Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Fernando Davalos Hernandes

PhD Program: Engineering Systems

Title of Thesis: Supercapacitor Energy Storage System based on Modular Multilevel Converter with embedded self-balance control

Supervisor: Associate Professor Federico Martin Ibanez

Name of the Reviewer: Dr. Pallavee Bhatnagar

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 15-08-2023**

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 relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

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

I congratulate the candidate and his guide for such an innovative work. The work is well explained, simulation and experimental results are validating the proposed concept. The work proposed is showing many future applications. I recommend the thesis with minor changes as given below.

<mark>Few observations from English/grammar point of view:</mark>

1. Page 7, 2.5 it should be comparison not comparative
2. 3.1 Principle instead of Principles
3. Page no 18 (Based on Fig. 4 it is possible to infer that if we moved in a diagonal from the left bottom to the upper right the volume would start to decrease,) it should be move
4. Page 18. (Depending on the application, the energy storage device must be selected based in a techno-economic analysis). It should be on instead of in
5. Page 19. (Therefore, they are very suitable for maintain the power quality in the grid for a period of time in the second's range.). It should be maintaining
6. Page 22 (Due the nature that the majority of energy storage devices only store energy in the form of DC, it is not possible to directly interconnect them to the AC grid.) needs correction.
7. Page 23. (Since ESSs already have the required energy buffer for successfully operate in the

    grid-forming control, they can also be used as to provide frequency support and black start services) to successes fully operate.
8. Page 35: (One solution is two put the transistors in series and switching them exactly at the same time) two or to???
9. Page 36: (Multi-level converters are a solution) a-remove a.
10. Page 36:(Although the first application of a multi-level converter were in the field of a) was instead of were.
11. Page 36: (the idea of synthetizing a higher voltage waveform from various voltage sour) synthesizing
12. Page 50 (Finally, other authors ……..created a hybrid ESS by) have to be included.
13. Page 68: (Boost-mode consists of five-time intervals.) this sentence needs correction.
14. Page 83: (The first simulation consisted of a discharge process). Consist of.

Few technical observations:

1. I would suggest the scholar to avoid using reference like [3], [4], [7]–[10]. The scholar has used reference in this style lot many times. This is not recommended mostly.

2. Page 26: There are so many other advantages of MMC when integrated with grid. I would suggest scholar to add more advantages.

3. Page 27 : It is observed that at many places scholar has used the past tenses and future tenses like (Simulations were done using Matlab Simulink and LTSpice or HSpice, Python), (In this section, several types of topologies for DC/DC converters and DC/AC inverters will be covered)
   It is always recommended to use present tenses.

4. Why fig. 9, 10, 11, 12……..are called proposed converters? Proposed word mostly is used while introducing your own work

5. Page 37: (transistors are used instead of diodes bidirectional power flow can be) I would recommend MOSFET instead of transistor. As in the topology shown in figure 14 uses MOSFETs ant transistors, also transistors are unidirectional. At many other places also word transistors is used please check.

6. Explanations given in 3.1.1 and 3.1.2 are good.

7. Some formatting corrections needed in Page 71

8. Page 81: Fig 35. Needs more explanation, as it is not clear from the given description.

9. Page (and an Iref signal) this Iref is differently used at different places please check.

10. Excellent simulation work. Results are properly explained.

11. Page 89: Formatting corrections are required

12. Methodology is well explained and implemented

13. Fig. 42 needs some formatting corrections

14. Experimental results validates the proposed objectives, if possible please check the labeling of the experimental figures. The labels and the resolution of the figures need improvement.

15. Conclusion is well written.

16. Sufficient and relevant references.

Thanks and regards

Dr. Pallavee Bhatnagar

Associate Professor

MIT MAHE Karnataka India

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*