Lab #9 **EC262**

LAB (Concurrent VHDL)

1. Implement an 8-to-1 multiplexer using logic operators in VHDL (**Boolean expression**).
   a. Implement this circuit using Quartus II software. Attach VHDL code to your lab notebook.
   b. Show a Quartus timing simulation to verify the correct operations of the circuit. Attach the timing diagram to your lab notebook.

2. Implement a 4-bit Binary-to-Gray code converter using a **WITH/SELECT/WHEN/ statement**. The binary encoded numbers and the equivalent Gray encoded numbers are shown in Table 1. The Gray code is based on the Hamming distance between 2 consecutive numbers, that is, only one bit changes between them. The circuit accepts a 4-bit binary encoded number and produces its equivalent number in Gray code.

Table 1. Binary encoded and Gray encoded numbers.

Decimal number	Binary code	Gray code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

   a. Implement this circuit using Quartus II software. Attach VHDL code to your lab notebook.
   b. Show a Quartus timing simulation to verify the correct operations of the circuit. Attach the timing diagram to your lab notebook.

3. Implement a 7-level priority encoder using a WHEN/ELSE statement. The block diagram for a 7-level encoder is shown in Figure 1. The circuit must encode the address of the input bit of the highest order that is active. For example, if the input bits are "0101011", then the output bits should be "110" as shown in Figure 1. "000" should indicate that there is no request at the input (all 0's).

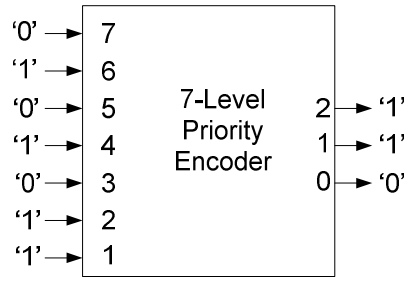

Figure 1. A block diagram of a 7-level priority encoder.

a. Implement this circuit using Quartus II software. Attach VHDL code to your lab notebook.
b. Show a Quartus timing simulation to verify the correct operations of the circuit. Attach the timing diagram to your lab notebook.

4. Implement a simple Barrel Shifter using a GENERATE statement. The block diagram for a simple Barrel Shifter is shown in Figure 2. The circuit must shift the input vector (8 bits) either 0 or 1 position to the left based on a controller signal, shift. When shifted by 1 position (shift = '1'), the LSb must be filled with '0' (shown in Figure 2). If shift = 0, then outp = inp (shifted by 0 position).

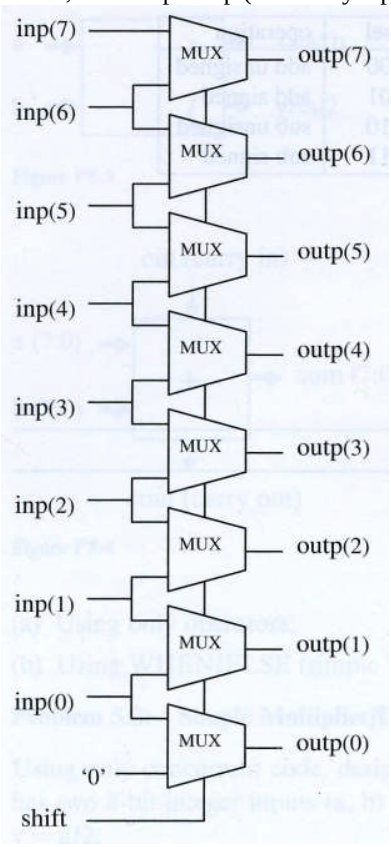

Figure 2. A block diagram of a simple Barrel Shifter (from Pedroni, *Circuit Design with VHDL*, 2nd ed.)

a. Implement this circuit using Quartus II software. Attach VHDL code to your lab notebook.
b. Show a Quartus timing simulation to verify the correct operations of the circuit. Attach the timing diagram to your lab notebook.
c. Demonstrate a working circuit to your instructor.
Requirements:
- Use SW(7:0) for *inp(7:0)*.
- Use LEDR(7:0) for *outp(7:0).*
- Use SW9 for *shift*.