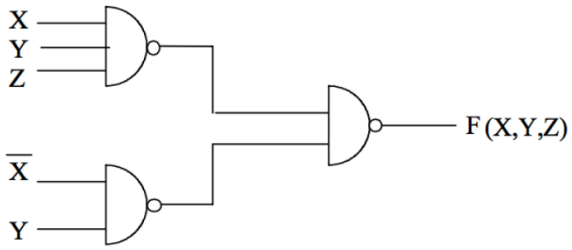
Homework 1 -- Combinatorial Logic & CPU

1. Determine the truth table for the following Boolean functions.

$$F(X,Y,Z) = \overline{X\overline{Z}} + XYZ$$

2. Determine the truth table for the following logic circuit.



3. (a) Find the **complement** of the following Boolean function and reduce it to seven literals in sum-of-products form.

$$\bar{F} = \bar{B}D + \bar{A}B\bar{C} + ACD + \bar{A}BC$$

(b) Implement the simplified expression ***F*** from Q.3(a) using AND, OR and NOT logic gates in a 2-level gate circuit.

4. Design an ALU with 3-bit commands and operations:

0: NOP
1: Accu = –Accu
2: Accu = Accu + data
3: Accu = Accu – data
4: Accu = Accu * data
5: Accu = data
6: don't care
7: don't care

5. Build a CU which advances the program counter by 2 in very step.

6. Review Functionality of CPU4 where its diagram and opcodes were showing below. Write a machine program to multiply two numbers by repeated addition by using the opcodes of CPU4. Your code must satisfy: (a). The two operands are in memory cells **0xA1** and **0xA2;** (b). Store the result in memory cell **0xFF.**

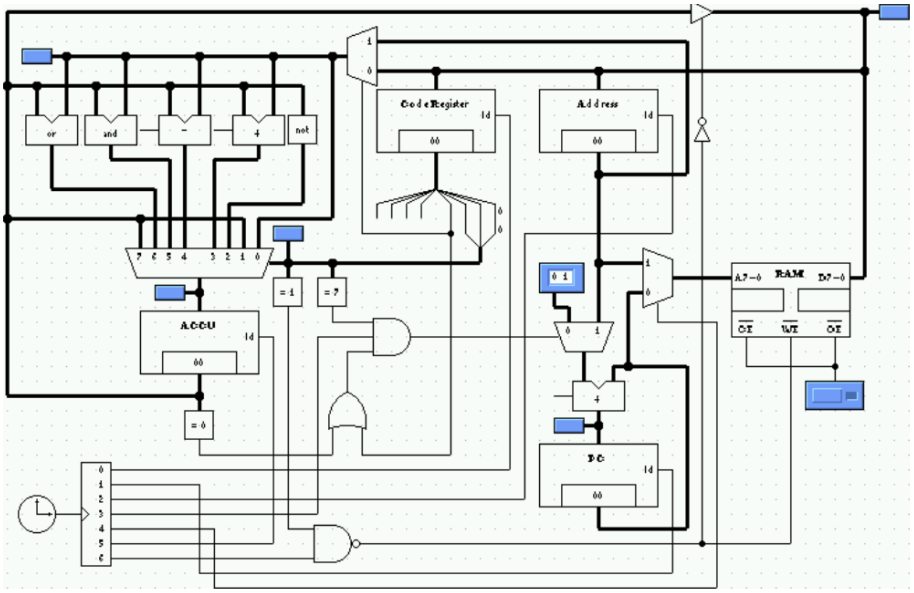


Fig.1 CPU4

Table 1 Opcodes

Opcode	Description	Abbreviation
0	acc ← memory pc ← pc + 2	**LOAD** memory
1	memory ← acc pc ← pc + 2	**STORE** memory
2	acc ← NOT acc pc ← pc + 2	**NOT**
3	acc ← acc + memory pc ← pc + 2	**ADD** memory
4	acc ← acc - memory pc ← pc + 2	**SUB** memory
5	acc ← acc AND memory pc ← pc + 2	**AND** memory
6	acc ← acc OR memory pc ← pc + 2	**OR** memory
7	(* acc unchanged *) if acc = 0 then pc ← pc + address else pc ← pc + 2	**BEQ** address
8	acc ← constant pc ← pc + 2	**LOAD** constant
9		
10		
11	acc ← acc + constant pc ← pc + 2	**ADD** constant
12	acc ← acc - constant pc ← pc + 2	**SUB** constant
13	acc ← acc AND constant pc ← pc + 2	**AND** constant
14	acc ← acc OR constant pc ← pc + 2	**OR** constant
15	(* acc unchanged *) pc ← pc + address	**BRA** address