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REVIEW
of the doctoral dissertation
of M.Sc., Eng. Faisal Saleem
entitled “Measurement uncertainty of quantity modelled with non-integer order differ-
integral equations”

1. Legal basis of the review

- Contract for a specific work UMC/2784/2026 of 07.08.2026, concluded with the Silesian University of Technology, represented by Katarzyna Mościńska, Ph.D., Eng., University Professor, with reference to application no. 2621/UMC/RAU0-3/2026;
- Act of 20 July 2018 – Prawo o szkolnictwie wyższym i nauce [Law on Higher Education and Science] (Dz.U. 2018 poz. 1668, as amended).

2. Profile of the Candidate

Mr. Faisal Saleem, M.Sc., Eng., is a doctoral candidate at the Doctoral School of the Silesian University of Technology, affiliated with the Department of Measurements and Control Systems at the Faculty of Automatic Control, Electronics and Computer Science. The supervisor of the dissertation is Józef Wiora, Ph.D., D.Sc., Eng., Associate Professor of the Silesian University of Technology, and the co-supervisor is Alicja Wiora, Ph.D., Eng.

Within the subject area of the dissertation, the Candidate is a co-author of three papers published in JCR-listed journals: in Measurement (IF 5.6; 200 ministerial points), in Scientific Reports (IF 3.9; 140 points) and in Communications in Nonlinear Science and Numerical Simulation (IF 3.8; 100 points), being the first author of the former two. Furthermore, the Candidate is a co-author of four conference papers (including the Conference on Automation 2024 and 2026, SPA 2025, and IMEKO TC-6 2025) and one published abstract. Outside the subject area of the dissertation, the Candidate is a co-author of five further papers in indexed journals (PLoS One, Journal of Systems Engineering and Electronics, Frontiers in Energy Research, Energies, Applied Mathematics – A Journal of Chinese Universities).

The documented international cooperation of the Candidate deserves emphasis, in particular with Prof. Delfim F. M. Torres (University of Aveiro, Portugal) and with Prof. Guido Maione and Prof. Paolo Lino (Politecnico di Bari, Italy). The Candidate's publication record indicates that the dissertation results from systematic research carried out over several years and that its key findings have already been positively assessed by reviewers for journals of international standing.

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3. Characteristics of the dissertation

3.1. Content and structure of the dissertation

The doctoral dissertation of M.Sc., Eng. Faisal Saleem, entitled “Measurement uncertainty of quantity modelled with non-integer order differ-integral equations”, prepared in the discipline of automation, electronics, electrical engineering and space technologies, comprises 185 numbered pages (the PDF file contains 221 pages), including: front matter (title pages, dedication, author declaration, declaration on the use of artificial intelligence tools, acknowledgements, abstracts in English and in Polish, list of publications, table of contents, lists of figures, tables and listings, list of acronyms and list of symbols), the main body consisting of nine chapters (pp. 1–168), Appendix A (pp. 169–170) and the bibliography (pp. 171–185). The work contains 67 figures, 28 tables, and 4 listings. The bibliography comprises 184 items, including eight co-authored by the Candidate as well as the fundamental normative documents of metrology. Chapters 5 and 8 develop material the Candidate previously published.

No thesis statement in the classical sense has been formulated in the dissertation; instead, six research objectives (Obj.1–Obj.6), three hypotheses (H.1–H.3) and five declared original contributions (C.1–C.5) have been defined. The mapping of objectives, hypotheses, methodology, and contributions onto individual chapters is summarised in Table 1.1 – a solution that the Reviewer assesses as very good and that greatly facilitates reading the work.

Chapter 1 introduces the problem of measurement uncertainty of dynamic quantities, formulates the research problem (the absence of experimentally validated methods for the assessment of time-dependent uncertainty of non-integer-order models), the motivation, the objectives, the hypotheses, and the original contributions, and outlines the structure of the work.

Chapter 2 constitutes the review part. It presents the foundations of metrology (Type A and Type B uncertainty, expanded uncertainty, dynamic metrology), the definitions of non-integer-order operators (Grünwald–Letnikov, Riemann–Liouville, Caputo) and the methods of their practical realisation by means of integer-order approximations (Oustaloup and its variants, CFE, the Matsuda method, the Carlson method, the Charef method, M-SBL). The chapter closes with a review of the literature concerning modelling, dynamic uncertainty assessment and control design, and unambiguously identifies the limitations of the state of the art.

Chapter 3 describes three case studies of increasing complexity: a simulation model of fractional-order inertia without delay, a simulation model of a nonlinear twin-rotor aerodynamic system (TRAS), and a laboratory setup for measuring water flow rate. The hardware configuration, input data acquisition algorithms, and the nature of the collected data are discussed, including the significance of the sampling interval.

Chapter 4 contains an accuracy analysis of seven approximation methods for fractional-order operators – in the steady state, in the time domain and in the frequency domain – as well as an analysis of the influence of the choice of approximation on control quality, illustrated by an optimal FO-PID controller designed for the TRAS under constraints imposed on overshoot, undershoot and settling time.

Chapter 5 presents the identification of integer-order models of the flow measurement setup: third- and second-order models identified by means of the SQP method, model order reduction with the use of PCA (Principal Component Analysis), and the construction of an LPV (Linear Parameter Varying) model, in which the parameters vary with the input frequency, thus making it possible to describe the entire operating range by a single model.

Chapter 6 is one of the two key chapters of the dissertation. It proposes identifying a fractional-order model (one non-integer-order pole and one non-integer-order zero, five parameters), formulated as a constrained nonlinear optimization problem, with the operators realized in the Grünwald–Letnikov sense. The problem has been implemented in the AMPL environment and solved on the NEOS-server platform, using training passes and the remaining passes as the test set. We investigated the nominal model's robustness to parameter perturbations, the influence of the truncation order of the GL coefficients, and the influence of the solver choice, and compared the results with second- and third-order integer-order models.

Chapter 7 presents the design premises for the FO-PI controller for the TRAS, namely controller tuning, computation of the controller parameters and the control task itself. The model equations were solved using MATLAB R2024b, employing routines from the Optimization Toolbox. The chapter closes with an analysis of the influence of the approximation method of the fractional-order operator (Oustaloup, Matsuda, Charef) on the closed-loop response.

Chapter 8 constitutes the principal achievement of the dissertation. For a three-parameter fractional-order model with delay, identified independently for 200 measurement passes, the normality of the distributions of the parameters has been demonstrated (Kolmogorov–Smirnov test, quantile–quantile plots); time-dependent sensitivity coefficients of the model response with respect to the parameters have been derived and – by applying the law of propagation of uncertainty together with the covariance matrix of the parameters – the time-dependent uncertainty has been evaluated. The approach has been compared with the digital filtering method and subsequently extended to a closed-loop system with an FO-PI controller, including an additional analysis of the influence of implementing the fractional-order operator (GL, RL, Caputo) on the uncertainty assessment.

Chapter 9 summarises the results, juxtaposes the fulfillment of the objectives with the verification of the hypotheses, explicitly states the limitations of the methods applied, and defines directions for further research.

Appendix A contains the text of the prompt used for the linguistic editing of the dissertation.

3.2. Assessment of the literature used

The Reviewer assesses the literature used as appropriately selected and up-to-date. The bibliography comprises 184 items, predominantly papers from journals of international standing published over the last dozen or so years, with a substantial part dating from 2020–2025. The dissertation also properly compiles the “canonical” literature from both areas: on the one hand, normative metrology documents and works on dynamic uncertainty; on the other, monographs and source works on fractional calculus and approximation methods for non-integer-order operators. The review of the state of the art in Chapter 2 is organized thematically

(modeling, measurement models and dynamic uncertainty, control design) and – which the Reviewer regards as its essential merit – closes with an explicit identification of research gaps, which are subsequently translated into the objectives of the dissertation. The citation style is uniform, and references to the Candidate's own works are clearly indicated.

In the Reviewer's opinion, the Candidate could have given greater prominence to the literature on methods for identifying parameters of fractional-order models under non-uniform sampling, as well as to Bayesian and Monte Carlo methods for assessing uncertainty in dynamic models. Monte Carlo methods are mentioned, yet they are not discussed as the natural point of reference for the proposed approach.

4. Substantive evaluation of the dissertation

4.1. General remarks

The dissertation's subject matter is topical and important, both scientifically and practically. Non-integer-order models are nowadays widely applied to the description of systems with distributed dynamics, with memory effects and with characteristics that are difficult to reproduce by means of classical models; in parallel, there is a growing demand for a reliable, time-dependent assessment of the uncertainty of measurement results, which the classical GUM (Guide to the Expression of Uncertainty in Measurement) framework does not provide. The combination of these two areas, namely metrology and fractional calculus, is an original undertaking and, in the Reviewer's opinion, fills a genuine gap in the literature. I consider it particularly valuable that the dissertation does not stop at theoretical considerations: the proposed methods have been validated against data from an actual laboratory setup. The triad characteristic of the technical sciences, namely experiment, mathematical modeling, and validation, is therefore fulfilled.

The aim of the work has been formulated correctly and – which deserves emphasis – decomposed into six specific objectives (Obj.1–Obj.6) of increasing complexity, explicitly related to hypotheses H.1–H.3 and to the declared contributions C.1–C.5. The principal aim, namely the development of a coherent framework for assessing the measurement uncertainty of quantities described by non-integer-order differ-integral equations, has been achieved. The Reviewer notes, however, that the structure of the objectives is not homogeneous: objectives Obj.1, Obj.2 and Obj.5 are auxiliary analyses in character (respectively: approximation accuracy, integer-order modelling, controller tuning rules), whereas the actual subject of the dissertation, as indicated in its title, is addressed by objectives Obj.3, Obj.4 and Obj.6. Consequently, Chapters 4, 5 and 7, which account for nearly one half of the volume of the main body, play a preparatory role with respect to Chapters 6 and 8 – which is methodologically justified, yet blurs the proportions of the work and has not been stated with sufficient clarity in the introduction.

The research methods employed have been properly selected and competently applied. These are: analysis of the accuracy of approximations of fractional-order operators in the time and frequency domains (simulations in the MATLAB/Simulink environment); black-box identification formulated as a constrained nonlinear optimisation problem – solved by means

of the IPOPT solver on the NEOS-server platform within the AMPL environment, as well as by the `fminsearch` and `lsqnonlin` routines in MATLAB; model order reduction with the use of PCA/SVD; design of FO-PI controllers by the frequency-domain method; statistical verification of the distributions of the parameters (Kolmogorov–Smirnov test, quantile–quantile plots); and the law of propagation of uncertainty together with the covariance matrix of the parameters in accordance with the GUM. The consistent use of the same case studies across successive chapters and uniform quality indices (e.g., RMSE, MAE, MAPE, residual analysis) make the results comparable. I also assess very favorably the explicit presentation of the code for the setup configuration and data acquisition (Listings 3.1–3.3) and the pseudocode of the optimization problem (Listing 6.1) – a practice conducive to the repeatability of the research.

I regard the use of the free NEOS server platform to solve the identification problem as ingenious and practical. At the same time, as part of the methodology, it warrants comment: processing measurement data on an external computational platform and the lack of control over the solver version limit the reproducibility of the results over a longer time horizon. The dissertation would benefit from adding information on the software versions and the values of the solver control parameters used to obtain the presented results.

The dissertation is written in comprehensible English and is correctly edited in technical terms (consistent numbering, good quality of figures, complete lists of acronyms and symbols). The transparent declaration on the use of artificial intelligence tools exclusively for linguistic editing, together with the attached text of the prompt employed (Appendix A), deserves separate mention – this is an exemplary practice. Paradoxically, however, the guidelines adopted in that prompt (among others, the requirement that sentences should not exceed 15 words) have had an adverse effect on the stylistic layer: a considerable part of the text consists of very short sentences that are disconnected from one another and that in many places repeat the same content (cf., e.g., the openings of Chapters 6 and 8 and the chapter summaries). This impedes the tracking of the argument, particularly in those parts containing derivations, where a complex sentence expressing a causal relation is required. Should the work be published in the future, the linguistic layer should be revised accordingly.

4.2. Original achievements of the dissertation

Among the original achievements of the Candidate, the Reviewer includes in particular:

- the formulation of the identification of a non-integer-order model as a constrained nonlinear optimisation problem, in which the fractional-order operators are realised directly in the Grünwald–Letnikov sense, with the transient and steady-state regions accounted for in the objective function and with an additional smoothing term enforcing agreement between the rates of change of the modelled and the measured responses (Chapter 6, Eqs. (6.9)–(6.11)); together with the experimental demonstration that the nominal model identified in this manner reproduces the response of the setup more accurately than second- and third-order integer-order models, above all in the transient region;
- the derivation of tuning rules for the FO-PI controller leading to a system of three equations for the controller parameters, together with the mapping of time-domain requirements (settling time, overshoot) onto frequency-domain requirements, and with an analysis of the

influence of the approximation method of the fractional-order operator on control quality (Chapter 7);

- the development of a direct, time-domain framework for assessing the uncertainty propagated by the identified parameters of a non-integer-order model, based on time-dependent sensitivity coefficients of the model response with respect to the parameters and on the covariance matrix of the parameters, with the application of the law of propagation of uncertainty (Chapter 8, Eqs. (8.7)–(8.13)). In the Reviewer’s opinion, this constitutes the principal achievement of the dissertation;
- the experimental demonstration – based on 200 independent measurement passes – that the parameters identified by the developed procedure follow normal distributions, which justifies their probabilistic description, and the demonstration that the uncertainty band determined by this method encloses the measured responses of the system;
- the extension of the proposed framework to the closed-loop system, namely the derivation of the sensitivity coefficients of the response of the system with an FO-PI controller and the assessment of the uncertainty propagated in the controlled dynamics, together with a comparative analysis of three implementations of the fractional-order operator (Grünwald–Letnikov, Riemann–Liouville, Caputo) and the demonstration of the consistency of the results obtained;
- the systematic comparative analysis of seven approximation methods for fractional-order operators and the demonstration that the choice of the method and of its order affects not only the accuracy with which the dynamics are reproduced, but also the stability margins and the control quality – together with an indication of the trade-off between accuracy and implementation complexity (Chapter 4).

These achievements have both a theoretical and a utilitarian dimension, and the directions for further research defined in Chapter 9 (adaptive selection of the truncation order, regularisation, the Bayesian approach, distributions other than normal, multivariable systems) allow it to be concluded that the Candidate may further develop the subject matter and may constitute a basis for building his own research team.

4.3. Critical remarks and questions

The remarks formulated below are of a discussion character and, in most cases, amount to questions to which I expect answers during the public defense. They do not diminish the scientific value of the dissertation.

1. Properness of the transfer function of the model in Chapter 6. On p. 92 the Candidate states that “the corresponding TF is constrained to be proper in order to preserve the causality”, whereas in problem (6.9) the constraint $\alpha \geq \beta + \varepsilon$ has been imposed. For the structure (6.1), i.e. $G(s) = K(s^\alpha + a)/(s^\beta + b)$, this condition implies that the degree of the numerator exceeds that of the denominator, and hence that the transfer function is improper. This is confirmed by the identified mean values (Fig. 6.4): $\bar{\alpha} = 1.54$ with $\bar{\beta} = 0.189$. This internal inconsistency requires clarification.

2. Non-uniform sampling versus the implementation of the Grünwald–Letnikov operator. In Chapter 3 (p. 38) the Candidate argues convincingly that the variable sampling interval is the

principal source of uncertainty of the data, and that resampling onto a uniform grid would introduce dynamics not present in the physical system. Meanwhile, definition (8.1) and the computations in Chapters 6 and 8 assume a uniform step, adopted as $\Delta t = 0.03$ s, while, as stated on p. 38, the mean value of the sampling interval is itself the result of resampling. Questions: (i) how can the use of a fixed-step GL approximation for data with a variable sampling interval be formally justified; (ii) what is the share of the error thus introduced in the overall uncertainty budget; (iii) have variants of the GL operator on a non-uniform grid, or interpolation with an explicit account of its contribution to the uncertainty, been considered? In its present form, this component is not quantified, which weakens the conclusion concerning the “conservativeness” of the proposed assessment.

3. Method of determining the sensitivity coefficients. The abstract and Chapter 8 declare that the time-dependent sensitivity coefficients are “derived analytically from FO differ-integral equations”. On p. 146, however, below Eqs. (8.8)–(8.10), the following statement is found: “This work calculates the partial derivatives numerically using the forward-difference scheme in MATLAB”. The declaration and its implementation are therefore inconsistent and require unification. Has the result obtained by the forward-difference method been compared with the central-difference scheme or with complex-step differentiation to control truncation and round-off errors?

4. Verification of the normality of the distributions of the parameters. Table 8.1 reports p-values obtained using the kstest function in MATLAB. In its default invocation, this function tests the hypothesis that the data follow a standard normal distribution $N(0, 1)$; for parameters with mean values on the order of 1.18 or 0.19, this hypothesis would be rejected. I therefore request clarification on whether the data were standardized before performing the test. Resolving this issue is essential, since assumption (A2) underlies the entire framework.

5. The delay in the model of Chapter 8. On p. 142 “an arbitrary delay time of $\tau = 2.2$ s” has been adopted, whereas the identification carried out in Chapter 6 yielded a mean value of $\bar{\tau} = 2.08$ s with a spread from approximately 1.6 to 2.4 s (Fig. 6.8). The delay does not belong to the parameter vector $p = [\alpha, a, K]$, and hence its variability is not accounted for in the uncertainty budget, although – as Fig. 6.8 demonstrates – it is comparable with the spread of the remaining parameters. Why, then, was τ fixed arbitrarily instead of being identified together with the remaining parameters?

6. Model order reduction by means of PCA (Chapter 5). Principal component analysis has been applied not to the signals but to the set of model parameters identified for different input frequencies. It is unclear how a projection in the parameter space of a third-order model (six parameters) leads to a second-order model (four parameters); a projection alters the parameter values, not the structure or order of the transfer function. Moreover, the notation in Eqs. (5.4)–(5.9) is dimensionally inconsistent: with $P \in \mathbb{R}^{(p_n \times Q)}$ and the decomposition $P = USV^t$, the matrix U is of dimension $p_n \times p_n$, whereas the text adopts $U \in \mathbb{R}^{(n_r \times p_n)}$, and the reconstruction is written as $\tilde{P} = U^t \hat{P}$, which does not restore the dimension of the original set. I request clarification of this observation and an explanation of the relation between the number of retained components n_r and the order of the resulting model.

7. Verification of the hypotheses and the phrase “100% verified”. Table 1.1 declares that hypotheses H.1 and H.2 have been verified as “(100% verified)”. This phrasing is too categorical for results obtained from a single laboratory setup. More importantly, however, with respect to H.1, i.e. the claim of a more accurate representation of a nonlinear system with a smaller number of parameters, the evidence presented is not conclusive: the fractional-order model has five parameters, that is, exactly as many as the integer-order model (6.13), with a computation time approximately twice as long (Table 6.11) and with comparable accuracy in the steady state. I request a precise indication of the extent to which hypothesis H.1 has been regarded as confirmed.

8. Influence of the operator approximation on the uncertainty assessment. Chapter 4 shows that the fractional-order operator approximation substantially affects the system response, and Chapter 7 shows that it also affects control quality. In Chapter 8, however, only three definitions of the operator (GL, RL, Caputo) have been compared, while the influence of the approximating realization (e.g., Oustaloup filters), which is unavoidable in implementation practice, has been omitted. Since the declared objective Obj.1 was precisely to analyze the influence of the approximation, closing this line of reasoning within the uncertainty assessment would be a natural step. Has such an analysis been carried out?

5. Practical application of the obtained results

The dissertation results have a clear utilitarian dimension. The proposed framework for the assessment of time-dependent uncertainty may be applied directly in dynamic metrology – wherever the measurement result is reported as a time history rather than as a single value: in flow systems, drives, robotics and industrial process monitoring systems.

The auxiliary results are also of practical value. The comparative analysis of approximation methods for fractional-order operators (Chapter 4) provides the designer with concrete criteria for selecting the method and its order, together with a quantitative description of the trade-off between accuracy and implementation complexity. The tuning rules for FO-PI controllers (Chapter 7) are ready for use in engineering practice and – as confirmed in two case studies – ensure the flatness of the phase characteristic, and hence robustness to bounded variations in plant parameters. The results concerning the influence of the truncation order of the GL coefficients and of the choice of solver (Chapter 6) are of direct significance for the implementation of fractional-order models in real-time systems with limited computational resources. I also consider it valuable that the limits of applicability of the proposed modeling approach are stated explicitly (p. 124) – fractional-order models should not be applied to plants whose integer-order dynamics are well described, nor in applications subject to stringent computation-time constraints.

Finally, a noticeable application potential is demonstrated by the Candidate’s work on digital twins and on the configuration of the measurement setup, together with data acquisition, described in sufficient detail (listings, P&ID diagram, list of instrumentation) to allow the experiment to be reproduced in another laboratory.

6. Detailed and editorial remarks

The dissertation has been edited with care; the remarks below are therefore of a housekeeping character (page numbers refer to the pagination of the dissertation):

- p. 8: “The uncertainty component are evaluated as Type A and Type B” (lack of number agreement) and “the inability to perform infinite measurements limits enforces the use” – the sentence requires rewriting;
- p. 33, Eq. (3.9): the denominator of the transfer function of the yaw angle is written as “ $s^3 + 6s + 5.01s$ ” – an exponent is missing in one of the terms (presumably $6s^2$);
- it has not been explained why the CA method was not included in Chapter 4;
- inconsistent use of abbreviations, e.g. XO–XOM, RO–ROM, etc.;
- p. 92: the parameter bounds are written as “ $0.1 \leq \alpha\beta \leq 5$ ”, which is to be understood as $0.1 \leq \alpha, \beta \leq 5$; the notation requires correction, all the more so as the identified values of α exceed 1;
- p. 140: “implementable FO-FO controllers” – should read FO-PI;
- p. 146: in the definition of the sensitivity coefficient, $\partial y_e / \partial k$ is written, whereas the parameter is K;
- p. 162: “the proposed provides provides a more conservative estimate” – the sentence is incomplete and contains a repetition;
- abstract (English version): “the covariance matrix of the the normally distributed parameters” and “GrünwaldLetnikov” – a hyphen is missing in the name; the duplicated “the the” also occurs on pp. 48, 62, 74 and 121;
- in Table 1.1 the phrases “Achieved” and “100% verified”, placed in a single column, conflate two distinct categories (fulfillment of an objective and verification of a hypothesis) – separating them would be clearer;
- the figures reproduced from the Candidate’s own works (among others 3.3–3.5) are correctly marked as reproductions; it would nevertheless be advisable to state the license conditions uniformly in the captions;
- the linguistic layer – in line with the general remark in Section 4.1 – would benefit from a reduction in the number of very short sentences and from the removal of repetitions between the introductions and the summaries of Chapters 6, 8 and 9.

7. Summary

The dissertation under review deserves a positive assessment. The critical remarks and questions formulated above are intended solely to make the argument more precise and to deepen it during the public defense, and they do not diminish the scientific value of the work. The Candidate has undertaken a difficult problem, requiring him to move freely across four areas simultaneously – metrology, system identification, fractional calculus and control theory – and has demonstrated that the description of quantities modeled by non-integer-order differential-integral equations can be given a rigorous metrological form. The fulfillment of the triad characteristic of the technical sciences, namely experiment, mathematical modeling, and validation, deserves emphasis, as does the consistent and honest identification of the limitations

of the proposed methods – which the Reviewer regards as evidence of the scientific maturity of the Candidate.

I state that the dissertation constitutes an original solution to a scientific problem. Its original results include, above all: a direct, time-domain framework for assessing the uncertainty propagated by the identified parameters of non-integer-order models, based on time-dependent sensitivity coefficients and on the covariance matrix of the parameters, together with its experimental validation and its extension to the closed-loop system; the formulation of the identification of a fractional-order model as an optimization problem with the operators realized in the Grünwald–Letnikov sense; and the tuning rules for FO-PI controllers derived by the frequency-domain method.

I further state that the dissertation demonstrates the Candidate's general theoretical knowledge in the discipline of automation, electronics, electrical engineering, and space technologies, as well as his ability to conduct scientific work independently. As evidence thereof, I regard: the competent review of the state of the art, closed by an explicit identification of research gaps; the conduct of experiments on a laboratory setup together with the development of data acquisition procedures; the correct application of the statistical and metrological apparatus; and the publication record comprising three papers in JCR-listed journals within the subject area of the dissertation.

The dissertation is an independent work and does not constitute a separate and distinct part of a collective work, and I regard the Candidate's contribution to the works underlying it as the leading one.

8. Final conclusion

I state that the doctoral dissertation of M.Sc., Eng. Faisal Saleem, entitled “Measurement uncertainty of quantity modeled with non-integer order differ-integral equations”, constitutes an original solution to a scientific problem, and the Candidate has demonstrated general theoretical knowledge in the discipline of automation, electronics, electrical engineering, and space technologies, as well as the ability to conduct scientific work independently.

In view of the above, I consider that the doctoral dissertation of M.Sc., Eng. Faisal Saleem, entitled “Measurement uncertainty of quantity modelled with non-integer order differ-integral equations”, satisfies the conditions set out in Article 187 of the Act of 20 July 2018 – Prawo o szkolnictwie wyższym i nauce [Law on Higher Education and Science] (Dz.U. 2018 poz. 1668, as amended), and I move that it be admitted to the public defense.