1. [5 points] Circle the correct answer among the choices given. If you circle more than one answer, you will lose the grade of the corresponding question.

(A) Which language of the following is the most hardware independent?
   - a. High Level language
   - b. Assembly language
   - c. Machine language
   - d. They are all hardware independent

(B) As the technology advances, which problem of the following types can actually be solved?
   - a. undecidable
   - b. intractable
   - c. unsolvable
   - d. all of them

(C) The compiler is:
   - a. language dependent
   - b. machine dependent
   - c. both a and b
   - d. machine and language independent

(D) If we want to stop using an instruction from the instruction set of a processor, which of the following must to be updated?
   - a. control unit
   - b. datapath
   - c. the compiler
   - d. all of them must be updated

(E) 00110101 can be (choose the most accurate answer):
   - a. negative number
   - b. positive number
   - c. unsigned number
   - d. floating point number
   - e. a and b
   - f. b and c
   - g. c and d
2. Suppose you wish to express +17 (signed number) in binary
   a. [1 point] What is the minimum number of bits we will need?
      
      010001 \rightarrow 6 \text{ bits} \ldots \text{less than that the number will look negative}

   b. [1 point] With this number of bits you mentioned above, what is the largest positive number you can represent, assuming signed numbers? (Please give answer both in binary and hexadecimal)
      
      011111 \rightarrow 0x \text{1F}

   c. [1 point] With that same number of bits you used in the above two questions, what is the largest unsigned number you can represent? (Please give answer both in binary and hexadecimal).
      
      111111 \rightarrow 0x \text{3F}

3. [2 points] State two differences between assembly language and machine code?
   
   - Assembly language is in ASCII while machine code is in binary
   - Assembly language is a super-set of machine code

4. a) [1 point] Why do we need sign extension?

   We need it when we want to make an arithmetic/logic operation and need the two operands to be of the same bit-length for the ALU to be able to process them.

   b) [1 point] Give two different instructions from MIPS that require sign extension.
   The two instructions will be of I-type, example
   addi r1, r2, 0x100
   lw r1, 0(r2)
5. Suppose we have two 1-bit variables x and y, and one control variable c. If c is 1, the output f is (x AND y). If c is 0, the output f is (x OR y). Also we need a variable z that is set to 1 whenever the output f is 0.

a) [4 points] Draw the truth table, showing clearly the inputs and outputs.

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<thead>
<tr>
<th>c</th>
<th>x</th>
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b) [2 points] Write the equation for each output.

\[ f = c'x'y + c'xy' + c'xy + cxy \]

z can be expressed in terms of c, x, and y and can also be expressed in terms of f.

If we express it in terms of c, x, and y:

\[ z = c'x'y' + cx'y' + cx'y + cxy' \]

If we express it in terms of f:

\[ z = f' \]

c) [2 points] Draw the logic circuit.