(Affiliated To Tribhuvan University)

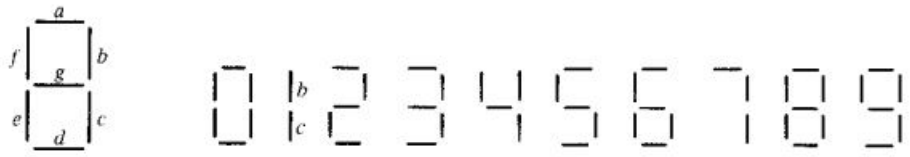
NIST College
Department of BScCSIT
First Semester
Digital Logic Design

Tutorial 3

Combinational Circuit

1. Design a combinational circuit with three inputs and one output. The output is equal to logic-1 when the binary value of the input is less than 3. The output is logic-0 otherwise.
2. Design a combinational circuit with three inputs x, y, and z, and three outputs, A, B, and C. When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is one less than the input.
3. A majority function is generated in a combination circuit when the output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Design a 3-input majority function.
4. Design a combinational circuit that adds one to a 4-bit binary number. $A_3A_2A_1A_0$. For example, if the input of the circuit is $A_3A_2A_1A_0$A = 1101, the output is 1110. The circuit can be designed using four half-adders.
5. A combinational circuit produces the binary sum of two 2-bit number, x_1x_0 and y_1y_0. The outputs are C, S_1, and S_0. Provide the truth table of the combinational circuit. Also design using two full adders.
6. Design a combinational circuit that multiplies two 2-bit numbers, a_1a_0 and b_1b_0, to produce a 4-bit product, $c_3c_2c_1c_0$. Use And gates and half-adders.
7. Show that a full-subtractor can be constructed from two half-subtractors and an OR gate.
8. Design a combinational circuit with three inputs and six outputs. The output binary number should be the square of the input binary number.
9. Find a function to detect an error in the representation of a decimal digit in BCD. In other words, write an equation with value 1 when the inputs are any one of six bit combinations in the BCD code, and value 0 otherwise.

10. Design a combinational circuit with four inputs that represent a decimal digit in BCD and four outputs that produce the 9's complement of the input digit. The six unused combinations can be treated as don't care conditions.
11. Design a Gray code-to-BCD code converter that gives code 1111 for all invalid input combinations. Assume that the Gray code sequence for decimal numbers 0 through 9 is 0000, 0001. 0011, 0010, 0110, 0111, 0101, 0100, 1100, and 1101. All other input combinations should be considered to be invalid.
12. Design a combinational circuit with four inputs and four outputs that produce the 2's complement of the input binary number.
13. Design a combinational circuit that converts a decimal digit from 2421 code to the 8421 code.
14. A BCD –to –seven-segment decoder is a combinational circuit that converts a decimal digit in BCD to an appropriate code for the selection of segments in a display indicator used for displaying the decimal digit in a familiar form. The seven output of the decoder *(a, b, c, d, e, f, g)* select the corresponding segments in the display. The numeric designation chosen to represent the decimal digit is shown in figure below. Design the BCD-to-seven-segment decoder using a minimum number of NAND gates. The six invalid combinations should result in a blank display.



(a) Segment designation

(b) Numerical designation for display

15. Design a combinational circuit that converts a 4-bit Gray Code to a 4-bit straight binary number. Implement the circuit with the exclusive-OR gates.
16. Design the circuit of a 3-bit parity generator and the circuit of a 4-bit parity checker using an odd parity bit.
17. Design the circuit of a 3-bit parity generator and the circuit of a 4-bit parity checker using an even parity bit.