

**CS303 Digital Design**

**Experiment 3**

**Combinational Logic**

**Objectives:**

After completing this experiment, you will be able to:

* Complete the design, build, and test a combinational circuit that convert Gray code number to Binary number.
* Use the Decoders and an OR gate to implement combinational logic circuits.
* Use the Multiplexers to construct combinational logic circuits.

**Theory:**

Logic circuits for digital systems may be combinational or sequential. A combinational circuit consists of logic gates whose outputs at any time are determined from only the present combination of inputs. A combinational circuit performs an operation that can be specified logically by a set of Boolean functions.

Each input and output variable exists physically as an analog signal whose values are interpreted to be a binary signal that represents logic 1 and logic 0. For n input variables, there are possible combinations of the binary inputs. For each possible input combination, there is one possible value for each output variable. Thus, a combinational circuit can be specified with a truth table that lists the output values for each combination of input variables.

A decoder is a combinational circuit that converts binary information from n input lines to a maximum of unique output lines. If the n-bit coded information has unused combinations, the decoder may have fewer than outputs.

A multiplexer is a combinational circuit that selects binary information from one of many input lines and directs it to a single output line. The selection of a particular input line is controlled by a set of selection lines. Normally, there are input lines and 𝑛 selection lines whose bit combinations determine which input is selected.

**Procedure:**

Step 1: Design a combinational circuit that converts a four-bit Gray code to a four-bit binary number. Hint: Implement the circuit with exclusive-OR (XOR) gates.

Step 2: From the result of Step 1 and without finding the truth table, implement a combinational circuit that converts a five-bit Gray code to a five-bit binary number.

Step 3: Design a four-bit combinational circuit 2’s complementer. (The output generates the 2’scomplement of the input binary number.) using a single decoder and OR gates only.

Step 4: Implement a full adder with two multiplexers.

**Report**:

1. Show the circuits that you implemented in steps 1 to 4.

A diagram of a binary number

Description automatically generated

A diagram of a binary number

Description automatically generated

A computer screen shot of a diagram

Description automatically generated

A diagram of a circuit

Description automatically generated

1. Implement (by Logisim) the function using A) Multiplexer B) Decoder with OR gate.

A diagram of a hexagon with a diagram and a diagram of a diagram

Description automatically generated with medium confidence

1. Design (by Logisim) a combinational circuit with four input lines that represent a decimal digit in BCD and four output lines that generate the 9’s complement of the input digit. Provide a fifth output that detects an error in the input BCD number. This output should be equal to logic 1 when the four inputs have one of the unused combinations of the BCD code.

A diagram of a computer error

Description automatically generated

1. A majority logic is a digital circuit whose output is equal to 1 if the majority of the inputs are 1’s. The output is 0 otherwise. Design (by Logisim) and test a three‐input majority circuit using A) Multiplexer B) Decoder with OR gate.

A screenshot of a computer

Description automatically generated