University of California, Berkeley
College of Engineering
Computer Science Division — EECS

Spring 1998 J. Wawrzynek

Prerequisite Quiz
January 29, 1998
CS152 Computer Architecture and Engineering

Your Name: Solution

ID Number: _____

This prerequisite quiz will be used in determining class admissions. The use of calculators or notes is not allowed during this quiz. Please put your name SID on each page.

Good luck!

1. The following MIPS program tries to sum together all the elements of a memory array holding a set of 32-bit two's complement integers. The register `$a0` is initialized to the address of the array, the register `$a1` is initialized to the number of integers in the array, and all other registers are uninitialized.

```
doit: lw    $t0, 0($a0)     # Read next element
      add   $v0,$v0,$t0     # Add to sum
      addi  $a0,$a0,1       # Advance pointer to next source
      addi  $a1,$a1,-1      # Decrement Counter
      bltz  $a0,doit        # Repeat until done
```

   There are multiple bugs in this MIPS program; fix them and write below a bug-free version.

```
      and   $v0,$v0,$r0     # Clear sum
doit: lw    $t0, 0($a0)     # Read next element
      add   $v0,$v0,$t0     # Add to sum
      addi  $a0,$a0,4       # Advance pointer by 4 bytes
      addi  $a1,$a1,-1      # Decrement Counter
      bgtz  $a1,doit        # Test counter (a1), Branch on greater than 0
```

2. For the following two's complement 16-bit integers, convert:

   -7_{10} to base 2: $1111\ 1111\ 1111\ 1001_2$

   $C152_{16}$ to base 2: $1100\ 0001\ 0101\ 0010_2$

   42_{10} to base 16: $002A_{16}$

   8000_{16} to base 10: -32768_{10}

3. Given the following boolean function:

$$F = \overline{b}c + bc + b\overline{c}$$

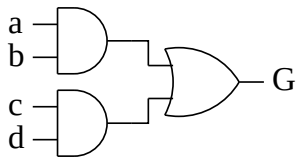
(a) Write the truth table for F:

a	b	c	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

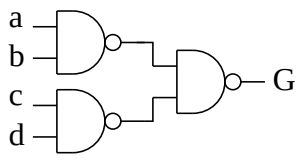
(b) Write F in sum-of-products form:

$$F = \overline{a}\overline{b}c + \overline{a}b\overline{c} + \overline{a}bc + a\overline{b}c + ab\overline{c} + abc$$

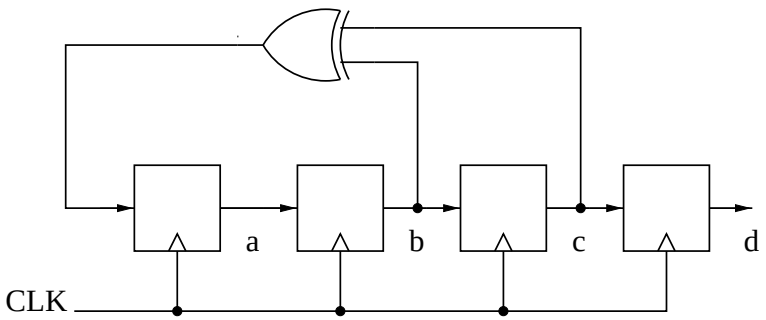
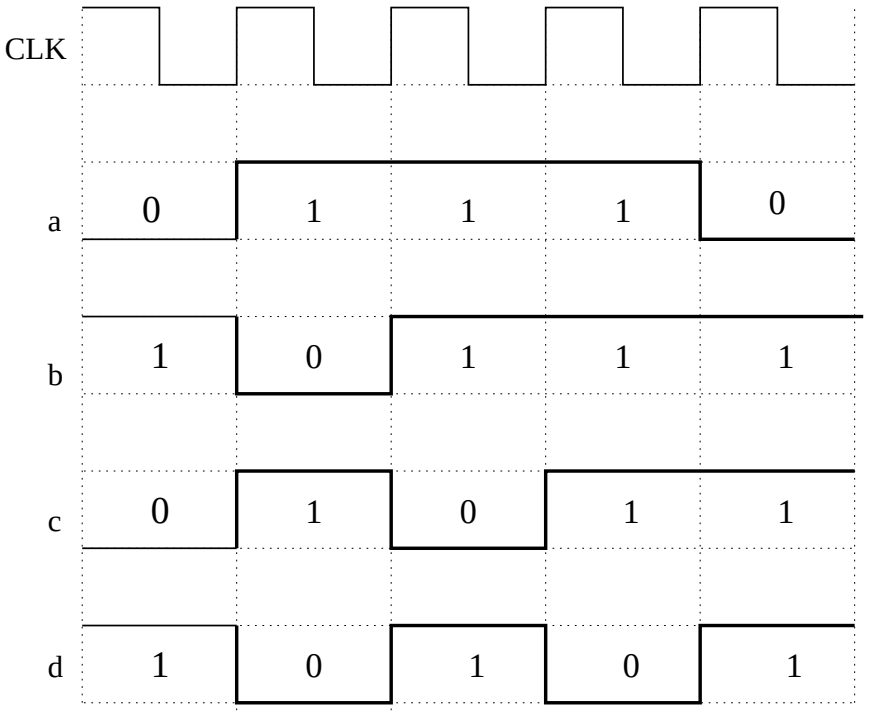
(c) Draw a schematic for the function $G = ab + cd$, using AND and OR gates:



(d) Draw a schematic for the function G above using only NAND gates:



(e) **Extra Credit:** Is there a simplier expression for F above? What is it?

$$F = b + c$$

4. For the following circuit built from positive edge triggered d-flip-flops and a single XOR gate, draw the ideal waveforms at the nodes a, b, c, and d.