Your turn in write up will be graded on neatness, clarity of exposition (notation and definitions) and cleverness, but MOSTLY correctness and using the best counting principles. There are 5 problems. Each problem is worth 20 points. You may ask me questions if you do not understand the problem. You may discuss the problems with others in class but the write up you turn in must be your OWN work. You may use the spread sheets we built in class or your own spread sheets, class notes or Chapters $1 - 8$ from our textbook and Desmos but your conclusions from these MUST be in your write up in your OWN words. You can include tables from spread sheets and graphs of functions from Desmos in your write up. Your write up must be turned in class and be stapled in the left corner if it is more than one page.

1. Build a TRUTH table for the following and indicate clearly which propositions are logically equivalent.

$$\sim(p \to q), \quad p \wedge \sim q, \quad \sim q \to p, \quad q \vee \sim p, \quad \sim p \to q, \quad \sim(q \vee p), \quad p \to q, \quad \sim p \wedge q$$

2.

(a) Write the sentence: When it rains, I use an umbrella. as a conditional proposition. Then give the converse, inverse, contrapositive and biconditional of it.

(b) If team A hires Jill then they will beat team B. If team B plays team C after they play team A then team B will win. (i) Team B loses to both team A and team C, what can you conclude? (ii) If team B beats both team A and team C, what can you conclude? (ii) Team B beats team A but loses to team C, what can you conclude?

3.

(a)) Let p be $\{x | x < -1 \ \cup \ x > 2\}$ and q be $\{x | 0 \le x \le 1\}$. Sketch the following and describe them.

(i) $p \vee q$ (ii) $p \wedge q$ (iii) $\sim (p \vee q)$ (iv) $\sim (p \wedge q)$

(b) Let p be $\{(x,y) | y \ge |x|\}$ and q be $\{(x,y) | x^2 - y \le 0\}$. Sketch the following and describe them.

(i) $p \vee q$ (ii) $p \wedge q$ (iii) $\sim (p \vee q)$ (iv) $\sim (p \wedge q)$

4.

(a) Let A be $(p \to q) \to r$ and B be $p \to (q \to r)$. Show whether or not A and B are logically equivalent.

(b) Let P be $p \wedge (\sim q \vee r)$ and Q be $p \vee (q \wedge \sim r)$. Show whether or not P and Q are logically equivalent.

5. Show whether or not the statement: If a is the average value of $A = \{a_1, a_2, \ldots, a_n\}$ then for some i with $1 \le i \le n$, we have $a \ge a_i$. is TRUE or FALSE.