

**Fall 2020 CIS 3362 Homework #5: Number Theory**  
**Check WebCourses for the due date**

- 1) Without the aid of a computer program, determine the prime factorization of 12180168000. Show your work. You may do division in a calculator.
- 2) What is  $\phi(12180168000)$ ?
- 3) Prove that  $\phi(n) = n \prod_{p \in P(n)} \frac{p-1}{p}$ , where the set  $P(n)$  represents the set of unique prime factors of  $n$ . For example,  $P(96) = \{2,3\}$  and  $P(7000) = \{2,5,7\}$ . Use the formula shown in class for  $\phi(n)$  for the starting point of your proof.
- 3) Using Fermat's Theorem, determine the remainder when  $7^{11596}$  is divided by 967.
- 4) Using Euler's Theorem, determine  $99^{10754} \bmod 3104$ .
- 5) Write a program that reads in an integer entered by the user (in between 2 and 1000) and determines if the integer is prime. If it is NOT prime, just report a proper divisor of the number less than 1 and end the program. If the number entered is prime, list out each primitive root of the prime number in between 2 and the number minus one, in numerical order.

Here are a couple sample runs of the program:

**Sample 1**

**Enter n.**

143

**143 is not prime. It's smallest non-trivial divisor is 11.**

**Sample 2**

**Enter n.**

17

**17 is prime.**

**Its primitive roots are: 3 5 6 7 10 11 12 14**