Computer Architecture Midterm I

NAME: _____

Directions

Read carefully. Work individually. Write legibly. Check work. Complete in 1 hour. Good luck!

Beforehand Visit the restroom if necessary. Close your laptop. Clear your desk. Silence your phone.

DO Use pencil, eraser, pen, or scratch paper to complete this exam.

DO NOT Distract others, talk, use electronic devices, notes, smoke signals, gestures, Morse code, ...

Confused? I will come to you to clarify questions. I won't answer: "Is this right or wrong?"

1 Number representation

Convert numbers to requested bases.

1. Show $0o1573006755$ in binary, and then convert from binary to hexadecimal.

2. Show -42 in binary using two's complement. **Show place values.**

2 Binary arithmetic

Perform arithmetic in binary. **Show place values and carry bits.**

1. Perform the following subtraction operation using two's complement.

```
                                    Place values


                                    Carry

              1   1   0   1   1   1

                                    Negate number below

-                   1   1   0   0
---------------------------------

                                    Sum
```

2. Perform the following addition operation.

```
                                    Place values


                                    Carry

              1   0   0   1   0   0
+                 1   1   1   1   1
---------------------------------

                                    Sum
```

3 Boolean algebra

1. Fill in the blanks in this table by showing the dual form of the law.

Law	Form	Dual form
Identity	$a \cdot 1 = a$	$a + 0 = a$
Identity	$a \cdot 0 = 0$	
Commutative	$a \cdot b = b \cdot a$	$a + b = b + a$
Associative	$(a \cdot b) \cdot c = a \cdot (b \cdot c)$	$(a + b) + c = a + (b + c)$
Distributive	$a \cdot (b + c) = a \cdot b + a \cdot c$	$a + (b \cdot c) = (a + b) \cdot (a + c)$
Idempotence	$a \cdot a = a$	$a + a = a$
Absorption	$a + a \cdot b = a$	
Complement	$\overline{0} = 1$	$\overline{1} = 0$
Complement	$a \cdot \overline{a} = 0$	
Involution	$\overline{\overline{a}} = a$	
DeMorgan's	$\overline{a + b} = \overline{a} \cdot \overline{b}$	$\overline{a \cdot b} = \overline{a} + \overline{b}$

2. Using the laws of Boolean algebra, show $\overline{b} + \overline{a} + a \cdot b = 1$. **Cite laws as you apply them.**

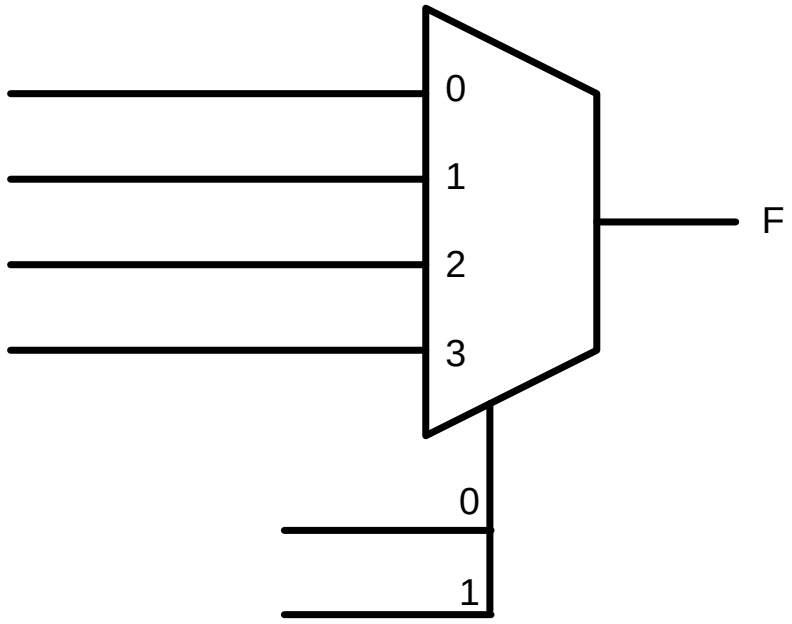
4 Combinational logic design

Let A be a 3-bit binary number. Design a circuit that determines whether A is even (divisible by two). For example, since 0 is even, when $A = 0b000$, the circuit should output 1.

1. Draw the truth table for this circuit. **Label inputs as A_2, A_1, A_0. Label the output as *even*.**

2. Write out the logic expression for this circuit. **Simplify all the way.**

3. Implement this circuit using a 4-1 MUX, even though it's a tad ridiculous. Label input and select lines with appropriate variables and expressions.



Huzzah! You are done. Be sure to go back and check all your work.