1. Implement the Boolean function $F(x,y,z)=z'+xy'$

    (a) use a 4×1 multiplexer.
    (b) use a 3x8 decoder　　　　　　　　　(10%)

2. Prove the equality $x+x=x$ using the following properties of Boolean algebra
    (1) $x \cdot 1=x$　(2)$x+x'=1$　(3)$(x+y)(x+z)=x+yz$　(4)$x \cdot x'=0$　(5)$x+0=x$　　　(5%)

3. Use *selection sort* to order the following list of numbers in an ascending order.
Initial list: 5, 4, 1, 3, 2
The selection sort algorithm is given as follows:
1. Get values for *N* and the *N* list items
2. Set the marker for the unsorted section at the end of the list
3. Repeat [steps 4 through 7] {
4.　　　　Select the largest number in the unsorted section of the list
5.　　　　Exchange this number with the last number in the unsorted section of the list
6.　　　　Move the marker for the unsorted section forward (left) one position
7. } until (unsorted section of the list is empty)
8. Stop
(a) Show the list after each exchange.
(b) How many comparisons of the elements in the list did the algorithm do in total?
(c) How many exchanges of the elements in the list did the algorithm do in total?　　　(15%)

4. Consider the following 11-bit floating point representation based on the IEEE floating point format:

   − 1 bit for the mantissa's sign (bit 10).
   − 6 bits for the mantissa (bit 4-9).
   − 4 bits for the exponent (bit 0-3). The exponent bias is 7.

Numeric values are encoded in this format as a value of the form $V=(-1)^S \times M \times 2^E$ where S is the sign bit, E is exponent after biasing, and M is the significand.
(a) How many floating point numbers are in the interval [1,2.5)?
(b) What is the smallest value E of the exponent after biasing?
(c) What is the largest value E of the exponent after biasing?
(d) What is the smallest value M of the significand?
(e) What is the largest value M of the significand?　　　(25%)

5. Suppose there is an arithmetic expression $((((25+13)*12)*(34-11))/(47-20))$, please express it in (a) INFIX notation (with parentheses), (b) PREFIX notation(without parentheses), and (c) POSTFIX notation(without parentheses).　　(15%)

6. (a) Use a binary tree to express the arithmetic expression $((((25+13)*12)*(34-11))/(47-20))$; (b) Let L, V, and R stand for moving left, visiting the node, and moving right when at a node of the above binary tree. What are the possible combinations of traversal? (c) Please show the nodes according to your visiting order using the LVR, LRV and VLR traversals.　　(15%)

7. Suppose there is a machine with only the following operations: ADD, AND, NOT, STORE, LOAD, BRn (branching when the result is negative), BRz (branching when the result is zero), BRp (branching when the result is positive), and BR (unconditional branching). There are 8 GPRs (R0 ~ R7) and 65536 memory cells. (a) Please use the above operations in your pseudo code to develop a stack and its operations. (b) Please use your stack operations and the machine built-in operations in your pseudo code to develop an algorithm that is able to evaluate an arithmetic expression in POSTFIX notation without any parentheses in ASCII format. The possible operators in an arithmetic expression are addition, subtraction, multiplication, and division. The numbers are all in decimal format. (c) Use your algorithm to evaluate the expression $((((25+13)*12)*(34-11))/(47-20))$ in POSTFIX notation.　　(15%)