

## I. IDENTIFICATION DATA

<b>Thesis name:</b>	<b>David Rutherford</b>
<b>Author's name:</b>	<b>Mohammed Fadel</b>
<b>Type of thesis:</b>	bachelor
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Electrical Power Engineering
<b>Thesis supervisor:</b>	David Rutherford
<b>Supervisor's department:</b>	Physics

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>challenging</b>
<i>Evaluation of thesis difficulty of assignment.</i>	
<p>This experimental-based project relied heavily on the student being able to work in the laboratory for a number of consecutive weeks. Due to COVID and the subsequent restrictions put in place, this was not possible and the amount of data that was able to be generated by the student was greatly reduced which limited the scope and impact of the thesis project. Without this crucial hands-on experience, the assignment became more difficult not due to any fault of the student.</p>	

<b>Satisfaction of assignment</b>	<b>fulfilled with minor objections</b>
<i>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.</i>	
<p>The submitted thesis focused on the ability of zinc oxide to kill bacteria and the environmental impact use of this material may have. The first part is in accordance with the project aims and the results were presented well. Where the thesis could improve was to have a more detailed analysis of the results and comparison between first and second exposures. The second part regarding the environmental impact was not part of the project aims but the student showed good initiative to include this aspect considering the lack of experimental data which would be required to fully investigate the development of resistance. Nevertheless, the concept of resistance development as a result of sub-lethal exposure to zinc oxide was not addressed.</p>	

<b>Activity and independence when creating final thesis</b>	<b>B - very good.</b>
<i>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.</i>	
<p>The student showed a keen interest in the topic from the start and was a willing participant with the early experimental work. They had a good understanding of the research but also weren't afraid to ask questions about techniques that they did not understand. Unfortunately, COVID restrictions meant that the student was also restricted from developing key laboratory skills and associated knowledge that would've been gained had they been able to conduct more experiments. In the short time the student was in the laboratory, they showed good initiative and ability to work with minimal supervision.</p>	

<b>Technical level</b>	<b>C - good.</b>
<i>Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.</i>	
<p>The technical aspect of the thesis was not particularly challenging from a microbiological point of view, however it did require attendance on a week by week basis in order to repeat the same experiment multiple times to re-expose bacteria to the same treatment. The student was shown the procedure once, and carried out the procedure once under supervision but did not have the opportunity to carry out the experiment unsupervised. It is clear from reading the thesis that the student has read literature around the general subject area of zinc oxide's ability to kill bacteria and has a good understanding on the mechanisms of inactivation. More emphasis could've been given towards bacteria resistance towards re-exposure to sub-lethal concentrations of nanomaterials and less on the environmental impact zinc oxide has on aquatic ecosystems which was outside of the scope of the thesis.</p>	

<b>Formal and language level, scope of thesis</b>	<b>C - good.</b>
<i>Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.</i>	
Generally, the thesis was well written and was without spelling mistakes. In some instances, however, the student tries to use overcomplicated things when it may be better to keep sentences simple which are easier to read.	

<b>Selection of sources, citation correctness</b>	<b>B - very good.</b>
<i>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.</i>	
As previously mentioned, it is clear from reading the thesis that the student carried out their own literature review and collected good sources of information relevant to zinc oxides interaction with bacteria. Due to the limited results generated which negatively impacted on investigating resistance development, the student addressed a different yet equally important concern of nanoparticle accumulation in aquatic environments and the impact on microorganisms including but not exclusive to bacteria. Text has been cited when needed to be, and the same convention was used throughout the document containing a complete reference list at the end.	

<b>Additional commentary and evaluation</b>	
<i>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>	
Please insert your commentary (voluntary evaluation).	

### III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

*The thesis was well presented and followed the standard format of a scientific report. Each section was appropriately separated and there was a logical order. The student created their own abstract for the thesis which is an important skill to develop. However, the aims and objectives of the research could be defined more clearly in bullet point form instead of or as well as paragraphs. The introduction contained relevant information relating to the research and it was obvious the student did their own reading around the subject area. It was a good overview of the antibacterial effect of zinc oxide, but it could've been improved by including more detail on the mechanism of resistance development by bacteria i.e. what doesn't kill it, makes it stronger. The methodology section was detailed and included all relevant information to repeat the study, however some minor details were incorrect. The results section was where there was some confusion as to the layout and structure of the results, and the results were not arranged in a logical order e.g. results from 1<sup>st</sup> exposure followed by results from second exposure. There was little comparison between the results of the experiments that used the same type of zinc oxide (e.g. nano 1<sup>st</sup> & 2<sup>nd</sup> exposure and then micron 1<sup>st</sup> and 2<sup>nd</sup> exposure), and the graphs were not discussed in detail (e.g. what was the exact number of cells that survived treatment relating to the bar graphs). This meant that the idea of resistance development due to re-exposure to the same treatment was not discussed. Also, the graphs did not have consistent a format which made comparing the data difficult (e.g. y-axis labels on Fig. 5, 6 & 7 are all different and there are no units for x-axis: colony forming units per milliliter, cfu/mL). Chapter 5 – 'The Implementation' was assumed to be the discussion section of the thesis, however the results of the experiments themselves were not discussed in great detail. What was discussed was the environmental impact of over-use of nanoparticles which is a major problem and the student showed initiative by including this additional information.*

I evaluate handed thesis with classification grade **C - good**.



## SUPERVISOR'S OPINION OF FINAL THESIS

Date: 15.1.2021

Signature:

A handwritten signature in black ink, consisting of stylized, overlapping loops and a long horizontal stroke at the end.