles a valuable body of work structured over 7 chapters followed by a conclusion that summarizes the main findings, and the bibliographical references used throughout the manuscript to support some of the statements made and also make good use of results found in the literature. Overall, one can appreciate the effort made by the author of this doctoral thesis to produce a coherent text where the ideas, concepts and the methodology are well explained, so that the added value of the research results appears clearly upon reading. This shows that the author has a sound knowledge of his scientific field, and that he understands the importance of conveying properly the highly technical content and messages of his research work to the reader.

- **The relevance of the topic of dissertation work to its actual content**

Though the systems for production, transmission and distribution of electrical power, have developed over more than one century, into a modern, complex, interconnected electrical networks, challenges are many on several fronts. From the practical viewpoint, power grids worldwide have to satisfy an ever growing demand while its efficiency, stability and safety must be ensured; further, the penetration of the so-called renewable energy sources poses particular constraints on the grid, which are as many challenges. These practical, but inherently complex, problems may find solutions in mathematical models and computational studies, but this approach requires advanced methods both for mathematical modeling and development of numerical methods. Therefore, the doctoral thesis of Mr. Mazhar Ali not only is topical as there is a strong push for power systems to evolve, but it also has the interesting feature that it lies at the interface of very practical problems relevant to industry, and more theoretical, academic mathematical and numerical problems.

- **The relevance of the methods used in the dissertation**

The operation and control of a power grid requires the proper characterization of the electrical power that flows through its transmission lines; so, the power flow problem can be summarized as the determination of the voltage magnitude and angle for each bus. From the mathematical viewpoint, this amounts to finding the solutions of a system of nonlinear equations, which in fine provide the needed information in terms of real and reactive power flow. The core problems that Mr. Mazhar Ali treated in his PhD thesis are essentially power flow solvability and voltage feasibility boundaries. The principle methods, notably the Newton-Raphson method, and state of the art are discussed in the PhD thesis manuscript, where their merits and limits are indicated. The main contribution in the thesis is the rigorous development of an algorithm that permits efficient identification of an operating point in the power flow solution space. More precisely, the Newton-Raphson method load flow solver has been extended by Mr. Mazhar Ali and his co-workers by enforcement of the transversality condition in order to restrict the solutions to the boundary of the solvability region. The key point here is that the obtained augmented systems of equations has a non-singular Jacobian, which thus allows for rapid numerical calculation of the maximal system loadability as successfully shown for various IEEE cases. The technique developed being numerically stable, operating points can be found in the close vicinity of the solvability boundary.

- **The scientific significance of the results obtained and their compliance with the international level and current state of the art**

The work of Mr. Mazhar Ali certainly is on par with the current state of the art in the field as concretely proven by his record of Scopus-indexed publications and presentation at leading international conferences. Mr. Mazhar Ali obtained sound results for power systems with complex topology, notably that of the Primorskaya energy system, which is of great importance for the development of the Far East.

- **The relevance of the obtained results to applications** (if applicable)

Operation of current power systems and their actual development require sound approaches to power flow studies. Clearly, the results of the doctoral thesis have a strong relevance for practical problems; in fact, these practical problems are the basis of the research works done by Mr. Mazhar Ali. And the various case studies presented in the thesis illustrate well the applicability of the mathematical approach and numerical tools he developed.

- **The quality of publications**

Mr. Mazhar Ali is author of 6 high-level publications, of which 5 may be found in the Scopus database. He presented his work at important international conferences. It is of interest to note that he is the sole author of one publication (2016) and first author of another 3, including a Q1 journal. This clearly satisfies and exceeds the publication requirements of the Skoltech Engineering Systems doctoral program.

The summary of issues to be addressed before/during the thesis defense

From the scientific viewpoint, the doctoral work is sound and significant. Though the effort to produce a clear and easy-to-follow manuscript is evident, it would be beneficial to:

1. Revise the text here and there. Clear the text of typos, which are a bit too many to list, and check the grammar. The Introduction, should not start on page 15, but page 1. I suggest that the Author uses roman numerals before the Introduction, and turns to Arabic numerals from page 1 of the Introduction. It may be a subjective matter of taste, but the systematic use of the passive voice to report work and personal analysis, makes the text dull at times.

2. Add a bit more personal reflection, notably in the Conclusion chapter, which is quite short. A doctoral thesis should not simply be a technical report, but should show somehow the personal opinion of the author on how his work fits into the efforts on the larger scale, to develop the power grids. The Conclusion chapter should be improved; as it is now, it boils down to a check list of the tasks done. Upon reading the conclusion, the reader expects a strong take-home message that answers the core research question of the doctoral work. The "future work" is laid out in a quite cursory fashion. If the section is also about the discussion of future work, it should be discussed, not necessarily at length but properly; clearly this deserves more than one sentence. Now, it looks like a short wish list.

I have no doubt that the above minor points will be easily and rapidly addressed. Therefore, considering the quality of the doctoral work done by Mr. Mazhar Ali and his sound contribution to scientific research in the field of power systems, I am pleased to state that his PhD thesis is worthy of consideration for the formal defense leading to the award of the PhD degree.

Provisional Recommendation

☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*