SUPERVISOR'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Low-cost particle filter integrity tester for periodic and roadside vehicle inspections**
Author's name:	**Yash Patel**
Type of thesis :	master
Faculty/Institute:	Faculty of Mechanical Engineering (FME)
Department:	Department of Automotive, Combustion Engine and Railway Engineering
Thesis supervisor:	Prof. Michal Vojtíšek, Ph.D.
Supervisor's department:	Department of Automotive, Combustion Engine and Railway Engineering

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

Evaluation of thesis difficulty of assignment.

There are three aspects of the assignment that made the assignment considerably challenging: A) the interdisciplinary nature of the topic, spanning internal combustion engines, aerosol science, and measurement and instrumentation; B) the experimental, hands-on part; C) the requirement to actually fabricate a working version of the designed apparatus.

Satisfaction of assignment **fulfilled**

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.

The assignment has been satisfied to its entirety. Mr. Patel has produced a reasonably working version of the low-cost instrument and has run a series of validation tests, which are reported on in the thesis.

Activity and independence when creating final thesis **A - excellent.**

Assess that student had positive approach, time limits were met, conception was regularly consulted and was well prepared for consultations. Assess student's ability to work independently.

Mr. Patel has worked independently on the preparation of the thesis and the underlying work, except for laboratory tests, which were done under supervision and with the requisite expert help (i.e., setup of reference instruments). He has always been prepared for progress meetings and experiments, diligently reported on the progress, met deadlines, communicated clearly, and took extraordinary initiative throughout the project.

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 thesis addresses a special topic of detecting a defunct diesel particle filter. Mr. Patel has become quite knowledgeable in this topic, and has written a technically correct and reasonably comprehensive summary of the state of knowledge. He has then used this knowledge to develop a working concept of a monitoring instrument. I would like to reiterate here that the assignment was to design and build a low-cost instrument using commonly available components and tools for citizen science campaigns, as opposed to designing a concept of an inspection-grade instrument for commercial use. The instrument was validated during a series of measurements of vehicles with and without a functional particle filter, in parallel with two laboratory-grade instruments that were used as a reference. Experimental data is shown and interpreted, and sound conclusions are derived. More work could be done to address some shortcomings of the design, but given the severe restrictions on the presence of students in university laboratories since March 2020, this could not have been reasonably expected.

Formal and language level, scope of thesis **C - good.**

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

The scope of the thesis is commensurate to the work presented. Of 78 pages in total, 17 are dedicated to a compact and comprehensive introduction, and 37 pages describe Mr. Patel's own work, including instrument design, set up of the validation experiment, results of the experiments, and discussion. The language level is best described as technical English

– reasonably structured, comprehensible, but with some stylistic, language and typographic shortcomings. Some parts of the text are in different font. The figures are well designed, readable and convey the message, but with a larger number of minor shortcomings such as text that is too small or blurry, or not being systematic in references to vehicles and test conditions.

Selection of sources, citation correctness **C - good.**

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.

Of the 49 sources cited in the thesis, several peer-reviewed papers and a small number of additional sources were assigned as a background literature. The rest of the sources were selected and obtained by Mr. Patel. In my opinion the selection of the sources – both in a thematic view and in terms of quality of the source – is reasonable. Multiple sources that could be classified as obscure (not indexed peer-review literature) are not precisely identified and could be difficult to locate using the information given.

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.

Instrumentation for identification of a defunct particle filter has been long sought for by the technical community, with many methods proposed and functional concepts and prototypes presented by multiple academic groups and instrument manufacturers; to date, the only such devices available on the market are those approved for federal Swiss legislation, with a market price of 10-20 thousands of EUR; the market price of a rather insensitive instrument, a smoke meter used in periodic inspections in many countries, is several thousands of EUR. Fabrication of a 40 EUR instrument made solely of parts that can be readily a purchased by the general population is, despite some shortcomings identified by the author and recommended to be addressed in the next version, a truly remarkable achievement.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation.

Overall, Mr. Patel has done remarkably well in designing, fabricating and validating a very low cost instrument for the measurement of particulate matter in vehicular exhaust for the purpose of identifying vehicles with defunct diesel particle filters. He has worked diligently, shown a great interest in the subject, and learned considerably. The work is rather comprehensive, from conception and design of the proof-of-concept to its fabrication, validation, and interpretation of the validation data. The work is technically sound, all shortcomings are relatively minor and of a formal character.

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

Questions:

1. **Please elaborate on why the particle concentrations were not steady during tests described as steady-state operation at target engine rpm**
2. **Please suggest a test procedure suitable for use with your device**

Date: **30.8.2021** Signature: