Math 314 - Fall 2017 **Worksheet 1**

Name 1:____________________ **Name 2:**____________________

(1) Fill out the following table of exponents modulo 11.

a^1	a^2	a^3	a^4	a^5	a^6	a^7	a^8	a^9	a^{10}	a^{11}
1	1	1	1	1						
2	4	8	5							
3	9	5								
4	5									
5										
6										
7										
8										
9										
10										

(2) What is special about the bases $a = 2, 6, 7, 8$?

These numbers are called **primitive roots** modulo p. (In this case $p = 11$.)

Using Sage, find the primitive roots modulo $p = 5, 7, 13, 17, 19\dots$ Make a guess for how many primitive roots there will be for any prime p. (Hint: it involves the φ function.)

(3) For which residues $b \pmod{11}$ does the equation $x^2 \equiv b \pmod{11}$ have a solution?

These are the only residues that have a square root modulo 11 and are called **quadratic residues** modulo 11. What are the quadratic residues modulo 13?