Opponent review of the doctoral thesis

Author of the thesis: Ing. Le Thi Minh Trang

Title of the thesis: Dynamic Model of Two Synchronous Generators Connected via Long Transmission Line

Study Program: Mechanical Engineering

Field of Study: Power Engineering

Training Department: Department of Instrumentation and Control Engineering, Faculty of Mechanical Engineering, Czech Technical University in Prague

Supervisor: prof. Ing. Ivan Uhlíř. DrSc.

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I prepared this opponent review at the request of the Vice Dean prof. Ing. Tomáš Jirout. Ph.D. from the Faculty of Mechanical Engineering Czech Technical University in Prague, dated November 8th, 2018.

Presented PhD thesis was written in English. It consists of 103 pages of text, figures, tables and appendixes. It has good graphical form. Adopted figures and texts refer to the literature sources.

The PhD thesis was plain-written. However its style corresponds rather to a textbook for those from other related fields interested in this topic. It does not have the form of scientific work.

Above mentioned approach is suitable for the first two chapters - Introduction and Literary Research on the current status of the issue. The Introduction chapter described convincingly the relevance and necessity of solving the dynamics of the phases in the distribution grids in relation to their stability.

It is necessary to appreciate the Literary Research presented by the PhD student. Most of the stated references are not older than 10 years. All references on the list were individually

evaluated from the point of view of their use in the PhD thesis. The PhD student also mentioned what she considered to be inadequate in the current papers. She pointed out, that some authors simplify incorrectly either mechanical or, on the other hand, electrical components of dynamical phenomena in the distribution grids.

Based on the well-prepared Literary Research, the PhD student specified the objectives of the PhD thesis:

1. To create mathematical model of the system with running synchronous machines connected to the distribution grid and in parallel arrangement fully respecting both the components, mechanical and electrical;

2. To use such a model to determine the influence of the length of long power line between two parallel running machines.

The text of the PhD thesis continues in the same textbook-like style in the Methodology chapters. There was uselessly long section describing the process of block model creation in MATLAB Simulink software. It was derived from the common expression of the synchronous machine transformed into the perpendicular axis on the rotor based on Park's equations. The model did not include nonlinearities of the magnetic circuit. There were only nonlinearities of *sin* and *cos* functions, which were not apparent in the model, because the PhD student used very low impulse in the input of the model. There was not explained why the PhD student had chosen such a low and short impulse. The omission of the magnetic nonlinearities was unnecessary; it usually causes huge differences between model behavior and the reality.

In the Results and Conclusions chapters, the PhD student mentioned time dependences recorded in nodes of the created model. She used parameters of two synchronous machines for the model and presented them in a clear table. However the machines were not sufficiently specified and the type of their drive was missing. It cannot be stated, that the created mathematical model was verified. The most that can be said about it is that the model became alive. The transient and sub-transient sections were not visible on the model curves neither the states of the nonlinearities were clear.

The mere visual comparison of the attenuations of time dependencies recorded by the model with long metallic power line was not sufficient criterion for estimating its influence on the stability. There should be at least short theoretical analysis of the influence of the power line length on the length of vertical wave of basic frequency.

The moments of inertia of mechanical control components should be examined within the first objective of the PhD thesis. The supply delay caused by the length of power line is not apparent from the results of the second objective.

In this context, I would like to ask the PhD student to draw and explain the scheme of electromechanical oscillating system.

The analysis results that were followed by designing a grid system of a long section of electricity distribution network located in central Vietnam can be considered a contribution of the PhD thesis of Ing. Le Thi Minh Trang. It is, however, questionable to what extent such a proposal is technically achievable and whether its costs are affordable and the results profitable. A theoretical contribution to the field of energy distribution is the PhD student's plan to address the impact of the long power line on network stability. According to the literature, this is the first attempt to solve this system in this way. It will be useful to address this issue in further research.

The PhD thesis of Ing. Le Thi Minh Trang in presented revised form is elaborated at appropriate professional and formal level and meets the requirements of qualification theses for the PhD degree. In the case of successful PhD thesis defense, **I recommend** granting Ing. Le Thi Minh Trang the title Ph.D.

In Prague on December 16th, 2018

prof. Ing. R. Adamovský, DrSc.