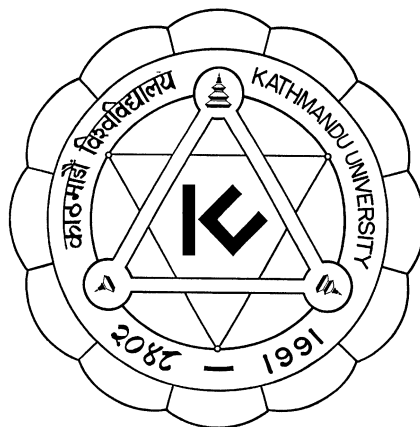


KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

PROJECT ACTIVITY REPORT



Design of Soil Moisture Sensor with Digital Display

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ABSTRACT

Soil moisture sensor with digital display is a circuit that measures the moisture content in the soil. The basic idea is that the moisture of the soil is measured in terms of its resistance. The more the resistance the less the moisture and vice versa. When the resistance of the soil is determined, corresponding voltage is dropped and the seven segment display displays the output in terms of percentage. It consists of various components like LM324, 74147, 4511, 7805 and seven segment display. It operates at dc voltage of 5V.

The primary application of the Soil Moisture Sensor is that it helps to determine the moisture content in a particular sample of the soil which is an indicator in determining the fertility of the soil. Furthermore, it is also applicable to check the moisture content and the amount of water to be supplied to the particular sample of soil.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Department of Electrical and Electronics Engineering, Kathmandu University for providing this opportunity to undertake this project ‘Design of Soil Moisture Sensor with Digital Display’.

We would like to thank our supervisor Mr. Bikalpa Upadhyaya for his guidance and help provided to us throughout the semester which undoubtedly helped us to take our project to the state it is today.

We would also like to thank the teachers, colleagues and seniors who have made a direct or an indirect contribution to our project.

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CHAPTER 1 INTRODUCTION

1. Background and Objectives

1.1 Background

The project Design of Soil Moisture Sensor with Digital Display has been selected because of the interest it provides in the field of agriculture . A soil moisture sensor is a device that is used to measure the volumetric content of water in the soil. There are different types of moisture sensors(resistive, capacitive). The sensor that is to be designed is a resistive moisture sensor. The resistance in the soil is measured, corresponding voltage is noted and finally the output is displayed in terms of percentage.

1.2 Motivation

Our motivation to undertake this project was that seeing acres of land left barren and also seeing low amount of productivity in cultivable land. This is because the moisture content of those land was unknown to the farmers. We were motivated to undertake such a project which would not only help enhance our ability as electronics engineers but also contribute to the society in some form or the other. Hence we decided to undertake the project “Design of Soil Moisture Sensor with Digital Display”.

1.3 Objectives

The project was carried out with the following objectives

1. To convert the moisture of the soil into appropriate units and display it as percentage.
2. To understand the operation and working of various electrical and electronic component unfamiliar to us earlier.

1.4 Block Diagram

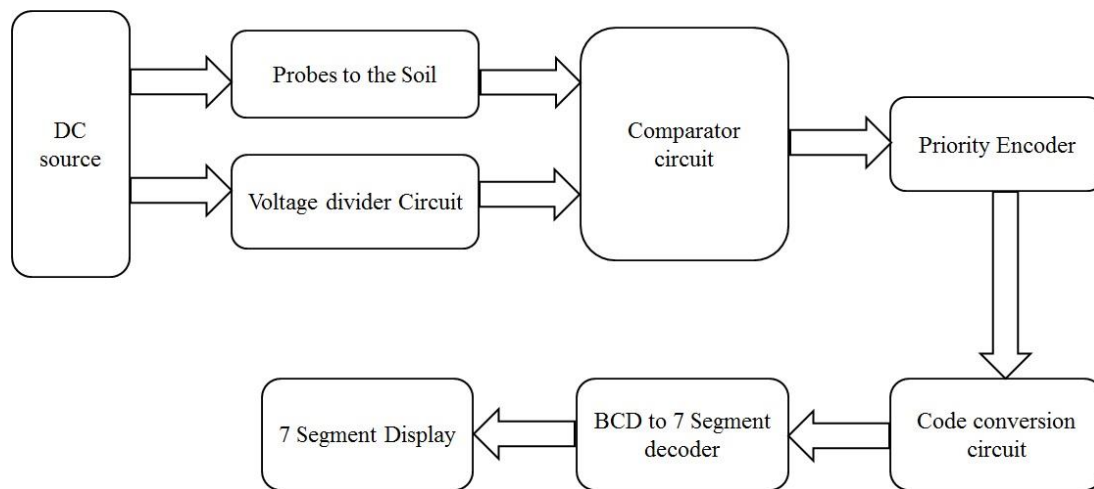


Figure 1 Block Diagram

1.5 System Overview

As per our block diagram, 5V from the DC source is supplied to the probes and the voltage divider circuit to create the reference voltages. We calculated the reference voltage was defined by the testing and observing the resistance of the soil and the voltage drop by the soil sample of times in different moisture contained soil. According to our assumption, we considered $V/4$ volume of water in V volume of soil contains 100% moisture.

A potential dropped by the soil's resistance and the reference voltage developed by the voltage divider circuit was connected to the comparators (LM324) of the Voltage comparator circuit. We have designed the comparator circuit with 9 op amps. Nine reference voltages were given to the non-inverting pin of the comparator and the potential drop is given to the inverting pin of the comparator.

The output of the comparator circuit is given to the priority encoder 74147. According to the order of the output of each comparator of the comparator circuit, the priority encoder encodes and provides the respective BCD output. The output BCD codes are of order from 0110 to 1111 which is not the desired representation of the moisture. So the BCD output code was converted to desired BCD code. And then the converted code is sent to the BCD driver 4511 which was then connected to the 7 segment display. In this way, moisture content in the soil is displayed.

CHAPTER 2 LITERATURE SURVEY

2.1 LM324

LM324 is a quad op amp integrated circuit, which uses 14-pin dual in-line plastic package, shape as shown. It contains four sets of the internal op amp in exactly the same form, in addition to power sharing, the four independent amplifier. Operational amplifier for each group of symbols shown in Figure 1 can be used to indicate that it has 5 leads to the foot, which "+", "-" two signal input, "V +", "V-" is positive, negative power supply side, "Vo" for the output. [1]

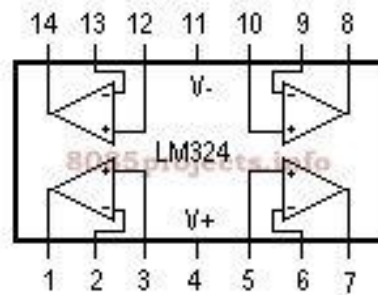


Figure 2 LM 324

2.2 IC 74147

IC 74147 is a Decimal to BCD priority encoder. When all inputs are HIGH, all the outputs are HIGH (i.e., 1111) which is the inverse of 0000, the BCD code for 0. Since there is no X0 input, the encoder assumes this as the decimal 0 condition. When X1 is LOW, the ABCD output is 1110, which is inverse of 0001, the BCD of 1. Similarly, when X9 is LOW, the ABCD output is 0110, which is inverse of 1001, the BCD of 9. Here the priority is given to the input with higher subscript value. The pin diagram of IC 74147 is as shown in figure. [2]

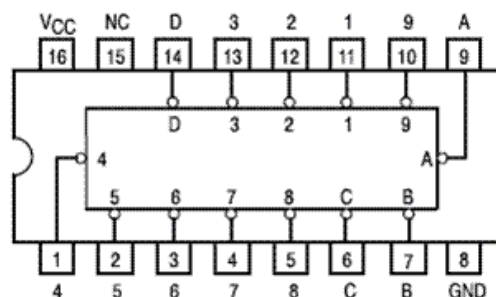


Figure 3 IC 74147

2.3 IC 4511

(Binary-Coded Decimal) value and energize the proper output lines to form the corresponding decimal digit on the 7-segment LED display. Since each LED segment requires its own dropping resistor, we used seven $670\ \Omega$ resistors placed in series between the 4511's output terminal and the corresponding terminals of the display unit.

IC 4511 is a 16-pinned Decoder. It is the IC with operating principle to a 4-bit BCD (Binary-Coded Decimal) value and energize the proper output lines to form the corresponding decimal digit on the 7-segment LED display. Since each LED segment requires its own dropping resistor, we used seven $670\ \Omega$ resistors placed in series between the 4511's output terminal and the corresponding terminals of the display unit.

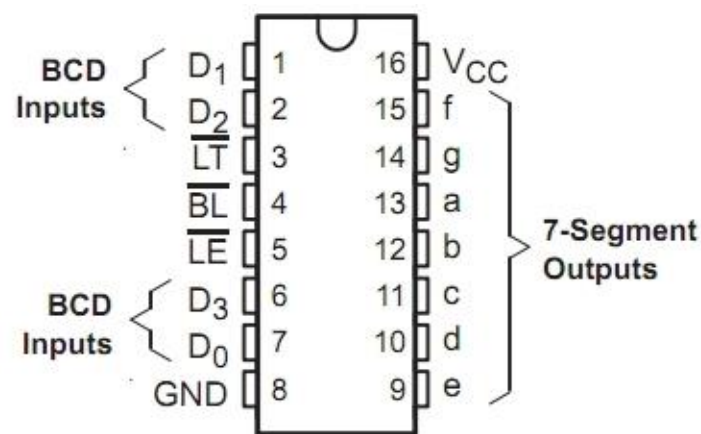


Figure 4 IC 4511 [3]

2.4 Seven Segment Display

It consists of seven LEDs arranged in a rectangular fashion. Each of the seven LEDs is called a segment because when illuminated the segment forms part of a numerical digit to be displayed. An additional 8th LED is sometimes used for the notation of a decimal point. 7-segment displays are mainly of two types: Common Anode (CA) and Common Cathode (CC). We have used Common Cathode (CC) for the display part in our system.

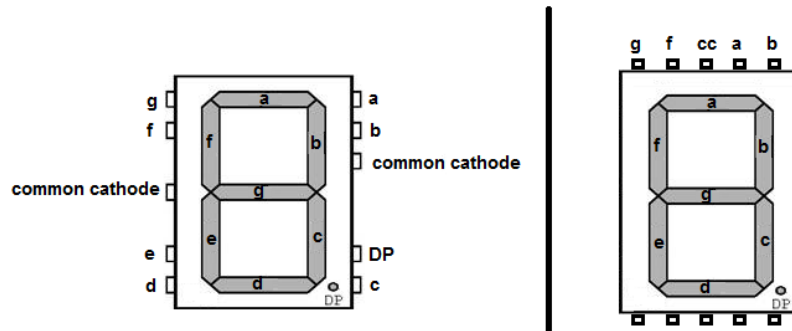


Figure 5 Seven Segment Display [4]

CHAPTER 3 DISCUSSION

3.1 Details On Project Activity

At the very first, we were focused on Display Unit. We started our Project with seven segment display. We did a detail study on seven segment display and then implemented it on breadboard.

We are doing our project using resistive probes so we had to work on voltage as input. For that, we did mathematical analysis and calculations and designed a voltage divider circuit using several resistors.

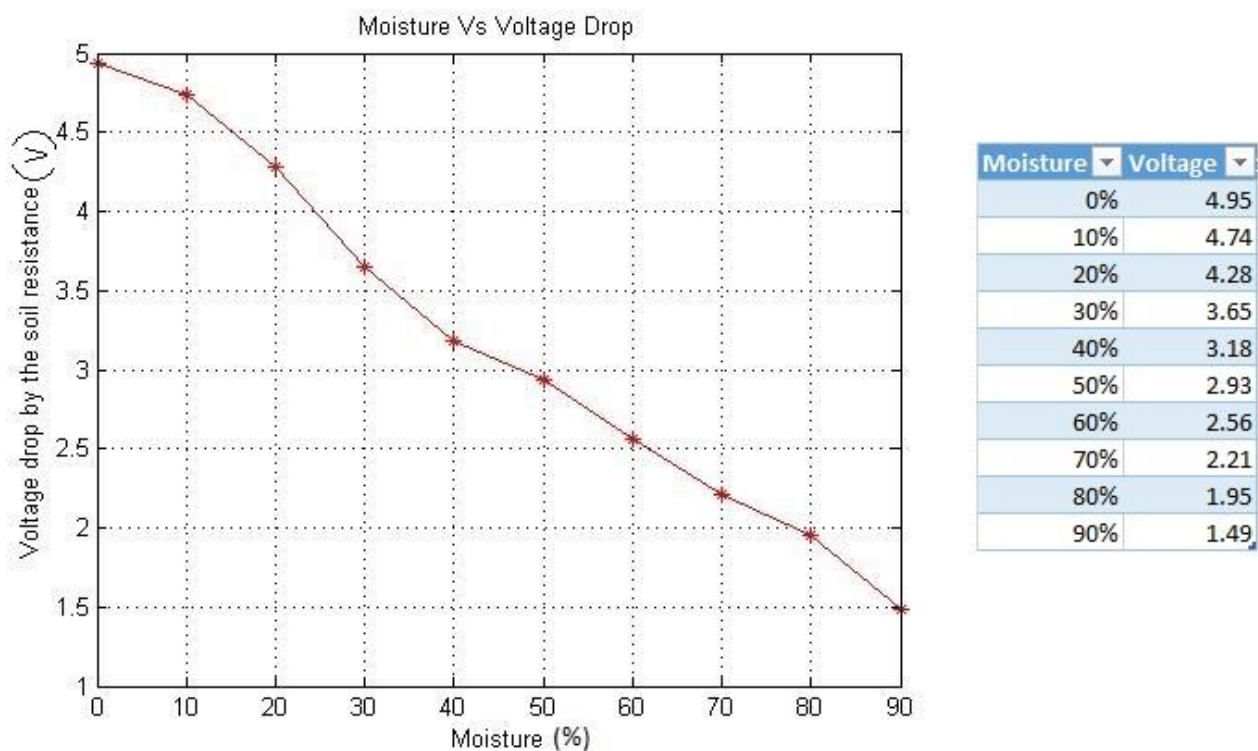


Figure 6 Graph of Moisture Vs Voltage Drop

Then, voltage drop across the resistors and voltage drop by the soil was to be compared. So we studied about comparator and implemented LM324 comparator in our circuit. 9

comparators were used in our circuit.

The outputs from comparators were analyzed. There were 9 different outputs. We needed to prioritize one of the outputs. So, we used a high priority encoder. We did a detail study on it and implemented it on the existing voltage divider and comparator circuit.

But outputs from priority encoder started from 6 to 15. But we needed combination of digits from 0 to 9. So we did code conversion and combined the code converter circuit with existing circuit.

Then we needed to decode the binary output to decimal output. So we used a BCD decoder and fed its output to seven segment display.

This way, we implemented voltage divider unit, comparator unit, priority encoder unit, code converter unit, BCD decoder unit and seven segment display unit in our breadboards. Still we had to design a resistive probe. For that we used aluminum plates, maintained a standard distance between the plates and fixed it on a wooden frame. Finally, a resistive probe was made. In this way the overall circuit and the probes were designed.

3.2 Calculations:

We take,

$R_1 = 1\text{K}\Omega$ then

$(R_2 + R_3 + R_4 + R_5 + R_6 + R_7 + R_8 + R_9 + R_{10})$ be R_a

Using Voltage Divider Rule,

$$4.74 = (5 * R_a) / (R_a + R_1)$$

$$R_a = 18.23\text{K}\Omega$$

And,

$(R_3 + R_4 + R_5 + R_6 + R_7 + R_8 + R_9 + R_{10})$ be R_b

Using Voltage Divider Rule,

$$4.28 = (4.74 * R_b) / R_a$$

$$R_b = 16.4\text{K}\Omega$$

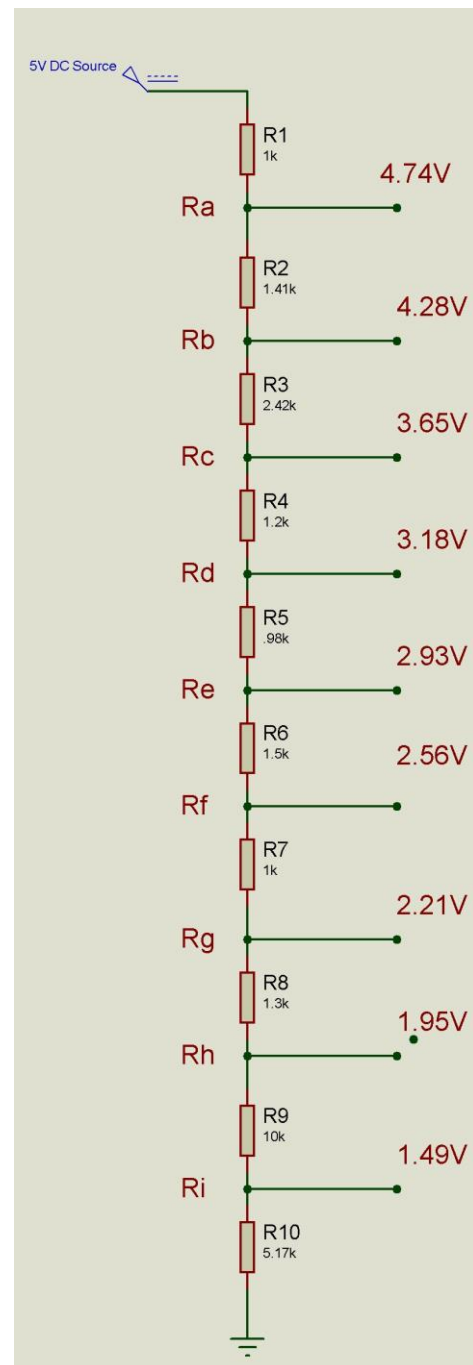
$$R_2 = R_a - R_b$$

$$= 18.23\text{K}\Omega - 16.4\text{K}\Omega$$

$$= 1.76\text{K}\Omega$$

$$R_2 = 1.76\text{K}\Omega$$

In similar way, we calculate all the resistances up to R_{10}



Calculation for code conversion :

K-map for W,

	00	01	11	10
00	X	X	X	X
01	X	X	0	0
11	0	0	1	1
10	0	0	0	0

$W = DCB$

K-map for X,

	00	01	11	10
00	X	X	X	X
01	X	X	0	0
11	1	0	0	0
10	0	1	1	1

$X = CB' + C'B$

K-map for Y,

	00	01	11	10
00	X	X	X	X
01	X	X	0	0
11	1	1	0	0
10	1	1	0	0

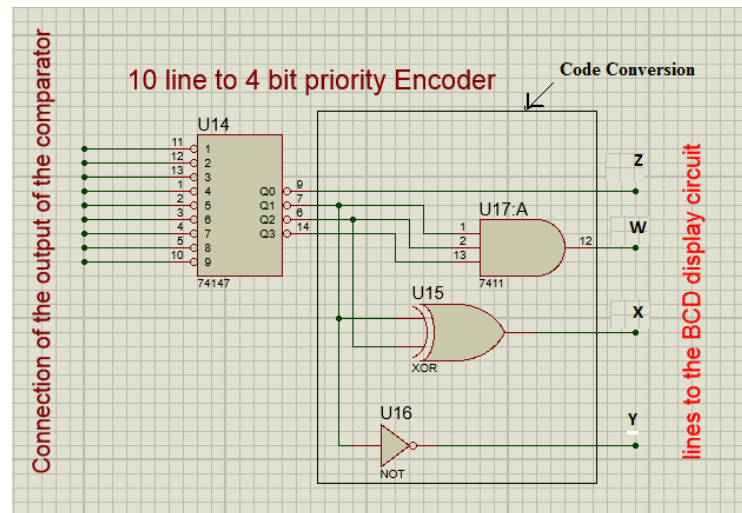
$Y = B'$

K-map for Z,

	00	01	11	10
00	X	X	X	X
01	X	X	1	0
11	0	1	1	0
10	0	1	1	0

$Z = A$

0=Low Level, **1**=High level, **X**=Don't care



Calculation for the resistor to drive 7 segment display:

For Dropping resistance(R) placed in series between BCD driver and seven segment cathode display,

Supplied voltage(V)=5V

Voltage drop across LED=2V

Resistance of LED=400Ω

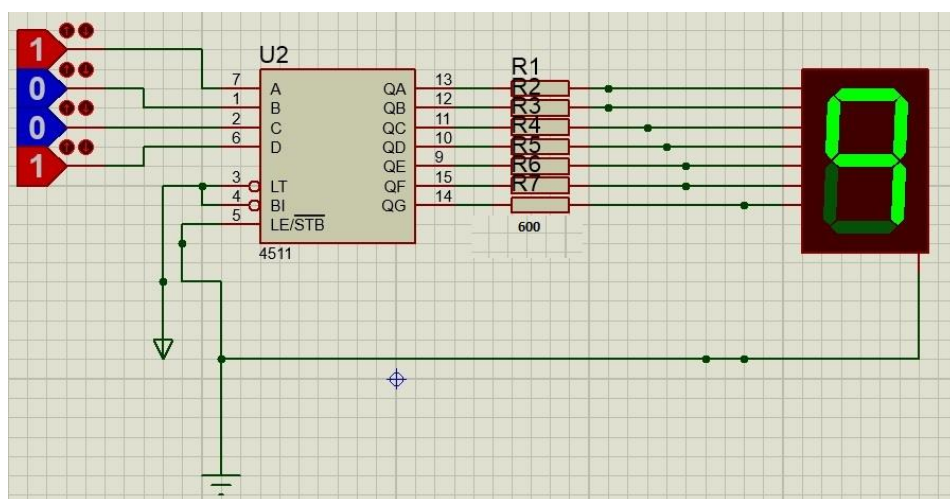
So, voltage drop across LED is given by,

$$2 = 5 \cdot 400 / (400 + R)$$

$$400 + R = 5 \cdot 400 / 2$$

$$R = (1000 - 400) \Omega$$

$$R = 600 \Omega$$



3.3 Work Accomplished

The following works were accomplished.

- i. Literature Survey has been done.
- ii. A circuit has been designed and simulated in work bench (Proteus).
- iii. Aluminium probes has been designed.
- iv. Circuit has been implemented in the breadboard.

3.4 Work Remaining

The following works are to be done.

- i. To improvise the sensor part of the circuit.
- ii. To design a simplified model of the existing circuit if possible.
- iii. The circuit has to be designed and fabricated in printed circuit board.
- iv. A presentation model has to be designed.

3.5 Problems Encountered

- i. The main problem encountered so far is calibration of the result obtained with the existing standard value.
- ii. The device displayed different result for same moisture in different soil. This is a reason for taking single sample of soil. Moreover, for the same sample, different readings were displayed for different time of testing.
- iii. Comparator didnot function to near about its operating voltage, the output voltage is always high.

3.6 Future Plans

Soil moisture content that we display is based on voltage as input. So we surveyed voltage drops by soil of different moisture contents and plotted moisture vs voltage drop graph more than once using the same soil. We found that although there was linearity between the graphs plotted, they varied between some intervals. In order to overcome this problem we need to calibrate our reading with standard reading of existing sensors so that we can get a standard and authentic display unit. Further, we also need to implement our circuit on a printed circuit board. These are our future plans for the project.

3.7 Gantt Chart

Month \ Task	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Research and Study									
Literature Survey									
Proposal Presentation									
Probe Selection									
Circuit Design									
Market Survey									
Circuit Testing									
Mid-Term Presentation									
PCB Design									
Final Presentation									

	Task Complete
	Task Incomplete

CHAPTER 4 CONCLUSION

This project is an outcome of group effort under the supervision and regular guidance of the supervisor along with the suggestions from teachers and seniors. This project would not have been up to this level without their parts.

A whole semester has come to an end doing this project. Many things were taught in the classroom about electronic devices and logics. It is due to this project, many of those teachings are implemented and the level of understanding has come to net level. As mentioned earlier, many problems were encountered during the course of this project so, many things were learned while solving those problems. Many things will be learned in days to come when the unsolved problems are solved. Moreover, time management became a denting task in the beginning and this has been solved up to some extent and the members are learning to cooperate at group works. Apart from these all, to go as per the plans throughout the semester has been quite an achievement.

It is expected that the project will be conducted in the same pace and smoothness in the days to come. With the combine efforts from the group members, supervisors and teachers, it is hoped this soil moisture sensor and display device will be launched in the market as a professional moisture sensor device.

BIBLIOGRAPHY

- [1] «Principle and Application of the Op Amp LM324,» 11 February 2016. [Internett].
- [2] «Design and implementation of encoders,» 11 February 2016. [Internett].
- [3] «BCD Driver,» 11 February 2016. [Internett].
- [4] «Seven Segment Display,» 11 February 2016. [Internett].