Online lecture 2a

Note from Previous Class

- Submission of last assessment
- LMS update
- Previous lecture
- Practice of questions from recommended textbook

Lecture 2 - Topic 1 contd

- BCD Code
- 1’s and 2’s Complements
- Gray Code

BCD Code

- When numbers, letters, or words are represented by a special group of symbols, we say that they are being encoded, and the group of symbols is called a code.
- The group of 0s and 1s used in binary number can be thought of as a code representing the decimal number (straight binary coding).
- If each digit of a decimal number is represented by its binary equivalent, the result is a code called binary-coded decimal (BCD).
- Since a decimal digit can be as large as 9, four bits are required to code each digit (the binary code for 9 is 1001).

- To illustrate the BCD code, take a decimal number such as 874. Each digit is changed to its binary equivalent as follows:

- As another example, let us change 943 to its BCD-code representation:

- Note that four bits are always used for each digit.
- Clearly only the four-bit binary numbers from 0000 through 1001 are used (i. e. 0 to 9 for decimal).
- If any of the “forbidden” four-bit numbers (i.e. 10 -15) ever occurs in a machine using the BCD code, it is usually an indication that an error has occurred.

More Examples

- 1

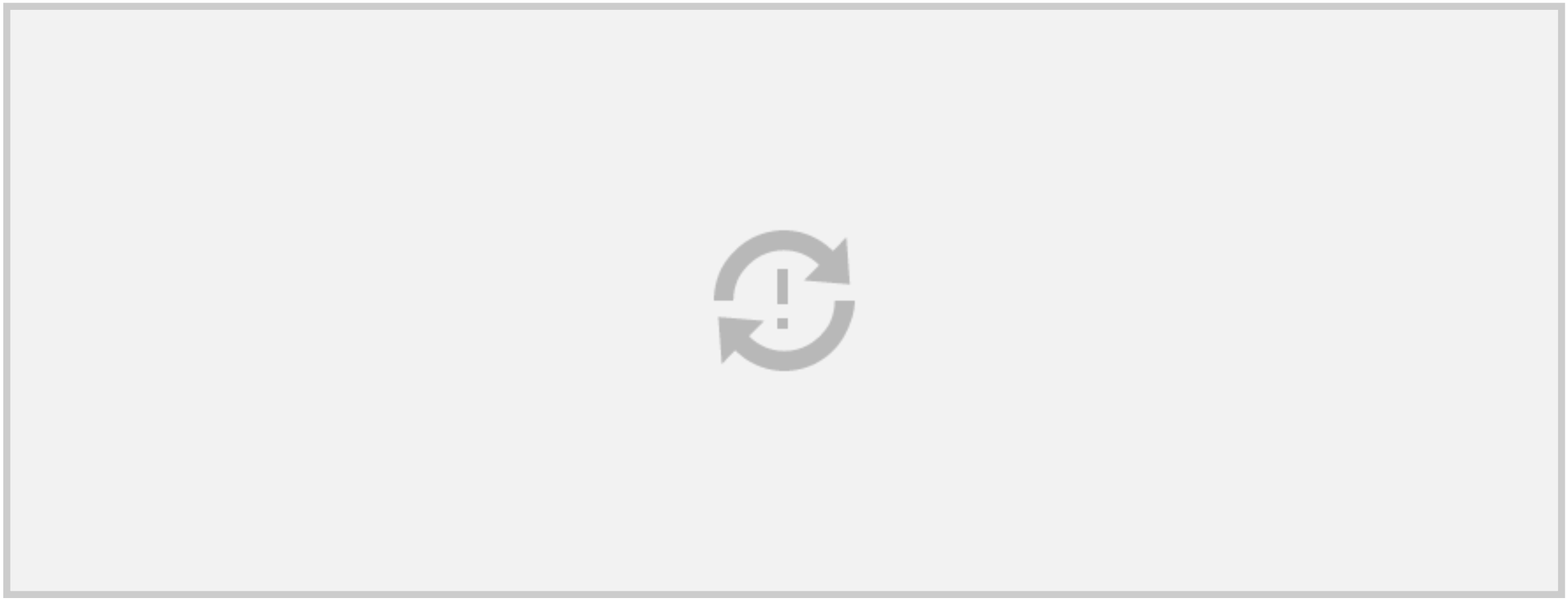
- 2

Comparison of BCD and binary

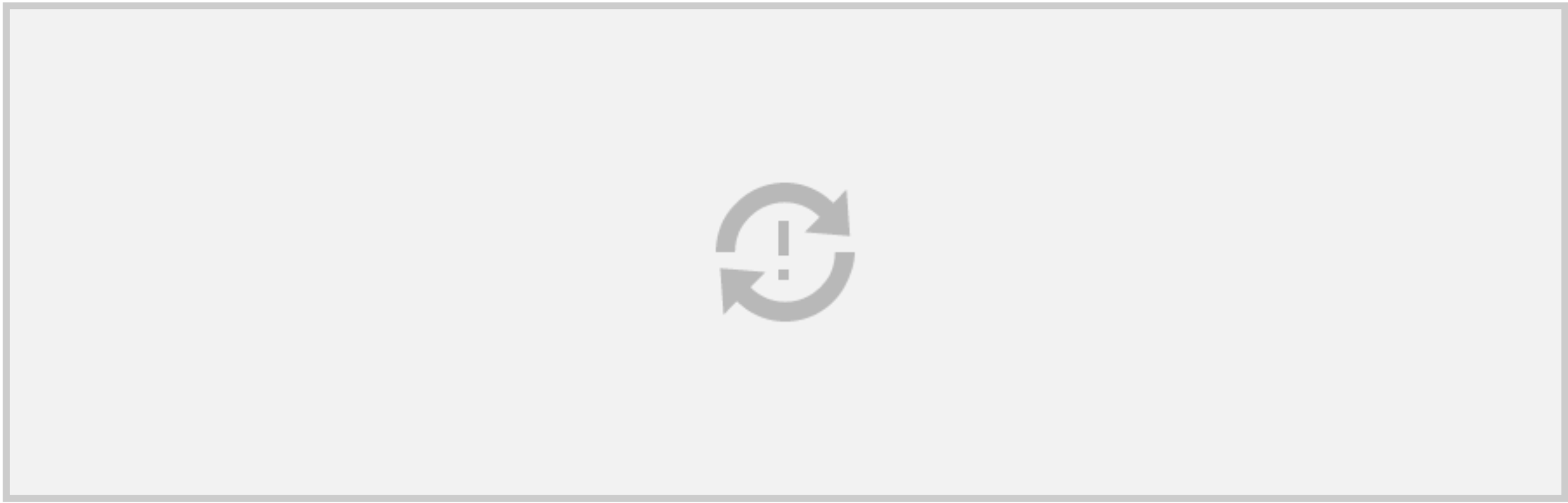
- A straight binary number takes the complete decimal number and represents it in binary; the BCD code converts each decimal digit to binary individually.
- To illustrate, take the number 137 and compare its straight binary and BCD codes:

- The BCD code requires 12 bits, while the straight binary code requires only eight bits to represent 137.
- Though BCD is somewhat inefficient, the main advantage of the BCD code is the relative ease of converting to and from decimal.

Exercise 1



Exercise 2



1’s and 2’s Complements

- 1s Complement and 2s Complement are both used to deal with signed bits, allowing one to find the opposite sign of the bit they are working with.
- The **1's complement** and the **2's complement** of a binary number are important because they permit the representation of negative numbers.
- **1’s complement** of a binary number is another binary number obtained by toggling all bits in it, i.e., transforming the 0 bit to 1 and the 1 bit to 0.
- Example:

  1's complement of "0111" is "1000" 1's complement of "1100" is "0011"
- **2’s complement** of a binary number is 1, added to the 1’s complement of the binary number.
- Example:

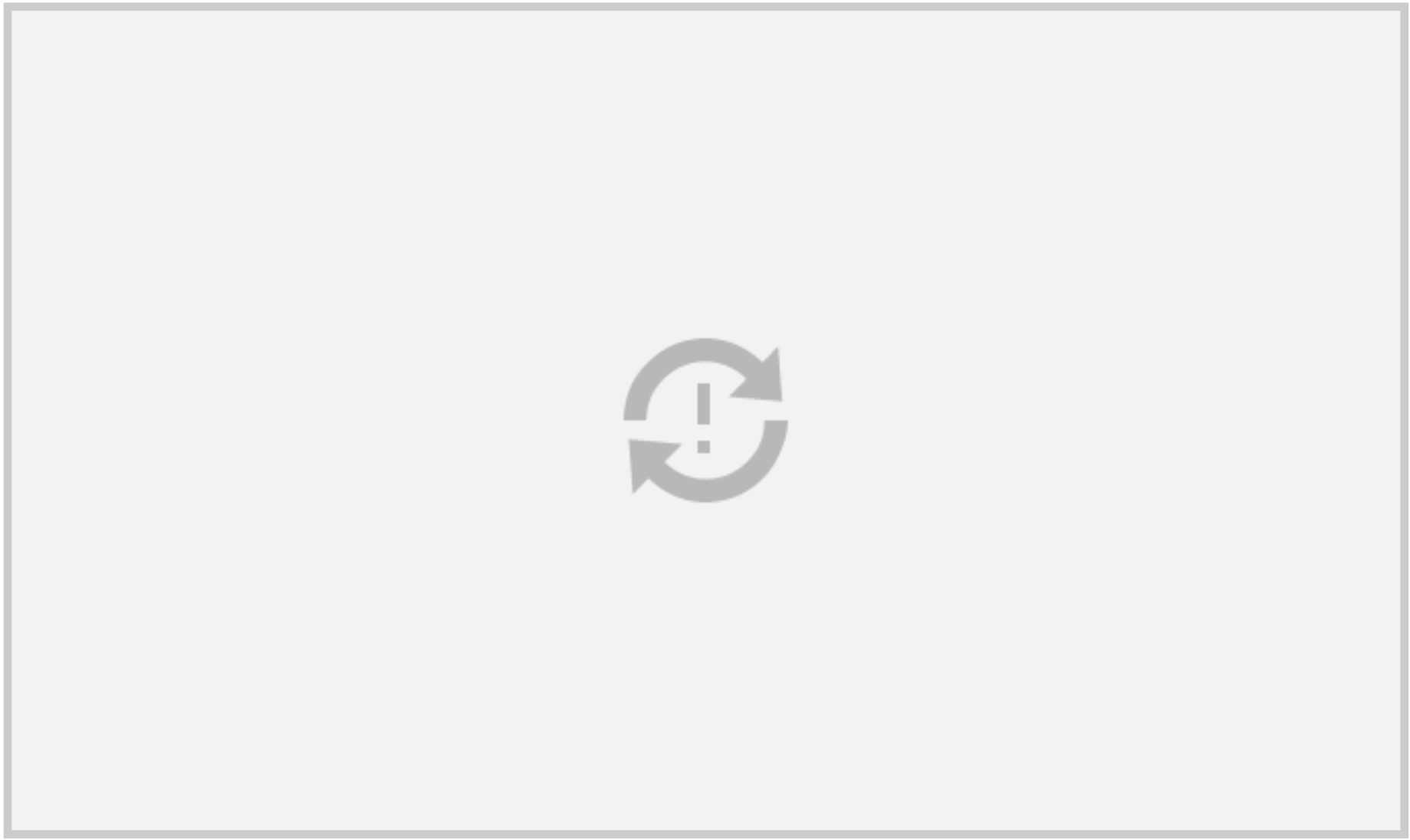
  2's complement of "0111" is "1001" 2's complement of "1100" is "0100"

The Gray Code

- Digital systems operate at very fast speeds and respond to changes that occur in the digital inputs.
- Just as in life, when multiple input conditions are changing at the same time, the situation can be misinterpreted and cause an erroneous reaction.
- For example, consider when the three-bit binary number for 3 changes to 4: all three bits must change state.
- In order to reduce the likelihood of a digital circuit misinterpreting a changing input, the **gray code** was developed to represent a sequence of numbers.
- The unique aspect of the Gray code is that only one bit ever changes between two successive numbers in the sequence.

Gray Code Contd.

- Three-bit binary and Gray code equivalents.



More explanation on Gray code

Excess-3 Code

- The excess-3 code (or XS3) is a non-weighted code used to express code used to express decimal numbers.
- It is a self-complementary binary coded decimal (BCD) code
- Excess-3 codes are unweighted and can be obtained by adding 3 to each decimal digit

These are following excess-3 codes for decimal digits −

Decimal Digit	BCD Code	Excess-3 Code
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

Examples

Decimal to Excess-3 Code

Excess-3 code to BCD and Decimal

E.g. 1

Example – Convert Excess-3 code 1001001 into BCD and decimal number.

So, grouping 4-bit for each group, i.e., 0100 1001 and subtract 0011 0011 from given number. Therefore,

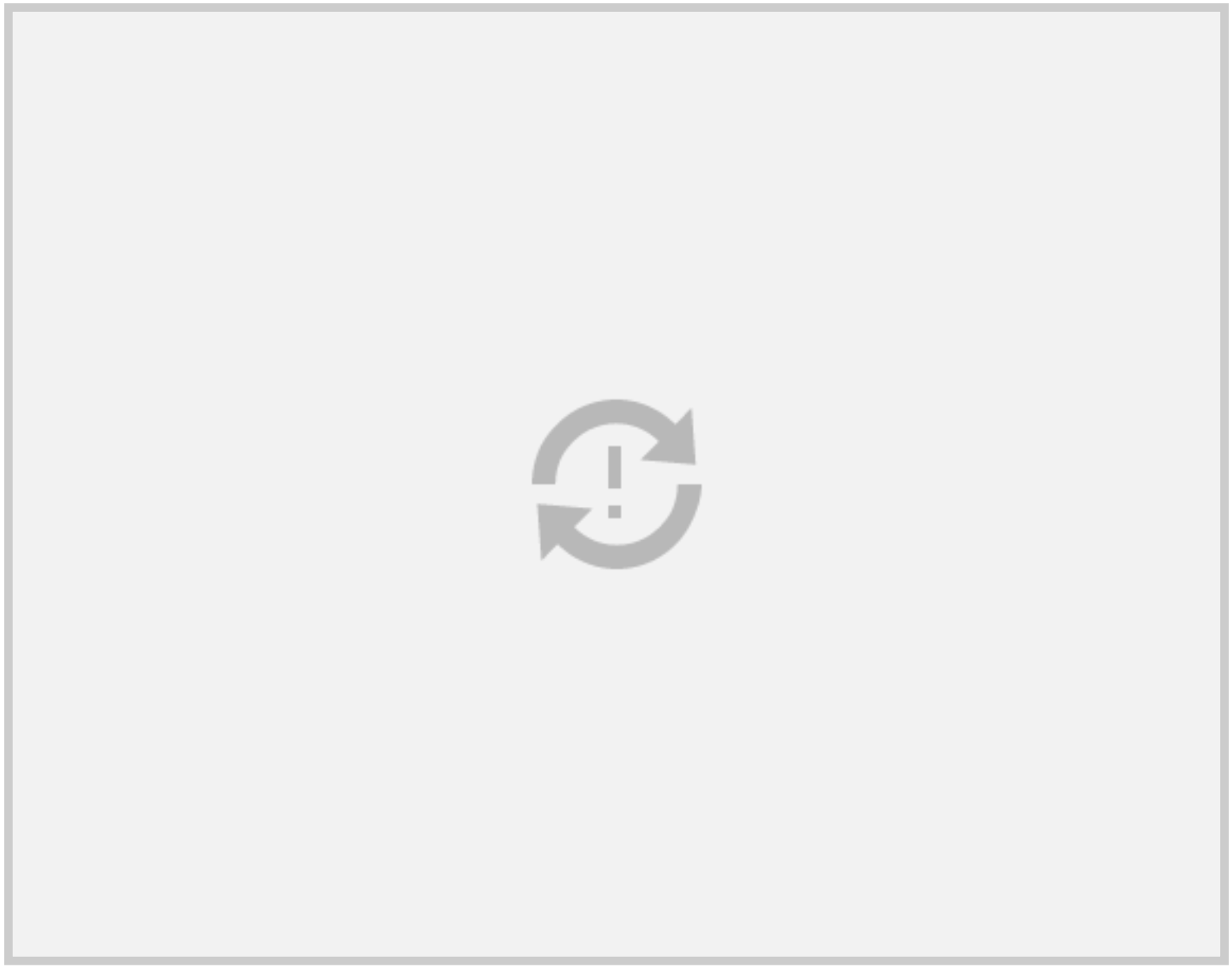
= 0100 1001 -0011 0011 =0001 0110

So, binary coded decimal number is 0001 0110 and decimal number will be 16.

Question: Fastest finger for extra credit

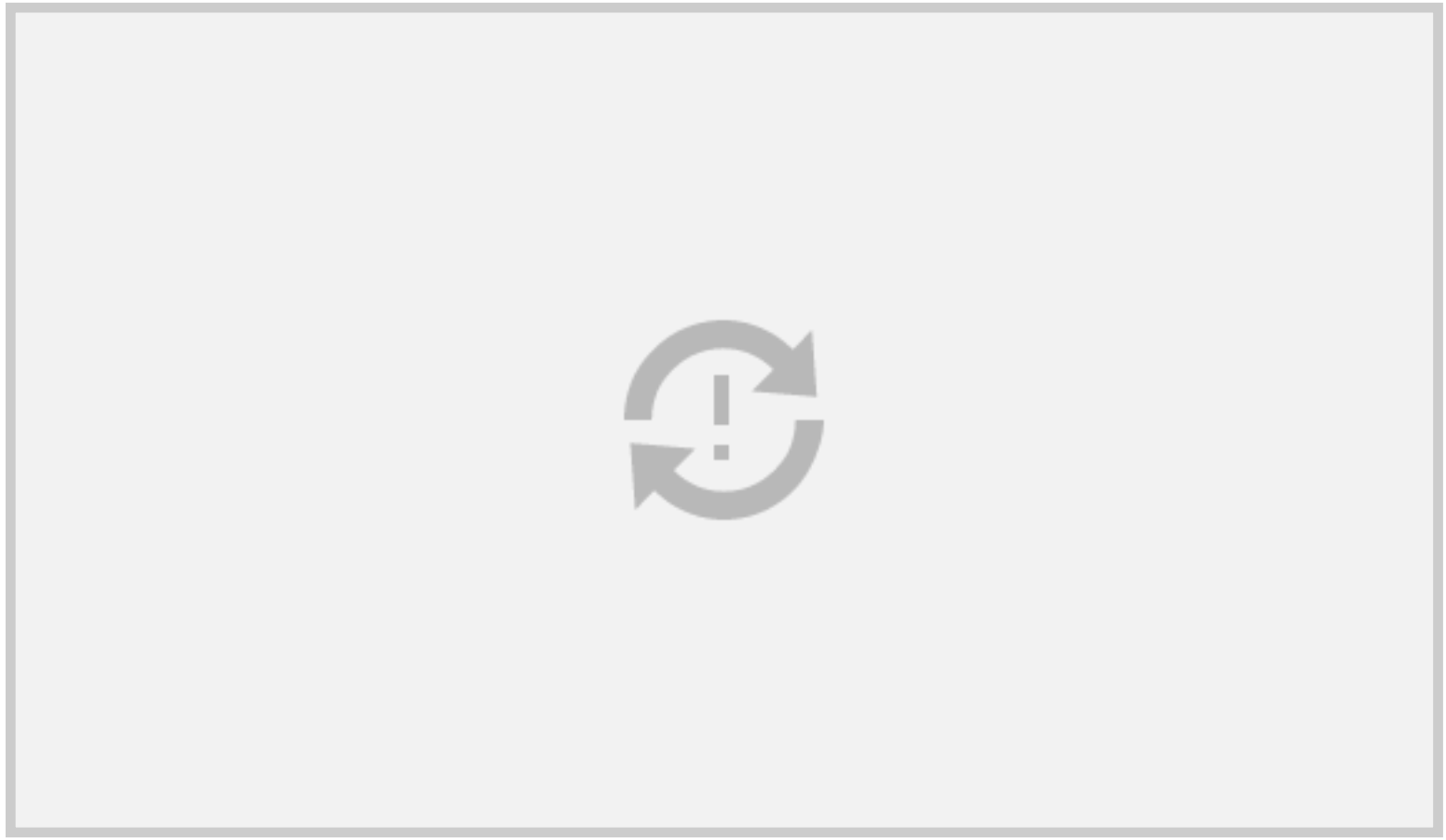
1. Convert decimal number 15.46 into Excess-3 code.

Summary



LOGIC CIRCUITS

- A logic circuit is an electronic circuit used in computers to perform a logical operation on its two or more input signals.
- Upon completion, you will be able to:



- In logic, only two possible conditions exist for any input or output: true and false.
- Life is full of examples of circumstances that are in one state or another. For example, a creature is either alive or dead, a light is either on or off, a door is locked or unlocked, and it is either raining or it is not.
- George Boole wrote An Investigation of the Laws of Thought, in which he described the way we make logical decisions based on true or false circumstances.
- The methods he described are referred to today as Boolean logic, and the system of using symbols and operators to describe these decisions is called Boolean algebra.
- As x and y are used to represent unknown numerical values in regular algebra, Boolean algebra uses symbols to represent a logical expression that has one of two possible values: true or false.