I. IDENTIFICATION DATA

Title of thesis:	**Thermochromic Liquid Crystals as a Temperature Indicator**
Author:	**Abubakar Shola SULEIMAN**
Thesis type:	Bachelor
Faculty/department:	Faculty of Mechanical Engineering
Department:	Department of Process Engineering
Opponent:	Ing. Viktor Vajc
Opponent affiliation:	Department of Process Engineering

II. EVALUATION OF THE PARTICULAR CRITERIA

Assignment	average

Assignment of the work was to write a literature review, which deals with problematics of thermochromic liquid crystals (TLCs), which are used for measurement of surface temperature. Author had to read scientific literature and put obtained information into a coherent text.

Practical part of the work included experimental investigation of calibration curves (hue vs. temperature) of a TLC illuminated from three different illumination angles. The laboratory stand used for measurement was already built. Author was supposed to get datasets, evaluate them and comment the results he obtained.

I consider this assignment to be averagely demanding.

Fulfilling the assignment	fulfilled

Author has fulfilled all points from the assignment.

Selected solution procedure	correct

In some parts of the work, it is challenging to distinguish between author's own conclusions and conclusions of other researchers since they are somehow mixed together. Especially in the third chapter, it is not immediately clear, whether author describes materials and methods he himself used or materials and methods in general. Similarly, in the fourth chapter, there should be more evident borderline between information gained from author's own measurements and information taken from literature.

Professional level	A - excellent

The quality of the literary review is high and quite surprising for a Bachelor thesis. Author is able to work with scientific literature, he is knowledgeable in the topic of the thesis and he can put various information into meaningful context.

Author analyzed the datasets he himself obtained and properly compared them with other papers according to various aspects.

Formal and language level, scope of work	B - very good

The work contains quite a lot of imprecisions (*these those substances, chloesteric, chelostrol, liotriopis, shi(f)t* and many others), word-order mistakes ("*The advantage of this method calibration using the hue is...*") and missing words ("*...in application such heat transfer investigations...*"). Some sentences are so long that reader has to read them multiple times in order to be able to fully understand them ("*The tendency of the molecules to point along a common axis called the director is hallmark of liquid crystalline state, which is different from liquid phase which has not intrinsic order and in between the solid state which has highly ordered molecules which has little translational freedom.*").

Author often uses special terms taken either from various sources, or defined by himself without explaining these terms in the work (*qualitative, quantitative, liquid crystal formulation* (maybe formation was meant), *imaging system, complete system, transient calibration technique, coating quality, resetting of TLCs, wide-band technique, startup temperature image*.

There are some confusing statements ("*...the blue color is also known as the clearing-point temperature...*", "*For the specification of thermochromic liquid crystals, two temperatures or color are used*."
Labels of tables should be put above the tables. There are no cross-references of multiple figures.
Text should be justified in order to improve its readability. Page 51 is missing.

Source Selection, Correct Quotation	B - very good

I have no comments on source selection. Author has chosen the literature closely related to the topic of the work and appropriate papers with which he has compared his own measurements.
The citations in the text are not written in unified style (Reif (1965), (Oxford Dictionary 2019), (Lagerwall and Scalia, 2012), (Baron 2003)). Direct quotations are written in the correct style.
There is no source of Figure 1.2. I did not find figures 1.4 and 1.5 in the source mentioned in the work.
List of literature is numbered, which is not necessary (rather intrusive) due to the used citation style. Font and font-size is not unified. Some papers in the list are ordered according to first names of their authors, while the most according to surnames. References in the list are complete.

More comments and ratings

I have no more comments.

III. TOTAL EVALUATION AND PROPOSAL FOR CLASSIFICATION

The submitted thesis fulfilled all the assignments and requirements needed for its acceptance. Author made several mistakes and imperfections – some of them mentioned above. However, the scope of the work and scientific level of the work are fully sufficient.

I have several questions that should be answered during the defense:
1. Obviously, calibration curves are dependent on illumination angle. Did you verify that these curves do not depend on the distance of the lights or distance of the camera from the surface?
2. On page 32, you say that you identified dominant color for each image to obtain the RGB start temperature. Then you mention a 'dominant RGB startup temperature image'. Can you describe the procedure? Can you explain the figure 4.8? What is the figure showing? Why is it important? What for are these figures used?
3. How come that the Fig 4.8 shows dominance of one single color as you mention on page 34? What are labels of axis in the figure?
4. According to Kaveh Azar's article on page 21, calibration can be done before spraying TLCs on the surface. Is it really so?
5. On page 19, you claim that camera should have linear relation of its output to the light. What do you mean by that? Is this guaranteed by manufacturer?
6. Is the resolution of narrow-band TLCs different compared to wide-band TLCs? What are the (dis)advantages of both types.
7. What is the transient calibration method? Could you compare it to the steady-state method?
8. On page 13, you mention that "The fundamental difference between the thermotropic liquid crystals and the lyotropic liquid crystals is in the dependence of the later on concentration while the former depends on temperature." By that, you mean dependence of which property on concentration of what substance?
9. Is Figure 1.7 on page 15 universal for all TLCs?
10. What is the 'glare effect'?

I evaluate the submitted final thesis with the grade **A - excellent**

Date: **13.6.2019**   Signature: Viktor Vajc v. r.