REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Unit for Vibrating Sample Magnetometer**
Author's name:	**Ramos Patrick Theodore**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Electrical Power Engineering
Thesis reviewer:	doc. Ing. Michal Vopalensky, Ph.D.
Reviewer's department:	Institute of Theoretical and Applied Mechanics, Czech Academy of Sciences

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

Evaluation of thesis difficulty of assignment.

The thesis requires theoretical knowledge as well as practical skills and leads to a working prototype. I consider the complexity of the thesis as challenging for a bachelor thesis.

Satisfaction of assignment **fulfilled with minor objections**

Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.

Overall, the student fulfilled the assignment of the thesis. However, the first point, i.e., design of the shape and number of turns of the pick-up coil derived by calculations and FEM modelling, is not addressed at all in the thesis. The student only states, without further analysis, the parameters of the used coil on page 16.

Method of conception **correct**

Assess that student has chosen correct approach or solution methods.

The thesis purpose is rather straightforward and the student followed correctly the right way. Minor difficulties that arose during the realization were very well solved (insufficient output current of an OpAmp, problems with input mode of lock-in amplifier, calibration of the Hall sensor etc.)
I have, however, certain objections to the methods used for concept evaluation, which I mention in the section Additional commentary and evaluation.

Technical level **B - very good.**

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

The practical part of the thesis is very convincing, the student can obviously orient himself in the field of simple digital as well as analog electronic design. However, there are some inaccurate concepts in the evaluation part.

Formal and language level, scope of thesis **D - satisfactory.**

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

The thesis is written in English and as such, it reads very well. Nonetheless, there are many formal problems:

- throughout the text, the student does not always keep a space in front of brackets, including References tags, or in between the number and unit
- in figures 4.4 – 4.7, the texts are overlapping
- all schematics could have been exported without the grid for the thesis
- I would definitely recommend not to use the "emu" unit for the magnetic moment. Also, using of units should be consistent (fig. 4.11 uses different units than the previous figure in Chapter 4)

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Selection of sources, citation correctness	**A - excellent.**
Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.	
The thesis cites 37 very relevant sources.	

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.

I am afraid there is an essential incorrectness in section 4.1. The student measures the jitter in reference signal and identifies its standard deviation to be 0.108°. After that, he applies the "68-95-99.7 rule" and concludes that the reference signal phase error will be in between +/-108° and +/-324° for 99.7% of the time. However:

1) the 68-95-99.7 quantiles are valid only for a Gaussian (normal) distribution and there is no evidence that the jitter is normally distributed.
2) even if the jitter was normally distributed, the "68-95-99.7" rule would imply that the phase error would be in the interval +/-324° for 99.7% of time, and not between +/-0.108° and +/-0.324°.
3) I do not understand the conception of eq. (4.1) and (4.2). The output of the lock-in amplifier is proportional to the mean value of the demodulated signal. If there is a phase error in the reference signal, the calculated mean value will change, and this change should be taken as the input for the error calculation.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

I evaluate handed thesis with classification grade **B - very good.**

Student fulfilled basically the assignment of the thesis. He proved his ability to develop a functioning prototype of a vibrating sample magnetometer. For this purpose, he had to show his skills in electronic design, both analog and digital, programming in several languages, mechanical design (model for 3D printer) and some manual dexterity. He also performed evaluation of the prototype and compared its performance to the commercial equipment. The thesis is written in English and is organized and read very well. I have a couple of remarks cited above, but considering the extend of the thesis and the level of fulfillment of its goals, I evaluate the thesis with the classification grade B – very good.

Questions for the defense:

- **why did you use the "emu" unit for the magnetic moment, instead of SI units in the most of your graphics?**
- **on page 17, you present your I-to-V converter, with 1 MOhm feedback resistor. Did you analyze the noise of such a circuitry?**
- **can you please comment on my objection regarding the jitter-induced error analysis (see section Additional commentary and evaluation)?**

Date: **31.8.2020** Signature: Michal Vopálenský