COMP1036 Computer Fundamentals
Lab 3

Below is a list of all the chip interfaces in the Hack chip-set. If you need to use a chip-part, you can copy-paste the chip interface and proceed to fill in the missing data. This is a very useful list to have bookmarked or printed.

```
Add16(a= ,b= ,out= );
ALU(x= ,y= ,zx= ,nx= ,zy= ,ny= ,f= ,no= ,out= ,zr= ,ng= );
And16(a= ,b= ,out= );
And(a= ,b= ,out= );
ARegister(in= ,load= ,out= );
Bit(in= ,load= ,out= );
CPU(inM= ,instruction= ,reset= ,outM= ,writeM= ,addressM= ,pc= );
DFF(in= ,out= );
DMux4Way(in= ,sel= ,a= ,b= ,c= ,d= );
DMux8Way(in= ,sel= ,a= ,b= ,c= ,d= ,e= ,f= ,g= ,h= );
DMux(in= ,sel= ,a= ,b= );
DRegister(in= ,load= ,out= );
FullAdder(a= ,b= ,c= ,sum= ,carry= );
HalfAdder(a= ,b= ,sum= , carry= );
Inc16(in= ,out= );
Keyboard(out= );
Memory(in= ,load= ,address= ,out= );
Mux16(a= ,b= ,sel= ,out= );
Mux4Way16(a= ,b= ,c= ,d= ,sel= ,out= );
Mux8Way16(a= ,b= ,c= ,d= ,e= ,f= ,g= ,h= ,sel= ,out= );
Mux(a= ,b= ,sel= ,out= );
Nand(a= ,b= ,out= );
Not16(in= ,out= );
Not(in= ,out= );
Or16(a= ,b= ,out= );
Or8Way(in= ,out= );
Or(a= ,b= ,out= );
PC(in= ,load= ,inc= ,reset= ,out= );
RAM16K(in= ,load= ,address= ,out= );
RAM4K(in= ,load= ,address= ,out= );
RAM512(in= ,load= ,address= ,out= );
RAM64(in= ,load= ,address= ,out= );
RAM8(in= ,load= ,address= ,out= );
Register(in= ,load= ,out= );
ROM32K(address= ,out= );
```

```
Screen(in= ,load= ,address= ,out= );
Xor(a= ,b= ,out= );
```

1. Work out the representation for the following unsigned numbers by hand.
   (a) 45
   (b) 1026
2. Work out the two's complement representations for the following signed numbers by hand(using 16-bits representation).
   (a) 26
   (b) -130
3. Implement the following circuits:
   (a) HalfAdder

   ```
   Half adder. Computes sum, the least significant bit of a + b,
   and carry, the most significant bit of a + b.
   ```

   (b) FullAdder

   ```
   Full adder. Computes sum, the least significant bit of
   a + b + c, and carry, the most significant bit of a + b + c.
   ```

   (c) Add16

   ```
   Adds two 16-bit values.
   The most-significant carry bit is ignored.
   ```