

Opponent Review of Doctoral Dissertation

Applicant: Ing. Jaroslav Zechmeister

Title of Dissertation: 3D Printed Microwave Structures

Opponent: Prof. Miroslav Joler

Opponent's Department: University of Rijeka, Faculty of Engineering (Rijeka, Croatia)

In accordance with the Study and Examination Rules of BUT, in his/her review the opponent will mainly comment on:

- a) the topicality of the dissertation,*
- b) whether the dissertation achieved its given objective,*
- c) the problem-solving procedure and the results of the dissertation along with the concrete contribution of the doctoral student,*
- d) the significance for practical application or the progress in the field,*
- e) formal and language qualities of the dissertation,*
- f) whether the dissertation fulfils the conditions of Section 47 (4) of the Act,*
- g) whether the student proved his/her creative abilities in the given research field and whether the work does or does not comply with the standard requirements placed on the dissertations in the given field. The review is not valid without this conclusion.*

It is necessary to add a concise commentary to each of the points below.

Ad a) Topicality of the dissertation

The topic of the dissertation is very topical.

Comment: In this dissertation, the Applicant successfully coped with a very interesting and challenging topic of novel designs of microwave structures by means of noncanonical pixelated geometries. The topic and the coverage presented in this dissertation are of significant interest in the microwave community.

Ad b) Objective of the dissertation

The objective of the dissertation was achieved.

Comment: There were three main objectives specified in this dissertation and all three of them were achieved and demonstrated.

Ad c) Problem-solving procedure and the results of the dissertation and the concrete contribution of the doctoral student

The problem-solving procedure and the results of the dissertation are excellent.

Comment: The student has demonstrated clear understanding of the objective and has developed and explained the solution to the degree that is adequate for a reader to grasp the topic. An efficient BISO algorithm for a microwave structure geometry has been developed, tested, and explained in words and through several practical examples, designing, building, and measuring the structures of substrate-integrated waveguides (SIW) and waveguide filters using 3D printing techniques. Each segment was adequately described by words, images, data, and measurement curves. The characteristics of the accomplished results were discussed with their pros and cons, and directions for future research outlined. Parts of the material presented in this dissertation have already been presented at scientific conferences or published in reputable journals, thus proving both the topicality and quality of the research tackled here.

Ad d) Significance for practical application or progress in the field

The significance for practical application or progress in the field is excellent.

Comment: Developing an efficient optimization algorithm based on genetic algorithm (here referred to as the Binary Ink Stamp Optimization (BISO) algorithm), the Applicant has explored and offered to the respective research field a novel algorithm, which can help researchers design single- and multi-objective- goal optimized microwave structures by means of noncanonical pixelated geometries and usage of time- and cost-effective additive manufacturing processes (i.e. 3D printing). Nowadays, that is a very appealing alternative to classical metal-based structures with flat surfaces and is worth further research.

Ad e) Formal and language qualities of the dissertation

Formal and language qualities of the dissertation are excellent.

Comment: The dissertation style and language is at a very high level for a non-native English speaker, with clear sentences and very few typographical or grammatical errors that would call for further editing. The text is very well structured and presented with an adequate breadth and depth.

Ad f) The dissertation fulfils the conditions of Section 47 (4) of the Act

The dissertation fulfils the conditions of Section 47 (4)*) Act No. 111/1998 Sb. Higher Education Act: YES

**(4) Studies are duly finished with a doctoral state exam and dissertation defence, which prove the ability and readiness to work independently in the field of research or development, or in theoretical and creative arts. The dissertation must comprise original and published results or results accepted for publication.*

Ad g) Creative abilities of the student in the given research field. Compliance with the standard requirements placed on the dissertations in the given field.

The doctoral student did prove his/her creative abilities in the given research field and the work does comply with the standard requirements placed on the dissertations in the given field.

Comment: With the complete text included in this dissertation and the Applicant's already published research works in conferences and journals, the Applicant has demonstrated his ability to work independently and creatively in research and development, exhibiting a good sense to organize the topic, achieve specified goals, and present the results in a comprehensive way.

Overall evaluation: The student has achieved the specified objectives, proposed a novel approach to the topical subject in the fields of microwave structures design and presented it in a comprehensive way combining good organization of the topic, good and adequate explanations and illustrations, and valuable work combining computational modeling, practical prototype building, and verifications by measurements, which is the best that can be wished in our line of work.

Opponent's questions:

1. **Ch. 3, pp. 27-28: How do you explain that the measured rel. permeability values were below 1, while the general theory teaches us rel. permittivity and permeability are ≥ 1 ?**
2. **Ch.5, p.53: clarify the statement that measured S11 of the SMA feed is not valid even though it is rated up to 26.5 GHz**
3. **Do you have to run the CST simulation for each individual in the GA generation in order to get the respective S-parameters and other quantities, and also after each generation again or when is it actually necessary?**

4. Ch. 5, p. 54: what was the population size in BISO for this? what was the chromosome length?
What was the length of particular genes?
5. Ch. 5, p. 58: Fig. 5.9a vs. Fig. 5.10 -> compare and explain how Fig. 5.9(a) can be read to Fig. 5.10 (emphasize the dummy bits)

I ☒ recommend ☐ do not recommend the dissertation for the defence.

Date: 27.08.2025

Signature: