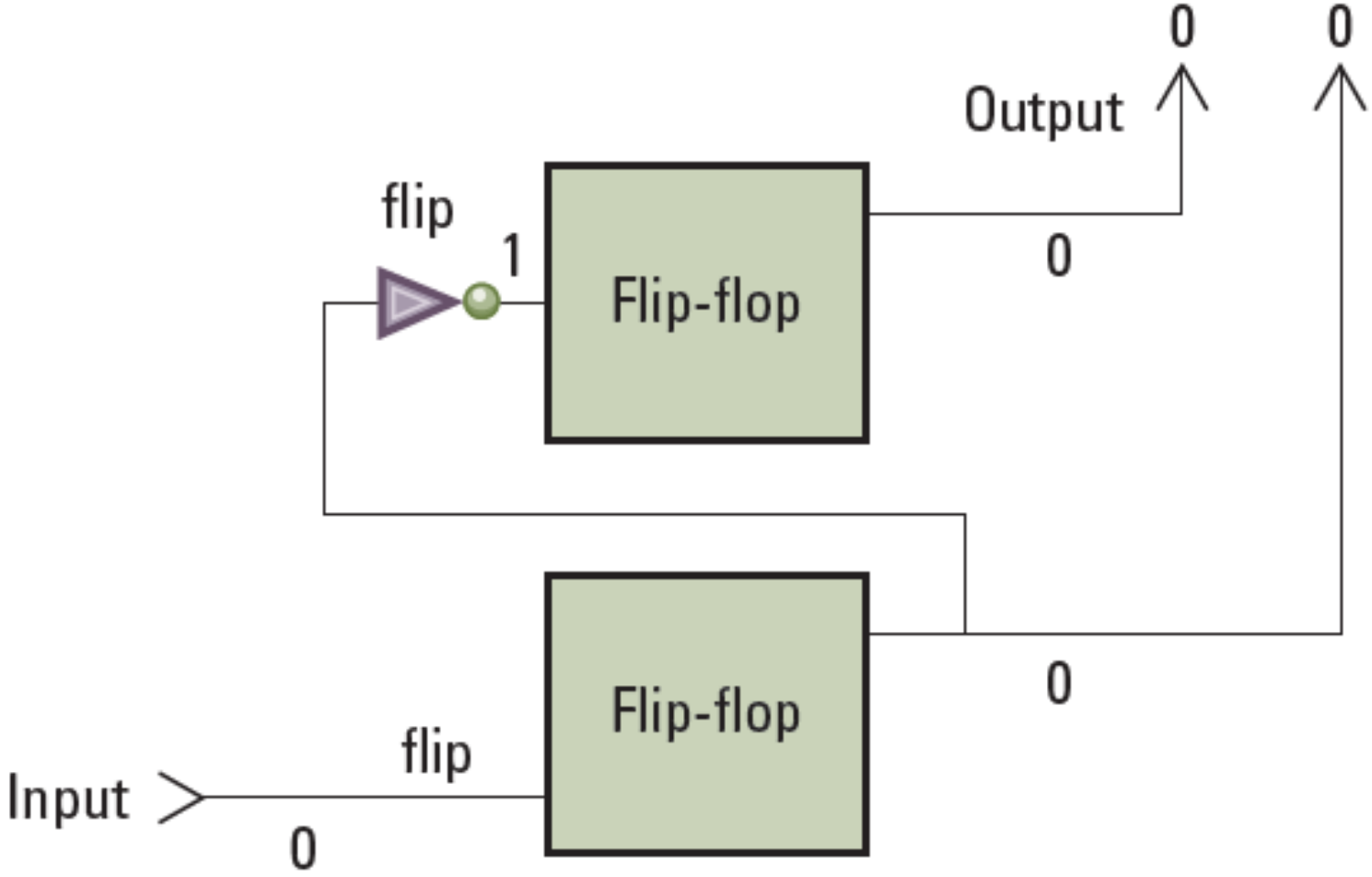
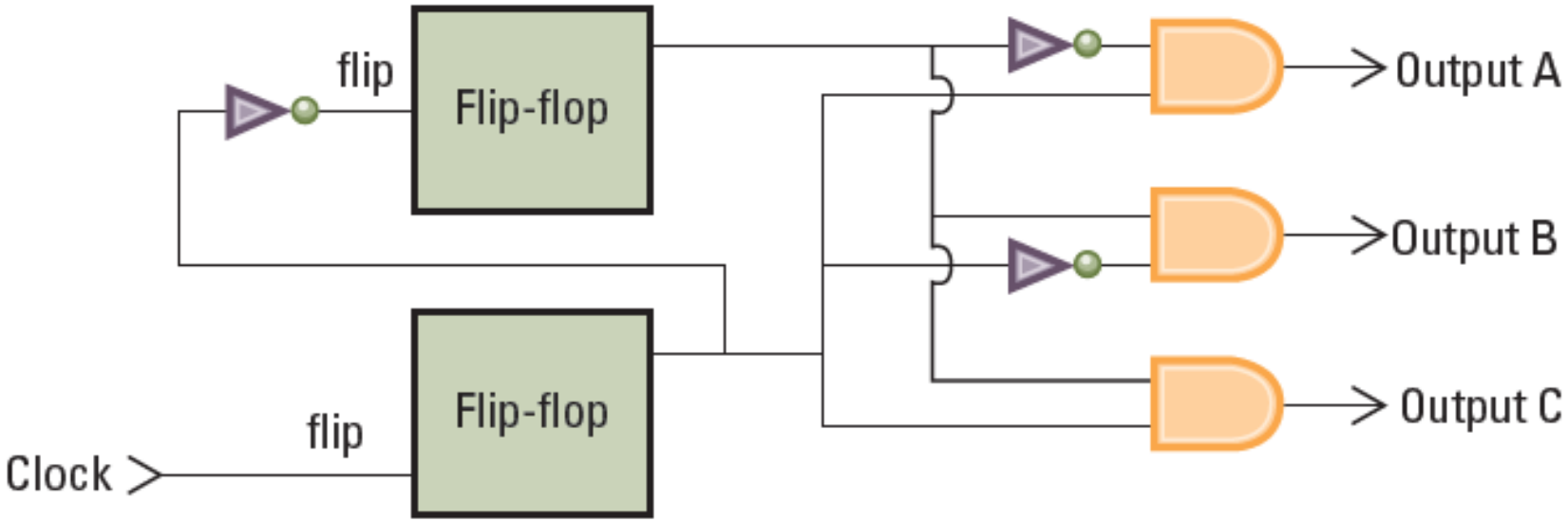
Assignment 1

1. If we were to purchase a flip-flop circuit from an electronic component store, we may find that it has an additional input called flip. When this input changes from a 0 to 1, the output flips state (i.e., if it was 0, it is now 1 and vice versa). However, when the flip input changes from 1 to a 0, nothing happens. Even though we may not know the details of the circuitry needed to accomplish this behavior, we could still use this device as an abstract tool in other circuits. Consider the circuitry using two of the following flip-flops. If a pulse were sent on the circuit's input, the bottom flip-flop would change state. However, the second flip-flop would not change, since its input (received from the output of the NOT gate) went from a 1 to a 0. As a result, this circuit would now produce the outputs 0 and 1. A second pulse would flip the state of both flip-flops, producing an output of 1 and 0. What would be the output after a third pulse? After a fourth pulse? (15 points)


0
0
Output
flip
1
Flip-flop
0
Flip-flop
0
flip
Input
0

2. It is often necessary to coordinate activities of various components within a computer. This is accomplished by connecting a pulsating signal (called a clock) to circuitry similar to part a. Additional gates (as shown) send signals in a coordinated fashion to other connected circuits. On studying this circuit, you should be able to confirm that on the 1st, 5th, 9th … pulses of the clock, a 1 will be sent on output A. On what pulses of the clock will a 1 be sent on output B? On what pulses of the clock will a 1 be sent on output C? On which output is a 1 sent on the 4^{th} pulse of the clock? (15 points)


flip
Flip-flop
flip
Flip-flop
Clock
Output A
Output B
Output C

3. Suppose an image is represented on a display screen by a rectangular array containing 1024 columns and 768 rows of pixels. Each pixel includes 3 colors; Red, Green and Blue. Each color uses 8 bits to store it's intensity, how many bytesize memory cells are required to hold the entire picture? (10 points)

4. Using the error-correcting code to decode the following words (10 points)

Symbol	Code
A	000000
B	001111
C	010011
D	011100
E	100110
F	101001
G	110101
H	111010

a. 111010 110110
b. 101000 100110 001100
c. 011101 000110 000000 010100
d. 010010 001000 001110 101111 000000 110111 100110
e. 010011 000000 101001 100110

5. Suppose the memory cells at addresses 0x00 through 0x05 in the Vole contain the following bit patterns, Assuming that the program counter initially contained 0x00, record the contents of the program counter, instruction register, and memory cell at address 0x02 at the end of each fetch phase of the machine cycle until the machine halts. (10 points)

Address	Contents
0x00	0x22
0x01	0x11
0x02	0x32
0x03	0x02
0x04	0xC0
0x05	0x00

6. Suppose the memory cells at addresses 0x00 through 0x0D in the Vole contain the following bit patterns, Assume that the machine starts with its program counter containing 0x00. (15 points)

a. What bit pattern will be in register 0x0 when the machine halts?

b. What bit pattern will be in register 0x1 when the machine halts?

c. What bit pattern is in the program counter when the machine halts?

Address	Contents
0x00	0x20
0x01	0x04
0x02	0x21
0x03	0x01
0x04	0x40
0x05	0x12
0x06	0x51
0x07	0x12
0x08	0xB1
0x09	0x0C
0x0A	0xB0
0x0B	0x06
0x0C	0xC0
0x0D	0x00

7. In each of the following cases, write a short program in Vole to perform the requested activities. Assume that each of your programs is placed in memory starting at address 0x00.

a. Move the value at memory location 0xD8 to memory location 0xB3. (6 points)

b. Interchange the values stored at memory locations 0xD8 and 0xB3. (9 points)

8. Suppose a machine has 200 GB of storage space available on a hard disk and receives data over a broadband connection at the rate of 15 Mbps. At this rate, how many hours will it take to fill the available storage space? (10 points)