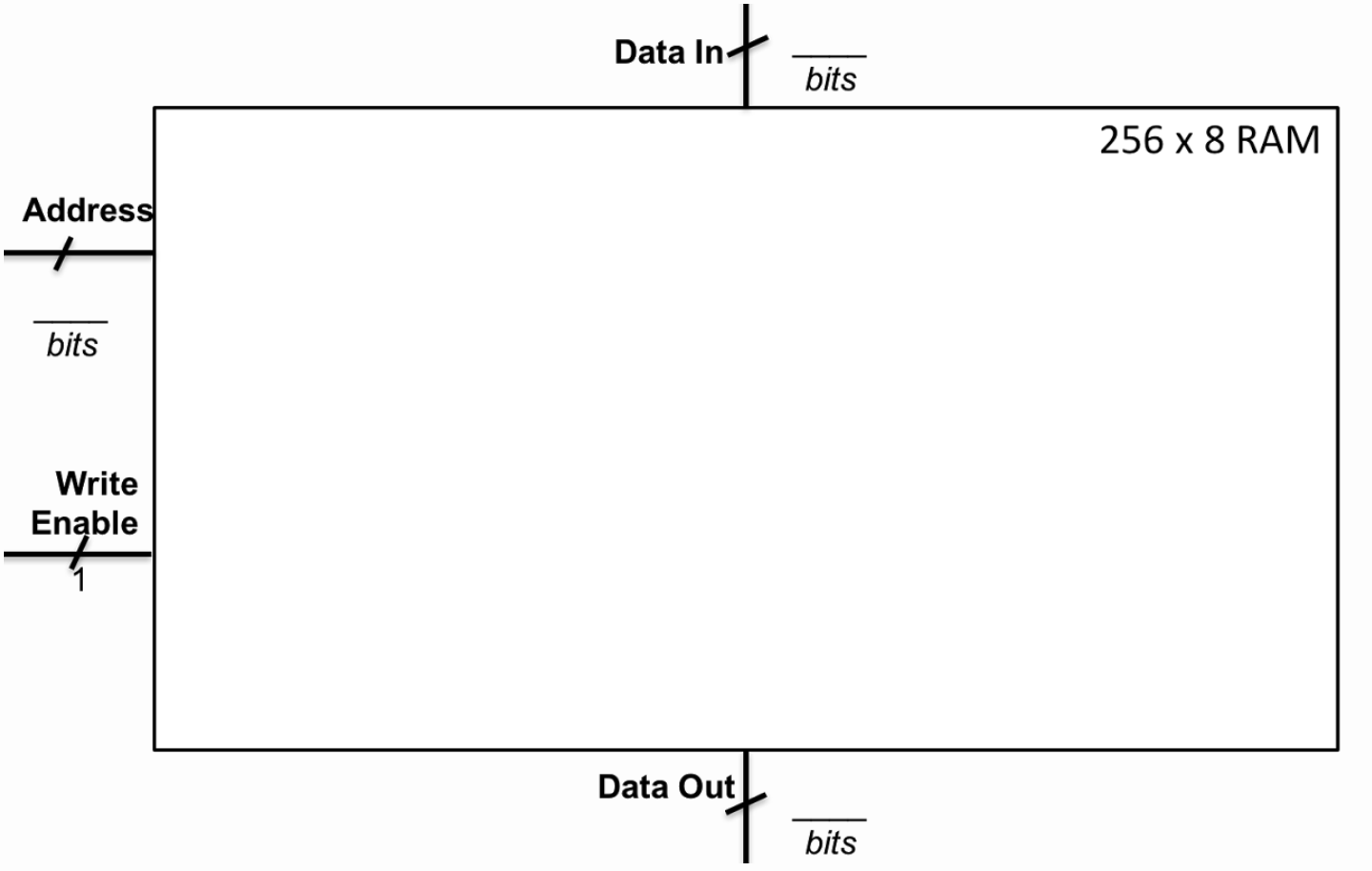
**CS 240 Pensieve Processing** **Name:**

**1. Flop-flip-flopping**

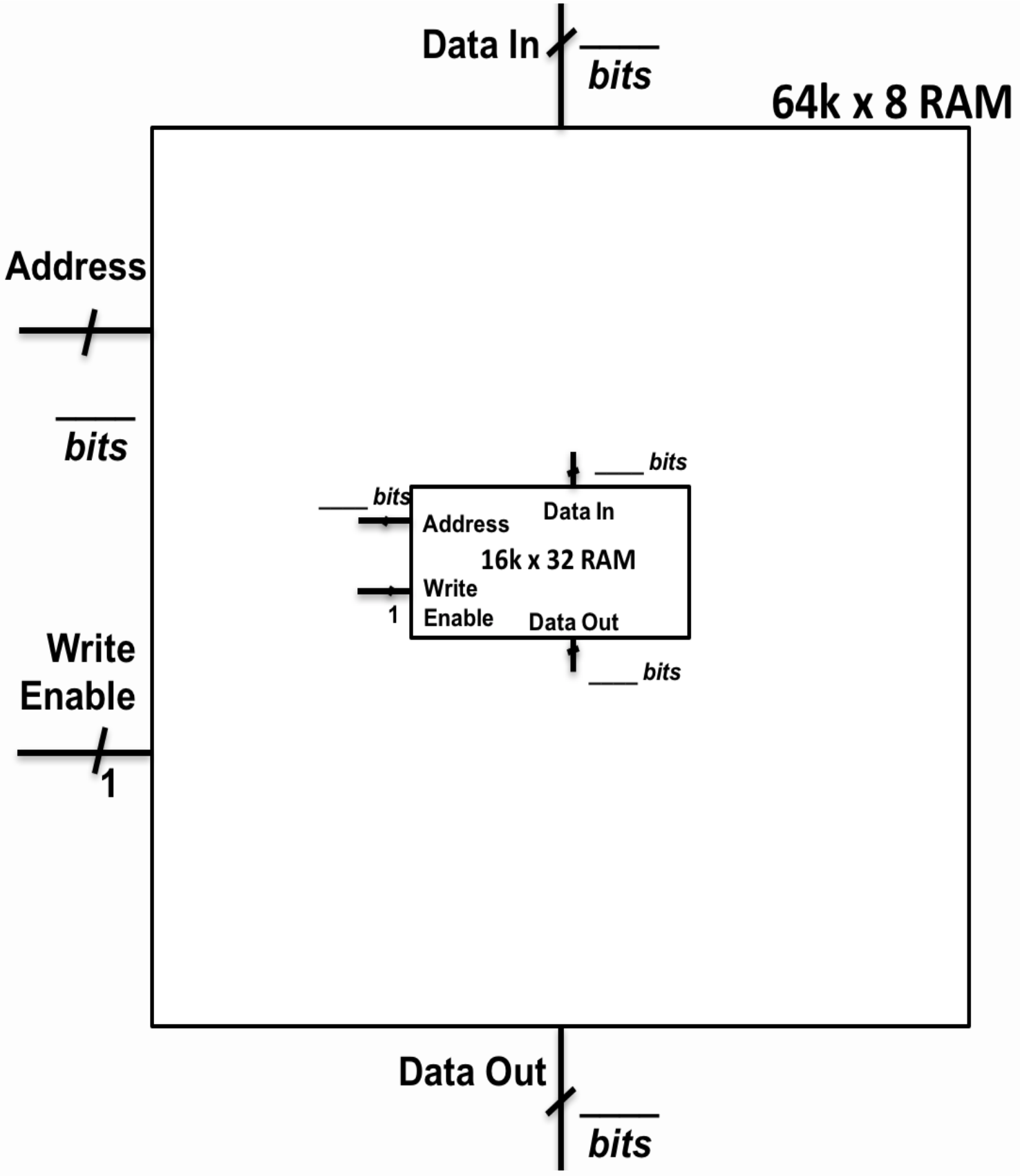
| **1b.** Cycles Completed | $Q_2$ | $Q_1$ | $Q_0$ | **1b. Explanation** (You do not need to fill this space.) |
|---|---|---|---|---|
| 0 (initial) | 0 | 0 | 0 | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

**2. Reconstructing Memories**

**2a.** Draw a 256×8 RAM based on two 256×4 RAMs. Your logic will go inside the box.



**2b.** Draw a 64K×8 RAM based on one 16K×32 RAM.



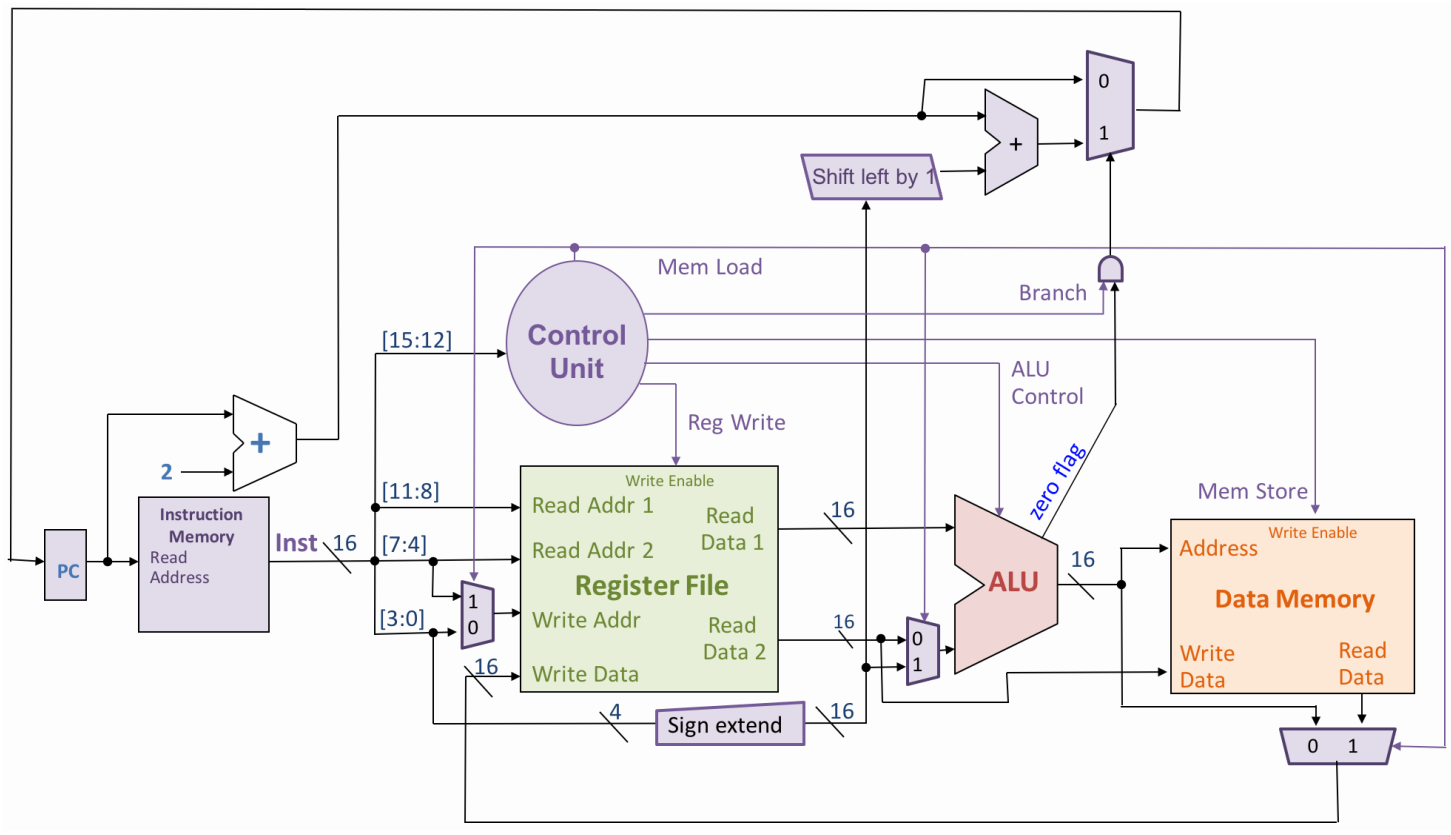
## 3. Taking Control

**Control Unit Truth Table**

| Instruction Name | Opcode$_{[3:0]}$ (4 bits) | Reg Write (1 bit) | ALU Op$_{[3:0]}$ (4 bits) | Mem Store (1 bit) | Mem Load (1 bit) | Branch (1 bit) | Jump **(4a)** (1 bit) |
|---|---|---|---|---|---|---|---|
| LW | | | | | | | |
| SW | | | | | | | |
| ADD | | | | | | | |
| SUB | | | | | | | |
| AND | | | | | | | |
| OR | | | | | | | |
| BEQ | | | | | | | |
| JMP **(4a)** | | | | | | | |
| NAND **(5b)** | | | | | | | |

## 4. Jumping into the Unknown

**4a.** Draw JMP logic and fill the JMP row in the control unit truth table above.



**4b i.** Execute this code, assuming **R2** holds 5 and **R3** holds 2. Indicate the final register values when the code reaches **HALT**.

```
0:  AND R2, R2, R4
2:  AND R3, R3, R5
4:  BEQ R5, R0, 3
6:  SUB R5, R1, R5
8:  ADD R4, R4, R4
A:  JMP 2
C:  HALT # Stops execution.
```

R2: _____ R3: _____ **R4:** _____ R5: _____

**4b ii.** Single line of C code equivalent to this code.

**R4 =** _____ **;**

## 5. Instruction Not Missing

**5a.** The instruction **NOT Rs,Rd** can be emulated by running the following instructions instead:

**5b-c.** NAND/NOT encoding and definition ---------- 16-bit encoding ----------

| Assembly | Meaning | Opcode [15:12] | Rs [11:8] | Rt [7:4] | Rd [3:0] |
|---|---|---|---|---|---|
| **(5b)** **NAND Rs,Rt,Rd** | ***R[d] ← ~(Rs & Rt)*** | | | | |
| **(5c)** **NOT Rs,Rd** | ***R[d] ← ~Rs*** | | | | |

## 6. Points Affixed and Afloat in a C of Numbers

| **6a.** Fixed point numbers **Sea Type** | Minimum (base ten) | Maximum (base ten) | **iii.** Adder (It fits! Reuse provided parts.) |
|---|---|---|---|
| **i.** `signed fixed8ths char` | | | |
| **ii.** `signed fixed32nds char` | | | |

**6b.** Floating point conversion.

| 6-bit floating-point encoding | **110101** | **100001** | **011100** | **000011** | **010010** | **111101** |
|---|---|---|---|---|---|---|
| Decimal number represented | | | | | | |