PASS- Computer Systems

Week 7

1. There is a limit on the number of ways to express a Nand chip in terms of other chips. True or False?

False. Nand gates can make every other gate, and other gates make NAND gates.

2. In eight-bit two's complement notation write down the binary for -126
   a. -125 is too large to represent in 8 bits 2's complement
   b. 1000 0010
   c. 1000 0011
   d. 0111 1101

Smallest is -2^{8-1} -128

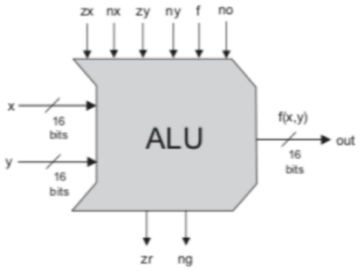
126 63 31 15 7 — 0 1 1 1

3 1 1 0 — 0 1 1 1 1 1 1 0 / 1 0 0 0 0 0 1 0

3. Imagine that you had a data flip-flop DDF and, during successive clock cycles the signal on its input is: 0,0,1,0,1,0,0,1. What is the output of the DFF on these same clock cycles?
   a. ?,0,0,1,0,1,0,0
   b. 0,0,1,0,1,0,0,0
   c. 0,1,0,1,0,0,1,0
   d. ?,0,1,0,1,0,0,1

1st is unknown

Use the following for questions 4-11



zx	nx	zy	ny	f	no
if zx==0 then x1=x else x1=0	if nx==0 then x2=x1 else x2=!x1	if zy==0 then y1=y else y1=0	if ny==0 then y2=y1 else y2=!y1	if f==0 then fout=x2&y2 else fout=x2+y2	if no==0 then out=fout else out=!fout

Notes:

- The values of **x1**, **x2**, **y1**, **y2**, **fout** and **out** must be expressed as simplified arithmetic expressions and may include a single **x**, a single **y**, a single digit (**0**, **1** or **2**) and the operators, **+** and **-**.
- If an expression starts with **-**, all operators must be **-**.
- If an expression is **0**, it may be expressed as **0** or **zero**.
- The values of **zr** and **ng** must be expressed as **true** or **false**.
- Your answers must not include any spaces.

What are the values x1, x2, y1, y2, fout and **out** when the ALU control inputs have the following values?

4. if zx == 0 then x1 = X

5. if nx == 0 then x2 = X

6. if zy == 0 then y1 = Y

7. if ny == 0 then y2 = Y

8. If f == 0 then fout = X & Y

9. If no == 1 then out = ! X | ! Y

What values would be output on the zr and ng wires if the values of x and y are as follows?

10. If x == true and y == false then zr = false or true → true (-1) False

11. If x == true and y == true then ng = false or false (0) False

12. What does the following Hack assembler code do?

```
(LOOP)
@KBD
D=M
@48
D=D-A
@num
M=D
@LOOP
D;JLT
@10
D=D-A
@LOOP
D;JGE
(END)
@END
0;JMP
```

// get value of kbd

// get actual value by removing 48

// store key value

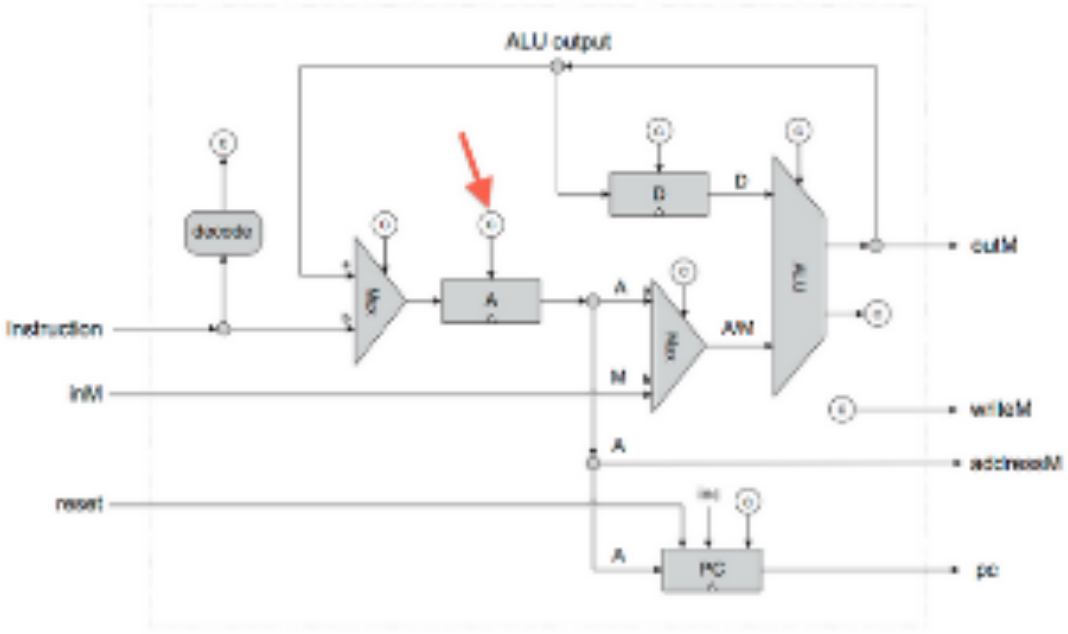
// jump if key press < 0

// remove 10 from key_press

//jump to loop if key press >= 0

a. It loops, putting the scan code into "num", until the key pressed is between scan code 48 and 57.
b. It loops, putting the scan code into "num", until the keyboard scan code is less than 48 (which translates to the char '0').
c. It doesn't work because it goes into an infinite loop at the end of the code.
d. It loops, putting the scan code minus 48 into "num", until the key pressed is between scan code 48 and 57.

13. Look at the following (incomplete) diagram of the Hack CPU. Look at the wire pointed to by the large red arrow. Where does the signal on this wire come from?



a. d1 (the left most ***destination*** bit in an instruction)
b. i15(left most bit of the instruction)
c. d1 OR i15
d. d1 OR (Not i15)

if A instruction, i15 outputs not 0 ensuring A is always written to
if C instruction, not 1, means only write if dl is true.

14. What does the following code do to current value in register D?

D = !D flip bits
D = D +1 add 1
] negate

a. Set D to be D-1
b. Set D to be 1-D
c. Set D to be –D
d. D does not change

15. Translate below HACK assembly instruction to 16-bit binary code:
    a. !D;JNE

C instruction - 1

= 1110 0011 01 000 101
c a comp dest jump

16. How does a programmer finish a program in Hack Assembler?
    a. By specifying a label followed by an instruction that unconditionally jumps to itself.
    b. By setting the address of the A register to zero.
    c. By using halt instruction
    d. By including an instruction that is all zero bits at the end of the code and then jumping conditionally to that instruction.

17. Assume that we have a stack where the value of the top element is 7 and the second top element is 12. If the VM command ***sub*** is executed, and the value 12 is stored at memory address 568, what is the new value of the stack pointer?
    a. 567
    b. 568
    c. 569
    d. 570

12 568
7 569
→ SP 570

18. How many memory segments does the Hack Virtual Machine store in the data memory?
    a. 8
    b. 7
    c. 6
    d. 5

8 if counting constant

19. Which of the following fragments of Hack assembly language would implement the following virtual machine command? If there is more than one correct answer, select all of them.

    push constant 0

    a. @SP
       M=M+1
       A=M
       M=0
       @SP

increments SP and pushes 0 there

→ SP 0

X

    b. @0
       D=A
       @SP

X M of SP is an address

M=D

@SP

M=M+1

c. A=0

M=M+1

AD=M-1

M=0

d. @SP

A=M

M=0

@SP

M=M+1