**\*If you have trouble viewing instructions/images below, please refer to the "Assignment" chapter in Unit 6's Learning Guide**

For the Unit 6 assignment, hand compile the following two assembly language programs into machine language that can be loaded into an executed on the Hack computer.

Chapter 4 of the Nisan and Schocken text describes the machine language instructions that  are supported by the Hack computer system.    It is important to understand that different computer architectures will support different capabilities and of course this translates into differences in both the machine language instructions of the computer and the assembler language  that supports the system.

In the Hack computer platform, there are essentially two types of machine language instructions the A instruction (see below)

A math problem with numbers and symbols

Description automatically generated with medium confidence

And the C instruction as follows.  ALL Hack computer programs can be developed using these two instructions.

A screenshot of a computer program

Description automatically generated

The C instruction allows the programmer to interact with the CPU(and in particular the ALU) to perform computations against the values in the registers.  If you recall, in Unit 2 we presented the ALU for the Hack computer as follows:

A diagram of a block diagram

Description automatically generated

Each of the instructions that the Hack ALU is capable of running  can be specified to the ALU through a set of control bits.  These control bits  or the C bits in the instruction and their associated functions are listed below.

A table of numbers and letters

Description automatically generated

IT IS IMPORTANT TO COMPLETE THIS EXERCISE.  I caution you not to take any shortcuts.  The best way to really gain an understanding of how machine language and assembler language works is by learning how to convert assembler into machine language.  We will gain an understanding of the relationship between hardware and software in this process.    As such I urge you to NOT be tempted to cheat and use a compiler for this task.

Once you have been able to translate each of the following two programs written in Hack Assembler into binary machine code,   Load your machine language program into the cpu simulator and execute it.

For your assignment post a description of YOUR process to convert the assembler symbols into machine language and what you learned in the process. Also include  both your assembler program and corresponding machine language program in  your assignment.

//Program 1 to convert to machine language  
// Computes R0 = 2 + 3  
  
@2  
D=A  
@3  
D=D+A  
@0  
M=D

// Program 2 to convert to machine language  
// Symbol-less version of the Max.asm program.

@0  
D=M  
@1  
D=D-M  
@10  
D;JGT  
@1  
D=M  
@12  
0;JMP  
@0  
D=M  
@2  
M=D  
@14  
0;JMP