

# **EMBEDDED SYSTEM AND DESIGN**

## **EXPERIMENT NO. 2**

# **NUMBER SYSTEM EMULATOR**

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Course/Section: CPE160P-4/A1

Group No.:

Date of Performance: 08/24/2024

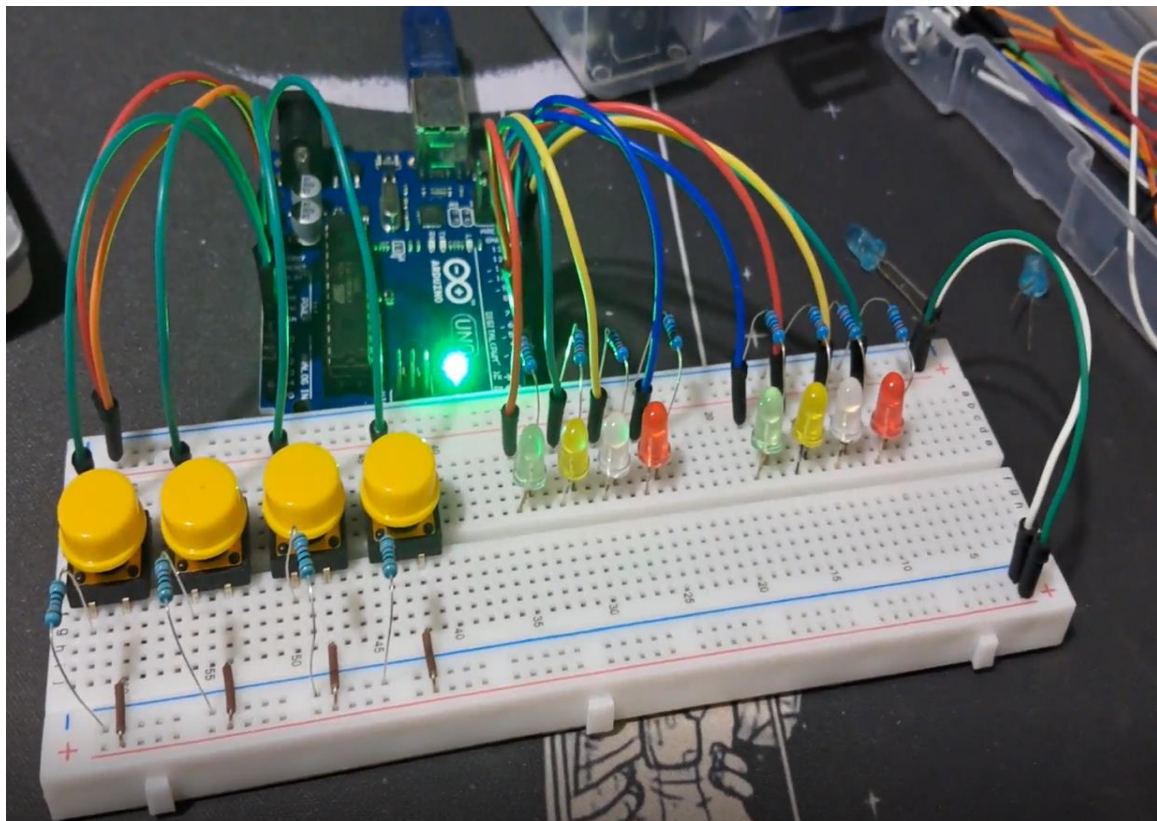
Date of Submission: 08/25/2024

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# DISCUSSION

*In the first conversion experiment, I decided to create a binary to 2's complement converter. The circuit was done easily by adding 4 switches to represent the binary digits and 8 LEDs to represent the binary digits inputs and 2's complement output. The 4 LEDs on the right are the LEDs for the indicator of the pressed button for the inputs binary and the buttons on the left are the button for the 2's complement output.*



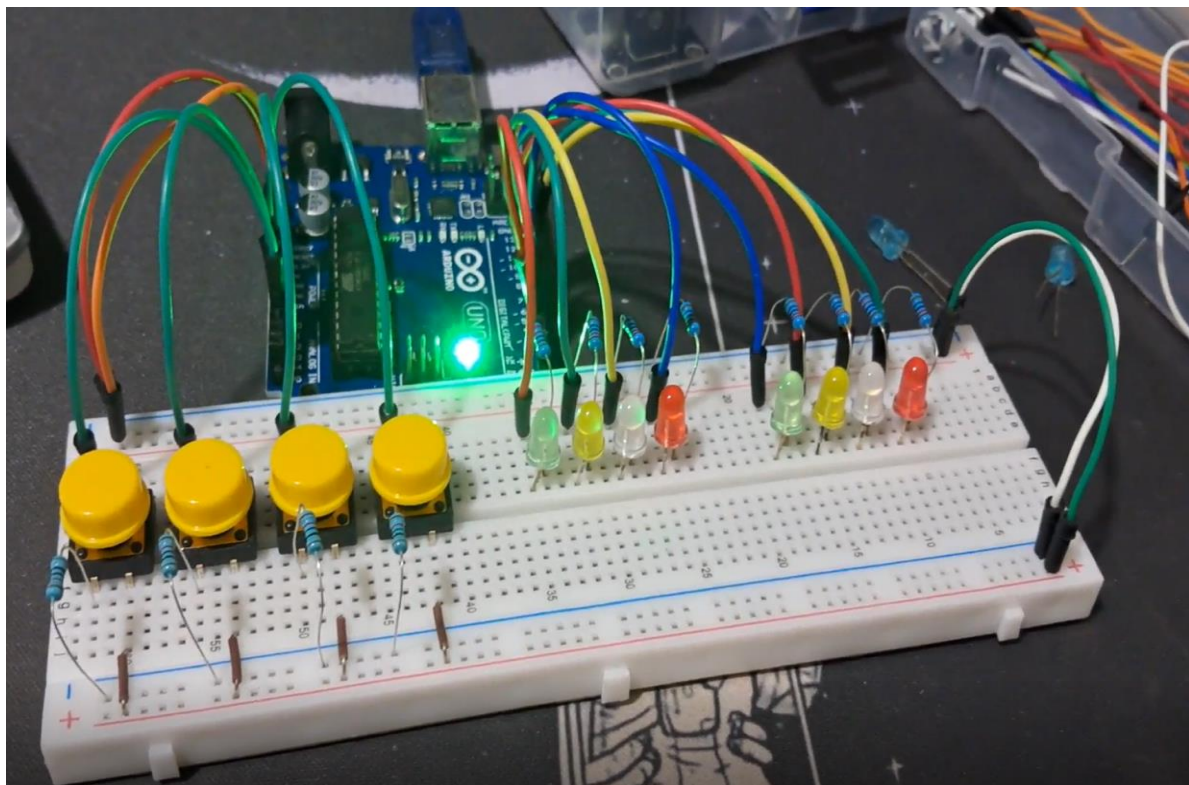
*Figure 1: Connections of the circuit for the conversion of binary to 2's complement.*

*The coding of the 2's complement converter, I decided to enter the code for the inputs that would require simultaneous button presses for the microcontroller to check for buttons pressed and then display the corresponding output in the other half of the LEDs. The code worked and the results were all correct.*

```
Arduino Uno
Navarro_Binary_to_2s_Complement.ino
1
2  const int Binary1 = 5;
3  const int Binary2 = 4;
4  const int Binary4 = 3;
5  const int Binary8 = 2;
6
7  const int Complement1 = 9;
8  const int Complement2 = 8;
9  const int Complement4 = 7;
10 const int Complement8 = 6;
11
12 const int switch1 = A0;
13 const int switch2 = A1;
14 const int switch4 = A2;
15 const int switch8 = A3;
16
17 int switchStatus1 = 0;
18 int switchStatus2 = 0;
19 int switchStatus4 = 0;
20 int switchStatus8 = 0;
21
22 int delay1 = 0;
23
24
25
26 void setup() {
27
28   pinMode(Binary1, OUTPUT);
29   pinMode(Binary2, OUTPUT);
30   pinMode(Binary4, OUTPUT);
31   pinMode(Binary8, OUTPUT);
```

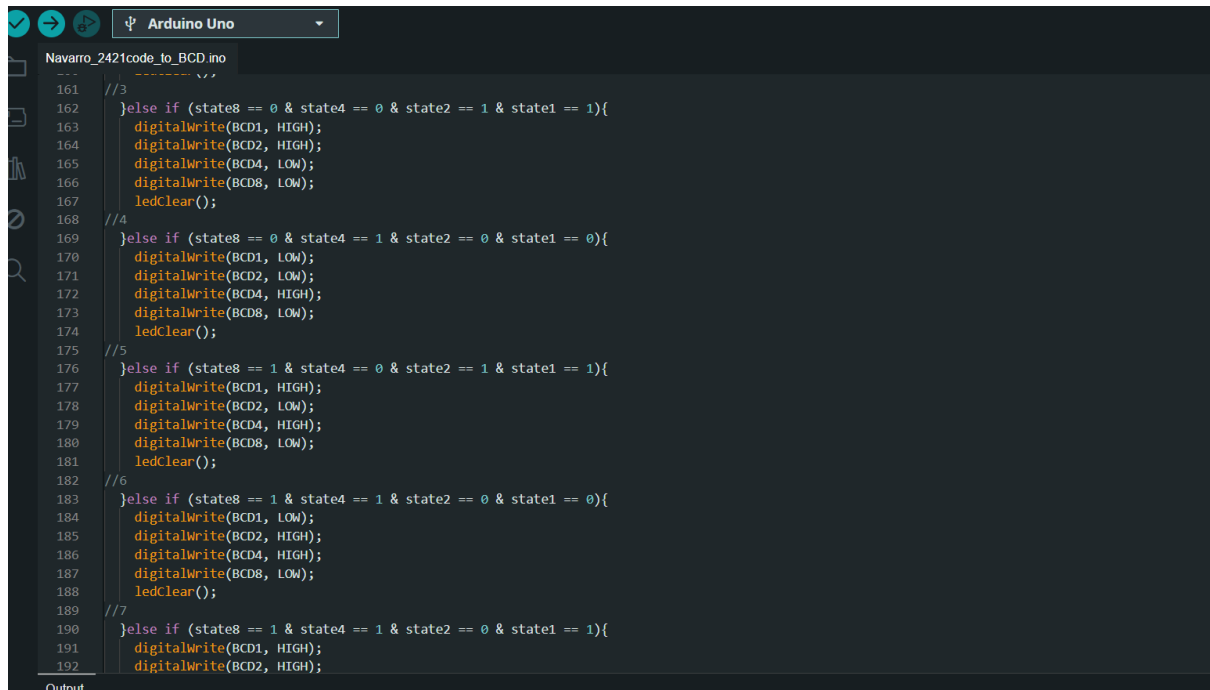
*Figure 2: The code for the binary to 2 complement conversion with checks for buttons pressed and converted output.*

For the second part of the experiment, I have created a conversion for 2421 code to BCD. This circuit is also similar in the first conversion. However, this conversion has its own different program compared to the first one. Same goes here for the conversion which involves the LEDs for the button pressed and the converted BCD output.



*Figure 3: Connections of the circuit for the conversion of 2421 code to BCD.*

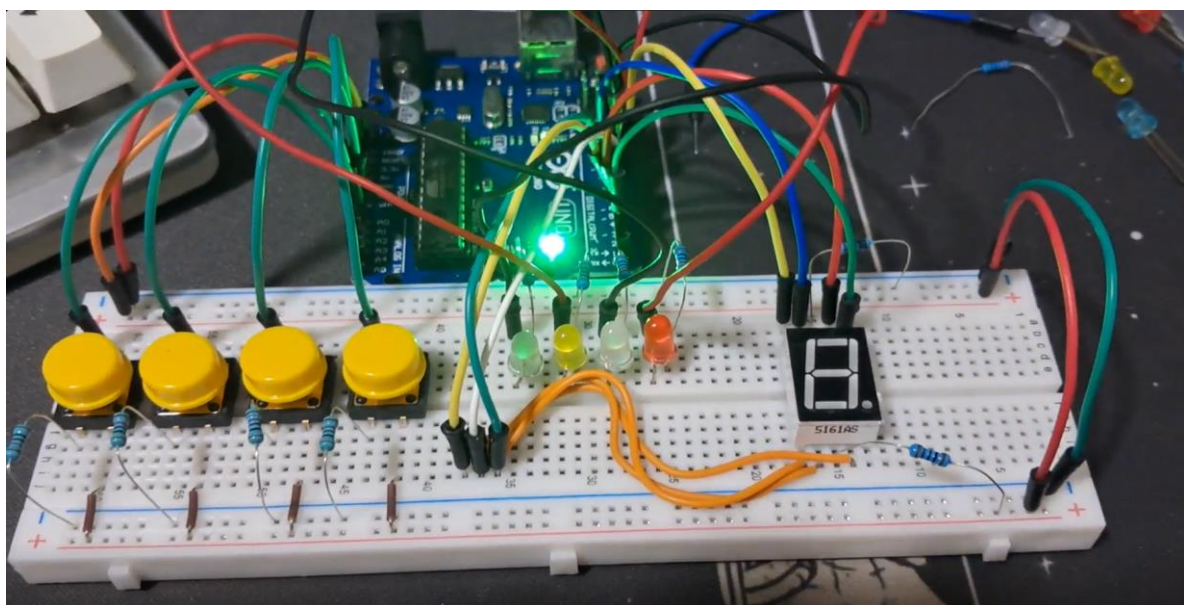
*The coding of the 2421 converter to BCD, I also decided to enter the code for the inputs that would require simultaneous button presses for the microcontroller to check for buttons pressed and then display the corresponding output in the other half of the LEDs. The code worked and the results were all correct.*



```
Navarro_2421code_to_BCD.ino
//3
161
162 }else if (state8 == 0 & state4 == 0 & state2 == 1 & state1 == 1){
163     digitalWrite(BCD1, HIGH);
164     digitalWrite(BCD2, HIGH);
165     digitalWrite(BCD4, LOW);
166     digitalWrite(BCD8, LOW);
167     ledClear();
168
169 //4
169 }else if (state8 == 0 & state4 == 1 & state2 == 0 & state1 == 0){
170     digitalWrite(BCD1, LOW);
171     digitalWrite(BCD2, LOW);
172     digitalWrite(BCD4, HIGH);
173     digitalWrite(BCD8, LOW);
174     ledClear();
175
176 //5
176 }else if (state8 == 1 & state4 == 0 & state2 == 1 & state1 == 1){
177     digitalWrite(BCD1, HIGH);
178     digitalWrite(BCD2, LOW);
179     digitalWrite(BCD4, HIGH);
180     digitalWrite(BCD8, LOW);
181     ledClear();
182
183 //6
183 }else if (state8 == 1 & state4 == 1 & state2 == 0 & state1 == 0){
184     digitalWrite(BCD1, LOW);
185     digitalWrite(BCD2, HIGH);
186     digitalWrite(BCD4, HIGH);
187     digitalWrite(BCD8, LOW);
188     ledClear();
189
190 //7
190 }else if (state8 == 1 & state4 == 1 & state2 == 0 & state1 == 1){
191     digitalWrite(BCD1, HIGH);
192     digitalWrite(BCD2, HIGH);
193     ledClear();
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```

*Figure 4: The code for 2421 code to BCD conversion with checks for buttons pressed and converted out put.*

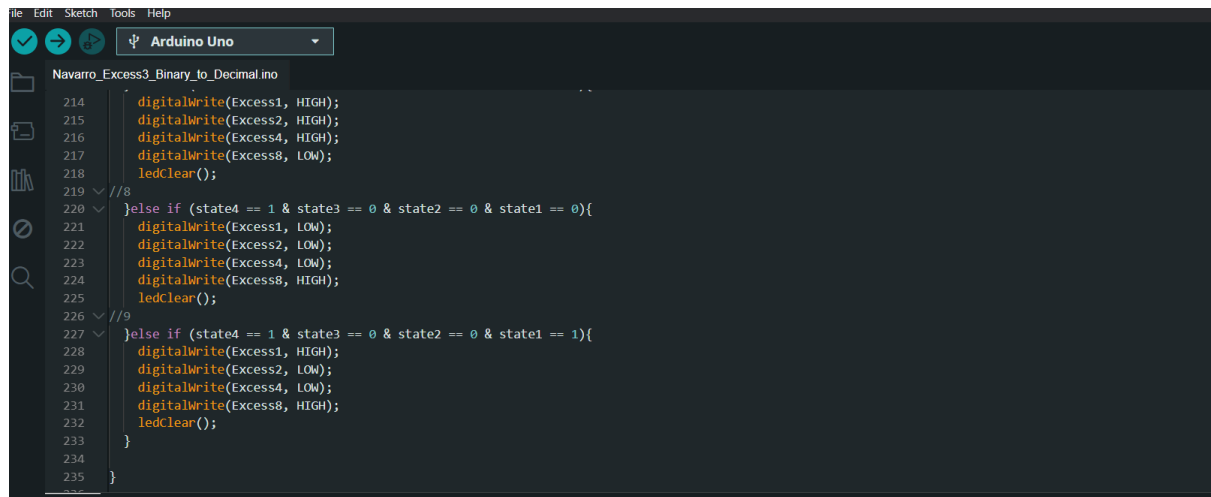
*For the third part of the experiment, I used a seven-segment display to convert excess-3 binary to decimal. I used buttons and 4 LEDs for the inputs and the seven-segment LED display as out put.*



*Figure5: Connections of the circuit for the excess-3 to decimal converter.*



*In this code, it is the same as the first part of the experiment which I decided to enter the code for the inputs that would require simultaneous button presses for the microcontroller to check for buttons pressed and then display the corresponding output in the other half of the LEDs, and I coded for the microcontroller to check for simultaneous press first before moving on to the individual presses for the input.*



```
file Edit Sketch Tools Help
Arduino Uno
Navarro_Excess3_Binary_to_Decimal.ino
214 digitalWrite(Excess1, HIGH);
215 digitalWrite(Excess2, HIGH);
216 digitalWrite(Excess4, HIGH);
217 digitalWrite(Excess8, LOW);
218 ledClear();
219 //8
220 }else if (state4 == 1 & state3 == 0 & state2 == 0 & state1 == 0){
221 digitalWrite(Excess1, LOW);
222 digitalWrite(Excess2, LOW);
223 digitalWrite(Excess4, LOW);
224 digitalWrite(Excess8, HIGH);
225 ledClear();
226 //9
227 }else if (state4 == 1 & state3 == 0 & state2 == 0 & state1 == 1){
228 digitalWrite(Excess1, HIGH);
229 digitalWrite(Excess2, LOW);
230 digitalWrite(Excess4, LOW);
231 digitalWrite(Excess8, HIGH);
232 ledClear();
233 }
234
235 }
```

*Figure 6: The code for excess-3 to decimal conversion with checks for buttons pressed and converted output using seven segment display.*

# CONCLUSION

*The experiment successfully demonstrated the process of converting different number systems using an embedded system. Through the construction of circuits and coding of a microcontroller, each part of the experiment binary to 2's complement, 2421 code to BCD, and excess-3 to decimal was accomplished with accurate results. The use of LEDs and a seven-segment display effectively represented the inputs and outputs, making it easier to verify the correctness of the conversions.*

*This experiment not only reinforced our understanding of number system conversions but also highlighted the importance of precise coding and circuit design in embedded systems. By systematically checking for button presses and ensuring correct outputs, I was able to achieve the desired outcomes, which aligns with the objectives of this exercise.*